International Journal of Epidemiology
© International Epidemiological Association 1996
Vol. 25, No. 5
Printed in Great Britain

Prevalence and Risk Factors for Asymmetric Posture in Preschool Children Aged 6–7 Years

VIDA JUSKELIENE,* PER MAGNUS,† LEIV S BAKKETEIG,† NIJOLE DAILIDIENE* AND VYTAUTAS JURKUVENAS*

Juskeliene V (Department of Children's Hygiene, Institute of Hygiene, Didzioji 22, Vilnius 2024, Lithuania), Magnus P, Bakketeig L S, Dailidiene N and Jurkuvenas V. Prevalence and risk factors for asymmetric posture in preschool children aged 6–7 years. *International Journal of Epidemiology* 1996; **25:** 1053–1059.

Background. Adult scoliosis can be a severe disease. Not much is known about its determinants and the predictive value of early trunk asymmetries. In Vilnius, Lithuania, a cohort study has been started among 6–7 year old children in 1994. The purpose of the present report was to estimate the prevalence of trunk asymmetry in 6–7 year old children, and the association between previous rachitis, frequent illness during childhood and reduced physical activity and trunk asymmetry.

Methods. The degree of asymmetry was established in 791 children in kindergartens by measuring with a ruler the distance from the seventh cervical vertebra to the lower angles of the left and the right scapulas. Rachitis and the number of illnesses were extracted from each child's medical card, whereas data on physical activity were based on questionnaires filled in by parents and kindergarten teachers.

Results. In all, 46.9% of children were found to have trunk asymmetry. The odds ratio of asymmetric posture was 2.76 (95% confidence interval [CI] : 1.62–4.72) for children with rachitis degree II compared to non-rachitic children, 3.97 (95% CI : 2.48–6.36) for those who were ill 16–28 times (over the years) compared to those who reported fewer than nine illnesses and 2.44 (95% CI : 1.21–4.91) for children with low physical activity level (13–22 points) as compared to children with a high level (>33 points).

Conclusion. These findings indicate the need for prophylactic measures to decrease the incidence of infantile rachitis, acute morbidity and to increase physical activity. The significance of the high frequency of asymmetric posture can only be assessed by a follow-up of this cohort.

Keywords: preschool age children, trunk asymmetry, scoliosis, morbidity, rachitis, physical activity

Idiopathic scoliosis is a structural deformity of unknown aetiology that affects body shape. It usually manifests itself in the period of prepubertal growth. The scientific reports on the prevalence of posture deviations in children are contradictory. Screening for scoliosis at school shows a wide range of prevalence: from 0.3 to 13.6%.[1–7] These differences may partly be due to age differences, but is most likely due to varying definitions of scoliosis and detection methods.

This paper estimates the prevalence and tests hypotheses about causes of asymmetric posture in preschool age children. In the age group under 9, the incidence of scoliosis characterized by a laterally curved vertebral column with axial rotation of the vertebrae is extremely low.[7] However, asymmetric posture may be an early sign of the predisposition to develop scoliosis. Trunk asymmetry is very common. Only 21% of 10 year olds were found to be exactly symmetric as evaluated by the forward bending test.[8] On the basis of screening 265 children (7–18 years old) in a Belgian school, Vercauteren *et al.* proposed a definition of physiological asymmetry differentiating it from structural asymmetry.[9] A 3-year follow-up study of 10–13 year old children who were free from scoliosis at entry, performed in Finland, showed that all kinds of trunk or extremity asymmetry at the prepubertal stage predicted scoliosis.[10] Willner found that every adolescent who developed scoliosis severe enough to need treatment had a visible trunk asymmetry at the age of 10.[11]

However, only a small proportion of children with asymmetric posture will develop scoliosis, since asymmetric posture is so common. In 1993, an investigation of the Vilnius paediatric population (aged 6–7 years) revealed that 43.2% (181/419) had asymmetric posture.[12] The present paper follows up this investigation by testing three causal hypotheses. The three risk factors under study are infantile rachitis, frequent incidence of

* Department of Children's Hygiene, Institute of Hygiene, Didzioji 22, Vilnius 2024, Lithuania.
† Department of Epidemiology, National Institute of Public Health, Gjetmyrsvn. 75, N-0462 Oslo, Norway.

acute diseases and reduced physical activity. We suggest that infantile rachitis could have caused weakness of the bone-muscle system as well as functional posture deviations in preschool age children. Rachitis is primarily a disease of infancy and childhood. The aetiology of rachitis is related to dietary deficiency of vitamin D. The formation of bone is dependent to a great extent on a proper supply of calcium and phosphorus to the bone tissue. In children with rachitis this metabolism is disturbed, and adverse effects of different organ systems, in particular the musculoskeletal system, are observed. There is no precise information on the prevalence of rachitis in Lithuania. However, analysis of medical history cards, carried out by the Children's Hygiene Department of the Hygiene Institute in 1993, showed that rachitis has been diagnosed for 23% of 419 infants born during the years 1987–1988.[12]

Frequently repeating acute diseases in children may lead to a weaker locomotor system. It is not only affected by the disease *per se*, but also by reduced physical activity during illness and convalescence. A study performed by Moscow scientists showed that among 5–6 year olds, one in five children was frequently falling ill, and among 7 year old children—one in ten.[13] In our group of 6–7 year old children studied in 1993, 12.2% were frequently taken ill with acute diseases, defined as having four or more acute diseases per year.[12]

Reduced physical activity—hypokinesia (decreased number and extent of movements) may be conditioned by lifestyle and by passivity during illness. Some authors state that the effect of reduced physical activity on the bone-muscle system is adverse: muscle power decreases as well as static and dynamic endurance and muscle tonus.[13] Thus, physical activity is one of the factors that may affect the posture quality. These hypotheses were tested in a cross-sectional study of 791 children in kindergartens in Vilnius.

MATERIALS AND METHODS

Population

The target population was all children (about 6000) aged 6–7 years attending preschool institutions in Vilnius. These children spend most of the daytime in fairly similar conditions, have the same dietary intake and are educated using the same programmes of mental and physical development. It is estimated that 46% of all 6–7 year olds in Vilnius attend kindergarten. Kindergartens were chosen by systematic sampling from a list of kindergartens taking every fifth in turn. Data collection continued until both groups (children with and without trunk asymmetry) were large enough for the planned analysis. It had been calculated previously that including 612 children (306 with and 306 without trunk asymmetry) would make it possible to detect an odds ratio (OR) of 2 with a prevalence of the exposure of about 20% in the control group. Altogether, 791 children from 34 kindergartens were studied.

Variables

The clinical examination was carried out by two paediatricians belonging to the Children's Hygiene Department at the Hygiene Institute in Vilnius. To ensure correct diagnosis several methods were applied. Posture was examined by looking at the spine from the back, front and side view using a posture grid and a plumb line, with the child in a relaxed upright standing position, paying attention to the symmetric level of the shoulders, scapulae, and to the size of the triangles between the arms and the waistline, and measuring with a ruler the distance from the seventh cervical vertebra to the lower angles of the left and right scapulas. Unequal distances means asymmetric posture. All children were examined at the same period of day (before noon) using the same methods.

Posture grid. The room in which the posture examination was administered had a grid comprised of 2-inch squares on the wall. The vertical lines in the grid extend all of the way to the floor and provide reference points for ascertaining the correct alignment of the body parts. Footprints were marked on the floor in front of the grid to facilitate a correct standing position.[14]

Plumb line. A plumb line is a long string, which is suspended from the ceiling, with a weight attached to the lower end. It is used as a vertical reference point to check the alignment of body parts. When used in the evaluation of posterior and anterior views, the plumb line can be considered the midline or line of gravity for the body. Table 1 shows the anatomical landmarks that the plumb line should crossect in a well-balanced body.[14]

Asymmetrical posture degree I is defined as a child with visible asymmetry, as judged by a well-trained observer using the posture grid and plumb line, for whom the difference between distances measured from the seventh cervical vertebra to the lower angle of the left scapula and to the lower angle of the right scapula is not more than 0.5 cm. Asymmetric posture degree II is defined as a child with visible asymmetry established as above where the scapula difference is more than 0.5 cm. The remaining children were considered to have normal posture.

TABLE 1 *Anatomical landmarks crossed by a plumb line in a well balanced body*

Back view	Side view	Front view
1. Centre of head	1. Earlobe	1. Centre of forehead
2. Centre of spinous processes	2. Tip of shoulder (acromion process)	2. Centre of nose
3. Cleft between buttocks	3. Greater trochanter femus (centre of hips)	3. Centre of chin
4. Centre between knees	4. Posterior to patella alba	4. Centre of linea alba
5. Centre between ankles, i.e. an equal distance between the two medial malleoli	5. About 1½ inches in front of lateral malleolus	5. Centre of umbilicus
		6. Centre of symphysis pubis
		7. Centre between knees
		8. Centre between ankles, i.e. an equal distance between the two medial malleoli

TABLE 2 *Number of children with normal or asymmetric posture degrees I (AP I) and II (AP II) as judged by two independent observers (A and B) in a series of 50 kindergarten children*

		Observer A		
		Normal	AP I	AP II
Observer B	Normal	22	3	0
	AP I	1	10	2
	AP II	0	0	12

Reliability

To evaluate the reliability of the study the degree of asymmetry was judged separately by two investigators for a group of 50 children from two kindergartens (Table 2). These were the same paediatricians who performed the study. There was no case when one investigator estimated normal posture, the other asymmetric posture degree II for the same child. There were some differences when estimating normal posture or asymmetric posture degree I, and asymmetric degree I and degree II. The kappa coefficient was 0.81.

Rachitis

A child was considered to have had rachitis if it had been diagnosed and recorded on the medical card. On the basis of these medical card records two levels of rachitis were established according to severity. Rachitis degree I was used when the record described (in addition to the diagnosis) slight signs of disease with short duration—the child has for instance troublesome, increased sweating, particularly around the head, slight craniotabes or baldness of the occiput. Rachitis degree II was used when the record described signs of advanced rachitis with short or long duration. Softness of the skull may result in flattening and, at times, permanent asymmetry of the head. The anterior fontanel closure may be delayed. There may be enlargement of costochondral junctions (so called pigeon breast deformity appears) or a variety of other thoracic deformities, epiphyseal enlargement of the wrist and ankles or bending of femur and tibia. The muscles may be poorly developed and hypotonic. Eruption of temporary teeth may be delayed.

Incidence of Acute Diseases

All acute diseases (respiratory, gastrointestinal, urinary, and general infectious diseases) were included. Three levels were designated according to the number of times the child had been ill during its lifetime (1–8, 9–15, 16–28). Data on the incidence of acute diseases were collected from medical cards.

Physical Activity

In order to determine the level of present physical activity, questionnaires were given both to parents and kindergarten teachers. The questionnaire included the following questions: 'How agile (active) is the child (very agile, agile, physically active when encouraged, prefers passive activities)?', 'What kind of activities does the child like (running, playing active games, painting, modelling, constructing, watching TV, etc.)?', 'For how long and how often does the child perform these activities?', 'How much time does the child spend outdoors?'. Each item in the questionnaire was scored, global scores were calculated and low (13–22 points), medium (23–32) and high (33–37) levels were determined.

Statistical Method

To assess contingency tables, χ^2-test were used. Crude and adjusted OR were estimated with multiple logistic regression. These OR reflect the relative risk of trunk asymmetry given a certain exposure level in comparison with a reference category of exposure. Since two case groups are defined (trunk asymmetry degree I and

TABLE 3 *Distribution of children according to rachitis by sex*

Gender	Without rachitis	Rachitis I degree	Rachitis II degree
Boys	315 (75.5%)	49 (11.8%)	53 (12.7%)
Girls	302 (80.7%)	49 (13.1%)	23 (6.1%)

II), separate logistic regressions were performed. To evaluate the inter-observer variation, the kappa coefficient was calculated. All analyses were done with the SPSS PC version 6.0.[15] The attributable proportion for risk factors was calculated according to the following formula:

$$p(R-1)/p(R-1)+1,$$

where p is exposure prevalence, and R is the adjusted OR.

RESULTS

Trunk asymmetry was seen in 46.9% (371/791) of the children. In boys, 50.5% (211/417) were asymmetric, while among girls 42.7% (160/374) had asymmetry. The sex ratio, male/female, is 1.18. This difference between boys and girls is statistically significant ($\chi^2 = 4.84$, d.f. = 1, $P < 0.05$). Cases of degree I asymmetry were seen in 24.0% (100/417) of the boys and in 23.3% (87/374) of the girls; cases of degree II asymmetry were seen in 26.6% (111/417) of the boys and 19.5% (73/374) of the girls. Of the children studied, 56.1% were 6 years and 43.9% were 7 years old. There was no significant difference between 6 and 7 year old children with respect to asymmetric posture ($\chi^2 = 1.50$, d.f. = 1, $P > 0.05$).

Analysis of anamnestic data showed that rachitis had been diagnosed for 22.0% (174/791) of infants (during the first 12 months of life); 12.4% (98/791) of children had rachitis degree I, and 9.6% (76/791) degree II rachitis. Table 3 shows the distribution of subjects according to rachitis among boys and girls. Boys had the more severe form of rachitis more often than girls ($\chi^2 = 9.81$, d.f. = 2, $P < 0.01$). The largest proportion of children were given the diagnosis aged 1–6 months —98.7%. Rachitis had been diagnosed for 27.8% (103/371) of children with asymmetric posture and 16.9% (71/420) children with normal posture.

Among children with normal posture, 23.3% (98/420) had experienced illnesses 1–8 times, 56.2% (236/420) 9–15 times, and 20.5% (86/420) 16–28 times. Among children with asymmetric posture 10.2% (38/371) had been ill 1–8 times, 49.3% (183/371) had been ill 9–15 times, and 40.4% (150/371) had been ill 16–28 times.

The lowest physical activity level (scoring 13–22) was reported for 9.8% (41/420) of children with normal posture and for 16.2% (60/371) of children with asymmetric posture. In all 80.2% (337/420) with normal posture and 78.7% (292/371) with asymmetric posture had the middle level of physical activity (scoring 23–32), whereas 10% (42/420) with normal posture and 5.1% (19/371) with asymmetric posture showed the highest activity level (scoring 33–37).

The significant association between trunk asymmetry and risk factors is shown in Tables 4, 5 and 6. The adjusted OR means that each independent variable is adjusted for the effects of the other two variables. The highest OR (3.42) was between rachitis degree II and asymmetric posture degree II and between the highest morbidity level (16–28 times) and asymmetric posture degree II (OR = 4.98) (Table 6).

The attributable proportion (AP) for rachitis was 11.6% (exposure prevalence (p) = 22%, OR = 1.60).

TABLE 4 *Crude and adjusted odds ratios (OR) for asymmetric posture by history of rachitis, number of illnesses and physical activity for 791 kindergarten children aged 6–7 years in Vilnius*

Risk factors		Normal posture	Asymmetric posture	Crude OR (95% CI)	Adjusted OR (95% CI)
Rachitis	no	349 (56.6%)	268 (43.3%)	1.00	1.00
	I degree	49 (50.0%)	49 (50.0%)	1.30 (0.83–2.04)	1.09 (0.70–1.69)
	II degree	22 (28.9%)	54 (71.1%)	3.19 (1.85–5.57)	2.76 (1.62–4.72)
No. of illnesses	1–8	98 (72.1%)	38 (27.9%)	1.00	1.00
	9–15	236 (56.3%)	183 (43.7%)	1.99 (1.29–3.19)	1.94 (1.26–2.97)
	16–28	86 (36.4%)	150 (63.6%)	4.49 (2.77–7.31)	3.97 (2.48–6.36)
Physical activity	33–37	42 (68.9%)	19 (31.1%)	1.00	1.00
	23–32	337 (53.6%)	292 (46.4%)	1.91 (1.06–3.50)	1.51 (0.84–2.71)
	13–22	41 (40.6%)	60 (59.4%)	3.23 (1.57–6.71)	2.44 (1.21–4.91)

TABLE 5 *Crude and adjusted odds ratios (OR) for asymmetric posture degree I by history of rachitis, number of illnesses and physical activity*

Risk factors		Normal posture	Asymmetric posture degree I	Crude OR (95% CI)	Adjusted OR (95% CI)
Rachitis	no	349	138	1.00	1.00
	I degree	49	23	1.19 (0.67–2.09)	1.02 (0.60–1.78)
	II degree	22	26	2.99 (1.57–5.68)	2.73 (1.47–5.07)
No. of illnesses	1–8	98	19	1.00	1.00
	9–15	236	101	2.21 (1.24–3.95)	2.18 (1.26–3.79)
	16–28	86	67	4.02 (2.16–7.55)	3.54 (1.94–6.45)
Physical activity	33–37	42	10	1.00	1.00
	23–32	337	147	1.83 (0.86–4.01)	1.43 (1.02–5.75)
	13–22	41	30	3.07 (1.24–7.74)	2.42 (1.47–2.99)

TABLE 6 *Crude and adjusted odds ratios (OR) for asymmetric posture degree II by history of rachitis, number of illnesses and physical activity*

Risk factors		Normal posture	Asymmetric posture degree II	Crude OR (95% CI)	Adjusted OR (95% CI)
Rachitis	no	349	130	1.00	1.00
	I degree	49	26	1.43 (0.82–2.64)	1.11 (0.71–1.90)
	II degree	22	28	3.42 (1.82–6.45)	3.02 (1.63–5.59)
No. of illnesses	1–8	98	19	1.00	1.00
	9–15	236	82	1.79 (1.00–3.24)	1.75 (1.00–3.06)
	16–28	86	83	4.98 (2.70–9.25)	4.45 (2.45–8.05)
Physical activity	33–37	42	9	1.00	1.00
	23–32	337	145	2.01 (0.91–4.56)	1.47 (1.10–5.53)
	13–22	41	30	3.42 (1.34–8.87)	2.23 (1.48–3.21)

For frequent incidence of acute diseases (16–28 times), AP was 6.2% (p = 29%, OR = 3.97) and for physical activity (score 13–22), AP was 19.7% (p = 17%, OR = 2.44).

There was a significant association between rachitis and frequency of illnesses (χ^2 = 18.97, d.f. = 2, $P < 0.0001$), but there was no association between rachitis and physical activity (χ^2 = 2.59, d.f. = 2, $P > 0.1$). There was a significant negative association between the number of illnesses and level of physical activity (χ^2 = 22.82, d.f. = 4, $P < 0.0005$). The correlation between them was –0.1372, ($P < 0.001$).

DISCUSSION

All three risk factors (rachitis, frequent illness and reduced physical activity) were found to be associated with trunk asymmetry. The highest OR were found for frequent incidence of acute diseases. Adjusted OR have smaller values than crude OR, implying that the independent variables were associated.

About half of the children (46.9%) studied were found to be asymmetric. The sex ratio was approximately the opposite to that reported for structural scoliosis.[1,16] Asymmetric posture is not a disease, and others have also reported a high prevalence of asymmetry.[8,9] It is unknown, however, whether small asymmetries at an early age belong to a normal, physiological variation or whether they are precursors of scoliosis. There are papers indicating a predictive value of asymmetries in the development of scoliosis[10] and early detection as a condition for successful treatment.[1] A follow-up study of children, 10–14 years of age, performed in Malmø showed that among those with very small asymmetries at the age of 10 years (<1 contour line detected by moire topography), no cases later developed an asymmetry of two contour lines or more. In the groups with higher level of asymmetry, some of the cases increased in asymmetry, but the majority of cases were unchanged during a 4-year period of observation. In about one-third of patients a decrease of moire asymmetry was seen (greater tendency to decrease in boys).[11] A 3-year follow-up study of Finnish prepubertal schoolchildren showed that hump size is the most powerful predictor of scoliosis (evaluated in the forward bending test). Large humps were more prevalent among cases in whom scoliosis subsequently developed.[10]

Our study cannot be compared with those mentioned previously, because of younger age, a different method of data collection and therefore a different definition of 'asymmetry'. The main idea in our study was that structural scoliosis results from axial rotation leading to a rib hump. Trunk asymmetry is a stage without axial rotation or with very small rotation, at a stage when a rib hump is not easily seen. Some authors state that 5% of asymmetries could be seen only in the forward bending test.[2,4] Our study methods thus enabled precise measurement of trunk asymmetry and detection of very small rib humps. There are reports that 2.75% (32/1160) of 7 year old school children in Beijing were found to have curves beyond 2 degrees of inclination measures with inclinometer[7] and that 3.5% (18/571) of 6 year old and 2.9% (25/975) of 7 year old school children in China had $\geqslant$10 degree curvature detected by roentgenographic examination.[4] We did not find children with structural scoliosis. This may be due to a selection effect, because children with severe health problems do not attend kindergarten.

The structure of the child health service in Lithuania has features that are favourable for epidemiological studies. Paediatric polyclinics carry out health care for infants and children under the age of 16. The district paediatrician is responsible for supervising the health of children residing in his district. He or she is engaged in prophylactic activities and treatment, and if necessary, children are sent for specialist consultation or to hospitals. A system of prophylactic activities is performed very strictly, especially for infants up to one year of age with the aim of detecting early stages of disease. A paediatrician checks a baby's health at the polyclinics or visits it at home every month during the first three months and every three months after that. Every child in Lithuania has a medical card that is updated every time the child is in contact with a doctor. The card is kept in the polyclinic. In the absence of private medicine, parents only have access to the district physicians. It is routine for parents to go to the doctor every time the child is ill because sick children are not allowed to attend kindergarten. Also, there is a requirement to bring a certificate, indicating diagnosis and duration of disease, from the physician upon return to the kindergarten. An advantage of performing the study in summer and early autumn, as we did, is that the chances of finding a representative sample of children is higher than in winter, when infectious diseases are more common. Health care is free of charge in Lithuania, and a physician can be called on every time the child is ill. Until 1991 parents were entitled to 100% paid sick leave when a child was ill. Over the last three years there may be some lack of information concerning the number of illnesses because medicines have become more available and parents may not seek a doctor every time a child has a minor ailment. The validity of the rachitis diagnosis and the number of illnesses as given on the medical card is not known in detail. However, no differential misclassification with respect to trunk asymmetry is likely, implying that information bias would tend towards the null. The high frequency of rachitis calls for focused clinical research on the content and limits of this diagnosis. It is evident that attention should be paid to some inaccuracies when giving the diagnosis of rachitis (the diagnosis is based on clinical symptoms only, blood analysis or roentgenographic studies are not performed, except in severe cases). Vitamin D is prescribed to all infants prophylactically, but it is not known how complete the intake of these prescriptions is. The results should encourage better efforts for preventing rachitis in Lithuania. Also, measures that can prevent frequent illnesses and programmes that increase physical activity among young children should be encouraged. The present study will be followed by repeated examinations of the cohort, possibly leading to a better understanding of the causes of scoliosis.

ACKNOWLEDGEMENT

The study has been supported by a four-month scholarship under the Cultural Exchange Programs (SEP) from The Research Council of Norway.

REFERENCES

[1] Brooks L, Azen S P, Gerberg E, Brooks R, Chan L. Scoliosis: a prospective epidemiological study. *J Bone Joint Surg* 1975; **57:** 968–73.

[2] Hazebroek-Kampschreur A A, Hofman A, van Dijk A P, van Linge B. Prevalence of trunk abnormalities in eleven year old children in Rotterdam, The Netherlands. *J Pediatr Orthop* 1992; **12:** 480–84.

[3] Ohtsuka Y, Yamagata M, Arai S, Kitahara H, Minami S. School screening for scoliosis by Chiba University Medical school screening program. *Spine* 1988; **13:** 1251–57.

[4] Pin L H, Mo L Y, Lin L *et al.* Early diagnosis of scoliosis based on school screening. *J Bone Joint Surg* 1985; **67:** 1202–05.

[5] Renshaw T S. Screening school children for scoliosis. *Clin Orthop* 1988; **229:** 26–33.

[6] Willner S. Prevalence study of trunk asymmetries and structural scoliosis in 10-year-old school children. *Spine* 1984; **9:** 644–47.

[7] Zhang G P, Li Z R, Wei X R, Cao Y L, Cui Q L. Screening for scoliosis among school children in Beijing. *Chin Med J* 1988; **101:** 151–54.

[8] Nissinen M, Heliovaara M, Tallroth K, Poussa M. Trunk asymmetry and scoliosis. *Acta Pediatr Scand* 1989; **78:** 747–53.

[9] Vercauteren M, Van Beneden M, Verplaetse R, Croene Ph, Uyttendaele D, Verdonk R. Trunk asymmetries in a Belgian school population. *Spine* 1982; **7:** 555–62.

[10] Nissinen M, Heliovaara M, Seitsamo J, Poussa M. Trunk asymmetry, posture, growth and risk of scoliosis. A three-year follow-up of Finnish prepubertal school children. *Spine* 1993; **8:** 8–13.

[11] Willner S. Development of trunk asymmetries and structural scoliosis in prepubertal school children in Malmø: follow up study of children 10–14 year of age. J *Pediatr Orthop* 1984; **4:** 452–55.

[12] Dailidiene N. *Children's Health, aged 6–7 Years. (Vaiku Sveikata 6–7 Metu Amziaus).* Vilnius: Higienos Institutas, 1993, p. 40.

[13] Sucharev A G. *Health and Physical Education of Children and Adolescents* (Zdorovye i Fizitcheskoe Vospitaniye Detey i Podrostkov). Moskva: Meditsina, 1991, p. 272.

[14] Sherrill C. *Adapted Physical Education and Recreation.* Dubuque, Iowa: Wm C Brown Co. 1976, pp. 77–121.

[15] *SPSS PC Version 6.0.* Chicago: SPSS Inc., 1993.

[16] Rogala E J, Drummond D S, Gurr J. Scoliosis: incidence and natural history. *J Bone Joint Surg* 1978; **60:** 173–76.

(Revised version received March 1996)