Adolescent Idiopathic Scoliosis In Ibadan, Nigeria

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Abstract

Objectives: The prevalence of idiopathic scoliosis which accounts for most cases of structural scoliosis not due to diseases or injury to bones among adolescent Nigerians has not been reported. This study was designed to provide preliminary data on the prevalence of idiopathic scoliosis among adolescent students of selected secondary schools in Ibadan municipality.Design: Cross-sectional survey.Setting: Nine secondary schools in Ibadan, the largest and the third most-populated city in Nigeria.Participants: They were 999 students (514 boys, 485 girls) aged 10-20 years (X=14.14±1.69years) sampled from nine purposively selected secondary schools in Ibadan.Intervention: All subjects had an initial visual screening of the spine but those who demonstrated visually recognizable lateral deviation of the spine also had secondary screening to ascertain the presence of rib hump, shoulder elevation, trunk decompensation and location of the scoliosis curve. Data were subjected to descriptive statistical analysis.Results: Fifty-three (5.3%) of the subjects had visually recognizable scoliosis. The male to female prevalence ratio was 1.5:1. All but one subject with scoliosis were right handed while 26 (51%), 23 (49%) and 4 (7.5%) of them had right thoracic, left thoracic and left lumbar scoliosis respectively. Twenty five subjects (2.5%) were twins but 3 (12.0%) of them had scoliosis.Conclusions: The prevalence of idiopathic scoliosis among adolescents in this study is similar to rates reported among similar age groups in other parts of the world. The finding suggests a need for a national survey of idiopathic scoliosis and institutionalization of the school screening program in Nigeria.

INTRODUCTION

The Scoliosis Research Society defines scoliosis as a lateral spinal curve of the spine that is greater than 10 ° when measured by the Cobb method on a standing radiograph[1] while the American Association of Orthopedic Surgeons defines it as a lateral spinal curve of 11 ° or greater.[2] It is an orthopedic condition that is characterized by a lateral deviation and/or rotation of a series of adjacent vertebrae from the normal midline axis.[3] Usually, it is an endpoint of a process that most often begins in childhood but which only manifests at the onset of puberty [3, 4] with structural abnormalities in the pelvis, vertebrae and thoracic cage.

On the basis of etiology, scoliosis can be classified as neuromuscular, osteopathic, postural and idiopathic. Idiopathic scoliosis is a structural curve with no clear underlying cause [5] and can best be considered as a complex genetic trait disorder.[6] It accounts for approximately 65% of cases of structural scoliosis; a large proportion of which develops during adolescence. [7] Indeed, most cases of structural scoliosis not resulting from disease or injury of bones are idiopathic in nature. [8] Idiopathic scoliosis is classified based on the patient's age at presentation or detection as infantile, juvenile and adolescent scoliosis [5, 9] but the adolescent form accounts for 80% or more of cases of idiopathic scoliosis.[10] Adolescent idiopathic scoliosis is primarily a diagnosis of exclusion.[5]

Although not all spinal deviations are significant, some diagnosed in adolescence are progressive and hence cause problems in adulthood.[11] Early diagnosis and proper management can however prevent the development of a serious deformity that may subsequently require expensive surgical correction.[3] Undiagnosed and/or untreated scoliosis may continue throughout the adolescent growth spurt with grave consequences for the patient.[11] Potential adverse effects of scoliosis include progressive development of unpleasant cosmetic deformities, back pain and social and psychological problems during childhood and adolescence[12] thus impacting on the physical and psychological health of affected individuals .[13]

The principal screening test for scoliosis is the physical examination of the back which includes upright physical inspection of the back and the Adams forward bending test.[14] Other methods of screening are standing roentgenograms,

inclinometer and Moire topography. However, except during mass screening, scoliosis is generally determined by radiography and the Cobb or Fergusson method.[15] Orthopedic surgeons have however accepted the effectiveness of physical examination for detecting spinal deformities during screening of school-aged children.[9, 15] The one-minute screening test has proved effective with only 18% false positive compared to the radiographic method.[16] Furthermore, visual screening in scoliosis was reported to have reliability and sensitivity values of 74% and 78% respectively in detecting curves greater than 10 ^{o} and significant agreement was obtained between visual screening and radiographic evidence; the accuracy of the test increasing as the scoliosis curve increases.[17] Screening for scoliosis should always include the forward bending test which is the most specific test for true scoliosis though no single test is completely reliable for screening.[13]

The objective of screening for any disease is to select highly vulnerable, previously undiagnosed cases for referral.[18] It also allows for the evaluation of the incidence of such disease in the population. The rationale behind screening for scoliosis is the assumption that the early detection of curves permits prompt initiation of conservative therapeutic interventions that may prevent progression of the curves thus avoiding the complications of advanced scoliosis.[19] It has however been opined that the school screening program screening program mainly gives the school-aged population the chance to rule out those who will be at risk for developing scoliosis rather than those who definitely have scoliosis.[20] Screening for adolescent idiopathic scoliosis was introduced in the USA and many other countries in the 1970s[21] but there is no information from Africa on school screening.[20] Specifically, school screening program is presently unavailable in Nigeria and there is generally a dearth of literature on the prevalence of scoliosis in the country. This prospective survey study was therefore designed to screen students from nine secondary schools in Ibadan, Nigeria for scoliosis. Specifically, the study was aimed at reporting the prevalence, gender distribution and curve location in the subjects studied.

METHODS

The study's protocol was approved by the University of Ibadan/University College Hospital Institutional Review Committee on human subject research while all subjects gave their informed consent after the procedure and rationale for the data have been duly explained to them. Nine hundred and nineteen students (514 males, 485 females) recruited through a multistage sampling technique from nine purposively selected public secondary schools in Ibadan city took part in this study. Only schools with boarding facilities were selected so as to ensure that the subjects were screened after school hours thereby avoiding the disruption of their academic activities. Ibadan, located in south-western Nigeria is the country's third largest city by population (2,550,593) and the largest by geographical area (1,189.2 sq mi).[22]

Data relating to subject's age as at last birthday, handedness and whether twin or not were recorded. The subject's height and body weight were then measured using the height meter and weighing scale respectively and following standardized methods as described by Willet.[23] All subjects were initially screened to identify those with scoliosis. Subjects were examined individually while undressed from the waist up (the girls being allowed to wear their bra) to allow for the observation of any spinal deviation. All measurements were carried out by one of the researchers (BLT) to eliminate errors due to inter-rater variability.

Visual (Initial) Screening: The subject in erect standing with his feet together was examined anteriorly and posteriorly. The levels of the shoulders and hips were noted to ascertain the presence of any lateral deviation of the spine.[3] The subject then assumed a forward-bend posture while the researcher standing behind him leveled his eyes with his back and looked at his trunk. The two halves of the upper thoracic and lumbar regions were compared to ascertain their being symmetrical.[3, 8] Subjects were considered to have scoliosis when screening revealed any of the following:

i) A mild thoracic or lumbar para-vertebral prominence with the researcher's eye level parallel to the area of the back being assessed.

ii) A lateral deviation of the spine.

iii) Asymmetry of shoulder or hip levels when subject was standing.

Final Screening: Subjects identified as having scoliosis by the initial screening went through a second more in-depth screening designed to identify the type and site of the scoliosis. The second screening consisted of the following two tests:

1. Assessment of spinal deviation and decompensation of the upper thorax over the pelvis: The researcher stood behind the subject who was standing erect with his feet together while looking straight. The string of a plumb was held over

the prominent spinous process of C7 thereby obtaining a vertical line with the weighted plumb.[3] The horizontal distance from the plumb line to the glutei cleft was measured with a tape measure and recorded in centimeters as the deviation to the left or right.[8] This is a measure of the extent of the spinal deviation and decompensation of the upper thorax over the pelvis. The distances from the lower angles of the left and right scapulae to C7 vertebra were also measured and recorded in centimeters. The difference between the distances to the right and left is a marker of the difference between the shoulder levels.[24]

2.Forward bending test: The subject standing barefooted with his feet approximately 15cm apart and backing the researcher was instructed to bend forward from his waist with the knees braced back, shoulders loose and hands positioned in front of the knees with the elbows straight.[14] The prominence of the spine was then measured with a spirit level that was positioned such that its spirit was at the centre (level) over the palpable spinous process in the area of maximal prominence.[8] The spirit level was made horizontal and the distance from it to the apex of the deformity was noted. The perpendicular distance from the valley of the deformity to the spirit level was measured with the mathematical ruler and recorded as the rib hump in centimeters as a measure of the extent of the deformity.

DATA ANALYSIS

Participants' data were presented using mean, standard deviation and percentages. Continuous variables of participants with and without scoliosis were compared using independent t-test at =.05.

Results

Subjects' characteristics are presented in Table 1.

Figure 1

Table 1: Characteristics of subjects

	Subjects with scoliosis (n=53)	Subjects without scoliosis (n=964)	All subjects (n=999)
Age (years)	14.55 (SD=1.45)	14.03 (SD=1.79)	14.06 (SD=1.72)
Height (metres)	1.55 (SD=9.69)	1.53(SD= 0.11)	1.53 (SD=1.80)
Weight (kg)	43.55 (SD=9.49)	42.53 (SD=10.18)	42.58 (SD=10.14)
BMI (kgm^{-2}	17.87 (SD=2.62)	17.92 (SD=2.76)	17.91 (SD=2.76)
Gender			
Male	32(60.4%)	482(51.0%)	514(51.5%)
Female	21(39.6%)	464(49.0%)	485(48.5%)
Twin sibling			
Yes	3(5.7%)	22(2.3%)	25(2.5%)
No	50(94.3%)	924(97.7%)	974(97.5%)
Dominant hand			
Right	52(98.1%)	923(97.6%)	975 (97.6%)
Left	1(1.9%)	23(2.4%)	24(2.4%)

SD= Standard deviation

The mean age, height, body weight and body mass index of the subjects were 14.06±1.78 years, 1.53± 0.11m, 42.58±10.14kg and17.92+ 2.75kgm^{-2} respectively. Independent t-test did not indicate any significant difference (p .05) between the characteristics of subjects with and without scoliosis. Fifty-three (5.3%) of the subjects had scoliosis. Thirty-two (60.4%) of the subjects with scoliosis were boys. Further, 32(6.2%) and 21 (4.3%) of the boys and girls respectively had scoliosis; the boys constituting 60.4% of those with scoliosis. Only three (5.7%) of the subjects with scoliosis were twins while 52 (98.1%) of the subjects with scoliosis were right handed.

The locations of the scoliosis curves are presented in Table 2.

Figure 2

Table 2: Scoliosis curve location in subjects

	Location of scoliosis curve			
	Right thoracic	**Left thoracic**	**Left lumbar**	**All**
Boys (n=32)	14(43.8%)	15(46.9%)	3(9.4%)	32(100.0%)
Girls (n=21)	13(61.9%	7(33.3%)	1(4.8%)	21(100.0%)
All (n=53)	27(50.9%)	22(41.5%)	4(7.5%)	53(100.0%)

Right thoracic curve found in 27 participants (49.1%) was most common while left lumbar curve found in 4 participants (7.5%) was least common in participants with

scoliosis.

The prevalence of shoulder elevation, upper thorax decompensation and rib hump among subjects with scoliosis is presented in Table 3. Twenty-nine (54.7%) of the subjects with scoliosis had left shoulder elevation and left rib hump. Furthermore, 22 (41.5%) of subjects with scoliosis had no plumb deviation (trunk decompensation) while 20 (37.7%) had right plumb deviation. Most (62.5%) of the male subjects with scoliosis had left shoulder elevation compared to 47.6% of the female subjects with scoliosis. About 94% of the male subjects compared to 85.6% of the female subjects had rib hump (right plus left).

Figure 3

Table 3: Shoulder elevation, trunk decompensation and rib hump in individuals with scoliosis

	Boys with scoliosis (n=32)	Girls with scoliosis (n=21)	All subjects with scoliosis (n=53)
Shoulder elevation			
None	1(3.1%)	6(28.6%)	7(13.2%)
Right	7(34.4%)	10(47.6%)	17(32.1%)
Left	24(62.5%)	5(23.8%)	29(54.7%)
Upper thorax			
Decompensation			
None	14(43.8%)	8(38.1%)	22(41.5%)
Right	11(33.4%)	9(42.8%)	20(37.7%)
Left	7(21.9%)	4(19.0%)	11(20.8%)
Rib hump			
None	2(6.3%)	3(14.3%)	5(9.4%)
Right	10(31.3%)	9(42.9%)	19(35.8%)
Left	20(62.5%)	9(42.9%)	29(54.7%)

DISCUSSION

The 5.3% prevalence rate observed in this study is comparable to the prevalence rates reported in literature.[11, 25] A prevalence of 3.3% was found among American school children aged 10-16 years[11] while a higher prevalence of 7% was found among 11-14 year old American school children.[25] Francis[15] however reported a considerably higher prevalence of 12% among college age females with a mean age of 19.7± 2.1 years. The higher prevalence in the later study is understandable since spinal deviations would have been more established and hence easier to identify in older age groups with consequent increased accuracy of diagnosis through visual inspection.[17] Variability in prevalence rates of scoliosis has been adduced to different “cutting points” such as age range screened and screening techniques used as well as racial differences.[1] Thus, Adair et al[26] recorded 8.6% prevalence in a population of 10-16 year olds screened by physical examination while a higher prevalence of 14% was observed when the same population was screened by Moiré topography[1]; a reflection of the influence of the screening techniques on the reported prevalence rates. The different prevalence rates of 2.5% and 0.03% found among Caucasian and Negroid South Africans respectively also points to the possible influence of racial categorization on the prevalence of adolescent idiopathic scoliosis.[27] The prevalence obtained in our study was however considerably higher than that obtained among the Bantus probably because the later study [27] evaluated scoliosis using radiography and defined it as a curve of 10 ^{o} or more. Prevalence of adolescent idiopathic scoliosis is generally very dependent on curve size cut-off point; decreasing from 4.5% for curves of 6 ^{o} or more to only 0.29% for curves of 21 ^{o} or more.[28]

The male - female prevalence ratio in this study was 1.5:1.0 indicating a higher prevalence in males than females in contradiction of the findings of previous studies outside Nigeria.[24, 25, 29] Kane and Moe [29] reported 1:5 male – female prevalence ratio, Adair et al[25] reported a 1: 1.3 male – female prevalence ratio while Francis and Bryce[24] observed a 1:2 male – female prevalence ratio among 11-14 year old school children. Our finding is however similar to those of Gore et al[11] and Mittal et al[30] which both reported higher prevalence in male adolescents. The ratio of boys to girls with small curves of 10 ^{o} is said to be equal[31, 32] but increases to 10 girls to one boy with curves greater than 30 ^{o}.[31] The higher prevalence among males in our study might have been due to racial differences.

Right thoracic curve was most common in this study as it was observed in 50.1% of the subjects with scoliosis. This is in agreement with the findings of Gore et al[11] which also reported the right thoracic curve to be the most common. However, Brooks et al[33] observed left thoraco-lumbar curve in 75 % of subjects with scoliosis in their study. The right thoracic curve is believed to be one of the most common idiopathic curve patterns.[33, 34, 35]Overall, thoracic curves were found to be most common in our study perhaps as a reflection of the view of Brooks et al[33] that thoracic scoliosis is the easiest to detect through physical signs. Generally, more than 90% of single thoracic curves are to the right, 80% of thoraco-lumbar curves are to the right, more than 70% of single lumbar curves are to the left, 90% of double major curves are right thoracic and left lumbar while a left

primary mid-thoracic curve is unusual.[36]

A genetic etiological factor has been postulated in idiopathic scoliosis [37, 38] with the genetic connection often manifested among twins. [15]Indeed, studies of twins have given the firmest indication that genetics is the most significant factor in the etiology of idiopathic scoliosis. [39]Three (5.7%) of the 53 subjects with scoliosis in this study were twins but the prevalence of idiopathic scoliosis among twins was 12%. Thus, whereas twins constituted only 2.7% of subjects in this study, 5.7% of the subjects with scoliosis were twins and the prevalence of idiopathic scoliosis among twins (12%) was considerably higher than among non-twins (5.1%). However, although the twin siblings of two of the three twins with scoliosis were not available for screening, the twin-sibling of the third twin who was available for screening had no scoliosis. This is understandable considering a recent study's conclusion that the risk of developing scoliosis in a twin whose other twin has scoliosis is smaller than hitherto believed .[40] The higher prevalence of idiopathic scoliosis among twins in this study may be evidence in support of the genetic connection of idiopathic scoliosis among twins. It may however be preposterous to use the outcome of this study to draw an inferential conclusion on the prevalence of scoliosis among twins.

Hand dominance has also been speculated to be associated with the direction of the convexity in scoliosis and the association between right-handedness and the prevalence of right thoracic scoliosis is a popular but largely unsubstantiated hypothesis.[15] In our study, though 98.1% of the subjects who had scoliosis were right hand dominant only twenty seven (50.9%) of the subjects with scoliosis had right thoracic curve. However, the only left-handed individual with scoliosis had left thoracic curve. Finding from this study does not appear to support the hypothesis on the association between right-handedness and right thoracic scoliosis and needs to be further examined.

LIMITATIONS

The prevalence of adolescent idiopathic scoliosis observed in our study should be viewed with some measure of caution since the Adams forward-bending test has been found to result in unacceptable number of false negatives especially when used as the only screening tool as in our study.[41] It is therefore plausible that the prevalence of adolescent idiopathic scoliosis in the population studied has been underestimated. The positive predictive value (PPV) of visual inspection and forward-bending test also varies among others with the degree of curvature by which "true positive" is defined, the prevalence of scoliosis in the screened population and the skills of the examiners; the PPV being inversely related to the degree of curvature used to define scoliosis.[19] An apparent limitation of this study is our failure to assess the scoliosis curve in our subjects. Also, the sample size of 999 used in our study may not be large enough for the likely population of adolescents in Ibadan. However, this study has come up with useful preliminary data on the burden of adolescent idiopathic scoliosis in Nigeria and will contribute to the global statistics on the condition. There is however a need to replicate the study in other parts of the country or over a larger area of the country in order to obtain a national prevalence rate.

CONCLUSIONS AND RECOMMENDATIONS

The observed 5.3% prevalence rate of idiopathic scoliosis in this study was similar to rates reported by similar studies around the world; the prevalence in male subjects being higher than in female subjects. While awaiting a definitive proof of the effectiveness of school screening on adolescent idiopathic scoliosis[42], we recommend that spinal screening be incorporated into the Nigerian school program as school screening may provide the only opportunity for back inspections of disadvantaged adolescents who often lack access to health facilities.[19] Alternatively, Nigerian clinicians should include visual inspection of the back of adolescents when it is being examined for other reasons. There is also a need to replicate the study in other parts of the country. Such studies should assess the scoliosis curve using more sophisticated assessment tools.

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