THE EFFECT OF SCHOOL SCREENING ON SURGERY FOR ADOLESCENT IDIOPATHIC SCOLIOSIS

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The objective of the study was to examine the effect of screening programmes for adolescent idiopathic scoliosis on population rates for adolescent idiopathic scoliosis surgery. A case-control study with data from The National Hospital Discharge Register, youth health care (YHC) departments in The Netherlands and a relevant census was used. The cases were 182 subjects aged 12-19 years, admitted to hospital in The Netherlands for surgical treatment of adolescent idiopathic scoliosis between 1990 and 1993. The total population of 12 or 13 year olds in the consecutive years of 1987-1992 in the regions of the participating YHC departments served as controls. Of the 182 patients that had surgery for adolescent idiopathic scoliosis in The Netherlands in the years 1990-1993, 37.9% had at one time had a screening for spinal deformities at the age of 12 or 13 years as compared to 37.9% of the control subjects. The odds ratio for cases that had surgery was 1.00 (95% confidence interval 0.74-1.35). This study does not support the view that screening for adolescent idiopathic scoliosis reduces the population rates for scoliosis surgery. As the primary aim of screening for adolescent idiopathic scoliosis is to prevent surgical intervention, this practice should be reconsidered.

Keywords: adolescent idiopathic scoliosis, school screening, surgery

INTRODUCTION

For more than two decades nation-wide screening for adolescent idiopathic scoliosis has been practised in a number of countries. However, the results of studies of the effectiveness and efficacy of this screening are still contradictory to such an extent that recommendations vary between countries and organizations.[1-6] The main purpose of nation-wide screening for adolescent idiopathic scoliosis is to reduce the number of scolioses that are sufficiently severe to warrant surgical intervention. Until now, studies have focused on comparing population rates of surgery and outcomes of non-surgical brace therapy in relation to the severity of scoliosis at presentation before and after introducing nation-wide screening.[7-9] However, this causes uncertainty as to whether changes in surgery rates can be attributed to the screening programme.

In The Netherlands, nation-wide screening for adolescent idiopathic scoliosis was introduced in the early 1980s as part of the regular examination and screening programmes of youth health care (YHC) departments. An agreement about the frequency of screening or appropriate age group was never reached.[4] Some YHC departments screen once as part of regular physical examinations at the age of 14 years (grade 2 of secondary school), while others screen twice by adding a screening in the last grade of primary school (age 12 years) or grade 1 of secondary school (age 13 years). These screenings are performed on all primary and secondary schools in the area of a department, as are all other relevant YHC activities. Generally, the uptake of screening is more than 95% at primary schools. In secondary schools this percentage differs between types of education and is generally somewhat lower (around 90%), although exact figures are not available.

The screening method most widely used, is the forward bending test (Adam's position). Studies show that it is the most effective and expeditious method for detecting scoliosis.[8,10,11]

The aim of this study was to determine the effect of screening for scoliosis by comparing population rates of surgery for adolescent idiopathic scoliosis between regions with and without an optimal screening programme through a case-control study.

OPTIMAL AGE FOR SCREENING

Several studies indicate that screening for adolescent idiopathic scoliosis could be useful in preventing progression of the curves by permitting prompt initiation of conservative preventive measures and thereby avoiding complications of advanced scoliosis. That being the case, screening should be conducted at least once. Furthermore, it should be performed at a time when children are the most susceptible to the development of adolescent idiopathic scoliosis. This means that the optimal time for screening is during the growth spurt; approximately the 10-16 years age group.

Apart from that, screening should be conducted at such a time that most if not all developing scolioses will be detected. Moreover, the situation where scolioses that will recover spontaneously and are supervised needlessly, thus causing the child to undergo unnecessary tests and evaluative procedures, must be prevented.[8,12] Studies indicate that these conditions are fulfilled if screening is performed after the age of 11 years because spontaneous recovery is only noted during the early stages of the growth spurt.[3]

Conversely, the time of screening should be such that initiation of non-operative treatment, in particular bracing therapy, is still feasible and worthwhile. Bracing in a child with a progressive scoliosis is only useful before skeletal maturity is reached,[13,14] up to an average skeletal age of 15 years in girls and 17 years in boys.[14] In addition, bracing therapy is more useful at the peak of skeletal growth, which occurs in (Dutch) girls at an age of 9.5-14.5 years (mean age 11.5 years).[10,14] Lastly, research indicates that in only very few cases does progression of scoliosis occur after menarche (in The Netherlands 10-14.5 years; mean 13.1 years).[1,12,15,16] As girls have a greater chance of developing progressive adolescent idiopathic scoliosis and reach skeletal maturity earlier than boys, the upper limit of the optimal age for screening is determined by these lower average ages.

Thus, based on these considerations, screening should be delayed until children are between 12 and 13 years old. Few important curves will be missed and needless roentgenograms will be avoided. Most children will have enough years of growth remaining for treatment with braces to be effective provided the curve is not too severe and early severe curves should usually be picked up apart from screening procedures.[6]

Thus, screening should be performed in grade 8 of primary school or grade 1 of secondary school. Screening in grade 2 of secondary school would be too late, therefore needlessly postponing necessary therapy which in some cases could render it useless.

POPULATION AND METHODS

To test the hypothesis that regions with an optimal YHC screening programme for adolescent idiopathic scoliosis show lower rates of surgery for adolescent idiopathic scoliosis compared with regions without such a screening programme, a case-control study was designed with the total population of either 12 or 13 year olds in The Netherlands in the consecutive years of 1987-1992 as the source population.

Demographic data were obtained from the National Institute of Public Health and Environmental Protection (RIVM) and The Netherlands Central Bureau of Statistics (NCBS). The Institute for Informatics in Health and Welfare (SIG Services) provided data from The National Hospital Discharge Register, concerning the number of surgical interventions for adolescent idiopathic scoliosis during the years 1990-1993 per YHC region. These data comprised all 12-24 year old surgery patients in this period and included information on place of residence (postcode), age at surgery, main diagnosis and year in which the surgery was performed.

The Spinal Column Study Group of the Dutch Orthopaedic Association supplied information as to the indications for conservative or surgical treatment of adolescent idiopathic scoliosis in The Netherlands, the consistency of treatment across the hospitals and possible differences in accuracy of coding.
A screening programme for adolescent idiopathic scoliosis was considered optimal when conducted in either grade 8 of primary school or grade 1 of secondary school. YHC departments that performed a screening at an earlier or later age were allocated to the non-screening category.
Of the 63 YHC departments, 62 could be assigned to one of the two categories (screening or non-screening). This allocation was based on annual reports, supplemented with information gained by postal questionnaire and if necessary direct personal contact. One YHC department refused to participate and therefore could not be allocated to one of the two categories.
Of the 22 YHC departments that screened for adolescent idiopathic scoliosis it was determined whether this examination was carried out in grade 8 of primary school (mean age 12 years) or in grade 1 of secondary school (mean age 13 years). Next, to determine the size of the reference population, the total number of 12 or 13 year olds respectively was calculated for these YHC regions. This total represented all children at the age of 12 or 13 years in The Netherlands, which in view of their age, could have been screened for adolescent idiopathic scoliosis in the years designated.
Of the 40 departments that did not screen for adolescent idiopathic scoliosis and thus were assigned to the other determinant category, the total number of 13 year olds was chosen as the reference population.
Cases were identified from the National Hospital Discharge Register. Each case was allocated by hand to the two screening categories, based on postcode, year of surgery, age of the patient at the time of surgery and YHC code. The distribution of cases was then compared with that of the population of either 12 or 13 year olds in the screening and non-screening YHC regions.
The size of the reference population in the period 1987-1992, i.e. the number of 12 or 13 year olds, was calculated to be 413,152 for YHC departments that screened and 676,840 for those that did not.

DATA ANALYSIS

The data were analysed as a case-control study, with 182 subjects aged 12-19 years that were admitted to hospital in The Netherlands for surgical treatment of adolescent idiopathic scoliosis between 1990 and 1993 as cases and the total population of either 12 or 13 year olds in the regions of the 62 participating YHC departments between 1987 and 1992 as controls. Odds ratios were calculated with their 95% confidence intervals.
A separate analysis was performed on a subgroup of 150 cases that had surgery at least 1 year after screening could have taken place and who therefore could have benefited more from the screening programme.
Possible confounding could occur because of an asymmetric distribution of gender across the determinant categories: girls have a higher chance of developing severe progressive adolescent idiopathic scoliosis and at the same time have a somewhat lower uptake of screening than boys, in particular in the age group that is eligible for screening. The Mantel-Haenszel approach was used to adjust for possible confounding by differences in gender distribution between the screening categories. As gender is the only possible confounder in the case of scoliosis, no other variables had to be taken into consideration.

RESULTS

In the years 1987-1992, on average 35% (n = 22) of the YHC departments performed a screening for adolescent idiopathic scoliosis.
In the period 1990-1993, 317 operations for scoliosis were performed, of which 249 were for adolescent idiopathic scoliosis and 68 for other types of scoliosis. Because of their age at the time of the operation and the year the operation took place, 62 cases could not have been screened in the 1987-1992 period and were consequently excluded. In five cases the screening category could not be determined. Therefore, after allocating the cases according to year of surgery and age at which surgery was performed, a total of 182 cases of adolescent idiopathic scoliosis (mean age at surgery 14.8 years and SD = 1.6 years) remained.
The mean age at surgery of screened cases with adolescent idiopathic scoliosis was 14.5 years (n = 69 and SD = 1.5 years) and of cases not screened 14.9 years (n = 113 and SD=1.7 years). This difference in mean age was not statistically significant (p = 0.15).
After excluding cases that had surgery less than 1 year after screening could have taken place, for the subgroup analysis a total of 150 cases of adolescent idiopathic scoliosis (mean age 15.2 years and SD = 1.4 years) remained.
Table 1 gives an overview of the distribution of cases among the YHC departments in the two screening categories according to the age at which the operation took place.
Table 2 shows the odds ratio with 95% confidence intervals for the risk of surgery for adolescent idiopathic scoliosis in non-screening YHC Departments. The results of the subgroup analysis are also presented in *table 2*. Adjustment for confounding by differences in gender distribution with the Mantel-Haenszel procedure resulted in odds ratios and confidence intervals that were exactly the same as those without adjustment. Therefore, an asymmetric distribution of gender across the determinant categories could be ruled out.

DISCUSSION

The major finding of this study is that YHC regions with an optimal screening programme for adolescent idiopathic scoliosis do not show lower rates of surgery compared with regions without such a screening. Before we accept this finding, some methodological issues need to be addressed.
As this is a registry-based study, several possibilities for misclassification should be considered. First, the information concerning the working methods of the YHC departments could be insufficient or even incorrect. Given the comprehensive method of data gathering, we consider this less likely. The migration of cases between YHC regions can be a second reason for misclassification. However, a major part of internal migration occurs among the older persons in the designated age group and those with severe scoliosis are unlikely to move to another part of the country prior to surgery. A third reason for misclassification could be differences between place of residence (as determined by postcode) and location of the secondary school, by which the YHC region is determined. To mask an otherwise significant difference, however, of the 22 cases that were screened in secondary school and subsequently had surgery more than half would have to be wrongly classified.
Selection bias is also unlikely, because there was no selection of the control population and the theoretical study base is almost identical to the reference population.
The absolute number of operations seems rather small. This is caused by the fact that only the population of 12 or 13 year olds of the year 1987 can be expected to be almost totally represented, because nearly all operations for adolescent idiopathic scoliosis will be performed before the age of 20 years. Indeed, the proportion of children that had surgery and were in 1987 12 or 13 years of age is approximately 2.5 per 10,000,

which is in accordance with expected rates as quoted in the literature.[17] In addition, this makes it unlikely that the results of this study are influenced by a bias introduced because of differences in the follow-up period between cases and the reference population.

One can argue that expecting any positive influence of screening at a time a scoliosis has progressed to such an extent that surgery is required in the same year is unreasonable. Therefore in a separate analysis cases were only included if surgery was performed at least 1 year after screening could have taken place and thus could have benefited more from the screening programme. The resulting odds ratio proved to be virtually the same as that of the total group.

It is argued that screening after the age of 13 years (grade 1 of secondary school) is suboptimal. Nevertheless, some hold that screening at the age of 14 years (grade 2) in some cases can still prevent surgery at a later age. However, when comparing those that had a screening to those that did not have any examination for adolescent idiopathic scoliosis, be it as a screening or as part of a regular examination, the odds ratio for surgery was virtually the same as that without inclusion of the 14 year olds (odds ratio with 14 year olds 0.98 and 95% CI = 0.48-1.98).

The main argument for nation-wide introduction of screening for adolescent idiopathic scoliosis is that the scoliosis can be detected in a phase early enough to enable successful conservative treatment. Consequently, severe progression of the scoliosis that makes surgical intervention necessary will be prevented. This study shows no effect of screening for adolescent idiopathic scoliosis on the population rates for adolescent idiopathic scoliosis surgery. As the medical facilities in The Netherlands are very extensive and comparable throughout the country, in particular where treatment of scoliosis is concerned, this factor cannot be of any influence on the results of this study. Therefore, the hypothesis that an active scoliosis screening policy prevents surgical interventions is not supported.

It is unlikely that adolescent idiopathic scoliosis necessitating surgical intervention has a natural history that is different from progressive adolescent idiopathic scoliosis that can be adequately treated with brace therapy alone, if detected early enough. Therefore, it is also unlikely that screening will have a measurable effect in, for instance, ameliorating the daily brace regimen. Moreover, because brace therapy is continued until skeletal maturity has been reached, screening will not affect the total duration of therapy, rather the opposite.

On the basis of these findings we suggest that screening for adolescent idiopathic scoliosis should be reconsidered. To continue screening would represent an unreasonable and disproportionate burden to the already limited resources of preventive health care. Moreover, it can result in mislabelling and, consequently, the inconvenience, financial and emotional cost and potential radiation exposure of needless follow-up evaluations.[5]

As medical care facilities for adolescent idiopathic scoliosis patients in The Netherlands are to a large extent similar to those in other countries, in particular those that have implemented nation-wide screening programmes or are considering doing so, the results of this study could be of significance for those countries as well.

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Table 1 Distribution of cases among the YHC departments in the two determinant categories according to age at which surgery took place

Age	screening	no screening	total
12 years	6	7	13
13 years	15	15	30
14 years	14	27	41
15 years	17	25	42
16 years	8	19	27
17 years	7	9	16
18 years	2	10	12
19 years	0	1	1
TOTAL	69	113	182

Table 2 Odds ratios (95% confidence intervals) for surgery for adolescent idiopathic scoliosis in non-screening YHC departments

	Cases	Controls	Odds ratio (95% CI)
All cases (n = 182)			
Screening	69	413152	
No screening	113	676840	1.00 (0.74-1.34)
Cases with surgery 1 year after possible screening (n = 150)			
Screening	58	413152	

	Cases	Controls	Odds ratio (95% CI)
No screening	92	676840	1.03 (0.74-1.43)