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Body posture in the sagittal plane in young females aged 17 Normative ranges of parameters of physiological curvatures

Postawa ciała w płaszczyźnie strzałkowej, młodzieży żeńskiej w wieku 17 lat Zakresy normatywne parametrów krzywizn fizjologicznych

INTRODUCTION

Data from Statistical Annual of 2006 show clearly that around 7 million children and youngsters study at schools of different types. The vast majority of them take part in organized physical education classes. It means that about 20 % of the population systematically takes advantage of physical activity. Conclusions based on research [Przewęda 1997] related to the fitness of the young generation are summed up by the sentence: "We do not recognize symptoms of potentially dangerous degradation of physical fitness of youth, but it does not mean we agree to accept hypo kinesis in the Polish population". According to data collected by the Ministry of National Education, 500 thousand pupils from grades I-III are covered by the plan of corrective classes devoted to treating body posture defects, scheduled 3 times per week. At the same time it has been estimated that only 25% of pupils who need compensation-corrective classes participate in them. Since 1973 [Zeyland-Malawka 1992], Academies of Physical Education (AWF) prepare students to start implementing tasks given to school corrective classes. The Ministry of Education at that time issued a regulation controlling matters related with organization of corrective activities at school. The number of schools providing such programs and the number of children covered by it has increased, but they still constitute only 15% of those qualified to join corrective dispensary teams, and the present status of the base and specialized staff does not cover even 50% of needs and expectations. Fortunately, the number of children covered by the school corrective program has increased. The authors of the report which has been based on studies conducted as a part of IV subject group CPBP 08.16 consider physical education an initiation to physical culture, underlining that - except for schools and kindergartens - other environments take place in the process of education, such as: families, various social organizations, after school educational-pedagogical offices and mass media.

All the factors affecting the child's body posture could be divided into the stimuli originating from the closest, local and family environments [Pilch T, Lepalczyk I., Ped. Społ., Wyd. Żak, 2002]. The origin of the posture variability should be sought, among others, in the anatomic and physiological conditions of these three environments. The child's body posture can only be evaluated when the child first tries to assume the vertical position. By that time, the spine has already developed the antecurvation within the cervical sector and

the light retrocurvation within the thoracic-lumbar sector. The antecurvation is sometimes subtly visible. small child's back is therefore slightly rounded and rarely flat. The lower limbs slightly bent in the hip and knee joints, the abdomen slightly bulging, the chest withdrawn. Changes in a child's body posture progress slowly. They consist in more and more visible shaping of the antecurvation of the lumbar section of the spine and gradual reduction of the excessive bulging of the abdomen. After 7-8 years, the lumbar antecurvation has already been distinctly shaped. Despite being visibly flattened, the abdomen is still slightly bulging. During this period, the strength of the muscles on both sides of the body significantly increases. With time, the strength of extensors on the right and the flexors on the left greatly increases. It is of particular importance for school children that the strength of the trunk and limbs muscles should grow symmetrically. A weak and dystonic muscular system will not make the spine sufficiently rigid in static positions. Therefore, a children's standing posture is highly labile, "mercurial" [Starosta 1993]. This favours functional and transient asymmetric changes in body part positions. At school age, the strength of muscles from the right is higher than those on the left. The full symmetry has been rarely observed in examination of the ability to tense the muscles of the back. The asymmetry in some children was quite distinct and in those with weak muscle system temporary functional scoliosis occurred [Starosta 1993]. Changes in physiological and lateral curvatures of the spine result from the lifestyle, changes in the body proportions and established balance, and are tested by deviations from the vertical axis. The deviations are the smallest before the age of 9. They intensify until the age of 13 with the growth of lower limbs and lowering the centre of gravity. The deviations decrease after the pubertal spurt [Starosta 1993]. During the school period, until the first signs of puberty appear, the posture is distinctly toned up. It becomes quite tough and springy. During the puberty period the posture deteriorates, signs of mental and physical fatigue appear. The posture becomes negligent and limp. The abdomen becomes bulging, the back is often excessively rounded. The head is bent forwards, which gives an impression that it is too heavy in relation to the neck that supports it. In girls' lower limbs, hyperextension is sometimes observed in the knee joints. During this period girls frequently move their shoulders forwards to hide their growing breasts. As a result, their upper limbs do not hang along the side of the body, but they are moved forwards, which makes the back even more rounded and gives an impression of a sunken chest. The end of the puberty period is the time of reshaping a correct body posture. The lumbar antecurvation of spine is finally formed, the abdomen becomes flat again, and the muscular tissue is intensively growing. The period lasts over ten years. As the growth of various body parts is uneven and changes in proportions which are typical of certain development periods become visible. The changes relate both to the length and the perimeter of the lower limbs and the trunk. The angle of pelvic anteversion and the angles of the spine curvatures also change. The body posture is an important medical problem for three reasons: diagnostics of the health condition, prevention of spine overloading and clinical pathology [Świderski, 1992]. The places which are typically vulnerable to degenerative changes due to an incorrect body postures include: the upper section of thoracic kyphosis (Th5 - Th6), occiput attachment of the back extensors at the site of the greatest cervical lordosis (C4-C5), lordotic lumbar curvature (L5-S1), medial part of a valgus knee, posterior structures of the knee joint with the hyperextension syndrome, tarsal sinus and the internal area in a planovalgus foot. A child's physical development is a complex process, dependent on many factors. None of them can be proven to play a dominant role [Dziak 1990].

The aim of conducted research was to specify the values of parameters characterizing chest kyphosis and loin lordosis in the sagittal plane in the population of 17-year-old females from the province of Warmia and Mazury and to determine uniQue normative ranges of chest kyphosis and loin lordosis.

MATERIAL AND RESEARCH METHOD

The research covered 134 females at the age of 17 from randomly selected schools from the province of Warmia and Mazury. Statistical analysis of the obtained study results was conducted based on those cases in which a doctor did not find any significant defects in body posture.

Research methodology covered measurement of parameters characterizing chest kyphosis and loin lordosis. To assess the value of selected parameters, a computer stand for the evaluation of body posture - a Posture Meter M – was used. The examination methodology and technique conformed to the adopted rules [Mrozkowiak 2003]. The obtained study results, in the form of a spatial, graphic image, enabled a numeral description of the researched parameters to be conducted.

A statistical analysis was carried out to measure Alfa: lumbosacral segment inclination angle, Beta: thoracolumbar segment inclination angle, Gamma: upper thoracic segment inclination angle, KPT+: trunk extension angle, KPT-: trunk bent angle, DKP: length of chest kyphosis, KKP: angle of chest kyphosis, RKP: height of chest kyphosis, GKP+: depth of chest kyphosis, DLL: length of loin lordosis, KLL: angle of loin lordosis, RLL: height of loin lordosis and GLL-: depth of loin lordosis, determining: mean value, -+ mean value, standard deviation, coefficient of variability, -+ standard deviation.

OBTAINED RESULTS

The study of body posture determined the mean values of parameters characterizing chest kyphosis and loin lordosis of the spine, lumbosacral segment inclination angle: 8,34 degrees, thoracolumbar segment inclination angle: 9,32 degrees, upper thoracic segment inclination angle: 9,5 degrees, trunk extension angle: 2,18 degrees, trunk bend angle: 0,64 degrees, length of chest kyphosis: 291,36 mm, angle of chest kyphosis: 161,31 degrees, height of chest kyphosis: 201,56 mm, depth of chest kyphosis: 18,39 mm, length of loin lordosis: 250,59 mm, angle of loin lordosis, 163,02 degrees, height of loin lordosis: 142,41 mm and depth of loin lordosis, 15,31 mm.

The greatest diversification in the obtained measurements occurs in: trunk bend and extension angle: coefficient of variability is, respectively: 191,89 and 95,36, lumbosacral segment inclination angle: 43,73 in depth of loin lordosis: 42,62. The smallest in the angle of chest kyphosis and loin lordosis, respectively: 3,25 i 3,67.

CONCLUSIONS

At the age of 17, the body posture of a female is characterized by: trunk bent to the back and if bent to the front then to a slight extent, nearing angular values. Considerably greater values of length, height and depth of chest kyphosis than of loin lordosis.

The normative ranges of parameters describing chest kyphosis and loin lordosis are presented in figure 1.

Gamma: 6,99 – 12,01 degrees
DKP: 256,07 – 326,65 mm
KKP: 156,07 – 166,55 degrees
RKP: 173,54 – 229,59 mm
GKP+: 11,49 – 25,3 mm

Beta: 5,86 – 12,78 degrees

DLL: 218,91 – 282,27 mm
KLL: 157,04 – 169,0 degrees
RLL: 120,72 – 164,11 mm
GLL-: 8,78 – 21,83 mm

Alfa: 3,69 – 11,98 degrees

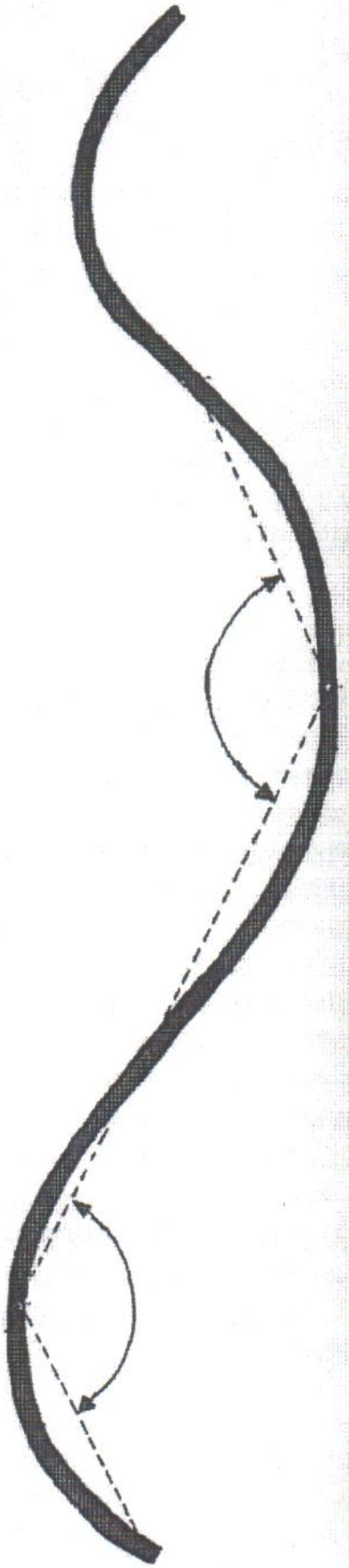

Fig. 1 Normative ranges of parameters describing chest kyphosis and loin lordosis in females aged 17

DISCUSSION

The results of the study and the statistical analysis have provided grounds for determination of the ranges of the optimum values of the thoracic kyphosis angle for each gender and age range, appropriate for the applied measuring instrument. Both the lower and the upper limit of the normative range in both genders have similar and symmetrical values; the differences are statistically insignificant. The absence of significant gender-related differences has been confirmed by other scholars: Lewandowski [2006], Korovessis [1998], Korovessis et al. [2001], Voutsinas and Mac Ewan [1986]. A remarkable feature for the restricting values of the normative range for both genders is the deviation of the diagram for the age of 8 from the general tendency. An increased amplitude can be associated only with the "school age spurt" in children. This has been confirmed in the author's own study [2007], which revealed that there is a rapid increase in the percentage of incorrect postures between the age of 7 and 8, which then decreases slowly until the age of 13. The deviation of the angle in question in girls is slightly greater and is statistically insignificant. The lower extreme in girls is equal to 143.85 degrees and in boys – 145.93 degrees; the upper extreme is equal to 175.07 and 171.11 degrees, respectively. In subsequent years, the values of the upper limit of the normative range in the girls and boys populations decrease and then grow, gradually approaching 160 degrees. It can be assumed that the body posture with the thoracic kyphosis angle which lies within the limits of the normative range will have the qualities of a correct posture; that whose thoracic kyphosis angle lies above the upper limit is one with a flat back and that whose angle lies below the lower limit is a rounded back. A study conducted by Iwanowski [1982] shows that the thoracic kyphosis angle in boys aged 7.5 lies within the range from 163.0 to 172.0 degrees, for a boy aged 14.5 – from 160.0 degrees a to 169.0 degrees; for the girls the ranges are: from 165.0 to 172.0 degrees and from 160.0 to 167.0 degrees, respectively. A study conducted by Łubkowska [2003] shows that the thoracic kyphosis angle in boys aged 7 lies within the range from 156.34 to 174.37 degrees, for a boy aged 15 – from 151.16 degrees to 164.7 degrees; for the girls the ranges are: from 158.69 to 173.36 degrees and from 151.23 to 166.27 degrees, respectively.

Different values of a thoracic kyphosis angle reported by the cited authors result from different measurement system and equipment. A comparison of the studies conducted by Iwanowski [1982], Łubkowska [2003] and Lewandowski [2006], in which the measurements were conducted with a Posturometr M, Sferosomatograf (constructed by Iwanowski) and an Elektrogoniometr, shows that the values of the thoracic kyphosis angle are very similar. Only the values of the angle given by Lewandowski considerably deviate from the other three. The differences result from the choice of method of evaluation of a measuring instrument. It is significant for a thoracic kyphosis angle that the values of the lower and upper extremes of the normative range, dispersed over a relatively small range between the age of 7 and 8, are narrowed down in subsequent years. The upper and lower values are quite close to each other, which indicates high reliability of the Sferosomatograf and Posturometr M measurement methods. Slight irregularities which have been measured should be linked with violent ontogenetic transformations during the period, the secular trend, the population size, regional variability of the body posture and the technical parameters of the measuring instrument. Barczyk [2005] evaluated the thoracic kyphosis angle with a Posturometr M, the achieved values lie within the normative range.

The results of the study and the statistical analysis have provided grounds for determination of the ranges of the optimum values of the lumbar lordosis angle for each gender and age range, appropriate for the applied measuring instrument. The upper and lower limits of the normative ranges are not close to each other and the differences are statistically significant. It is remarkable for the diagram of the values that there is a deviation from the general

tendency during a period from the age of 9 to 10. The higher values of the normative range for boys have not been corroborated by Widhe [2001], Nissinen [1995], Iwanowski [1982] or Łubkowska [2003], whose findings indicate that the angle of lumbar lordosis in the female population is greater. The lowest value of the lower extreme for girls is equal to 173.36 degree at the age of 8; for boys it is 175.07 degree at the age of 11; the upper limits are equal to 156.07 degree at the age of 14 and 157.36 degree at the age of 13, respectively. However, one should note that the upper and the lower extreme for each gender has a similar value.

It can be assumed that the body posture with the lumbar lordosis angle which lies within the limits of the normative range will have the qualities of a correct posture; that whose thoracic kyphosis angle lies above the upper limit is one with a flat back and that whose angle lies below the lower limit is a sunken back.

A study conducted by Iwanowski [1982] shows that the lumbar lordosis angle in boys aged 7.5 lies within the range from 145.0 to 158.0 degrees, for a boy aged 14.5 – from 147.0 degrees a to 162.0 degrees; for girls the ranges are: from 145.0 to 157.0 degrees and from 145.0 to 157.0 degrees, respectively.

A study conducted by Łubkowska [2003] shows that the lumbar lordosis angle in boys aged 7 lies within the range from 145.92 to 163.97 degrees, for a boy aged 15 – from 152.39 degrees to 163.87 degrees; for girls the ranges are: from 148.95 to 167.95 degrees and from 151.78 to 166.27 degrees, respectively.

The different values of a lumbar lordosis angle reported by the cited authors result from different measurement system and equipment. A juxtaposition of the findings of the studies by Barczyk [2005], Iwanowski [1982], Łubkowska [2003], Widhe [2001] and Nissinen [1995] shows that the higher values of the discussed angle in boys cannot be corroborated. It is in a female population that a higher angle of the lumbar lordosis occurs more frequently. Lewandowski [2006] has shown the lumbar lordosis angle in boys aged 9-14 to be higher. Similar tendencies at the age of puberty have been observed by Willner and Johnson [1983], Waddell et al. [1992] , Ng et al. [2001] , Melin et al. [1988, 1992].

Studies conducted by Iwanowski [1982], Łubkowska [2003] and Lewandowski [2006], in which the angle measurements were conducted with a Posturometr M, Sferosomatograf (constructed by Iwanowski) and an Elektrogoniometr, shows that the values of the lumbar lordosis angle are very similar. Only the values of the angle given by Lewandowski considerably deviate from the other three. The differences result from the choice of method of evaluation of a measuring instrument. It is remarkable for the lumbar lordosis angle that the values of the lower and upper limits of the normative range in both genders are dispersed to a relatively low extent. The upper and lower values are quite close to each other, which indicates high reliability of the Sferosomatograf and Posturometr M measurement methods. Slight irregularities are linked with violent ontogenetic transformations during the period, the secular trend, the population size, regional variability of the body posture and the technical parameters of the measuring instrument. Barczyk [2005] evaluated the lumbar lordosis angle with a Posturometr M, and the achieved values lie within the normative range.

LITERATURE

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Tab. 1 Parameters describing body posture in the sagittal plane in females aged 17

Mean values, -+ mean value, standard deviation, coefficient of variability, -+ standard deviation, (n) 134

Feature Number	Feature	Mean value (r)	-+ r	Stand. dev. 4	Coeff. of var.	r – Stand. dev.	r + Stand. dev.
1	Alfa	8,34	0,59	3,64	43,73	3,69	11,98
2	Beta	9,32	0,56	3,46	37,13	5,86	12,78
3	Gamma	9,5	0,4	2,5	26,39	6,99	12,01
4	KPT+	2,18	0,33	2,08	95,36	0,1	4,27
5	KPT-	0,64	0,2	1,24	191,89	0,0	1,89
6	DKP	291,36	5,73	35,28	12,11	256,07	326,65
7	KKP	161,31	0,85	5,23	3,25	156,07	166,55
8	RKP	201,56	4,55	28,02	13,9	173,54	229,59
9	GKP+	18,39	1,12	6,9	37,55	11,49	25,3
10	DLL	250,59	5,14	31,68	12,64	218,91	282,27
11	KLL	163,02	0,97	5,98	3,67	157,04	169,0
12	RLL	142,41	3,52	21,69	15,23	120,72	164,11
13	GLL-	15,31	1,06	6,52	42,62	8,78	21,83

Source: own research

Legend:

Alfa: lumbosacral segment inclination angle (degrees)
Beta: thoracolumbar segment inclination angle (degrees)
Gamma: upper thoracic segment inclination angle (degrees)
KPT+: trunk extension angle (degrees)
KPT-: trunk bent angle (degrees)
DKP: length of chest kyphosis (mm)
KKP: angle of chest kyphosis (degrees)
RKP: height of chest kyphosis (mm)
GKP+: depth of chest kyphosis (mm)
DLL: length of loin lordosis (mm)
KLL: angle of loin lordosis (degrees)
RLL: height of loin lordosis (mm)
GLL-: depth of loin lordosis (mm)

ABSTRACT

The research covered 134 young females aged 17 from randomly selected schools from the province of Warmia and Mazury. At the age of 17, the body posture of a girl is characterized by: trunk bent to the back and if bent to the front then to a very slight extent, with similar angle values. The length, height and depth of chest kyphosis are clearly greater than loin lordosis. Normative ranges of parameters describing chest kyphosis and loin lordosis are presented in figure 1.

STRESZCZENIE

Badaniami objęto 134 dziewcząt w wieku 17 lat, z wybranych losowo szkół regionu Warmińsko - Mazurskiego. Postawa dziewczyny w wieku 17 lat jest o: tułowiu odchylonym w tył, jeśli w zgiętym w przód to w bardzo niewielkim stopniu, zbliżonych wartościach kątowych. Zdecydowanie większych wartościach długość, wysokość i głębokości kifozy piersiowej niż lordozy lędźwiowej. Zakresy normatywne parametrów opisujących kifozę piersiową i lordozę lędźwiową zostały przedstawione na rys. 1.