

Spinal Deformities among Pupils – A Growing Issue

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ABSTRACT

This paper presents data obtained by somatic examination of pupils in the 1st, 5th and 8th grade of elementary school in the area of the Town of Split in the period of three school years. There was a corresponding increase in bad posture, over the school years observed, with an increase in kyphosis among pupils of both genders. The occurrence of kyphosis among boys ranged from 0.49% in the first grade, 0.88% in the fifth grade, to 2.11% in the eighth grade. The frequency of kyphosis was at first somewhat lower in girls; however, it significantly increased later, exceeding the frequency among male students. Thus, kyphosis in girls ranged from 0.42% in the first grade, 0.88% in the fifth grade, and even up to 4.60% in the eighth grade of elementary school. Therefore, the ratio of 14-year old girls to boys with kyphosis was 2.2:1. The frequency of scoliosis among boys ranged from 0.55% in the first grade, 2.13% in the fifth grade, and up to 3.01% in the eighth grade. Throughout the whole period, the frequency of this deformity was higher in girls than boys. Thus, scoliosis in female students ranged from 0.89% in the first grade, 3.23% in the fifth grade, and even up to 5.70% in the eighth grade. It is obvious that scoliosis as a deformity affects girls significantly more often than boys during the entire period of elementary school, and the ratio at the age of 14 is 1.8:1.

Key words: bad posture, kyphosis, scoliosis, pupils

Introduction

The period of elementary school is one of the most significant periods for monitoring growth and development. A serious problem in elementary school population refers to spinal deformities. They usually develop in this age group in the puberty growth period. The sensitivity in this age does not reflect merely a medical, but also an economic and social problem. Therefore, it is of interest for both orthopedic specialists, pediatricians and physiatrists, as well as for other school professionals¹. Deviations in structural relations result in reduced motor and functional abilities. Furthermore, due to expressed growth, which is often not accompanied by a sufficient amount of quality kinesiological stimuli, regular morphological development is put at risk².

For centuries humans were under the misconception regarding the etiology and treatment of deformities related to this body part³. As late as since the middle of the last century many interesting changes and innovations in treating spinal illnesses have been introduced. How-

ever, we still have not come any closer to understanding the etiology of scoliosis, whereas the treatment is still based on reversing curvatures. The most frequent spinal changes are acquired deformities that start at the early school age, between the age of 7 and 11. As at that age new and inconvenient strains are imposed to the locomotor system due to spending time at school and sitting for longer periods, and some pupils start their sports activities at that time, the interest of experts in this area is justified⁴⁻⁶. Although sport has positive effects on health, certain sport activities may represent a stimulating factor for the development of spinal deformities. The elementary school period is the time when the locomotor system becomes more sensitive to unfavorable influences, due to the fact that the functional muscle strength stays behind the bone growth rate. Furthermore, various genetic, inborn and acquired external conditions lead to various spinal deformities⁷⁻¹¹.

Spinal deformities may be divided into indicated and expressed deformities. Indicated deformities may be: flat back, roundback, scoliotic posture, bad posture, while expressed deformities are: scoliosis, kyphosis and kyphoscoliosis. Expressed deformities may also be referred to as structural deformities, and are characteristically connected with skeletal system changes that are confirmed by radiography. After the diagnosis is confirmed, the most frequent therapy for expressed spinal deformities includes various surgeries and orthopedic aids. Expressed spinal deformities are diagnosed as scoliosis, kyphosis, kyphoscoliosis and bad posture^{12,13}.

Bad posture or spinal paramorphism may be defined as initial disruption of the biomechanical spine balance. In this phase there are still no changes in skeletal parts, so muscle weakness may be strengthened by means of appropriate exercises and brought into the state of muscle sufficiency with normal spine curvatures^{2,14–16}.

The objective of this paper is to determine the frequency of spinal deformities in elementary school children in the Town of Split. Furthermore, the paper aims at determining possible gender differences in the frequency of observed clinical entities, as well as dynamical spine changes in children during their elementary school development. Expected results may point to the need for an early active approach in the prevention of development or aggravation of observed deformities. An early approach to solving these problems allows for achieving successful results by less radical treatment methods in sensitive population.

Subjects and Methods

This paper presents data obtained by somatic examination of pupils in the 1st, 5th and 8th grade of elementary school in the area of the Town of Split in the period of three school years. Spine was first examined by observing person as a whole, in order to obtain a general picture of posture, constitution and relation of individual body parts. This observation is carried out in the frontal and sagittal plane. The subject is barefoot and naked down to below hips, so from the back side the intergluteal cleft is visible. The assessment of the spinal status was carried out according to clinical criteria.

Although the criteria in the detection of spinal deformities are not completely harmonized, everybody agrees that an early initiation of treatment is of significant importance and a lot of effort is made to find new methods for detecting spinal deformities. Along with the somatic examination, which allows for a certainty percentage amounting to 50% in the diagnostics of spinal deformities, the moiré topography method is used as well. Compared with the x-ray, this method has proven to be successful in 90–100% of cases¹⁷.

The analysis was made during physical examinations of pupils that are routinely and mandatorily carried out three times during the elementary education. The assessment and diagnosis were carried out by specialists in

the treatment of school-age children, taking into account common clinical criteria.

In making the diagnosis exclusively the somatic examination of pupils was used. Further diagnostics and therapy was carried out by physiatrists and orthopedic specialists by using other diagnostic and therapy methods. These methods give an insight and an answer to all diagnostic criteria made, whereat the most accessible and the most objective methodology is selected that is possible to be used within the framework of the treatment of school-age children. Of course, such methodology is not completely reliable and cannot be final. Therefore, in the frequency assessment of individual deformities this fact should be kept in mind and one should be cautious in drawing conclusions.

The statistical data processing of the mentioned variables was carried out in the programme STAT. 6.1 using the contingency table method. The data on the assessment of subjects are shown in tables containing the frequency of individual deformities and the corresponding percentages for each variable (for each examined group and gender). The significance of the difference between groups defined in this way was determined by the χ^2 -test.

Results

Pupils were examined in the course of three school years, namely in the first, fifth and eighth grade. All subjects were divided into age groups (elementary school grades) and according to gender. The number of pupils according to grades and the year of observation are shown in Table 1.

In the observed three-year period the frequency of individual noticed deformities among elementary school pupils in Split was monitored. Table 2 shows the presence of bad posture in boys, whereas Table 3 refers to the presence of bad posture in girls. It may be noticed that bad posture is present in a large number of subjects and increases with age. For that matter no significant differences between genders were observed. The frequency of bad posture ranges between 21% in the youngest pupils and 36% in the oldest subjects (8th grade of elementary school).

The kyphosis frequency among the examined pupils ranged between 0.25% in the youngest subjects and

TABLE 1
SUBJECTS/ELEMENTARY SCHOOL PUPILS IN SPLIT

Elementary school grade	1 st year of observation	2 nd year of observation	3 rd year of observation
	Number of subjects	Number of subjects	Number of subjects
I	5,527	5,443	5,509
V	4,972	5,299	5,018
VIII	5,705	5,446	5,460
Total	16,204	16,188	15,987

TABLE 2
BAD POSTURE FREQUENCY IN BOYS

Elementary school grade	1 st year of observation		2 nd year of observation		3 rd year of observation		Total	
	Number of deformities	%	Number of deformities	%	Number of deformities	%	Number of deformities	%
I	664	23.95	668	24.23	444	16.05	1,779	21.40
V	848	32.80	793	29.20	824	32.50	2,465	31.50
VIII	1,033	36.90	951	34.70	918	33.30	5,367	35.00

TABLE 3
BAD POSTURE FREQUENCY IN GIRLS

Elementary school grade	1 st year of observation		2 nd year of observation		3 rd year of observation		Total	
	Number of deformities	%	Number of deformities	%	Number of deformities	%	Number of deformities	%
I	584	21.21	563	20.96	369	13.45	1,516	18.50
V	746	31.20	707	27.40	862	34.70	3,831	31.10
VIII	1,057	36.30	986	36.40	946	35.00	5,870	36.00

TABLE 4
KYPHOSIS FREQUENCY IN BOYS

Elementary school grade	1 st year of observation		2 nd year of observation		3 rd year of observation		Total	
	Number of deformities	%	Number of deformities	%	Number of deformities	%	Number of deformities	%
I	18	0.65	16	0.58	7	0.25	41	0.49
V	18	0.70	29	1.10	14	0.60	61	0.78
VIII	58	2.10	71	2.60	46	1.70	175	2.11

TABLE 5
KYPHOSIS FREQUENCY IN GIRLS

Elementary school grade	1 st year of observation		2 nd year of observation		3 rd year of observation		Total	
	Number of deformities	%	Number of deformities	%	Number of deformities	%	Number of deformities	%
I	15	0.54	12	0.45	8	0.29	35	0.44
V	24	1.00	21	0.80	21	0.80	66	0.88
VIII	181	6.20	156	5.80	137	5.10	509	4.60

6.20% in the oldest subjects. There is no significant difference between genders in the youngest subjects, but there are significant differences in the oldest ones. Kyphosis is significantly more frequent among girls. Statistical data processing delivered results that clearly point to significant differences that develop within the same gender during the development period between the first and the eighth grade (between the age of 7 and the age of 14), as well as to significant differences between genders. The results are shown in Table 4 and 5.

The scoliosis frequency among the examined pupils ranged between 0.04% in the youngest pupils and 6.20% in the oldest ones. There is also no significant difference

between genders in the youngest subjects, but there are significant differences in the oldest pupils. Scoliosis is significantly more frequent in girls and in this sense the deformity is present at a similar level as kyphosis. Statistical data processing delivered results that clearly point to significant differences that develop within the same gender during the development period between the first and the eighth grade (between the age of 7 and the age of 14), as well as to significant differences between genders. The results are shown in Table 6 and 7.

The deformities development dynamics and differences between genders are clearly presented in Figure 1 and 2.

TABLE 6
SCOLIOSIS FREQUENCY IN BOYS

Elementary school grade	1 st year of observation		2 nd year of observation		3 rd year of observation		Total	
	Number of deformities	%	Number of deformities	%	Number of deformities	%	Number of deformities	%
I	30	1.08	15	0.54	1	0.04	46	0.55
V	58	2.20	58	2.10	51	2.00	167	2.13
VIII	102	3.60	93	3.40	55	2.00	250	3.01

TABLE 7
SCOLIOSIS FREQUENCY IN GIRLS

Elementary school grade	1 st year of observation		2 nd year of observation		3 rd year of observation		Total	
	Number of deformities	%	Number of deformities	%	Number of deformities	%	Number of deformities	%
I	38	1.34	16	0.60	19	0.69	73	0.89
V	96	4.00	89	3.40	56	2.30	141	3.23
VIII	181	6.20	156	5.80	137	5.10	474	5.70

There is a statistically higher percentage of bad posture in boys in the 1st grade compared to girls in the second year of observation ($\chi^2=5.2$; $p=0.024$), third year of observation ($\chi^2=5.5$; $p=0.021$) and first year of observation at the probability level of 95% ($\chi^2=3.75$; $p=0.053$). In the third year of observation a decrease in bad posture is noticed compared with the previous two years both in boys ($\chi^2=70.8$; $p<0.001$) and in girls ($\chi^2=70.4$; $p<0.001$).

There is no statistically significant difference between boys in the 5th grade with bad posture and girls in the first ($\chi^2=0.78$; $p=0.378$), second ($\chi^2=1.16$; $p=0.281$) and third year of observation ($\chi^2=1.4$; $p=0.240$). In the third year of observation an increase in bad posture was noticed compared with the previous two years, both in boys ($\chi^2=10.1$; $p<0.001$) and in girls ($\chi^2=31.8$; $p<0.001$), as well as an increase in the third year compared with the second year of observation in boys ($\chi^2=10.1$; $p<0.001$).

There is no statistically significant difference in bad posture frequency in boys in the 8th grade compared with girls in the first ($\chi^2=1.5$; $p=0.220$), second ($\chi^2=0.82$; $p=0.365$) and third year of observation ($\chi^2=0.94$; $p=0.330$). In the third year a decrease in bad posture was noticed compared with the previous two years ($\chi^2=8.4$; $p=0.015$). In girls no change has been proven ($\chi^2=1.4$; $p=0.496$). The obtained results are shown in Table 8 and Figure 3.

In the first grades for the three observed years statistics showed that significantly more boys had bad posture than girls ($\chi^2=14.3$; $p=0.0002$). In the 5th grade no differences in bad posture ($\chi^2=0.15$; $p=0.702$) were noticed, as well as in the 8th grade ($\chi^2=0.79$; $p=0.737$). The comparison of bad posture in boys in the 1st, 5th and 8th grade in the three observed school years showed a statistically significant increase of this paramorphism in the 8th grade

compared with the previous two, as well as in the 5th grade compared with the 1st grade ($\chi^2=396$; $p<0.001$).

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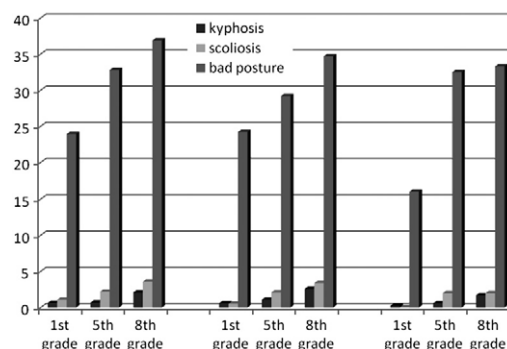


Fig. 1. The frequency of kyphosis, scoliosis and bad posture (%) in boys in the course of the three observed years.

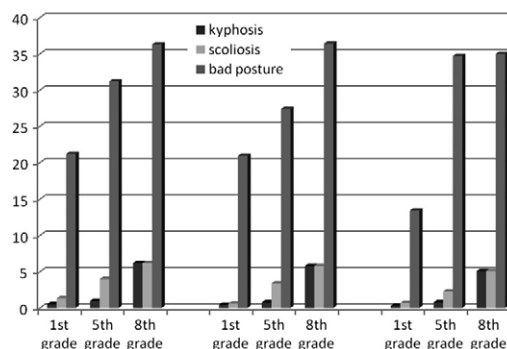


Fig. 2. The frequency of kyphosis, scoliosis and bad posture (%) in girls in the course of the three observed years.

TABLE 8
OVERVIEW OF THE TOTAL NUMBER OF PUPILS AND THE NUMBER OF PUPILS WITH BAD POSTURE ACCORDING TO THE YEAR OF OBSERVATION, AGE AND GENDER

Grade		Number of pupils N (%)					
		Year of observation					
		1 st year		2 nd year		3 rd year	
		Total	Deformity	Total	Deformity	Total	Deformity
1.	Male	2,773	664 (23.9)	2,757	668 (24.2)	2,766	444 (16.1)
	Female	2,754	584 (21.2)	2,686	563 (20.9)	2,743	369 (13.4)
	Total	5,527	1,248 (22.5)	5,443	1,231 (22.6)	5,509	813 (14.7)
5.	Male	2,582	848 (32.8)	2,718	793 (29.2)	2,536	824 (32.5)
	Female	2,390	746 (31.2)	2,581	707 (27.4)	2,482	862 (34.7)
	Total	4,972	1,594 (32.0)	5,299	1,500 (28.3)	5,018	1,686 (33.2)
8.	Male	2,796	1,033 (36.9)	2,739	951 (34.7)	2,760	918 (33.3)
	Female	2,909	1,057 (36.3)	2,707	986 (35.3)	2,700	946 (35.0)
	Total	5,705	2,090 (36.6)	5,446	1,937 (35.6)	5,460	1,864 (34.1)

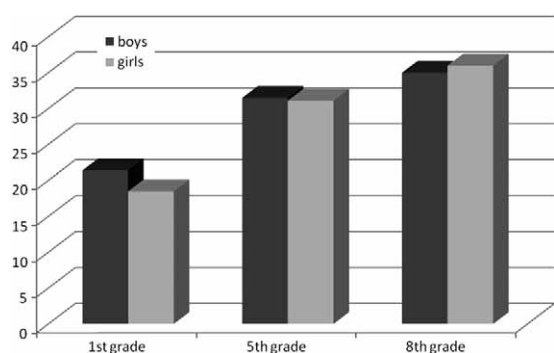


Fig. 3. Bad posture frequency (%) in boys and girls in the 1st, 5th and 8th grade in the period of three years.

statistically significant increase of this paramorphism in the 8th grade compared with the previous two, as well as in the 5th grade compared with the 1st grade ($\chi^2=650$; $p<0.001$).

Discussion and Conclusion

The main objective of providing pupils with health care is monitoring the constant mutual influence between school and education and the child's growth and development. Positive effects on health should be maximally utilized, whereas the negative ones should be eliminated or at least reduced¹⁸.

The health care of school children should primarily be implemented within school as pupils' natural environment^{2,15,16,19}. Regarding some problems that appear frequently, such as bad posture that appears in 30–35% of pupils and has the trend of frequency increase, it should necessarily be intervened at the level of the entire popu-

lation. Therefore, it is necessary that as soon as during the enrollment in the first grade of elementary school the initial state of pupils is assessed as objectively as possible and that thereby one of the initial grounds for planning and programming the gym classes for pupils is determined. The starting point for this is the assumption that school and gym classes constitute a realistic place of possible larger volume and preventive influence. Knowing the features of growth and development is the starting point for all medical areas that deal with prevention and therapy related to illnesses of school children and youth. This also applies to the spinal deformities treatment²⁰.

Spinal deformities also demonstrate a significant prevalence in school population, which encourages efforts of more efficient way of discovering them, preventing their appearance and development, as well as treating them – especially scoliosis. Scoliosis and bad posture in general, as medical problems, require an elaborated statistical processing along with a suitable epidemiological approach to a problem²¹.

Prevalence reports, obtained through researches of other authors, confirm that scoliosis is significantly more frequent than it was assumed, which constantly widens the interest and intensifies the need for information and knowledge that are as accurate as possible and generally acceptable preventive program^{18,22}.

Various statistical data may be found in the available literature regarding the frequency of scoliotic posture and scoliosis. Many authors report on a specific mutual relation between these data, depending on the population in question and distribution according to gender and age, types of scoliosis, etiology (idiopathic or others), whether the scoliosis is functional or structural, the degree to which the spine is curved and the examination method (clinical, rtg, moiré-topography etc.)^{23–26}.

Drobnjak presents the data obtained through physical examination of more than 100,000 pupils in 1961/1962, when 23.18% of bad postures were recorded. Ten years later an increase in bad posture to 30.36% was recorded. Regarding the defined spinal deformities an increase from 5.17 to 7.81%, and in expressed deformities a drop from 2.95 to 1.73% was recorded in the same observed period²⁷.

The standpoints on the scoliosis frequency relations between genders point to a somewhat higher prevalence of juvenile scoliosis in girls compared with boys (2:1), while adolescent idiopathic scoliosis is significantly more frequent in girls, although the proportions significantly differ among various authors^{28,29}.

In order to compare the results of this research, we are mentioning some of the results of similar works done by other authors. Plavec, who monitored 334 pupils during the period between their 7th and 13th year of life, found that in the course of monitoring body posture in most subjects (56.40%) varied from good to bad and vice versa. At the same time, this author presents the fact that in 9.30% of bad postures an improvement in findings was made, while in 6.30% there was a deterioration³⁰. The latest research of spinal deformities in students in the 8th grade in Split, carried out in 2008, recorded bad posture in 38.20% of boys and 42.80% of girls, scoliosis in 3.60%, i.e. 7.10%, and kyphosis in 1.9%, i.e. 1.40%²². Deformity of the spine can sometimes be associated with back pain³¹.

If the aforementioned results are compared with the ones obtained in this research, it can primarily be pointed out that bad posture is the most common among elementary school pupils in Split. This paramorphism demonstrates the trend of frequency increase among pupils from the 1st to the 8th grade of elementary school. In the 1st grade bad posture is more frequent in boys (21.40% : 18.50%). However, during the next five years the frequencies among genders equalize. At the end of the elementary school education bad posture becomes more frequent in girls than in boys (36.00% : 35.00%). Statistical processing points to the significance of differences among pupils in the 1st and 8th grade with a significant frequency increase, especially among girls ($\chi^2=650$; $p<0.001$).

Regarding kyphosis, it has been determined that girls are more susceptible to this type of deformity. As the observed school years have passed, the percentage of kyphosis among pupils of both genders has increased. The appearance of kyphosis in boys ranges between 0.49% in the 1st grade, 0.78% in the 5th grade and 2.11% in the 8th grade. In girls kyphosis frequency is somewhat lower in the beginning, but later it significantly increases and exceeds the frequency in boys. Kyphosis in girls ranges between 0.42% in the 1st grade, 0.88% in the 5th grade and even 4.60% in the 8th grade of elementary school. Therefore, the kyphosis proportion between girls and boys aged 14 amounts to 2.2 : 1.

Scoliosis frequency among boys ranged between 0.55% in the 1st grade, 2.13% in the 5th grade and 3.0% in the 8th

grade. The frequency of this deformity is all the time higher in girls than in boys. Scoliosis in girls ranged between 0.89% in the 1st grade, 3.23% in the 5th grade and even 5.70% in the 8th grade. It is obvious that scoliosis is a significantly more frequent deformity among girls than among boys, during the whole period of elementary school education. The proportion at the age of 14 amounts to 1.8:1. This deformity demonstrates a significant frequency increase as the pupils' age increases, whereby it increases significantly faster in girls than in boys. By comparing the obtained results with the ones obtained by other authors, it may be determined that they are similar and that they point to a large significance of scoliosis among school children.

Bad posture is the most frequent deformity in school children. In the first grades for the three observed school years statistics showed that significantly more boys had this deformity than girls ($\chi^2=14.3$; $p=0.0002$). In later years this difference disappears. By comparing bad posture in boys during their school education a statistically significant increase in this deformity in the 8th grade was determined compared with younger age ($\chi^2=396$; $p<0.001$). The same trend was noticed in girls ($\chi^2=650$; $p<0.001$).

The percentage of kyphosis increases with the age of pupils of both genders. The appearance of kyphosis in boys ranges between 0.49% in the first grade, 0.78% in the fifth grade and 2.11% in the eighth grade. In girls the kyphosis frequency is somewhat lower in the beginning, but later it significantly increases and exceeds the frequency in boys. Kyphosis in girls ranges between 0.42% in the 1st grade, 0.88% in the 5th grade and even 4.60% in the 8th grade of elementary school. The kyphosis frequency proportion between girls and boys aged 14 amounts to 2.2 : 1.

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Considering the obtained results, which point to the fact that bad posture and spinal deformities constitute a serious health and clinical problem among elementary school children in the Town of Split and that preventive, corrective and other therapy measures are to be taken very early, it is important that all society segments become involved in solving these problems. First of all, there is the role of the school that through gym classes has to exert the primary influence on good posture and its preservation. Treatment of school-age children as preventive medical discipline plays a further important role,

as well as the primary health protection, which detect and solve simpler problems at an early stage. Finally, at solving more serious spinal deformities physiatrists and orthopedic specialists should be included as well.

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DEFORMITETI KRALJEŽNICE MEĐU ŠKOLSKOM DJECOM – RASTUĆI PROBLEM

SAŽETAK

Cilj ovog rada bio je utvrditi incidenciju deformiteta kralježnice kod školske djece. Istraživanje je provedeno tijekom jedne školske godine među učenicima prvih, petih i osmih razreda osnovnih škola u Splitu, Hrvatska. Jednako kao i nepravilno držanje kroz promatrane godine školovanja raste udio kifoza među učenicima oba spola. Učestalost kifoze se kreće među dječacima od 0,49% u 1. razredu, preko 0,78% u 5., do 2,11% u 8. razredu. Kod djevojčica je u početku učestalost kifoza nešto niža, ali kasnije znatno raste i nadmašuje učestalost među dječacima. Tako se kifoza kod djevojčica kreće od 0,42% u 1. razredu, preko 0,88% u 5., pa čak do 4,6% u 8. razredu osnovne škole. Stoga je omjer kifoza između djevojčica i dječaka u 14. godini života 2:2:1. Učestalost skolioza kretala se među dječacima od 0,55% u 1. razredu, preko 2,13% u 5. razredu do 3,01% u 8. razredu. Cijelo vrijeme je učestalost ovog deformiteta među djevojčicama veća negoli među dječacima. Tako se skolioza među djevojčicama kretala od 0,89% u 1. razredu, preko 3,23% u 5. razredu do čak 5,70% u 8. razredu. Očito je da je skolioza znatno češći deformitet među djevojčicama negoli među dječacima i to kroz cijelo vrijeme osnovnog školovanja, a omjer u 14. godini života je 1.8:1.