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Growth and ethnicity in scoliosis

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We analyzed height, weight, and body-mass index of 54,030 male and 38,102 female army recruits who underwent a complete routine health assessment at the age of 17 years. Totally, 6,711 males and 4,864 females were diagnosed as having idiopathic scoliosis and were categorized according to 3 grades of severity. There was a difference in prevalence in both sexes with parental origin from Iraq and western Europe. Females as compared with the males were at increased risk of developing the more severe grades of scoliosis.

Young scoliotic adults were taller, lighter, and thinner than the nonscoliotic controls. These differences in height, weight, and body-mass index correlated with the severity of the scoliosis. We suggest that genetic factors and growth pattern are of major importance for the prevalence of scoliosis.

Knowledge of the relationship between somatic growth and idiopathic structural scoliosis remains conflicting. Nachemson (1971) and Willner (1974) observed taller stature in scoliotic girls when compared with healthy girls, whereas Roaf et al. (1974), Duval-Beaupere (1971), and Burwell et al. (1986) found no differences in height between scoliotic and healthy girls, and Roaf et al. (1974) reported shorter stature in scoliotic as compared with healthy individuals.

Because these above-mentioned studies were confined to preadolescent ages and to a selective population from northwestern European countries where the diet and lack of sunshine can affect bone metabolism (Holick et al. 1980), we have studied the final growth in an unselected group of 17-year-old males and females with scoliosis living in Israel.

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Subjects and methods

We analyzed the military medical records of 54,125 males and 38,185 females who had undergone a complete physical examination at the age of 17 years as part of a routine health assessment in the conscription office. Adolescents suffering from bone or neuromuscular disease that might have any influence on growth were excluded. Thus, 54,030 males and 38,102 females were candidates for the study.

Clinical inspection for asymmetry of the back on bending forward was the test used by a physician to identify scoliosis. All those judged to have asymmetry or who complained of back pain were seen by a trained orthopedist. Radiography of the back was performed according to the orthopedist's decision, based on his impression of the severity of the scoliosis. The severity of scoliosis was then graded according to the following criteria:

Grade A: Adolescents with asymptomatic curvature of less than 20°.

Grade B: Adolescents with curvature of less than 20°, but associated with back pain.

Grade C: Adolescents with curvature of > 20° with or without recurrent back pain. Grade C was determined solely by the orthopedic surgeon.

Table 1. Percentage adolescents with scoliosic according to sex and parental origin

	West Europe n 13 414	East Europe n 4 152	Iraq n 5 573	Morocco n 10 066	Yemen n 3 758	Others n 17 067	Total n 54 030
MALES							
Grade A	12.1**	11.1	12.8***	8.4***	11.9	11.3	11.1
Grade B	1.4	1.3	1.8***	0.8***	1.1	1.1	1.2
Grade C	0.05	0.05	0.11	0.01*	0.05	0.08	0.06
Total	13.5***	12.5	14.7***	9.2***	13.1	12.5	12.4
FEMALES							
	n 11 122	n 2 732	n 4 230	n 6 650	n 2 204	n 11 165	n 38 102
Grade A	11.2	11.7	13.4***	7.3***	11.4	11.5	10.9
Grade B	2.0	2.5	1.8***	1.0***	1.1	1.8	1.7
Grade C	0.22	0.29	0.05	0.15	0.05	0.09	0.15
Total	13.5	14.5*	15.3***	8.4***	12.6	13.3	12.8

*; $P < 0.05$.
**; $P < 0.01$.
***; $P < 0.001$.

Growth parameters studied included height, weight, and body-mass index (weight/height^2).

Because the growth parameters studied differ according to sex and ethnic groups in Israel, a separate analysis was made for each of six ethnic groups (east or west European, Iraqi, Moroccan, Yemenite, and others), except for Grade C because the number of adolescents with Grade C in each ethnic group was as small as 1 to 25. Adolescents from different ethnic groups were examined together and randomly.

Statistical analysis was made using the Student's *t*-test and chi-square test.

Results

The prevalence of Grade A mild scoliosis ranged from 8.4 to 13 percent for the males and 7.3 to 13 percent for the females. The prevalence of Grade B scoliosis ranged from 0.8 to 1.8 percent for the males and 1.0 to 2.5 percent for the females. Lower prevalence of scoliosis was found in males and females whose parents originated from Morocco and a higher prevalence in both sexes with parental origin from Iraq and western Europe (Table 1).

Males and females with scoliosis (Grades A, B,

Table 2. Height, weight, and body-mass index of males and females with scoliosis in comparison with the nonscoliotic controls. Values are mean (SEM)

	Scoliosis grade				
Males	A n 6 023	B n 656	C n 32	Total n 6 711	Nonscoliotic n 47 313
Height (cm)	174±0.9***	174±0.3*	173±1.1	174±0.08***	173±0.03
Weight (kg)	61±0.01***	61±0.4***	58±1.5***	62±0.11***	63±0.04
Body-mass index	21±0.03***	20±0.1***	20±0.4***	21±0.03***	21±0.02
Females	A n 4 101	B n 657	C n 56	Total n 4 814	Nonscoliotic n 33 276
Height (cm)	162±0.009***	163±0.2***	164±0.9*	163±0.09***	162±0.03
Weight (kg)	55±0.11***	54±0.3***	53±0.09***	55±0.11***	56±0.04
Body-mass index	21±0.04***	20±0.1***	20±0.3***	21±0.04***	21±0.002

*; $P < 0.05$.
***; $P < 0.001$.

C) were taller, lighter, and thinner than the respective nonscoliotic adolescent controls, except for males with Grade C scoliosis who were not found taller, but lighter and thinner (Table 2).

These differences in height, weight, and body-mass index correlated with the severity of the scoliosis. The more severely affected adolescents were taller (except for males with Grade C scoliosis), lighter, and thinner as compared with the mild cases.

When the analysis was made separately for each of the six main ethnic groups, similar results were found for body-mass index and weight. In each ethnic group (except for the Iraqi with Grade B scoliosis), the scoliotic adolescents were somewhat taller than the controls.

Discussion

Our study, which is the first to deal with young adults, suggests that even without correction for the deformity, males and females with scoliosis are taller than their respective nonscoliotic controls. These results support the observation of Nachemson (1971) and Willner (1974) and Buric and Momcilovic 1982) about taller stature of scoliotic girls of comparable chronologic age. These data compare less favorably with the observations of Dangerfield and Road (1974), Roaf et al. (1974), and Burwell (1971) who found either no effect of scoliosis on stature or shorter stature in scoliotic girls. However, the fact that these authors did not correct their data on height of scoliotic girls could be a source of considerable error, especially if the groups consist of a rather small number of patients with severe scoliosis. Similarly, Duval-Beaupere (1971) considered girls with postpoliomyelitis scoliosis; therefore, her groups were not homogeneous with respect to idiopathic scoliosis.

We found idiopathic scoliosis to be associated with decrease in body weight and especially with decrease in body-mass index. These changes in weight and index correlated well with the severity of scoliosis and were even more striking than those in height. Drummond et al. (1979) found scoliotics to be even heavier than normals, whereas no difference in body weight was found between healthy and scoliotic girls, as noted by Dangerfield and Roaf (1974) and Willner (1975). Although Willner (1975) noted that when corrected for height, the difference in weight becomes obvious, no apparent consideration for this discrepancy was given by other investigators. In scoliosis screening, there are far too many false positives detected by clinical inspection of the back with the child bending forward (Morais et al. 1985). However, false positive cases were probably not included in our more severe cases where the diagnosis was determined by the orthopedic surgeon and confirmed by radiography of the back, and, nevertheless, the changes noticed in height, weight, and BMI were even more marked.

The prevalence of idiopathic structural scoliosis found in our study was close to that found by other investigators from Israel – 11.8 percent (Keret et al. 1986), 12 percent (Folman et al. 1980) – and from other countries (Brooks et al. 1975, Adair et al. 1977). The sex-specific prevalence of scoliosis and the increased risk of developing the more severe grades in females was also in agreement with other studies (Willner 1974, Keret et al. 1986, Brooks et al. 1975).

Idiopathic structural scoliosis is regarded as mutifactorial in origin. Its development, relation to growth, and progression of the curvature is most likely during periods of rapid growth, particularly around puberty (Burwell 1971).

The prevalence of scoliosis was found to be higher in adolescents with parental origin from Iraq, eastern Europe, and Yemen. Neither height nor weight nor body-mass index could explain the prevalence trend of the different ethnic groups. In fact, adolescents originating from Morocco and and Iraq had the two extreme prevalences of scoliosis, but otherwise had very similar growth parameters. Therefore, it seems that genetic factors influence the prevalence of scoliosis.

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