Observational Study

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Low hospital referral rates of school scoliosis screening positives in an urban district of mainland China

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Abstract

Significant prevalence rates of adolescent scoliosis in China were suggested in previous studies. However, school screenings for adolescent scoliosis have been suspended due to low rates of positive detection under the past screening system in China. The present study was undertaken to screen for adolescent scoliosis in middle school students under a modern assessment system in a district of Shanghai. We performed a population-based, cross-sectional study of a middle school scoliosis screening program in the Jingan district. In 2015, schoolchildren were initially screened by visual inspection of clinical signs and the forward-bending test. Suspected cases were referred for radiography in hospital for scoliosis diagnosis. A total of 5327 middle school students (grades 6–8) were screened with 520 (9.76%) positives (the positive rates of girls and boys at 15.28% and 4.59%, respectively) and no statistically significant difference among grades. Only 301 positives (57.9%) followed the referral for hospital radiography. There were 102 cases (33.9%) that were diagnosed with scoliosis by radiography criteria (Cobb angle ≥10°) including mild scoliosis (Cobb 10–25) for 94 cases and moderate scoliosis (Cobb 25–40) for 8 cases, and false-positives (Cobb 0) for 39 cases. The putative prevalence rate was estimated as 1.9% from the referred students. Under an accurate and modern assessment system, school screenings can detect scoliosis at a significant rate, but awareness of scoliosis risks is needed for residents in China to take up referrals for hospital diagnosis after school screenings.

Abbreviations: AIS = adolescent idiopathic scoliosis, CDC = Center for Disease Control and Prevention.

Keywords: adolescent idiopathic scoliosis, hospital diagnosis, school scoliosis screening, scoliosis prevalence

1. Introduction

Adolescent idiopathic scoliosis (AIS) is a common backbone abnormality in adolescents defined by a Cobb angle greater than 10° in coronal curvature. The lateral spine curvature in untreated scoliosis patients is prone to develop with complex 3-dimensional deformities such as frontal curves, fixed vertebral rotations, and flattering of the sagittal physiological curves. In most untreated patients, significant symptoms are not obvious in adults less than 65 years of age, but back pain may become a more prominent complaint in the untreated elderly. As severe cases of untreated scoliosis require clinical attention and bring morbidity and mortality risks, early detection of AIS brings broad benefits for both patients at any age and clinicians.[1]

Scoliosis results from unequal force to the 2 sides of the backbone, affecting adolescent growth of height and causing back pain. Scoliosis occurs at any age but in most cases their onset is before the skeletal maturity and it accelerates during skeletal growth; it is reported that if untreated, approximately 60% of elementary school students and 20% of middle school students with scoliosis will deteriorate.[2,3] The development of scoliosis is positively correlated with Cobb angle, and approximately 70% of adolescents with more than 20 Cobb degrees and 20% with 10° to 20° will develop scoliosis, respectively.[3,4] Due to the progressive nature of adolescent scoliosis, early treatment can prevent significant deterioration. Therefore, early detection of AIS is cost-effective and beneficial for adolescents. The prevalence of AIS has been considered as close to or over 1%.[3–11] According to a report by Rowe et al[12] in 1999, there was a 1% to 3% incidence of AIS in 10 to 16 year olds in the United States. In a 2004 survey, it was shown that in 2546 children from ages

Editor: Daryle Wane.

Funding/support: This study was funded by the Jingan District Shanghai Health and Family Planning Commission Programs, number JWXK201209; the Jingan District Government, and from the Tokiwa Foundation; and the Medical Governance Research Institute, Tokyo, Japan.

The authors have no conflicts of interest to disclose.

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Medicine (2017) 96:14(e6481)

Received: 25 November 2016 / Received in final form: 21 February 2017 / Accepted: 6 March 2017

http://dx.doi.org/10.1097/MD.0000000000006481

11 to 14 in urban areas in Serbia, the AIS incidence was as high as 7.8%, with the incidence in girls 2.7 times higher than that in boys.[13]

In China, Li and Liu[14] reported in 2000 that the incidence of scoliosis in Chinese adolescents was 0.75% to 2.4%, of which accounted for 95.77% to 96.90% of the total incidence of AIS. Compared to earlier surveys, higher incidence rates of AIS in recent reports are assumed to be caused by more accurate AIS assessments. In a meta-analysis in 2014, Zhang et al[5] have also estimated a scoliosis prevalence of 1.02% in mainland China. However in a more recent survey of 99,695 adolescents aged 15 to 19 years in China, the incidence rate was measured at 5.14%.[15] Therefore, while past surveys showed differences in the AIS incidence rates between China and other countries, with China having a lower incidence, recent reports suggest that that scoliosis prevalence rates in China are actually similar to, not lower than, those in other countries.

In China, scoliosis school screenings began in the 1980s, but after 2000, China, like many other countries, stopped such programs. The main reason for the suspension in Shanghai at that period was that the positive rate of school screenings was extremely low – close to 0 (statistical table of health examination for students in Shanghai, Shanghai Center for Disease Control and Prevention [CDC]), and there was little appreciation of its cost-effectiveness. The reason for the low detection rate may have been due to a lack of accurate assessment systems, as the scoliosis screening was included only in a minor part of the student health screening program. Moreover, the doctors and the partners who conducted the health screening program were not trained to properly perform scoliosis screenings, which may have led to the screenings being unprofessional and of low quality, ultimately underestimating the actual prevalence rate.

Jingan District is one of the 16 districts located in the center of Shanghai city. It is rich in economic and medical resources. In 2002, under the direction of the local government, Jingan District was the first to adopt the Healthy City Shanghai Pledge. In 2015, the life expectancy of residents increased by 3.81 years, reaching 84.47 years. In addition, the health of adolescents has now emerged as one of the most important concerns for residents at all levels of the government. The District Health and Family Planning Commission set up a school medical education project in 2012 to further promote and improve the medical and health institutions and the schools' disease prevention and control system. In order to enhance the health level of the District, learning from domestic and foreign experiences, Jingan District Health and Family Planning Commission in 2015 decided to align public health professionals with clinicians to carry out a scoliosis school screening program under an accurate and modern assessment system. In the present study, we report an evaluation of the school screening in Jingan District under the new system.

2. Materials and methods

2.1. Study design

Between April 2015 and November 2015, we conducted a scoliosis school screening, which ranged from 6th grade to 8th grade in all 14 middle schools in Jing'an district, with a total number of 5327 students. Positive screening cases were referred to the designated hospital (Shanghai Children's Hospital) with their accompanying parent or guardian, for further diagnosis, on the basis of full spine anteroposterior and lateral X-ray film. School health teachers and Shanghai Children's Hospital reported information to the District CDC. The District CDC communicated with the school health teachers, District Center Hospital, Community Hospital, and Shanghai Children's Hospital to collect and analyze study information.

2.2. School scoliosis screening program

The screening program was one of the Jing'an District Shanghai Health and Family Planning Commission Programs, number JWXK201209, and additionally one of the 10 Jing'an District Government Programs in 2015, conducted by the district government. Students in middle schools were required to participate in the program for screening.

After the project identification, the district Health District Family Planning Commission was responsible for organization and guidance. At the beginning of the program, mid-term evaluation, and the final evaluation, they organized expert consults to guide and ensure the screening methods, implementation scheme, working process, and working contents. The experts included epidemiology, pediatric bone science, and pediatric health rehabilitation professionals. The District Board of Education was responsible for the assessment for each school. School health teachers publicized screenings, helped to organize the actual screenings, gave feedback to students, and informed and led positive students to the designated referral hospitals. These teachers were additionally in charge of collecting and submitting student information to the District CDC, including age, sex, screening results, referral hospitals that students went to, and Cobb angle degree. The District CDC was responsible for the development of the implementation of the program, and collection and analysis of information. The District Central Hospital Department of Orthopedics doctors and community hospital general practitioners went to schools to carry out the screenings, recorded the results, and gave feedback to the school. Shanghai Children's Hospital was invited as the project's designated hospital; orthopedics and rehabilitation doctors were also invited to train for screenings, to operate in the schools, to control the screening quality, and to report information to district CDC about students who went to designated hospitals.

2.3. Screening method

Screenings were conducted by 2 checks, physical examination and X-ray (see Fig. 1). For the 1st check, the District Central Hospital Department of Orthopedics doctors and general practitioners of community hospitals performed a physical examination for students including the symmetry and bending test at school, as described below. For the 2nd check, suspected students were referred to the designated hospital's orthopedics department (Shanghai Children's Hospital) for further diagnosis, on the basis of full spine anteroposterior and lateral X-ray film.

Following the Diagnostic Criteria of Surgical Disease and Practical Orthopedics, physical examination included the following assessments:

(1) Observing whether both shoulders are symmetrical, whether both inferior angles of scapula are at the same level, whether concaves of the waist on both sides are symmetrical, whether heights of crista iliaca on both sides are equal, and whether the line of the spine is deviating from the center. In the 5 checks, if 1 or more results are abnormal, physical examination is considered positive.
(2) For the spinal Adam anteflexion test, observing whether the upper thoracic segment, thoracic segment, thoracic lumbar segment, and waist segment are equal-height and symmetrical

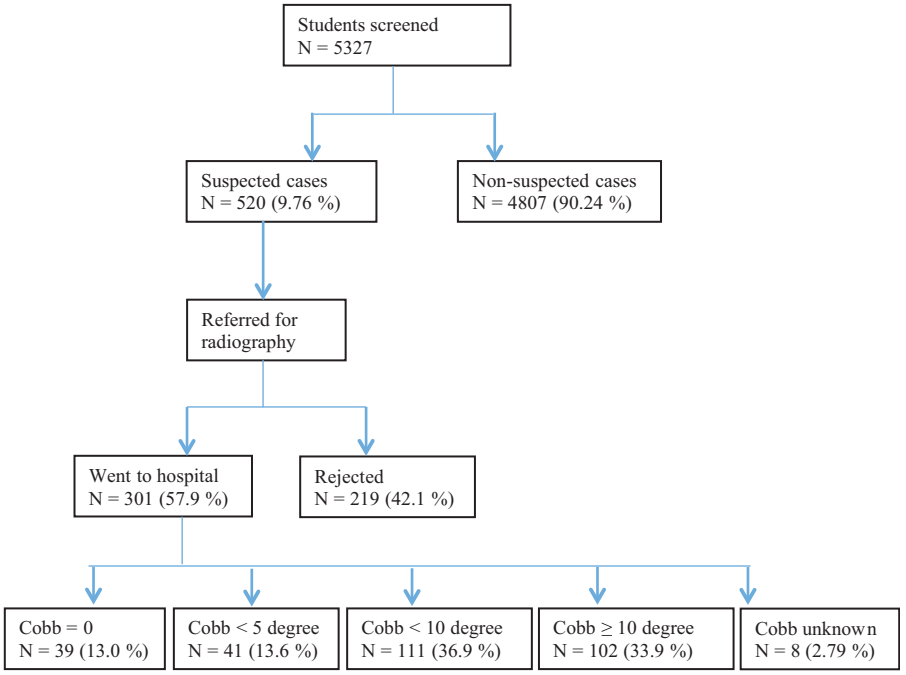

Figure 1. Flow-chart of the school screening program. The middle school students from 6th to 8th grades were screened for scoliosis incidence, and recommended for further diagnosis in hospitals. Only 301 students went for hospitals. The flow of the scoliosis screening and diagnosis with measured Cobb angles is illustrated with the subject numbers.

on both sides, respectively. Based on the test outcome, positive cases will move to the next step.

(3) Asking students with positive physical examination (in either (1) or (2), or both) to go to the hospital for an X-ray to assess the Cobb angle.

2.4. Diagnostic criteria of scoliosis

Following the International Scoliosis Research Association, a diagnosis of scoliosis was made if a Cobb angle of 10° or more was seen in standing X-ray film of spinal lateral bending.

2.5. Statistical analysis

Using SAS 9.1.3., detection rates were compared with Fisher exact test (2-sided) on both sides of the exact *P* value, recording X^2 value of the Chi-square at the same time. Any data are accessible upon direct request to Dr Xiaocang Ding (xcding126@126.com).

2.6. Ethics statement

The committee on Ethics and the Institutional Review Board Shanghai Municipal Center for DCP (IORG0000630 & FWA00000090) approved the study protocol (Approval number: 2016-30)

3. Results

3.1. Participants characteristics

Table 1 shows the characteristics of the participants. A total of 5327 junior middle school students were included, with 520 positive cases at total positive rate of 9.76% (520/5327) (Fig. 1). The positive rates of boys and girls were 4.59% and 15.28%, respectively, and the difference was statistically significant ($X^2 = 172.686$, $P = 0.001$). The positive rates for the 6th, 7th, and 8th grade were 9.91%, 9.95%, and 9.42%, respectively. There was no statistically significant difference among grades ($X^2 = 0.356$, $P = 0.83$).

3.2. Hospital diagnosis

Only 301 (57.9%) of positive cases among the 520 screening positives were successfully referred for X-ray diagnosis in hospitals (Fig. 1). There were 265 (88.0%) that went to the designated hospital, and the remaining 36 cases (12.0%) went to district-class hospitals or provincial-class hospitals. There were 102 cases out of 301 (33.9%) that were diagnosed with scoliosis by radiography criteria (Cobb ≥ 10). Of these, 94 cases (31.2%) had mild scoliosis (Cobb angle 10°–25°), 8 cases (2.7%) showed moderate scoliosis (Cobb angle 25°–40°), and the largest Cobb

Table 1

Positive cases of physical examination by grade and sex.

Grade		Boys n	n = 2748, %	Girls n	n = 2579, %	Total n	n = 5327, %
Sixth grade	n = 1796	44	(4.82)	134	(15.16)	178	(9.91)
Seventh grade	n = 1758	38	(4.20)	137	(16.06)	175	(9.95)
Eighth grade	n = 1773	44	(4.73)	123	(14.61)	167	(9.42)
Total	n = 5327	126	(4.59)	394	(15.28)	520	(9.76)

Table 2

Cobb angle of scoliosis in the 301 students that went to the hospital by grade and sex.

	Gender	0 n, %	<5 n, %	<10 n, %	<25 n, %	<40 n, %	Unknown n, %	Total n, %
Sixth grade	Boys	3 (13.0)	5 (21.7)	7 (30.4)	7 (30.4)	1 (4.3)	0 (0)	23 (100)
	Girls	6 (7.0)	9 (10.5)	37 (43.0)	32 (37.2)	1 (1.2)	1 (1.2)	86 (100)
	Total	9 (8.3)	14 (12.8)	44 (40.4)	39 (35.8)	2 (1.8)	1 (0.9)	109 (100)
Seventh grade	Boys	4 (17.4)	4 (17.4)	10 (43.5)	3 (13.8)	1 (4.3)	1 (4.3)	23 (100)
	Girls	17 (19.3)	10 (11.4)	27 (30.7)	28 (31.8)	2 (2.3)	4 (4.5)	88 (100)
	Total	21 (18.9)	14 (12.6)	37 (33.3)	31 (27.9)	3 (2.7)	5 (4.5)	111 (100)
Eighth grade	Boys	2 (7.7)	5 (19.2)	13 (50.0)	5 (19.2)	1 (3.8)	0 (0)	26 (100)
	Girls	7 (12.7)	8 (14.5)	17 (30.9)	19 (34.5)	2 (3.6)	2 (3.6)	55 (100)
	Total	9 (11.1)	13 (16.0)	30 (37.0)	24 (29.6)	3 (3.7)	2 (2.5)	81 (100)
Total	Boys	9 (12.5)	14 (19.4)	30 (41.7)	15 (20.8)	3 (4.2)	1 (1.4)	72 (100)
	Girls	30 (13.1)	27 (11.8)	81 (35.4)	79 (34.5)	5 (2.2)	7 (3.1)	229 (100)
	Total	39 (13.0)	41 (13.6)	111 (36.9)	94 (31.2)	8 (2.7)	8 (2.7)	301 (100)

angle observed was 36° (Figure 1). The Cobb angles for 8 cases (2.7%) were unknown (Table 2). Among these 8 cases, one case attended the designated hospital but declined further diagnosis, and in the other 7 cases the X-ray inspection suggested scoliosis, but the Cobb angles were not recorded. Gender composition: boys accounted for 23.9% of cases, and girls accounted for 76.1%. Grade composition: 109 (36.2%) of cases were from the 6th grade, 111 (36.9%) from the 7th grade, and 81 (26.9%) from the 8th grade.

There were 111 cases (36.9%) judged to be within the prestage of scoliosis (Cobb angle 5°–10°), and 41 cases (13.6%) with Cobb angles of 0° to 5°. However, there were 39 cases (13.0% from 39/301) found to have no Cobb angle (0°), reflecting the presence of false-positive candidates in the school screening. Given these findings, the prevalence rate of scoliosis among the referred positives was estimated as 1.9% (9.76% [520 positives among 5327 students) × 57.9% (301 referred subjects from 520 positives) × 33.9% (diagnosed 102 students from 301]).

4. Discussion

AIS may progress before skeletal maturation, and untreated cases are highly susceptible to various morbidity problems in later life with increased disability. Therefore, early detection followed by appropriate treatments is significantly beneficial for AIS patients. As an approach to early detection, scoliosis screening in schools has been regarded as the most effective, though in some countries sufficient evidence, particularly in terms of the cost-effectiveness, does not yet exist to provide arguments for or against school screenings.[16,17]

Various countries have already carried out a number of studies on the patterns for early detection of AIS cases.[6,7] Screening programs for AIS were instituted in many school settings in the 1970s, consisting of back examinations of young adolescents, usually performed by a specially trained nurse searching for asymmetries in standing and forward bending positions (Adams forward bending test).[18] In 2010, the Scoliosis Research Society presidential line determined that it would be worth exploring scoliosis screening from a multinational perspective by creating an International Task Force.[19]

In China, scoliosis screening in schools began in the 1980s, but was gradually suspended because it had been judged to not have merit in cost-effectiveness, with reported positives at nearly null. However, from accumulated information, these low detection rates in the scoliosis screening have been recognized to be underestimated due to insufficient organization of the screening system and lack of knowledge in those conducting the school screening. In fact, in a clinical survey in 2000, the incidence rates of AIS in China were estimated at high ranges from 0.75% to 2.4%, consistent with the incidence rates of AIS school children reported in other countries.[14] The Jingan district is well placed among the Chinese districts to conduct accurate and systematic health care school screenings as a central district in Shanghai city, and the present scoliosis school screening was carried out in middle schools with the cohort of the examinees living a relatively similar lifestyle. The rate of positives in this screening (520/5327) was higher (9.76%) than those reported in the previous literature,[2,9] but there were no statistically significant differences among the tested grades (6th to 8th). Among the 520 positive cases, only 301 cases (57.9%) went to the hospital for X-ray diagnosis. Out of the 301 successfully referred, 102 cases (33.9%) were diagnosed with scoliosis by radiography criteria (Cobb ≥ 10), and 94 cases (31.2%) had mild (Cobb angle 10°–25°) scoliosis, and 8 cases (2.7%) showed moderate scoliosis (Cobb angle 25°–40°). Although there were 111 cases (36.9%) within the prestage of scoliosis (Cobb angle 5°–10°), and 41 cases (13.6%) with a Cobb angle of less than 5°, there were 39 cases (13.0% from 39/301) with a Cobb angle of 0°, and we can regard these cases as false-positives.

Among the 520 screening positive cases, only 301 cases (57.9%) went to the hospital for scoliosis diagnosis, and 102 cases among these 301 screening positive candidates were indeed diagnosed with scoliosis. Thus, the school screening was successful in positive detection, and more importantly in informing a number of the examinees (102 cases) of their scoliosis. However, the most notable facet from the present study is the remarkably low rate (57.9%) of successful referral of the screening positive examinees to further hospital screening and diagnosis. Similarly low rates in hospital referral after initial screenings have also been observed for the other diseases in Jingan district, for example, in ametropia screenings, the proportion of screening positive cases successfully referred to the hospital was 31.14% (Jingan District student ametropia screening analysis report, 2015). However, the rate of successful referrals observed in this study (57.9%) was much higher than the ratios (5.4%–17.5%) estimated from unpublished mid-term evaluations for other projects for adults in the Jingan district (analysis of colorectal cancer in community residents in Jingan District, 2013–2015). Thus, the present observations may reflect the current attitudes toward Western style medicine for the residents of Jiang district, and we can speculate this may be true for most districts in Chinese major cities. It is evident that health

literacy and public awareness of scoliosis and its harm are needed for students and parents; moreover, this could be true not only for scoliosis but also for other diseases.

The positive rate (9.76% calculated from 520/5327) detected in this study was higher than the referral rate by a previous meta-analysis, in which the pooled referral rate was estimated as 5.0% by radiography.[20] The reason for difference in the positive rates between our study and the meta-analysis may be that, first, false positives were included in the present study, namely with the Cobb angle of 0°, accounting for 39 cases (13.0%) among the 301 cases judged as positive in the school screening. Second, we cannot rule out the possibility of regional variations of scoliosis prevalence. Therefore, we presume that carrying out scoliosis school screening within limited areas with similar lifestyles is important to more accurately assess the scoliosis prevalence, and in this respect, screenings in primary and middle school appear meaningful. Irrespective of limitations, such as the diagnosis of only 102 students from the 301 candidates in the school screening, we hypothesize that the prevalence of adolescent scoliosis in the tested Jing'an District is approximately 1.9%. The estimated prevalence rate from this study is similar to those reported in the other countries[12] as well as that (1.02%) in mainland China overall.[5]

5. Conclusions

This was a population-based, cross-sectional study of a middle school scoliosis screening program in Jingan District, Shanghai, Mainland China. The results show a positive rate of 9.76% (520/5327) in middle schools, and 102 cases (33.9%) among the 301 cases successfully referred for hospital diagnosis were indeed found to meet diagnostic criteria for scoliosis (Cobb $\geq$ 10), with an estimated prevalence rate of 1.9%. Thus, school screening appears to be important and effective for early scoliosis detection in China. However, it is notable that only 301 cases (57.9%) of the 520 screening positives were successfully referred to the hospital, clearly suggesting that more rigorous health awareness of scoliosis and its harm is needed for students and guardians in order to promote uptake of hospital diagnosis after positive school screening in China.

Acknowledgments

The authors thank the Jingan District Shanghai Health and Family Planning Commission Programs, number JWXK201209; and the Jingan District Government, and from the Tokiwa Foundation for the support. The authors also thank all of the related staff in the Fudan University School of Public Health, Shanghai, China; and the Medical Governance Research Institute, Tokyo, Japan for its support, as well as personal assistance from Yang Wang in manuscript preparation.

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