Higher Prevalence of Trunk Rotation of the Egyptian Students in Urban Areas than Countryside One

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Abstract:

Purpose: This study was conducted to compare the prevalence of trunk rotation in selected urban and countryside areas in Egypt. **Methods:** Eight hundred forty male students were divided into two equal groups; group A, representing urban school students, and group B, representing students of the countryside school areas. Both groups were first, screened using Adam's forward bend test (FBT), then the Scoliometer HD application was used to determine the angle of trunk rotation. Reading of 7 degrees or more (≥20 degrees Cobb´s angle) were referred to the medical facility and their parents were informed about the findings. **Results:** FBT in group A showed a higher prevalence (41.43%) than in group B (17.14%). The scoliometer HD application readings (≥7) showed a significant difference between the two groups: group A was 12.61%, and group B was 5%. **Conclusion:** Male students of urban schools have a higher prevalence of trunk rotation than that in countryside schools.

Keywords: Trunk rotation; The scoliometer HD application; School screening; Adam's forward bend test

Introduction

Adolescent idiopathic scoliosis (AIS) is a common disease with an overall prevalence of 1% to 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 Egyptian society by causing disability and psychological problems, as children between 10 - 15 years old represent 9.5 % of the population of the third largest category [3].

The literature identified differences in prevalence in other countries. This variability can be explained by variations in the method of identification, targeted age and sex, and the impact of geography, socio-economic, and environmental influences on human biology [4]. The Scoliosis Research Society (SRS) and the American Academy of Pediatrics (AAP) 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. (2010)[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, which include urban and rural populations.

Unfortunately, till now little attention was paid to the relationship between socio-demographic variables, like income, residence, or patient perception of trunk deformation. It may be important to investigate whether socio-demographic factors related to the residential environment could impact the condition of patients in other developing countries, as Egypt, so early scoliosis detection and identification of more affected areas will 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 etiologies and natural history of this kind of scoliosis. The relevance of particularly evaluating prevalence in the Egyptian population may not be obvious, but its evaluation is essential because it can be related to a factor contributing to AIS pathogenesis.

Socio-economic barriers to access to pediatric care have been thoroughly identified in the literature. Less well-insured children from low-income communities are slightly less likely to obtain preventive treatment or to have a regular source of care [7]. A 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 socioeconomic 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

Study design

This is cross-sectional study was conducted at Al Wasta city, Beni Suef Governorate, Upper Egypt from October 2018 to November 2019. The study was approved by our institutional ethical committee (number: P.T.REC/012/002051) and registered at ClinicalTrials.gov (ID: NCT03894865).

Participants

Eight hundred forty male students aged 10-15 years participated in this study. Subjects were selected randomly from four schools (two urban and two countryside). They were divided into two equal groups. Group A (n=420); urban school students and group B (n=420); rural school students. Parents were asked to sign informed consent and participants whom parents refused to participate in the study were excluded. Students with congenital deformities, recent fixation for fractures in the upper or lower extremities, neuromuscular disorders (muscular dystrophies, myopathy), cerebral palsy, osteogenesis imperfecta, and 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. Sampling was probabilistic and proportional to the total number of students in each school, and random drawings using the numbered attendance list of each classroom were carried out, with a total sample size of 840.

Screening procedures

The director of every school was interviewed and given the approval of the head of Education directorate. The participants were interviewed; the procedures and purpose of this screening were explained to them. The informed consent of parents was obtained from selected students. A special room was prepared for the evaluation, considering that the room is warm, closed, and safe from any risks. Throughout the school morning broadcast, ten minutes were taken to increase staff and students' awareness of the causes, signs, severity, and how to prevent scoliosis, and detailed procedures were discussed. Data collection was performed by a trained physiotherapist.

Steps of screening

Physical examination

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

Adam's forward bend test (FBT)

The student was asked to lean forward with his knees straight, his feet together, and his hands-free and loosely hanging. The appearance of hump indicates positive test. The absence of hump indicates that the test is negative [8].

Measurement of angle of trunk rotation (ATR)

The angle of trunk rotation was measured using The Scoliometer HD Application which becomes a valid and reliable tool for evaluating scoliosis [9]**.** The subjects were asked to bend forward, to 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]. The smartphone (Scoliometer HD) was positioned on the student back with the central dark area in the application positioned on the spinal processes at the apex of the lower (lumbar) middle (thoracolumbar) and upper (thoracic) back to determine the angle of rotation of the trunk.To read the scoliometer, the examiner was positioned behind the subject in such a position that the device was at eye level. Three measurements were recorded, with the subject returning to the upright position between each measure. The average of the two closest values was recorded. Students with an HD scoliometer reading ≥7 degrees (≥20 degrees) were referred for orthopedic consultation and their parents were informed about the findings of the screening by the school manager and the social worker [11].

Data analysis

Statistical analyzes were performed using Windows SPSS, 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 using a chi-square test ($\chi 2$). The normality of the Shapiro-Wilk and Kolmogorov-Smirnov tests shows that the population is normally distributed as the significance values for all variables are > 0.05.

Results

A total of 840 male students. Subjects were assigned into two groups based on the place where they live in as shown in figure 1. The urban group (group A) consisted of 420 students with a mean age of 12 (±2) years. The highest frequent age in this group was 12 years which represents 30.95%, and the least frequent age was 15 years old with a percentage of 7.14%. The countryside group (group B) consisted of 420 subjects with a mean age of 12 (±2) years. The highest frequent age in this group was 10 years with a percentage of 23.33%, and the least frequent age was 15 years old with a percentage of 5.95%. There were no significant differences between the groups regarding age.

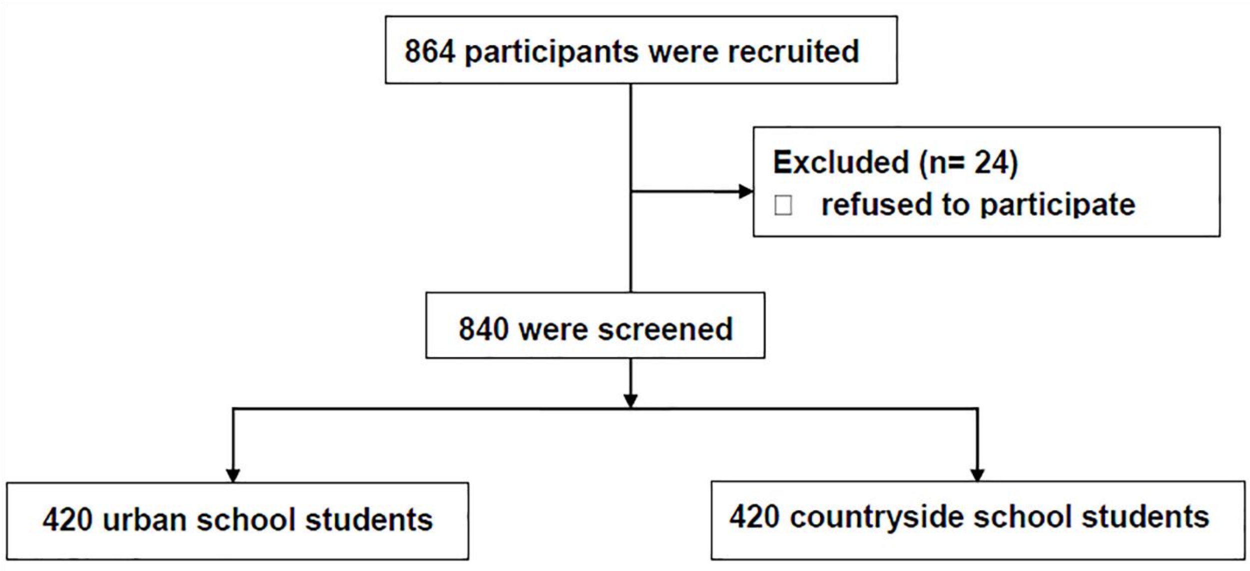

Figure 1. Participant's flowchart

For the forward bend test (FBT), the overall prevalence was 29.29%. Group A showed higher positive results (41.43%) than group B (17.14%) with a significant difference between the two groups (Chi-Square V = 56.14 with p-value < 0.01). Age 12 years was the age of the highest positive FBT results with 12.86% in group A and 6.19% for group B.

The prevalence of trunk rotation by using scoliometer HD application reading which is 7 or more was 8.8% and showed a significant difference between the two groups as shown in table 1. The percentage of reading 5 or 6 was 20.9% in the group (A) and 11.42% in the group (B).

Table 1. Frequency, P values of the Scoliometer HD in group A & B.

Scoliometer HD	Below 7	7 or above	Cho-Square correlation test	*p*-value
Group A (Urban)	367 (87.39%)	53 (12.61%)	V=14.24	.000*
Group B (countryside)	399 (95%)	21 (5%)		

*** significant**

The urban group had 10 years as one of the most frequent age, where 24% of them had a score of 7 or above and 12 years as the second most frequent age where 39.77% of this group had a score of 5 or 6. On the other hand, countryside group had 12 years as the most frequent age with

33.3% of them having a score of 7 or above. Other frequent ages in the countryside group (10, 12, 14-year groups), 20.8% of them had a score of 5 or 6 for each group (Table 2).

Table 2. Frequency, *P* values of the Scoliometer HD and the Age groups in groups (A and B).

Age	Group A, HD ≥7	Group B, HD ≥7	Group A, HD =5 or 6	Group B, HD =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-value	<0.01*	<0.01*	<0.01*	<0.01*

*** Significant**

According to the location of the curves, the percentage of the thoracic location was higher in both groups in HD scoliometer score 7 or above, where in HD 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. Frequency, P values of the Scoliometer HD (≥7), (=5 or6) and the curve location

	Lumbar	Thoracic	*P*-value
Group A, HD 7 or above	14 (26.4%)	39 (73.6%)	0.364**
Group B, HD 7 or above	3(14.29%)	18 (85.71%)	
Group A, HD 5 or 6	25 (31.25%)	55 (68.75%)	0.034*
Group B, HD 5 or 6	20 (51.3%)	19 (48.7%)	

***Significant; **nonsignificant; HD, Scoliometer application**

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 use of x-rays. Our results showed that the positive values for the forward bending test were 29.29%. The results of Adams forward bend test varied in the literature. Some studies showed low positive results 1.5 % [12], 3.26% [4], and 5.14 % [13] among school-aged children. In accordance with our study results, a high positive result was reported in many studies; 19.1 % [14], 24.3 % [15], and 66 % [16]. However, these findings did not report a correlation between high positive results and the area of the country in which the study was performed. The difference identified in the prevalence of the various studies may be attributed to the different methods used.

In our study, the prevalence of trunk rotation using a scoliometer smartphone application was found to be 8.8% among 840 schoolchildren, and the application was found to be validated, 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 previously published studies. Although several similar studies have been conducted in different populations [4, 18, 19].

In the present study, a scoliometer reading of 7 (≥20 degrees 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 percentage of reading 5 or 6 in our study was 20.9% in the urban group and 11.42% in the countryside one and this is compatible with the 5-degree cut-off taken by **Suh et al. (2011**)[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 use for the therapist, and we could screen for children who need even more investigation.

Ohtsuka et al. (1988) [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 reported prevalence rates of 1.77 and 0.25 percent for 13–14-year-old girls and boys, respectively. Another part of their study was that they have used the Moire topography for testing. However, we found 8.8% prevalence in our study; also, we noticed these prevalence rates using a Cobb angle cutoff of ≥20 degrees. It indicates that using 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 the forward bending, not the Moire topography, for our testing. They reported a higher prevalence in urban populations similar to those in our sample population.

The scoliometer HD application readings, which are 7 or more, showed a significant difference between the two groups as group A(urban) was 12.61 % and group B (countryside) was 5 % and for the forward bend test (FBT), group A showed higher positive results (41.43 %) than group B (17.14 %). This leads to the conclusion that life in the countryside does not mean necessarily "healthy life" in all ways, but that it also has some flaws and that the number of causes leading to spinal deformities is much greater in urban than countryside areas and this come in contrast to **Ĉanjak et al. (2018)** [22] who reported that no significant difference in the prevalence of scoliosis between girls in urban and rural areas.

Our result comes in agreement with **Kamtsiuris et al. (2007**) [23], who reported a higher prevalence rate of scoliosis in German children (5.5 percent) than in immigrant children (3.5 percent). This difference in prevalence can be explained by genetic factors and not to malnutrition or other factors such as lower social status, even though children of families with a high or middle socioeconomic status had a higher prevalence (6.2% high, 5.6% middle) than children with lower socioeconomic status (3.5%).

The prevalence rate of AIS varies widely (from 0.13% to 13.00%) [24].This is primarily due to methodological variations in the studied age groups, as well as the guidelines used to refer a patient 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 three-dimensional surface topography) and the identified Cobb angles [25].The age of the highest percentage of scoliometer HD readings of 7 or more was the age of 10 years old in group A and 12 years old in group B.

In our study, screening of male students showed that younger males were at higher risk for clinically diagnosed scoliosis. This finding is in contrast to studies that have shown an increase in the prevalence of scoliosis with an increase the age [2, 14]. The possibility of increasing male adolescent scoliosis with age is recommended by the American Academy of Pediatrics to perform Adam's test at ages 10, 12, 14, and 16 years [10].

Based on the percentages of the HD scoliometer readings and the location of the curve, it was observed that the HD scoliometer readings of ≥7 for urban groups were 73.6 % thoracic and 26.4 lumbar and 85.71 % thoracic and 14.29% lumbar for countryside areas. This finding is consistent with the literature, as the scoliosis curves occurring commonly in the thoracic portion of the spine [4, 26]. According to **Wang et al., (2012)** [27], the inflexibility of both thoracic and lumbar curves in male subjects with a severe AIS curve may result in the lower curve and weak brace responding than in female students.

On the other hand, the findings of the present study did not agree with the study of **Ĉanjak et al. (2018)** [22], which 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 on male students only. But thoracic scoliosis was the most prevalent, which is consistent with our study concerning the location. And this comes in accordance with a study conducted by **Suh et al. (2011)**[4], which demonstrated that the thoracic scoliosis rate was 47.59 %, followed by thoracolumbar curves (40.10 %), double curves (9.09 %), and double thoracic curves (3.22 %).

The high prevalence of AIS in Egyptian children may represent the socio-economic and environmental aspects where the persons live. In addition to a lack of proper nutrition, the frequent use of inappropriate footwear and other modulating characteristics have an impact on phenotypes. The condition is aggravated when children are physically inactive during adolescence, so the adverse effects of hypokinesia are displayed in the health and function of the osteomuscular structure and body posture. **Boyle et al. (2010)** [28] concluded that the lack of engagement by children in 60 minutes of moderate activity may have major public health implications. If maintained, it might contribute to more overweight and obese adults and more health problems.

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

A study was conducted to measure the intrarater and interrater reliability of scoliometer measurements, to assess the relation of values obtained by scoliometer measurements with Cobb angle measurements obtained by radiography, and to assess the sensitivity and specificity of scoliometer measurements for the different diagnostic criteria for idiopathic scoliosis. They found that there were excellent intrarator reliability values and very good interrator reliability values. The connexion between the measurement of the scoliometer and the analysis of the radiography was considered to be strong. The highest sensitivity value for trunk rotation was 87% at 5 °. The scoliometer is therefore a good measuring method for idiopathic scoliosis[31].

Repeated exposure to radiation due 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 thyroid cancer[32,33].It should be considered that early detection of trunk rotation will lead to early intervention using bracing and physiotherapeutic scoliosis-specific exercises (PSSE) according to 2016 SOSORT guidelines[34]

The limitations of this study were the refusal of girls and their parents to participate in the study due to cultural differences and traditions, as screening required girls to take off their clothes to expose their backs. In the future, therefore, studies on girls and comparative studies between two sexes are recommended.

Conclusion:

Trunk rotation in males aging from 10 to 15 years old has a higher prevalence in urban school students than that in countryside schools. Scoliometer HD application is an easy, safe and low cost screening method for trunk rotation.

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