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Higher prevalence of trunk rotation among Egyptian students in urban than in countryside areas

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Abstract

Introduction. This study was conducted to compare the prevalence of trunk rotation in selected urban and countryside areas in Egypt.

Methods. Overall, 840 male students aged 10–15 years were divided into 2 equal groups: group A, representing urban schools, and group B, representing countryside schools. Both groups were first screened with the Adams forward bend test; then, the Scoliometer HD application was used to determine the angle of trunk rotation. Children with a reading of 7° or more (≥ 20° Cobb angle) were referred to a medical facility and their parents were informed about the findings.

Results. In group A, the Adams forward bend test showed a higher prevalence of trunk rotation (41.43%) than in group B (17.14%). The Scoliometer HD application readings (≥ 7°) indicated a significant difference between the 2 groups: group A result was 12.61% and group B result was 5%.

Conclusions. Male students of urban schools exhibit a higher prevalence of trunk rotation than those of countryside schools.
Key words: trunk rotation, Scoliometer HD application, school screening, Adams forward bend test

Introduction

Adolescent idiopathic scoliosis (AIS) is a common disease, with an overall prevalence of 1–14.8% [1]. It commonly occurs at the age of 11–18 years and accounts for approximately 90% of cases of idiopathic scoliosis in children [2]. Scoliosis may have an impact on the Egyptian society by causing disability and psychological problems, as children aged 10–15 years represent 9.5% of the population of the third largest category [3].

The literature identified differences in the prevalence in other countries. This variability can be explained by discrepancies in the method of identification, targeted age and sex, and the impact of geographic, socio-economic, and environmental aspects on human biology [4]. The Scoliosis Research Society and the American Academy of Pediatrics have issued a knowledge statement that recommends scoliosis screening annually in girls aged 10 and 12 and only once in boys aged 13 or 14 years [5].

Wang et al. [6] suggested several factors affecting the quality of life of adolescents with scoliosis, such as the degree of deformity, the treatment method used, culture, and the environment. They reveal that these factors may be particularly important in Eastern countries, such as China, where the level of development varies between regions, including between urban and rural populations.

Unfortunately, until now, little attention has been paid to the relationship between socio-demographic variables, like income or residence, and patient perception of trunk deformation. It may be important to investigate whether socio-demographic factors related to the residential environment could impact on the condition of patients in other developing countries, such as Egypt, so that early scoliosis detection and the identification of more affected areas can help in early management.

While numerous studies show a wide range of AIS prevalence in different countries, no study records the prevalence of scoliosis in the Egyptian population, which results in a lack of information on the aetiologies and natural history of this form of scoliosis. The relevance of particularly evaluating the prevalence in the Egyptian population may not be obvious, but its determination is essential because it can be related to a factor contributing to AIS pathogenesis.

Socio-economic barriers to access to paediatric care have been thoroughly identified in the literature. Worse insured children from low-income communities are slightly less likely to obtain preventive treatment or to have a regular source of care [7]. The lack of adequate care can also put these underserved patients at risk of missing early diagnosis and nonsurgical treatment of scoliosis.

Epidemiological studies of children in schools from areas with low socio-economic status in Egypt are scarce. The present study aimed to compare the prevalence of trunk rotation among children in selected urban and countryside areas in Egypt.

Subjects and methods

Participants

This is cross-sectional study was conducted in El-Wasta city, Beni Suef Governorate, Upper Egypt, between October 2018 and November 2019. A total of 840 male students aged 10–15 years participated in the study. The subjects were

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selected randomly from 4 schools (2 urban and 2 countryside ones). They were divided into 2 equal groups: group A (*n* = 420), urban school students, and group B (*n* = 420), rural school students. Students with congenital deformities, recent fixation for fractures in the upper or lower extremities, neuromuscular disorders (muscular dystrophies, myopathy), cerebral palsy, osteogenesis imperfecta, or spina bifida were excluded. Sample size calculation was conducted to determine the size of the sample with a power of 0.95 and an effect size of 0.25. The sampling was probabilistic and proportional to the total number of students in each school, and random drawings by using the numbered attendance list of each classroom were carried out, with a total sample size of 840.

Screening procedures

The headmaster of each school was interviewed and given the approval of the head of the Education Directorate. The participants were interviewed; the procedures and purpose of the screening were explained to them. A special room was prepared for the evaluation; effort was taken to ensure that the room was warm, closed, and safe from any risks. In the school morning broadcast, 10 minutes were devoted to increase staff and students' awareness of the causes, signs, severity, and prevention of scoliosis, and detailed procedures were discussed. Data collection was performed by a trained physiotherapist.

Steps of screening

Physical examination

Each student was asked to stand upright with knees straight, feet at the same level, hands free to hang. The therapist stood firstly facing, then behind the student, observing the shoulder level, spine (straight or curved), shoulder blades level, waist creases, pelvis and knees level, and, finally, the distance from both arms to the side of the body (equal or unequal).

Adams forward bend test

The students were asked to lean forward with their knees straight, feet together, and hands free and loosely hanging. The appearance of a hump indicated a positive test result. The absence of a hump implied that the test was negative [8].

Measurement of angle of trunk rotation

The angle of trunk rotation was measured by using the Scoliometer HD application, which constitutes a valid and reliable tool for evaluating scoliosis [9]. The subjects were asked to bend forward and look down, with their feet about 6 inches (15 cm) apart, their knees extended, elbows extended, and palms together in front of their knees [10]. A smartphone (Scoliometer HD) was positioned on the student's back, with the central dark area in the application located on the spinal processes at the apex of the lower (lumbar), middle (thoracolumbar), and upper (thoracic) back to determine the angle of trunk rotation. To read the scoliometer, the examiner remained behind the subject in such a position that the device was at the eye level. Overall, 3 measurements were recorded, with the participant returning to the upright position between the trials. The average of the 2 closest values was reported. Students with a Scoliometer HD reading of ≥ 7° (≥ 20° Cobb angle) were referred for orthopaedic consultation and their parents were informed about the screening findings by the school manager and the social worker [11].

Data analysis

Statistical analyses were performed by using the Windows SPSS software, version 15.0 (SPSS Inc., Chicago, IL, USA). The percentage of children with positive test results and the overall prevalence rate for trunk rotation were determined. Our sample population was further divided into groups to determine age-specific prevalence rates. Differences between subsamples were evaluated with a chi-square test. The normality of the Shapiro-Wilk and Kolmogorov-Smirnov tests showed that the population was normally distributed as the significance values for all variables were > 0.05.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the ethics committee of the Faculty of Physical Therapy, Cairo University (approval No.: P.T.REC/012/002051) and registered at ClinicalTrials.gov (ID: NCT03 894865).

Informed consent

Informed consent has been obtained from the legal guardians of all individuals included in this study.

Results

A total of 840 male students were assigned to 2 groups on the basis of the place of residence, as shown in Figure 1. The urban group (group A) consisted of 420 students with a mean age of 12 (± 2) years. The most frequent age in this group (represented by 30.95%) was 12 years, and the least frequent age (7.14%) was 15 years. The countryside group (group B) consisted of 420 subjects with a mean age of 12 (± 2) years. The most frequent age in this group (represented by 23.33%) was 10 years, and the least frequent age (5.95%) was 15 years. There were no significant differences between the groups regarding age.

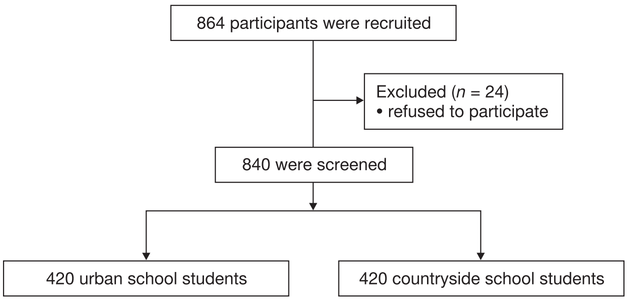

Figure 1. Participants' flowchart

In the forward bend test, the overall trunk rotation prevalence was 29.29%. Group A showed more positive results (41.43%) than group B (17.14%), with a significant difference between the 2 groups (chi-square V = 56.14, $p < 0.01$). The age of the most frequent positive forward bend test results was 12 years (12.86% in group A and 6.19% in group B).

The prevalence of trunk rotation as determined with the Scoliometer HD application reading of 7° or more was 8.8% and exhibited a significant difference between the 2 groups,

Table 1. Frequencies of Scoliometer HD results in groups A and B

Group	< 7°	≥ 7°	Chi-square correlation test	*p*
A (urban)	367 (87.39%)	53 (12.61%)	V = 14.24	0.000*
B (countryside)	399 (95%)	21 (5%)		

* significant

as presented in Table 1. The proportion of a 5° or 6° reading was 20.9% in group A and 11.42% in group B.

One of the most frequent ages in the urban group was 10 years, with 24.5% of these participants presenting a score of 7° or above; among 12-year-olds, the second biggest age subgroup, 39.77% had a score of 5° or 6°. In turn, in the countryside group, one of the most frequent ages was 12 years, with 33.3% of these subjects exhibiting a score of 7° or above. In other frequent age subgroups of the countryside group (10, 12, and 14 years), 20.8% had a score of 5° or 6° (Table 2).

Table 2. Frequencies of Scoliometer HD results in age subgroups of groups A and B

Age	Group A, ≥ 7°	Group B, ≥ 7°	Group A, 5° or 6°	Group B, 5° or 6°
10	13 (24.5%)	5 (23.8%)	22 (25%)	10 (20.8%)
11	6 (11.3%)	2 (9.5%)	8 (9.09%)	5 (10.4%)
12	12 (22.6%)	7 (33.3%)	35 (39.77%)	10 (20.8%)
13	7 (13.2%)	2 (9.5%)	13 (14.77%)	8 (16.7%)
14	8 (15.09%)	5 (23.8%)	7 (7.95%)	10 (20.8%)
15	7 (13.2%)	0 (0%)	3 (3.41%)	5 (10.4%)
p	< 0.01*	< 0.01*	< 0.01*	< 0.01*

* significant

With the consideration of the curvature location, the percentage of the thoracic location was higher in both groups for the Scoliometer HD score of 7° or above. For the Scoliometer HD score of 5° or 6°, the percentage of thoracic location was higher in group A and lower in group B, as shown in Table 3.

Table 3. Frequencies of Scoliometer HD results depending on the curvature location

Result	Lumbar	Thoracic	*p*
Group A, ≥ 7°	14 (26.4%)	39 (73.6%)	0.364**
Group B, ≥ 7°	3 (14.29%)	18 (85.71%)	
Group A, 5° or 6°	25 (31.25%)	55 (68.75%)	0.034*
Group B, 5° or 6°	20 (51.3%)	19 (48.7%)	

* significant, ** nonsignificant

Discussion

This study was performed to distinguish between urban and rural students in the prevalence of trunk rotation by using a secure, non-invasive, and non-radiation approach to avoid the application of X-rays. Our results showed positive values of the forward bend test in 29.29%. The results of the Adams forward bend test vary in the literature. Some studies revealed low positive results in 1.5% [12], 3.26% [4], and 5.14% [13] of school-aged children; high positive scores were reported in many studies: in 19.1% [14], 24.3% [15], and 66% [16]. However, these papers did not determine the correlation between high positive results and the area of the country in which the study was performed. The difference in the prevalence identified in the various studies may be attributed to the different methods used.

In our study, the prevalence of trunk rotation as evidenced with the Scoliometer HD smartphone application was 8.8% among the 840 schoolchildren, and the application was found to be valid, accurate, and cost-efficient for scoliosis screening. It may also replace the expensive scoliosis screening device and may be included in school health programs [17]. This prevalence is similar to that reported in previous research; several similar studies have been conducted in different populations [4, 18, 19].

In the present study, a scoliometer reading of 7° (≥ 20° Cobb angle) was used as a cut-off in our screening; several recommendations suggest a scoliometer reading of 7°–7.5° as a cut-off point for scoliosis [20]. Also, the proportion of a score of 5° or 6° in our study was 20.9% in the urban group and 11.42% in the countryside one. This is compatible with the 5° cut-off assumed by Suh et al. [4]; however, our target was not to miss a single case of trunk rotation. The comparatively higher false-positive rate in our sample is therefore justified. Another benefit of this cut-off is that it was very convenient and easy to apply for the therapist, and we could screen for children who needed even more investigation.

Ohtsuka et al. [21] conducted a study on the prevalence rate of idiopathic scoliosis in 1.24 million Japanese children who had been screened for 8 years. Cut-off Cobb angles of 15° or more allowed to report prevalence rates of 1.77% and 0.25% for 13–14-year-old girls and boys, respectively. In another part of their study, they used moiré topography for testing. However, we found an 8.8% trunk rotation prevalence in our research; also, we noticed these prevalence rates when using a Cobb angle cut-off of ≥ 20°. It indicates that applying the Cobb angle of 15° as a cut-off point may result in a lower prevalence rate. Another difference is that we used a scoliometer reading in forward bending, not moiré topography, for our testing. Ohtsuka et al. [21] reported a higher trunk rotation prevalence in urban populations, a result similar to that obtained in our sample.

The Scoliometer HD application readings of 7° or more showed a significant difference between the 2 groups: the prevalence was 12.61% in group A (urban) and 5% in group B (countryside). In the forward bend test, the proportion of positive results was higher in group A (41.43%) than in group B (17.14%). This leads to the conclusion that living in the countryside does not necessarily mean living a healthy life in all ways, but it also has some flaws, and that the number of factors causing spinal deformities is much greater in urban than in countryside areas. This contrasts with the observations reported by Čanjak et al. [22], who found no significant difference in the prevalence of scoliosis between girls in urban and in rural areas.

Our results remain in agreement with those obtained by Kamtsiuris et al. [23], who reported a higher prevalence rate of scoliosis in German children (5.5%) than in immigrant children (3.5%). This difference can be explained by genetic factors and not by malnutrition or other aspects, such as lower social status; children of families with a high or middle socio-economic status presented a higher prevalence of scoliosis (6.2% for high, 5.6% for middle) than children with a lower socio-economic status (3.5%).

The prevalence rate of AIS varies widely (0.13–13.00%) [24]. This is primarily due to methodological differences in the studies, as well as in the guidelines used to refer patients to a radiographic examination and to diagnose scoliosis. Also, the AIS screening studies differ in terms of the instrument used to identify or quantify the deformity (scoliometer, moiré topography, or 3-dimensional surface topography) and the determined Cobb angles [25]. The age of the highest percentage of the Scoliometer HD readings of 7° or more was 10 years in group A and 12 years in group B.

In our study, the screening of male students showed that younger boys were at a higher risk for clinically diagnosed scoliosis. This finding contrasts with research that revealed an increase in the prevalence of scoliosis with an increase in age [2, 14]. Because of the possible raise of male adolescent scoliosis prevalence with age, the American Academy of Pediatrics recommends to perform the Adams test at the ages of 10, 12, 14, and 16 years [10].

As for the percentages of the Scoliometer HD readings depending on the curvature location, scores of ≥ 7° were observed in 73.6% for the thoracic region and in 26.4% for the lumbar region in the urban group, as well as in 85.71% for the thoracic region and in 14.29% for the lumbar region in the countryside group. This finding is consistent with the literature, as scoliosis curvatures commonly occur in the thoracic portion of the spine [4, 26]. According to Wang et al. [27], the inflexibility of both thoracic and lumbar curvatures in male subjects with a severe AIS curvature may result in a lower curvature and weaker brace responding than in females.

On the other hand, the results of the present study do not agree with those obtained by Čanjak et al. [22], who stated that all types of scoliosis were fairly distributed among girls of different socio-economic status. This may be attributed to gender differences, as we conducted our study in male students only. But Čanjak et al. [22] found thoracic scoliosis to be the most prevalent, which is consistent with our study with regard to the location. This also corroborates a study by Suh et al. [4], who demonstrated a thoracic scoliosis rate of 47.59%, followed by thoracolumbar curvatures (40.10%), double curvatures (9.09%), and double thoracic curvatures (3.22%).

The high prevalence of AIS in Egyptian children may reflect the socio-economic and environmental aspects of their places of residence. In addition to a lack of proper nutrition, the frequent use of appropriate footwear and other modulating characteristics have an impact on phenotypes. The condition is aggravated when children are physically inactive during adolescence: adverse effects of hypokinesia are manifested in the health and function of the osteomuscular structure and body posture. Boyle et al. [28] concluded that children's lack of engagement in 60 minutes of moderate activity may have major public health implications. If maintained, it might contribute to a higher prevalence of overweight, obesity, and other health problems among adults.

There are many risk factors promoting alterations in postures, such as genetics, poor posture habits, lack of physical activity, overweight or obesity, and some other issues [29]. In developing countries, the economic conditions of various regions are sometimes imbalanced. Compared with rural ones, the lifestyle of urban areas may be relatively open, with high income and considerably higher quality of the medical system [30].

A study was conducted to determine the intrarater and interrater reliability of scoliometer measurements, to assess the relationship of values obtained with scoliometer measurements with Cobb angle radiographic results, and to establish the sensitivity and specificity of scoliometer measurements for the different diagnostic criteria of idiopathic scoliosis. Excellent intrarater reliability values and very good interrater reliability values were found. The association between the measurement of the scoliometer and the radiographic analysis was considered to be strong. The highest sensitivity value for trunk rotation was 87% at 5°. The scoliometer is therefore a good measuring instrument to diagnose idiopathic scoliosis [31].

Repeated exposure to radiation owing to a number of follow-up assessments can increase the risk of cancer. Previous studies have documented that radiation exposure during early childhood and adolescence can increase the risk of malignancies and, specifically, thyroid cancer [32, 33]. It should be considered that early detection of trunk rotation will lead to early intervention with the use of bracing and physiotherapeutic scoliosis-specific exercises in accordance with the 2016 guidelines of the Society on Scoliosis Orthopaedic and Rehabilitation Treatment [34].

Limitations

The limitation of this study was the refusal of girls and their parents to participate in the research owing to cultural differences and traditions, as the screening required girls to take off their clothes in order to expose their backs. In the future, therefore, studies among girls and comparative studies between the 2 sexes are recommended.

Conclusions

Trunk rotation in males aged 10–15 years has a higher prevalence in urban school students than in those of countryside schools. The Scoliometer HD application is an easy, safe, and low-cost screening tool to assess trunk rotation.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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