IDIOPATHIC SCOLIOSIS

PREVALENCE AND ETHNIC DISTRIBUTION IN SINGAPORE SCHOOLCHILDREN

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Routine examination for spinal deformity as part of a school health screening programme was introduced in Singapore in 1981. The three different ethnic groups included in the study provided figures for the prevalence of idiopathic scoliosis in an Asian population.

A three-tier system of examination was used and a total of 110 744 children in three age groups were studied. In those aged 6 to 7 years the prevalence was 0.12%. The prevalence in those aged 11 to 12 years was 1.7% for girls and 0.4% for boys, a ratio of 3.2 to 1. In girls aged 16 to 17 years the prevalence was 3.1%. In the latter two age groups there was a significantly higher prevalence in Chinese girls as compared with Malay and Indian girls. The optimal age for school screening seemed to be 11 to 12 years, but repeated examinations may be worthwhile.

In the last two decades the conservative and operative management of progressive structural scoliosis has greatly improved. If conservative treatment is started early the number of operations can be reduced (Lonstein *et al.* 1976; Torell, Nordwall and Nachemson 1981). With this in view, screening at school for the early detection of scoliosis has been introduced in many countries (Segil 1974; Brooks *et al.* 1975; Span, Robin and Makin 1976; Ascani, Salsano and Giglio 1977; Rogala, Drummond and Gurr 1978; Drummond, Rogala and Gurr 1979; Takemitsu *et al.* 1980; Dickson *et al.* 1980; Torell *et al.* 1981). In the USA, such screening is mandatory in nine states (Lonstein *et al.* 1982) and is done to some extent in others.

Shands and Eisberg (1955) studied 50 000 minifilms of the chest in the State of Delaware and detected scoliosis of at least 10° in 1.9% of the population over 14 years of age. Except for the high rates reported by Grant *et al.* in 1973 (13.4%) and Brooks *et al.* in 1975 (13.6%), the reported prevalence of scoliosis varies from 1.6% to 4.6% because of the use of different criteria or of variation in sampling (Segil 1974; Brooks *et al.* 1975; Golomb and Taylor 1975; Span *et al.* 1976; Lonstein 1977; Rogala *et al.* 1978; Drummond *et al.* 1979; Smyrnis *et al.* 1979, 1980).

The effective School Health Service in Singapore

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and the presence of three different ethnic groups (Chinese, Indian and Malay) have provided an opportunity to study the prevalence of idiopathic scoliosis in an Asian population.

MATERIAL AND METHODS

The forward-bending test for spinal deformity was introduced as part of a school health screening programme in 1981 by the University Department of Orthopaedic Surgery, Singapore General Hospital, in collaboration with the School Health Services. Moiré topography, or contourgraphy, was added to this programme in 1982.

A three-tier system similar to those described by Hensinger *et al.* (1975) and Owen *et al.* (1980) was adopted. Initial screening is done in schools by nurses who have been taught the forward-bending test. Children with a positive test are referred to the second tier, and are examined by School Health Medical Officers. A moiré photograph is taken. Some children may be discharged from review at this level, while others are referred to the third tier, a specialist clinic at the Singapore General Hospital. In this clinic a comprehensive examination is done and a standing radiograph of the spine is taken.

In 1982 three age groups of children were chosen for a study to discover the optimal age for screening. These groups were: 6 to 7 years (primary one), 11 to 12 years (primary six), and 16 to 17 years (secondary four). The last group contained only girls, since the boys had left for National Service. Altogether 110 744 children were examined, 60 167 girls and 50 577 boys.

The criteria for the diagnosis of scoliosis were a rotational prominence detected on forward bending, and a curve showing a Cobb angle of 5° or more measured on a standing radiograph.

RESULTS

Of the 110 744 children, 1943 (1.8% of the total) were found to have a positive bending test at the first examination by nurses. At the second tier, rotational asymmetry was not confirmed by School Health Medical Officers in 403 children, so that 1540 children (1.4%) were referred to the third tier.

At this stage 178 children (11.6% of those referred) defaulted and 1362 children were reviewed at the specialist clinic. Idiopathic scoliosis was diagnosed in 1096 of these children (80.5% of attenders), and scoliosis due to congenital and other definite causes was seen in an additional 25 children. Kyphosis was detected in five children and 21 had a leg-length discrepancy producing a postural scoliosis. Rotational asymmetry without scoliosis was noted in 152 children. There was no clinical or radiological evidence of scoliosis in 63 children.

Prevalence. In those aged 6 to 7 years 41 (0.2%) of the 20 362 boys and 43 (0.22%) of the 18 999 girls were referred to the scoliosis clinic. Of these, 20 boys and 28 girls were found to have idiopathic scoliosis, giving a prevalence for this age group of 0.1% in boys and 0.15% in girls.

In those aged 11 to 12 years 200 (0.66%) of the 30 215 boys and 535 (2.1%) of the 25 532 girls were seen in the specialist clinic. Idiopathic scoliosis was found in 133 boys and 427 girls. The prevalence for this age group was 0.44% in boys and 1.67% in girls, giving a male to female ratio of 1 to 3.2. In addition, five boys and seven girls had congenital scoliosis, while two boys and six girls had scoliosis due to a variety of other causes.

In the group of 15 636 girls aged 16 to 17 years 543 (3.47%) were referred to the scoliosis clinic. Idiopathic scoliosis was confirmed in 488 girls, a prevalence of 3.12%. Scoliosis due to congenital abnormalities was found in three, and in two girls it was due to other causes.

The prevalence of idiopathic scoliosis in the whole series ranged from 0.1% in boys aged 6 to 7 years to 3.12% in girls aged 16 to 17 years (Table I).

Ethnic groups. The number of children aged 6 to 7 years with scoliosis was insufficient for statistical analysis in ethnic groups. In those aged 11 to 12 years, there was no significant difference between ethnic groups amongst the boys, but there was a highly significant difference amongst the girls (Table II). The greatest difference was between the Chinese and non-Chinese groups (chi-square = 14.9, $P < 0.001$). A similar difference with the same highly significant probability was seen in the girls aged 16 to 17 years (Table II). Thus, Chinese girls in Singapore have a significantly higher prevalence of idiopathic scoliosis than Malaysian and Indian girls.

DISCUSSION

The school screening programme for the early detection of spinal deformities was introduced in 1981 and is now well established. Since its inception over 350 000 children have been examined by the forward-bending test. In 1982, moiré topography was incorporated with the second-tier examination in order to study the accuracy of this method of detecting and recording the site and severity of the curve in comparison with radiographs. The preliminary results of this study were reported in

Table I. Age, sex distribution and prevalence of idiopathic scoliosis in schoolchildren in Singapore (1982)

Age group (years)	Sex	Number of children			Prevalence (%)
		Screened	Seen in scoliosis clinic	With idiopathic scoliosis	
6 to 7	Boys	20 362	41	20	0.1
	Girls	18 999	43	28	0.15
11 to 12	Boys	30 215	200	133	0.44
	Girls	25 532	535	427	1.67
16 to 17	Girls	15 636	543	488	3.12
TOTAL		110 744	1362	1096	1.0

Table II. Prevalence of idiopathic scoliosis by ethnic group in girls of two age groups

Ethnic group	11 to 12 years			16 to 17 years		
	Screened	Scoliosis	Prevalence (%)	Screened	Scoliosis	Prevalence (%)
Chinese	19 142	359	1.9	12 390	438	3.5
Malay	3385	50	1.5	1711	29	1.7
Indian	1994	15	0.8	835	14	1.7
Others	1011	3	0.3	700	6	0.9

The difference between Chinese and non-Chinese was significant in both age groups: 11 to 12 years— $\chi^2 = 14.9$, $P < 0.001$; 16 to 17 years— $\chi^2 = 23.1$, $P < 0.001$

1983 (Daruwalla *et al.* 1983), and the conclusions are presented on pages 221 to 223 of this journal (Daruwalla and Balasubramaniam 1985).

The forward-bending test is a quick and reliable clinical method of detecting small curves. It may be positive even in the absence of radiological scoliosis; this was noted in 152 children (11.5% of those reaching the third tier). The use of a three-tier system helps to minimise the referrals to a scoliosis clinic. The proportion of children (1.4%) so referred is less than that reported in other series (Sells and May 1974; Rogala *et al.* 1978; Lonstein *et al.* 1982).

The prevalence of 0.1% in boys aged 6 to 7 years and 0.15% in girls is similar to that reported by Wynne-Davies in 1968. The prevalence of 0.44% in girls and 1.67% in boys aged 11 to 12 years, and of 3.12% in 16-year-old-girls is also similar to those in other studies; variation between ethnic groups has also been reported. Segil (1974) reported a 2.5% prevalence in South African white children, but only 0.03% in South African black children; in our series, the Chinese girls have a significantly higher prevalence than Malaysian and Indian girls (Table II).

It is well known that adolescent idiopathic scoliosis occurs more commonly in girls. The sex ratio has been reported to be as high as 5 to 1 by Kane and Moe (1970) and 7 to 1 by Wynne-Davies (1968), but Rogala *et al.* (1978) and Brooks *et al.* (1975) have reported the much lower figure of 1.2 to 1. The female to male ratio in this series in the group aged 11 to 12 years was 3.2 to 1.

From the results of this series the optimal age for screening appears to be 11 to 12 years since the incidence of idiopathic scoliosis in those under 8 years is extremely small. As the prevalence in girls aged 16 to 17 years was double that in the group aged 11 to 12 years we added in 1983 a screening programme for an intermediate age group (13 to 14 years). These children would have already been screened two years previously and it was felt that a re-screening would detect curves which had been missed at the initial screening and would also pick up children with scoliosis who had defaulted from the clinic, and allow treatment before their curves had deteriorated significantly.

Conclusions. A school screening programme for the detection of spinal deformities in children has been effective in Singapore.

The prevalence of idiopathic scoliosis in 1982 by age group was:

6 to 7 years —boys 0.1%, girls 0.15%;

11 to 12 years—boys 0.44%, girls 1.67%;

16 to 17 years—girls 3.12%.

The female to male ratio in the group aged 11 to 12 years was 3.2 to 1. Chinese girls in Singapore have a significantly higher prevalence of idiopathic scoliosis than Malaysian and Indian girls. The optimal age for screening is 11 to 12 years; under 8 years the prevalence is very small.

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