Comparison of body weight and height between normal and scoliotic children

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Abstract. Aim: The creation of a database with somatometric parameters (body weight and height) from school screening children and the comparison of nonscoliotic children with their counterparts suffering of scoliosis to Cobb angle ≥10° curves.

Material and Method: 3631 screened children where divided in 3 groups. The 1st group comprised normal children with 0° angle of trunk inclination, (ATI). The 2nd group comprised children with ATI ≥1° and ≤ 6°. The third group comprised children with ATI >7° and Cobb angle ≥10°. The mean/median and standard deviation (± 1 SD) of body weight and height, the body mass index (BMI = weight/height²) and the corrected for the scoliotic curve height were calculated by age. Statistical analysis included descriptives (mean, ± 1 SD, median) and Mann - Whitney non-parametric test.

Results: In boys of the 1st and 2nd group 4,25% had obesity (BMI = 30-35), 2,9% severe obesity (BMI = 30-35) and 1,7% morbid obesity (BMI = 40-45) - while 6,4%, 1,9% and 1,3% in girls respectively. In the 3rd group girls, 27,2% were underweight (BMI = 16-20) and 11,3% severely underweight (BMI < 16), while among boys 42% were severely underweight. In the 3rd group there were no obese girls and only 5% obese boys. The comparison of body weight between scoliotic (3rd group) and nonscoliotic children (1st and 2nd group) fails to show any statistical difference.

In the 1st and 2nd group, the girls' mean height is greater than that of boys aged 9 –12 years but less when boys are 13-18 years old. In the 3rd group a mean of 1,15 cm increase is observed after height correction for the scoliotic curve, in boys and 1,3 cm in girls respectively. The comparison of body height (both uncorrected and corrected) between scoliotic and nonscoliotic children fails to show any statistical difference.

Discussion-Conclusions: A variety of findings regarding the stature and weight of AIS children has been published. In this studied Mediterranean sample of the population, the somatometric parameters of height and weight in children with scoliosis, regardless of curve type and site, are not statistically different from their nonscoliotic counterparts.

1. Introduction

The somatometric parameters body weight and height are directly associated with the child’s growth. Since idiopathic scoliosis is a deformity which develops mainly during growth, the above somatometric parameters are potentially related to this deformity. The progression of growth across the various geographical regions is not similar. Therefore, the study of body weight and height in healthy and scoliotic Mediterranean children may be interesting.
The aim of this report is the formation of a database with somatometric parameters (body weight and height) from school screening children and the comparison of the same somatometric parameters of non-scoliotic children with these of their counterparts suffering scoliosis with a Cobb angle of ≥10° curves.

2. Material and Method

2.1 The examined children.
3631 children, 1809 girls and 1822 boys, screened for scoliosis were included in the study. The children were divided into three groups. The 1st group comprised 1592 healthy children, 836 boys and 756 girls, with an 0° angle of trunk inclination, (ATI). The 2nd group comprised 1592 children, 1009 girls and 583 boys, with ATI ≥1° and ≤6°. The 3rd group comprised 63 scoliotics, 19 boys and 44 girls, with a ATI ≥7° and a Cobb angle of ≥10°. Subsequently the children of each group were sorted by age and sex.

2.2 The measurements. The mean body height, and weight with standard deviation (±1SD) and median was calculated for each of the above subgroups of children. The body mass index (BMI) was also measured as body weight divided by height². The corrected for the curve height of the scoliotics was also calculated using the Bjureand Nachemson 1973, formula[1]:

\[ \log_{10} y = 0.011x - 0.177 \]

where \( y \) is the body height loss in cm and \( x \) the Cobb angle of the major scoliotic curve.

The stature meter for measurement of the standing height in cm and a scale with 0.5 Kg increments for the body weight was also used.

The children were divided in relation to their weight according to Bray and Metropolitan Life Insurance classification as follows:
- BMI < 16 severe under-weight children,
- BMI 16-20 under-weight children,
- BMI 20-25 normal children,
- BMI 25-30 overweight children,
- BMI 30-35 obese children,
- BMI 35-40 severe obese children,
- BMI 40-45 morbid obese children,
- BMI > 50 severe morbid obese children.

2.3 The statistical analysis. The techniques used included frequencies, descriptives, (mean, ± SD, Median), Kruskal-Wallis test, Pearson Correlation Coefficient and independent Samples T-test, (SPSS).

3. Results

A. Height.

In the 1st group, figure 1, the girls' mean height is larger in 9-14 years of age. The boys' mean height is larger in 14 years, and after this age the difference is statistically significant.

In the 2nd group, figure 2, the girls' mean height is larger in 10-13 years of age. The boys' mean height is larger following the age of 13 years with a statistically significant difference.
In the 3rd group, figure 3, the mean corrected height is larger for girls in 12-13 years of age compared with the boys matched for age, but this difference is not statistically significant.

Comparing the girls’ height in the three groups, it is noticed that scoliotics are taller but not significantly so than the healthy counterparts, figure 4. The same is also noticed for the scoliotic boys, figure 5.

An increase of 1,15 cm is noticed in the mean height of the scoliotic boys and 1,3 cm of the scoliotic girls respectively, after the correction of the height for the curve.

It is also interesting to note that there is no statistically significant difference for the height (nor for the corrected one) among scoliotics and the healthy groups (1,2) of children by age.

B. Weight.

It is shown that in the 1st group, figure 6, the girls’ mean weight in 9-12 years of age is arithmetically larger than this of boys but not statistically different, while boys’ mean weight is statistically larger from the age of 14 years and afterwards.

In the 2nd group, figure 7, the girls mean weight, from the age of 8 to 12 years, is arithmetically larger than this of boys but not statistically different, while boys’ mean weight from the age of 14 years and afterwards is statistically larger than this of the girls.

Comparing the girl’s weight in the three groups, figure 8, it is noticed that from the age of 8-12 years, scoliotics are heavier compared to their non-scoliotic counterparts but are thinner after the age of 13.

Studying the BMI of the non-scoliotic boys it is shown that 4,25% are obese, 2,9% severe obese and 1,7% morbid obese. Similarly, for the non-scoliotic girls it is shown that 6,4% are obese, 1,9% severe obese and 1,3% morbid obese. The majority of scoliotics have normal BMI and there is no record of obese scoliotic girl in the study population.

4. Discussion

Studying the height, it was found that scoliotic girls are taller compared to healthy counterparts, Willner 1974[24]. On the contrary Duval-Baupere[8] did not report any height difference between scoliotics and healthy children. Buric et al, 1982[4], reported that scoliotic are 5 cm taller than the healthy girls in the studying population, but there was no difference in the weight between them. Dickson and Sevitt, 1982[7], in Britain and Leong et al, 1982, in south China, reported that AIS girls are taller compared to findings for girls from recent studies. Archer and Dickson, 1985[1], reported that the mean girls height suffering AIS with curves measuring Cobb angle ≥ 15°, were significantly larger from the mean height of girls with curves measuring Cobb angle ≤ 15°. Carr et al, 1989[5], found that scoliotics have a loss of height from 0 to 5,3 cm (mean 2,2 cm), when the estimation of height loss is based on the severity of the lateral curve of the spine and the kyphosis /lordosis. The formula they use to estimate the height loss in scoliotics is: CLS + (SSL - SSL normal). They used ISIS for curve assessment. When their measurements were compared to the height loss due to the curve using Bjure – Nachemson’ s 1986[3],
formula, it was found that the height loss was significantly smaller when ISIS was used for curve assessment.

Miraloncar-Dusek et al, 1991[16], showed that scoliotic girls presented higher growth spurt (8.1 cm per year) compared to the healthy girls (7.1 cm per year). They showed a similar growth pattern for boys respectively. Nikolopoulos et al 1985[17], reported that the scoliotics standing height is significantly increased compared with healthy girls. Goldberg et al 1993[9], found that scoliotic girls are taller when they are younger while there was no difference in adolescence. This findings are alike to these of Nordwall and Willner 1975[18], namely there is an auxesis in scoliotics height only in younger age. According to Goldberg’s findings the increased height observed in younger scoliotic children is due to the early adolescent growth spur of these girls with late commencement of IS. This theory is supported by the fact that the mean menarch age was significantly lower compared with the relevant national mean age. Grivas et al 1999[11], reported no difference of the menarch age for the scoliotics and the non scoliotic counterparts, using Mediterranean school screening population. It has been reported that in AIS boys and girls BMI is normal before the development of scoliosis, Nissinen et al 1993[18], and it is decreased during the maturation, Shohat et al 1988[21]. Cole et al[6] found that AIS girls show an increase in all their anthropometric parameters compared to their normal counterparts except in the thorax, where the lateral thoracic diameter is significantly different from normal. The mean stature growth in the preoperative AIS girls is constant, as is reported elsewhere too. Grivas, 1984[10], reported that the healthy girls of 12 years of age are at average taller and heavier than their counterparts. Tsanakas et al 1985[22], using BMI found that in a Greek study population, the obesity percentage for boys is almost constant in all the ages, while in girls it is increased significantly by the age. The same was shown by Bitsioris et al 1995[2] studying a population in Crete island. Mazagroitio et al 1986[15], documenting the national growth patterns, reported that boys show greater growth velocity from the age of 6 to 10,3 years. From the age of 10,3 and then, this pattern is changing and girls present a greater value of this variable of 0,7 cm compared to boys. From 12,3 years of age when girls have attained their maximum of growth spurt, a gradual decrease in this difference is commencing so that at the age of 13 years boys are taller than girls. They also observed an obesity tendency in both sexes in all ages, which is stronger for girls. Kapetanos et al 2000[13], reported a significant difference in height between scoliotics and non-scoliotics, but he did not take into account the height loss due to the curve. It is reported that thin children are more susceptible to develop scoliosis at a percentage of 9%, while in fat children the percentage is 4% (Smyrnis et al 1979[22], Kapetanos et al 1986[12]). A variety of findings regarding the stature and weight of AIS children has been published. As it appears in this studied Mediterranean sample of population, the somatometric parameters of height and weight in children with scoliosis, regardless of curve type and site, are not statistically different from their nonscoliotic counterparts. These findings are in accordance to Duval-Beaupere[8] findings. Coldgerg et al 1993[9], and Willner 1975[25], reported that stature development is independent from the severity of the curve. Normelli et al 1985[20], found that girls with thoracolumbar and double major curves are taller at menarch compared to girls suffering from right thoracic curves.

It must be mentioned that variables as severity, type and site of the curve and the age at diagnosis of scoliosis are not defined in this study population.
References


**Figure 1:** Comparison of boys and girls height in the 1st group. (Line with blue circle represents boys, with red triangle represents girls).

**Figure 2:** Comparison of boys and girls height in the 2nd group. (Line with blue circle represents boys, with red triangle represents girls).

**Figure 3:** Comparison of boys' and girls' corrected height in the 3rd group. (Line with blue circle represents boys, with red triangle represents girls).

**Figure 4:** Comparison of girls' height in the three groups. (Line with blue diamonds represents group 1, with red triangle represents group 2, and with black rectangle represents group 3).

**Figure 5:** Comparison of boys' height in the three groups. (Line with blue circle represents group 1, with red rectangle represents group 2, and with black triangle represents group 3).

**Figure 6:** Comparison of boys' \ girls' weight in the 1st group. (Boys weight is represented by the line with blue diamonds, girls with red triangle respectively).
Comparison of boys' \& girls' weight in the 2nd group.

Figure 7: Comparison of boys' \& girls' weight in the 2nd group. (boys weight is represented by the line with blue diamonds, girls with red triangle respectively).

Comparison of girls' weight among the three groups.

Figure 8: Comparison of girls' weight among the three groups. (Line with blue diamond represents group 1, with red rectangle represents group 2, and with black triangle represents group 3).