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PRIMARY AND SECONDARY SCHOOL CHILDREN OF THE TRI-CITY (GDAŃSK, GDYNIA, SOPOT) IN THE LIGHT OF WEIGHT/STATURE$^2 \times 100$

ABSTRACT — The report presents data concerning the weight stature ($W/S^2 \times 100$) index of children and young people living in one of the big Polish conurbations. The main purpose of the work was to define the percentile values for $W/S^2 \times 100$ of examined groups. 12279 girls and boys from 8 to 19 years of age were examined in 1985 and 1986. As the result the following information was obtained:

1. *The relationship between W/S^2 and age is statistically significant in boys as well as in girls.*
2. *By comparing the marginal age groups of boys and girls, it has been observed that there are over 54 % more common values of W/S^2 for girls than there are for boys.*
3. *In the groups of 8-and 19-year old boys and girls, common values of W/S^2 are exhibited by 16.8 % and 25.6 % of the subjects respectively.*
4. *Values of W/S^2 for the boys and girls we have examined are significantly lower than the values found for the American sample population in all age groups.*

KEY WORDS: Weight/Stature^2 — School Children — Percentile values.

Weight/stature index (W/S^2) is one of the best simple indicators of total body fat (TBF), particularly in girls and women aged from 6 to 50 years. It is also informative as far as 6 to 18 year old boys are concerned (Cronk, Roche 1982; Roche et al. 1981). This indicator exhibits a high correlation with percentage body fat (%BF) and TBF (total body fat) (Roche et al 1981).

The main purpose of this study is to determine:

i. changes in W/S^2 according to age,
ii. differences between boys and girls with regard to W/S^2,
iii. percentile values for the groups under investigation.

MATERIAL AND METHODS

We examined a sample of over 12.000 children from randomly selected primary and secondary schools in the Tri-City (Gdańsk, Gdynia, Sopot in the years 1985 and 1986.

Stature and body weight were measured in accordance with standard methods by means of a sliding-weight scale with a height gauge. The measurements of stature and weight were exact to 0.5 cm and 0.1 kg respectively. The data we obtained were used in calculating the indicator according to the formula $W/S^2 \times 100$, where W was given in kg and S in cm (Taton 1985).

All the data were processed statistically by calculating the arithmetic mean ($\bar{x}$), the standard deviation (SD), the Pearson linear correlation coefficient (r) its significance (p), and the regression equation (y). The coefficient of variation was calculated according to the formula $V\% = SD \times 100/\bar{x}$. Student's t-test was used to determine statistical differences between means. The computing was done on a $TXP-1000$ General Electric computer manufactured in the USA in 1985.

RESULTS

W/S^2 in Girls

Table 1 shows stature and body weight data and W/S^2 for 6450 girls. The dependence of W/S^2 upon age is presented in *Figure 1*, where the data point to a systematic increase in W/S^2 along with the girls' increasing age. This relationship is confirmed by a relatively high Pearson linear correlation coefficient which equals $r_{x,y} = 0.983$. The coefficient is extremely significant at $p < 0.001$.

It follows from the regression equation that in the case of girls and increase in age by one year corresponds to an increase in W/S^2 on the average by 0.00525 kg/cm². A detailed analysis of the data points to a considerable variability of W/S^2. For example, its maximal value for 8-year old girls is 136 % higher than its minimal value, for 10-year olds it is 155 % higher, for 17-year olds 132 % higher, and for 19-year olds it is 71 % higher.

Figure 2 demonstrates changes in W/S^2 in each consecutive age group in contrast to the immediately preceding age group together with the statistical variability of the changes. In each of the eleven 1-*yr* intervals values of W/S^2 are higher than those found in the preceding interval (see also *Table 1*). Yearly changes in W/S^2 in the odlest girls are smallest and statistically insignificant ($p > 0.05$). The most considerable change in W/S^2 is observed in girls aged 13–14 years.

A comparative analysis of the frequency of occurrence of the particular values of W/S^2 for 8-and 19-year old girls is shown in *Figure 3*. What is interesting is the fact that in both 8-and 19-year old girls values of W/S^2 are either particularly high or particularly low. 18.1 % of 8-and 19-year old girls have common values of W/S^2.

W/S^2 in Boys

The data concerning stature and body weight together with the values of W/S^2 for 5825 boys are shown in *Table 2*, and the dependence of W/S^2 upon age is illustrated in *Figure 4*. The dependence is exceptionally strong and the linear correlation coefficient is $r_{x,y} = 0.998$. It follows from the regression equation that in the case of boys an increase in age by one year corresponds to an increase in W/S^2 on the average by 0.00568 kg/cm².

Boys also show a great variability of W/S^2, the maximal value of W/S^2 in the youngest boys being 212 % higher than the minimal value. Older boys exhibit a relative stability in this respect as the maximal values of W/S^2 exceed the minimal ones by 63.6 % in 17-year old boys, by 75.8 % in 18-year olds and by 83.8% in 19-year olds.

Figure 5 illustrates changes in W/S^2 in each age group in relation to the immediately preceding age group and the statistical significance of the changes.

The greatest change occurs in 14-and 16-year old boys, and the smallest in 13-year old boys. In the latter case the change is the only one which does not bear any statistical significance (see also *Table 2*).

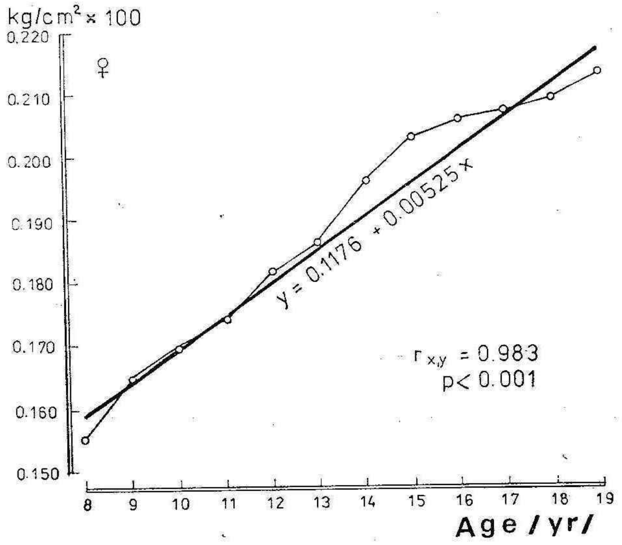


FIGURE 1. *The relation between $W/S^2 \times 100$ and age in girls.*

TABLE 1. *The basic data concerning body height and weight as well as $W/S^2 \times 100$ of girls*

Age (yr)	n	Height (cm)		Weight (kg)		$W/S^2 \times 100$					
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	V %	t	p	%
8	331	125.0	5.3	24.7	4.9	0.1554	0.0224	14.4	—	—	—
9	392	130.7	6.1	28.4	4.8	0.1646	0.0207	12.6	5.696	<0.001	5.9
10	472	136.8	6.2	32.1	5.7	0.1698	0.0226	13 3	3.526	<0.001	9.3
11	557	142.4	7.2	35.7	6.0	0.1735	0.0211	12.2	2.697	<0.01	11.6
12	913	148.3	7.8	40.2	7.1	0.1814	0.0232	12.8	6.704	<0.001	16.3
13	674	154.1	7.5	44.7	7.5	0.1861	0.0232	12.5	3.989	<0.001	19.8
14	548	158.8	6.4	49.8	8.2	0.1954	0.0259	13.3	6.539	<0.001	25.7
15	579	162.4	5.5	53.6	7.2	0.2025	0.0240	11.9	4.766	<0.001	30.3
16	617	162.3	5.4	54.4	6.6	0.2053	0,0216	10.5	2.116	<0.05	32.1
17	559	163.0	5.8	55.2	7.0	0.2065	0.0242	11.7	0.893	>0.05	32.9
18	506	163.1	5.5	55.7	6.8	0.2087	0.0230	11.0	1.797	>0.05	34.3
19	306	163.4	5.2	56.5	6.4	0.2113	0.0212	10.0	1.635	>0.05	36.0

t — values of Student's *t*-test

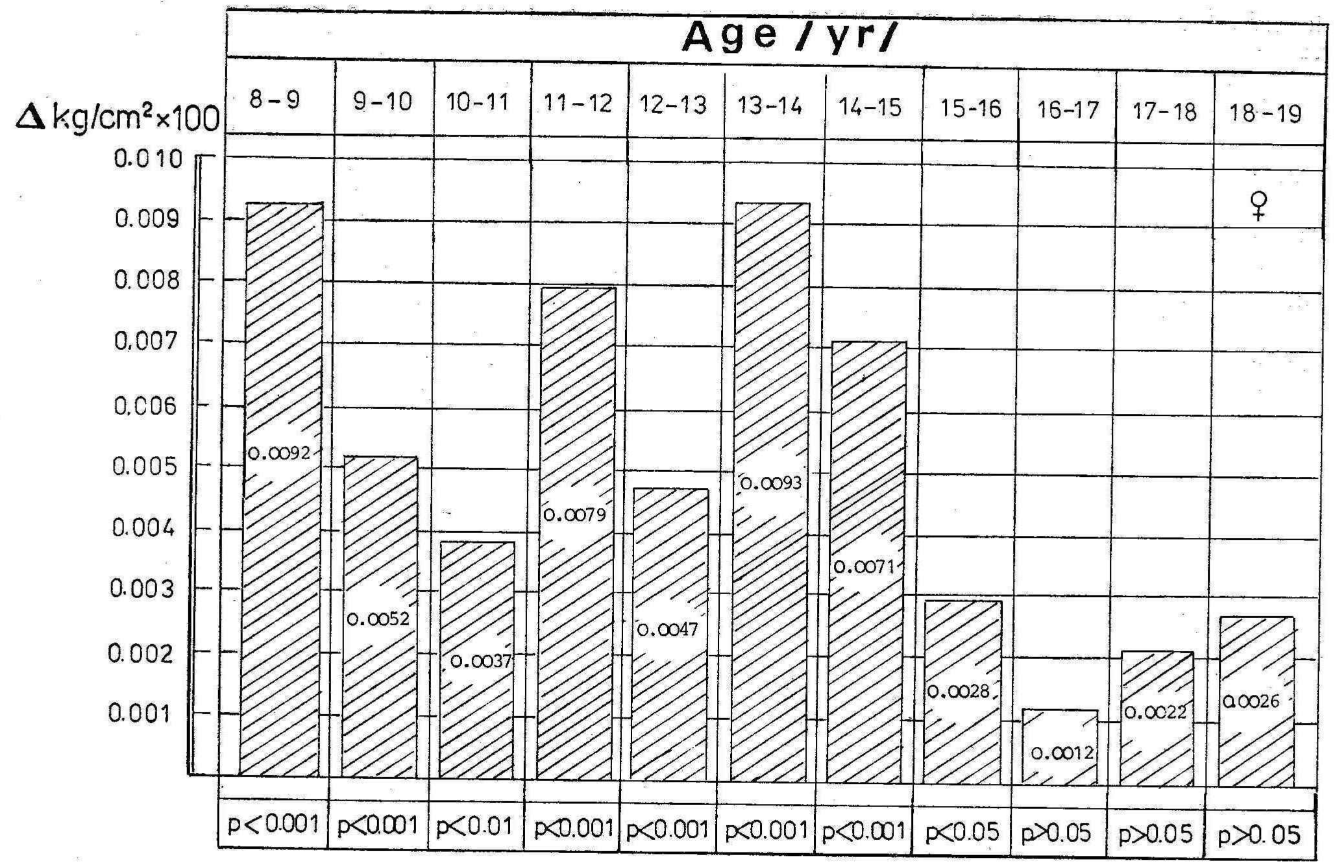


FIGURE 2. *The formation of changes of $W/S^2 \times 100$ in relation to previous group of girls.*

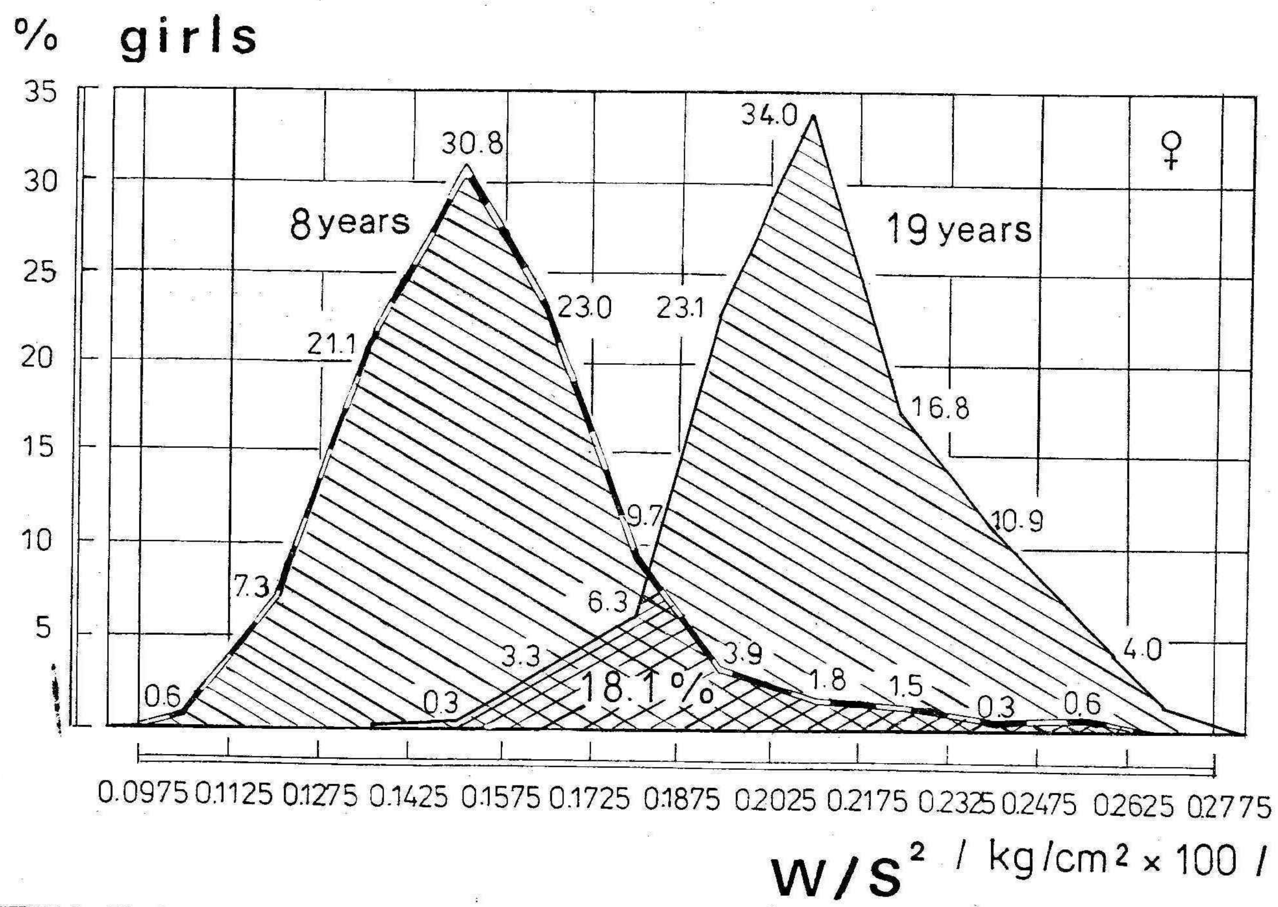


FIGURE 3. *The frequency of different values of $W/S^2 \times 100$ in 8 and 19 years old girls.*

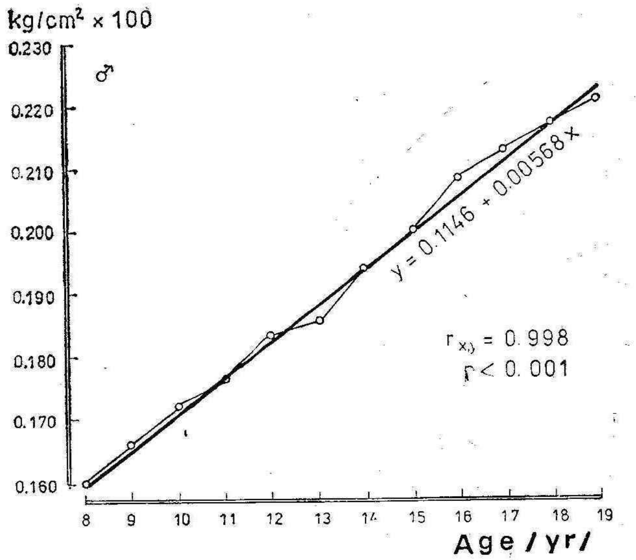


FIGURE 4. *The relation between $W/S^2 \times 100$ and age in boys.*

As far as the differences between the mean values of W/S^2 in girls and boys are considered, we can distinguish three age brackets (*Figure 7*):

i. the 8—12 age bracket, where the values are higher for boys than for girls: 3.0 % higher for 8-year old boys ($p < 0.001$) and 1.7 % higher for 11-year old boys ($p < 0.05$),

ii. the 13—15 age bracket, where the values are slightly higher for girls than for boys ($p > 0.05$),

iii. the 16—19 age bracket, where the values are once again higher for boys than for girls at $p < 0.001$: 3.0 % higher for 17-year old boys, 4.1 % higher for 18-year old boys, and 4.6 % higher for 19-year old boys.

FIGURE 5. *The formation of changes of $W/S^2 \times 100$ in relation to previous group of boys.*

FIGURE 6. *The frequency of different values of $W/S^2 \times 100$ in 8 and 19 years old boys.*

TABLE 2. *The basic data concerning body height and weight as well as $W/S^2 \times 100$ of boys*

Age (yr)	n	Height (cm)		Weight (kg		$W/S^2 \times 100$					
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	V %	t	p	%
8	395	127.1	6.8	26.6	4.3	0.1601	0.0210	13.1			
9	438	131.0	5.9	29.0	4.7	0.1665	0.0194	11.7	4.453	<0.001	4.0
10	463	138.3	6.2	32.2	5.2	0.1721	0.0213	12.4	4.129	<0.001	7.5
11	645	143.3	6.7	36.7	6.2	0.1765	0.0280	15.9	2.970	<0.01	10.2
12	617	148.3	6.6	40.6	6.7	0.1833	0.0232	12.7	4.761	<0.001	14.5
13	612	154.4	7 8	44 5	7.4	0.1856	0.0223	12.0	1.772	>0.05	15.9
14	606	161.0	8.9	50.9	9.2	0.1943	0.0235	12.1	6.626	<0.001	21.4
15	455	167 2	7.9	56.1	9.1	0.1996	0.0240	12.0	3.591	<0.001	22.8
16	462	171.7	7.2	61.6	7.8	0.2080	0.0240	11.5	5.344	<0.001	29.9
17	478	174.2	6.4	65 2	7.3	0.2126	0.0179	8.4	3.338	<0.001	32.8
18	385	176.2	5.9	67.7	7.1	0.2172	0.0180	8.3	3.713	<0.001	35.7
19	269	177.2	5.6	69.7	6.8	0.2211	0.0171	7.7	2.808	<0.01	38.1

t — values of Student's *t*-test

A comparative analysis of the frequency of occurrence of the particular values of W/S^2 for 8-and 19-year old boys is presented in *Figure 6*. Common values of W/S^2, both high and low, occur in 11.7 % of boys aged 8 and 19 years. This means that 88.3 % of 19-year olds exhibit values of W/S^2 higher than those of 8-year olds.

While comparing the values of W/S^2 for boys and girls, it should be emphasized that there is a strong dependence of those values upon age in both sexes and that the dependence is stronger in boys than it is in girls.

By analyzing the coefficients of variation (*Tables 1, 2*), it is possible to state that increasing age, in both boys and girls, is parallelled by a greater stability of W/S^2 though girls display greater liability in this respect.

Although the dynamics of changes with regard to W/S^2 is different in boys and in girls, the fact that W/S^2 always increases in each age group in comparison to the immediately preceding age group pertains to both sexes (*Tables 1, 2, Figures 2, 5*).

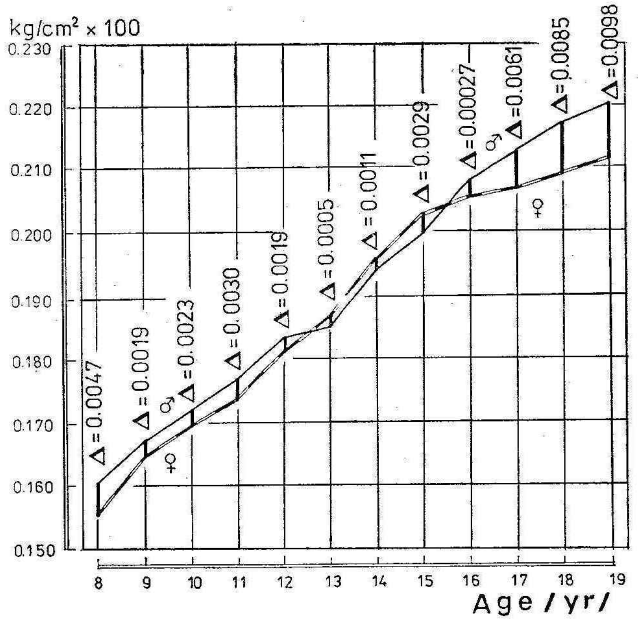
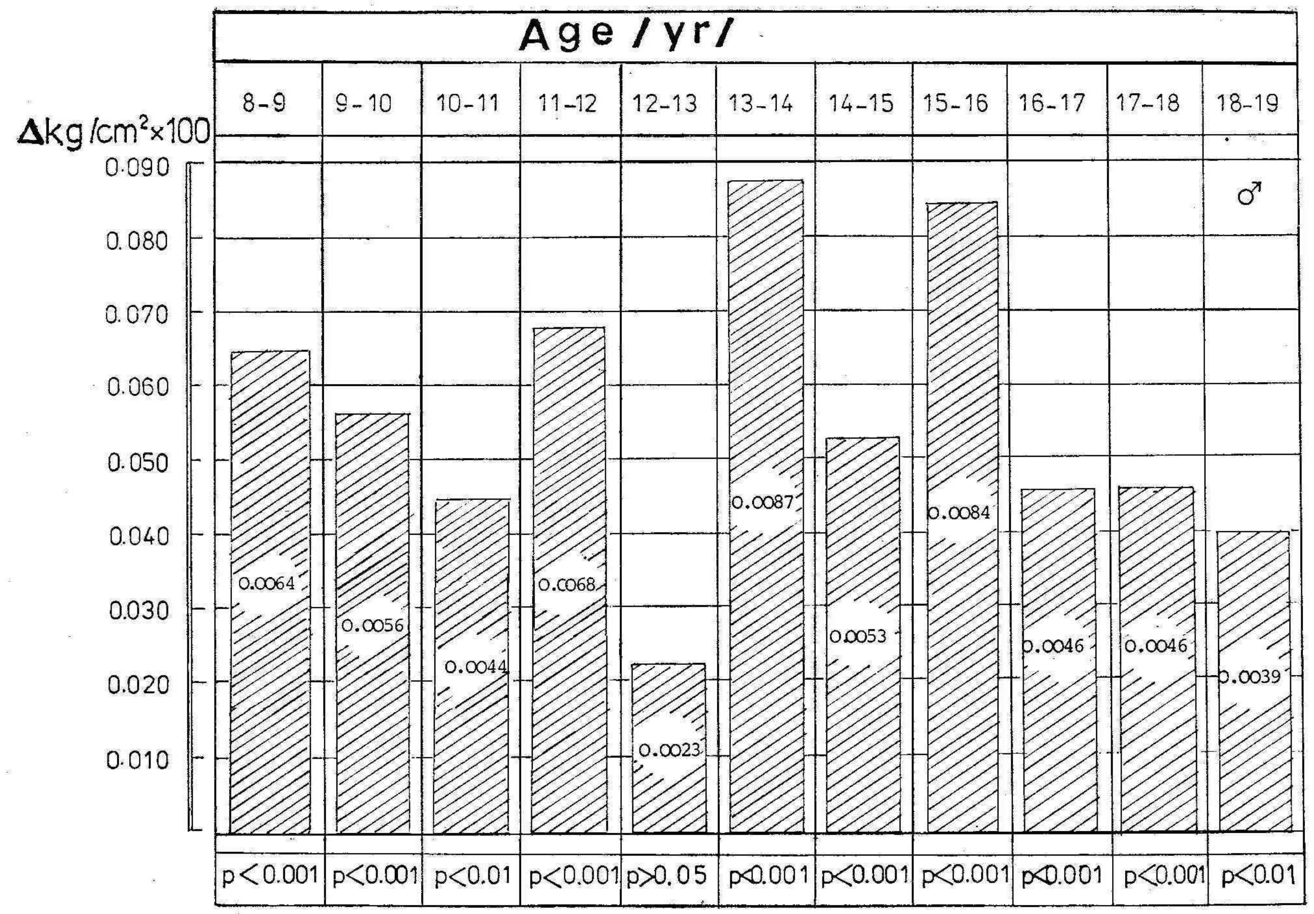
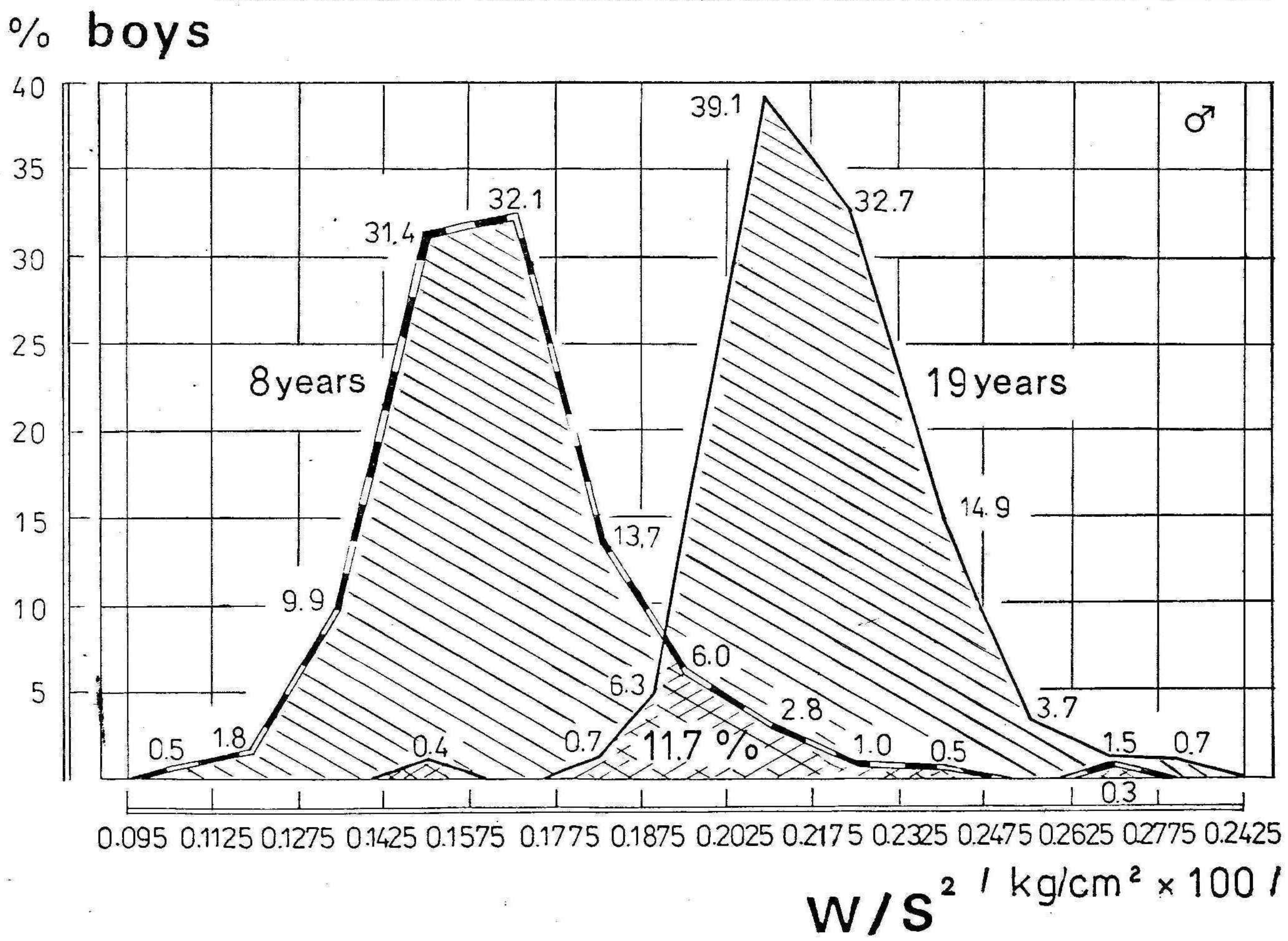


FIGURE 7. *The average values of $W/S^2 \times 100$ for girls and boys and differences in given years.*





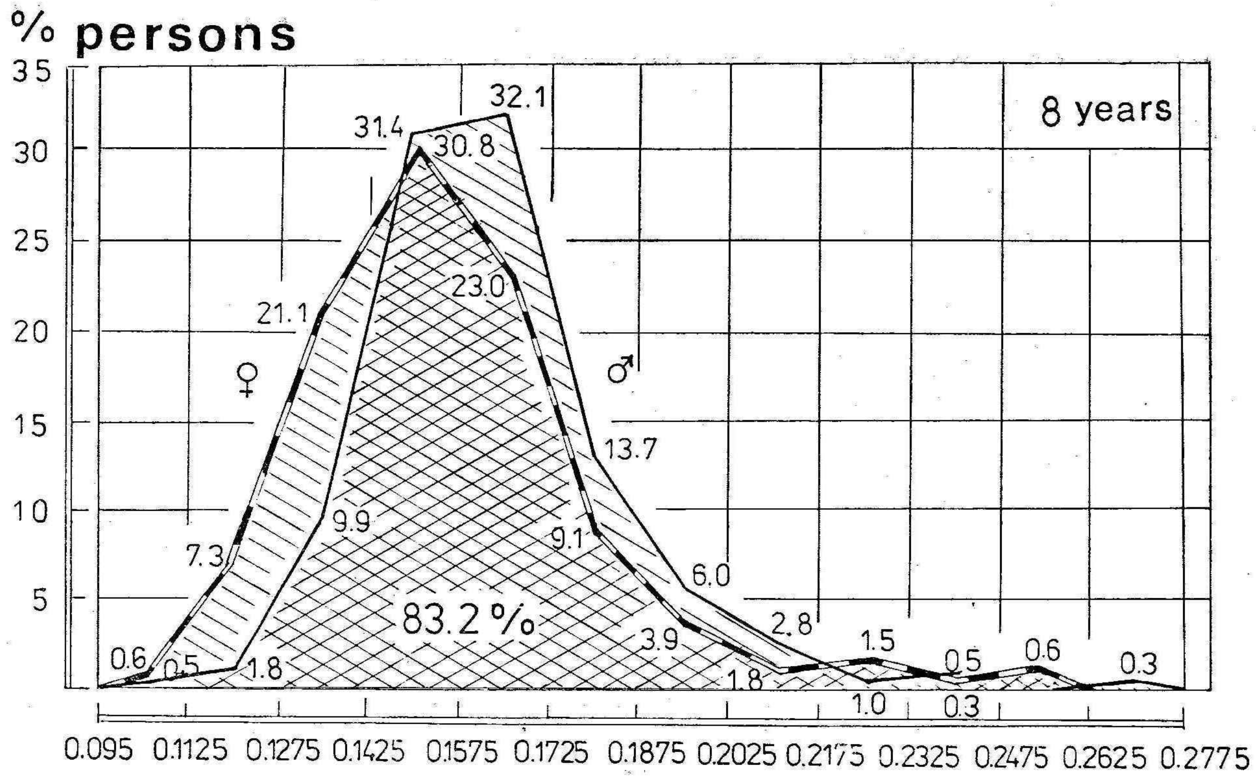


FIGURE 8. *The frequency of different values of* $W/S^2 \times 100$ *in 8 years old girls and boys.*

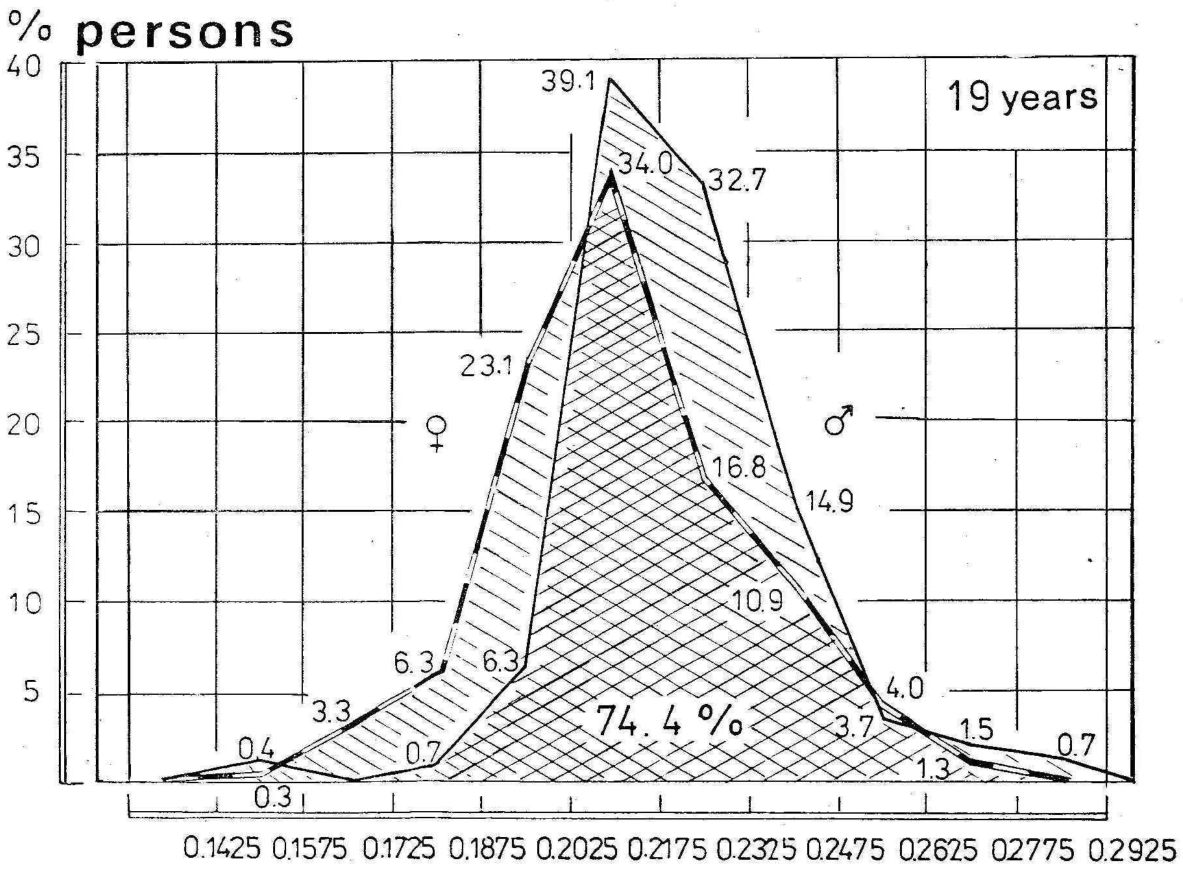


FIGURE 9. *The frequency of different values of* $W/S^2 \times 100$ *in 19 years old girls and boys.*

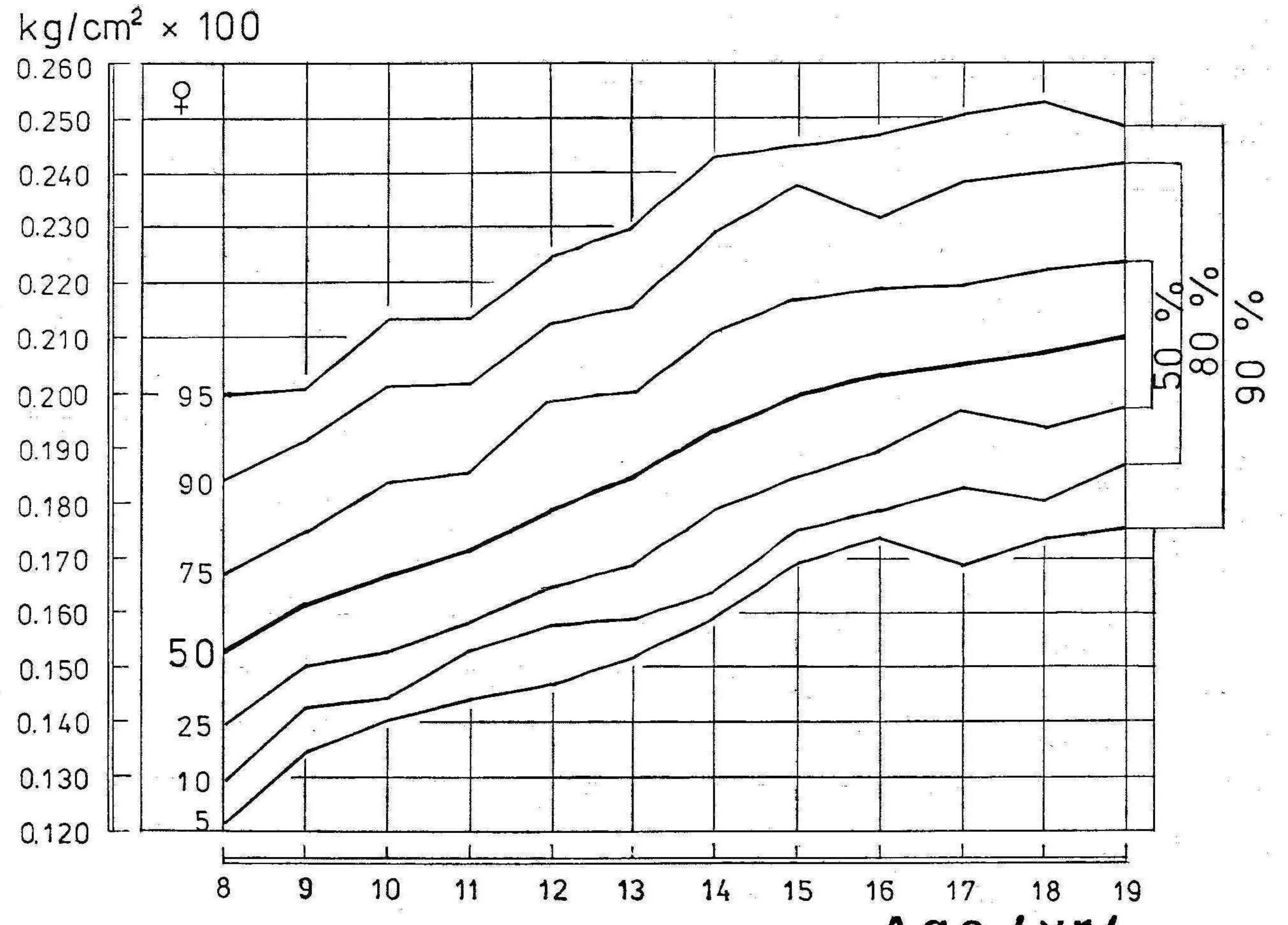


FIGURE 10. *The schedule of percentile values for* $W/S^2 \times 100$ *for girls.*

TABLE 3. *Percentile values for* $W/S^2 \times 100$ *for girls*

Percentile	Age (yr)											
	8	9	10	11	12	13	14	15	16	17	18	19
95th	0.1996	0.2004	0.2134	0.2135	0.2249	0.2296	0.2431	0.2453	0.2462	0.2506	0.2532	0.2486
90th	0.1845	0.1906	0.2008	0.2010	0.2124	0.2150	0.2296	0.2363	0.2316	0.2379	0.2400	0.2410
75th	0.1674	0.1748	0.1838	0.1851	0.1955	0.1999	0.2109	0.2171	0.2190	0.2193	0.2221	0.2246
50th	0.1527	0.1623	0.1663	0.1712	0.1793	0.1843	0.1933	0.1993	0.2035	0.2051	0.2070	0.2100
25th	0.1397	0.1503	0.1525	0.1587	0.1645	0.1686	0.1776	0.1847	0.1899	0.1910	0.1932	0.1973
10th	0.1290	0.1427	0.1447	0.1479	0.1530	0.1588	0.1637	0.1742	0.1782	0.1770	0.1802	0.1876
5th	0.1216	0.1343	0.1405	0 1441	0.1469	0.1514	0.1576	0.1669	0.1738	0.1686	0.1726	0.1758

TABLE 4. *Percentile values for* $W/S^2 \times 100$ *for boys*

Percentile	Age (yr)											
	8	9	10	11	12	13	14	15	16	17	18	19
95th	0.1989	0.2021	0.2135	0.2190	0.2270	0.2253	0.2381	0.2433	0.2446	0.2449	0.2474	0.2513
90th	0.1866	0.1927	0.2008	0.2073	0.2138	0.2113	0.2243	0.2318	0.2337	0.2369	0.2414	0.2434
75th	0.1697	0.1783	0.1843	0.1880	0.1965	0.1985	0.2078	0.2145	0.2206	0.2244	0.2280	0.2306
50th	0.1580	0.1644	0.1689	0.1731	0.1801	0.1838	0.1922	0.1968	0.2069	0.2117	0.2147	0.2191
25th	0.1461	0.1520	0.1570	0.1604	0.1665	0.1699	0.1780	0.1820	0.1931	0.2010	0.2054	0.2093
10th	0.1367	0.1442	0.1469	0.1495	0.1581	0.1593	0.1660	0.1713	0.1817	0.1899	0.1953	0.2035
5th	0.1291	0.1385	0.1435	0.1452	0.1503	0 1520	0.1600	0.1636	0.1763	0.1833	0.1902	0.1967

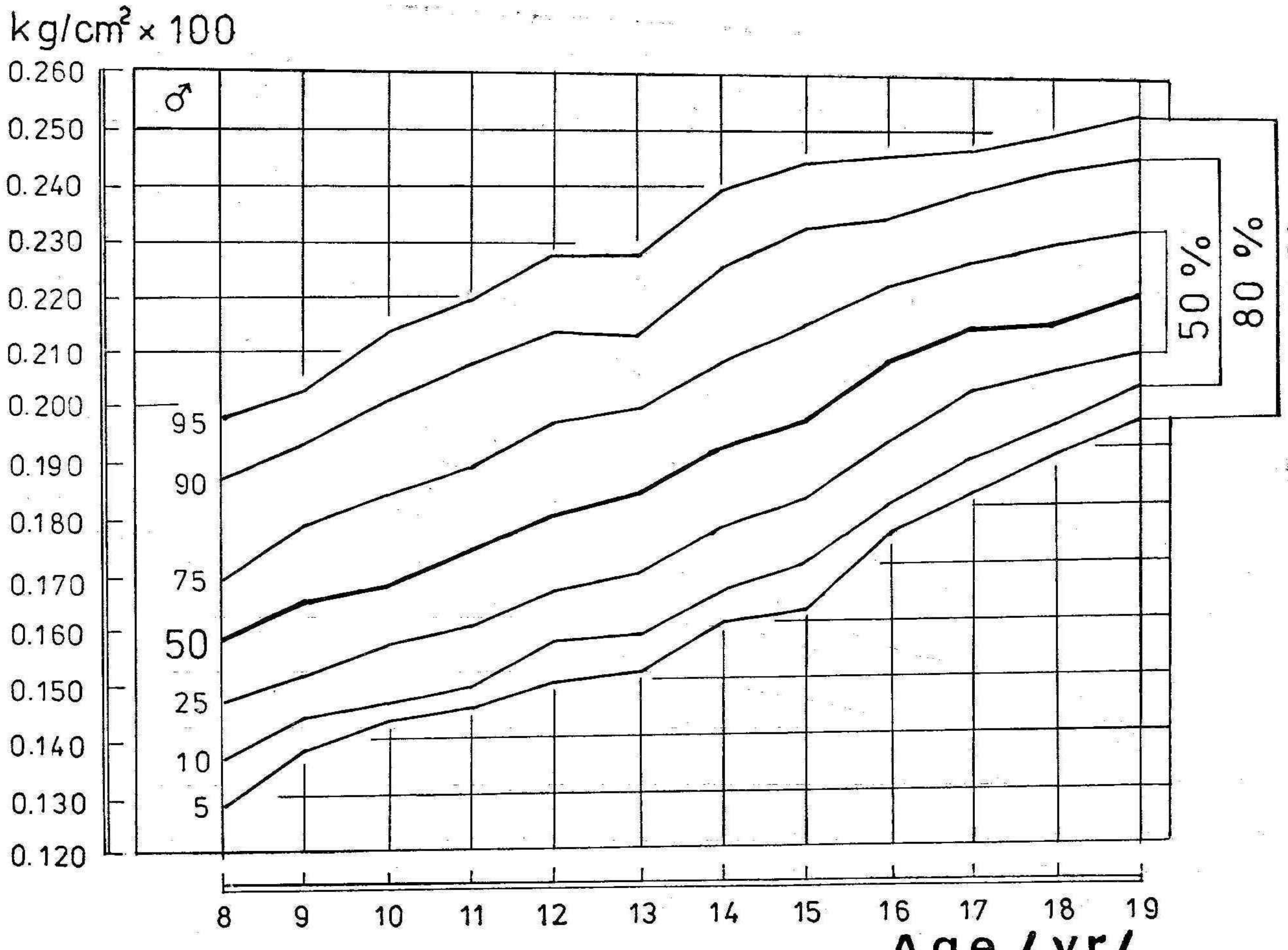


FIGURE 11. *The schedule of percentile values for $W/S^2 \times 100$ for boys.*

The frequency of occurrence of the particular values of W/S^2 for 8-and 19-year olds of both sexes are presented in *Figure 8* and *Figure 9* respectively. It follows from the data that common values of W/S^2 are exhibited by 83.2 % of 8-year olds and by 74.4% of 19-year olds. This means that 16.8 % of 8-year old boys and 25.6 % of 19-year old boys exhibit higher values of W/S^2 than girls at the same age.

Percentile values of W/S^2 for boys and girls are given in *Tables 3 and 4,* and their graphic representation is shown in *Figures 10 and 11.*

In the channel of the 10th to 90th percentile the smallest differences in W/S^2 are exhibited by 9-year old girls, and the biggest differences are exhibited by 14-and 15-year old girls. As far as boys are concerned, the smallest differences occur in 19-year olds and the biggest ones occur in 15-year olds. In the group of 13-to 15-year old girls the mean values of W/S^2 expressed by medians are higher than those in the group of boys at the same age. In the other age groups the medians are higher for boys than for girls.

TABLE 5. *The values of the 50th percentile for $W/S^2 \times 100$ for the Polish and American groups of girls and boys*

Age (yr)	Girls studied			Boys studied		
	by Drabik	by Cronk and Roche	Difference %	by Drabik	by Cronk and Roche	Difference %
8	0.153	0.162	5.9	0.158	0.161	1.9
9	0.162	0.169	4.3	0.164	0.166	1.2
10	0.166	0.175	5.4	0.169	0.171	1.2
11	0.171	0.182	6.4	0 173	0.176	1.7
12	0.179	0.188	5.0	0.180	0.182	1.1
13	0.184	0.193	4.9	0.184	0.188	2.2
14	0.193	0.199	3.1	0.192	0.194	1.0
15	0.199	0.203	2.0	0.197	0.201	2.0
16	0.204	0.207	1.5	0.207	0.208	0.5
17	0.205	0.210	2.4	0.212	0.214	0.9
18 19	0.209	0.216	3.3	0.217	0.230	6.0

Table 5 shows the values of the 50th percentile of W/S^2 for the groups under examination together with the corresponding values for white American boys and girls (Cronk, Roche 1982). Since the 18—20 age bracket is a standard age bracket used in the American study, we have combined 18-and 19-year old subjects into one age bracket giving the mean values of their W/S^2.

Values of W/S^2 for the boys and girls we have examined are significantly lower than the values found for the American sample population in all age groups, especially in the case of girls. We can state that the biggest difference concerns 11-year old girls (values higher by 6.4 %) and 19-year old boys (values higher by 6.0 %), having assumed the relative nature of our comparison in the latter case.

CONCLUSION

1. The relationship between W/S^2 and age is statistically significant in the case of boys as well as girls.
2. The diversification of W/S^2 values in the particular groups proves that there is significant changeability in adiposity and body structure, especially in girls and younger boys.
3. By comparing the extreme age groups of boys and girls, it has been observed that there are over 54 % more common values of W/S^2 for girls than there are for boys.
4. In the groups of 8-and 19-year old boys and girls, common values of W/S^2 are exhibited by 16.8 % and 25.6 % of the subjects respectively.

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