CHAPTER XVIII

Akademia Wychowania Fizycznego w Poznaniu
Zamiejscowy Wydział Kultury Fizycznej
Gorzów Wielkopolski

MIROSŁAW MROZKOWIAK

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

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

INTRODUCTION

According to demographic forecasts, in 2020 in the Polish population there will be 20,4% of children aged from 0-14 and over two times more (41,1%) of young adults at the post-gymnasium age and adults in the reproductive age. It means that in social policy, we should consider two times greater needs in terms of health protection and physical activity of young adults and adults than of children in the stage of puberty [Przewêda 1997]. Own research [2007] conducted by means of a Posturometer M on populations of 9,744 children and young adults at the age of 4-19 from randomly selected kindergartens, primary schools, gymnasiums and grammar schools from 13 Polish provinces have shown that the greatest percentage of multi-plane asymmetries occurs within the age range from 8 to 10 and significantly less at the age of 7, 11 and 12. The percentage of postures with parameters within the boundaries of accepted standards is the largest at the age of 8, little less at the age of 7, 9 and 10. Detailed analysis of the studies [2007e] has shown that the greatest percentage of posture defects and scolioses among males occurs in the following provinces: podkarpackie: 39,25%, pomorskie: 31,15%, śląskie: 29,04%, mazowieckie: 28,11%, łódzkie: 28,82% and podlaskie: 28,07%. Among females, in pomorskie: 25,88%, warmińsko-mazurskie: 25,58% and małopolskie: 23,1%. In the provinces with the greatest percentage of posture defects and scolioses among males from the age of 6, percentage of boys with defected symmetry of body posture increases from the age of 8 – 9, and then decreases from the age of 10 – 11 to increase again up to the age of 12. In the following years its value gradually decreases. Among the girls from the age of 6, it grows rapidly up to the age of 8, and then up to the age of 12 smoothly decreases its value, to finally decrease rapidly. The greatest percentage of body posture within the boundaries of accepted standards in terms of registered features among males in particular provinces was: podlaskie: 21,05% and małopolskie: 16,4%. Among the females, in: podlaskie: 20,55% and pomorskie 15,61%.

Owing to the unfavourable structure of the skeletal system, 70% of its weight is situated at 2/3 of its height. Maintaining a vertical position which is typical of a contemporary human requires that the moments of external forces, acting on particular passive and active segments, should be balanced. The ability to keep the balance is affected by the morphology and function of the systems: skeletal, muscular, nervous, as well as the base area and the height of the centre of gravity. To put it simply, a human body in a vertical position consists of segments put upon one another, making up a set of reversed pendulums in an unstable equilibrium. Therefore, in this position there is no balance, only the lost balance is constantly regained. Among the reasons there are breathing movements of the chest (0.3 – 0.5 Hz), muscular tremor (7-14 Hz), heartbeat (0.9-1.3 Hz) and the movements which adjust the body posture (0.05 – 0.2 Hz) [Wit 1999].

While the static habitual posture was being maintained, action currents were recorded. Hallebrandt [1997] showed that if the condition of maintaining the centre of gravity within the base area is met, a human body in a standing position makes constant oscillating movements. Such micromovements and swayings in particular joints are accompanied by alternating tensing of antagonistic muscles which stabilises the joints. A close relationship has been found between the amplitude and frequency of the swaying movements and the change in muscle tonus. According to Sherrington, the essence of the tonus are static spontaneous reactions to stretching, which depend on the asynchronous character of the stimuli triggered by various stretching receptors and on asynchronous and spontaneous discharging of stimuli along the motion routes of the spinal cord to the muscles. [after White, Penjabi 1978]. This results in the confirmed fact of alternating and non-simultaneous occurrence of periods of rest and activity of various muscular fibres, which ensures energy saving [Kasperczyk, Pelczar 1999].

Active and passive control processes are used in maintaining the upright body posture. Some of them are related to maintaining the body posture, others with the minimisation of the effects of a loss of balance in a specific position and/or back to the previous posture, or with assuming another. The most typical feature of balance disorders is an increased amplitude of the body leaning in the frontal and sagittal planes, which brings the vertical line from the centre of gravity close to the edge of the supporting base. If this is crossed, the body may fall. Maintaining the body posture is regulated by the nervous system, which is informed about a threat to stability by the receptors of the organs of balance, sight, skin and proprioreceptors of muscles and joints [Zeyland - Malawka, 1999a].

Studies conducted on children aged 6 to 18 have shown the absence of any relationship between the parameters taken for analysis, which characterise the equilibrium, and the degree of somatic development [Lebiedowska, 1997]. This indicates an independence of the conditions of support of forces of the base reaction on foot, but as the foot length and width increases, the conditions of maintaining balance while standing improve as the distance between the extreme points of the supporting plane increases, thereby reducing the risk of the latter being crossed by the centre of gravity. Research has revealed a stabilising effect of a visual feedback on the posture control mechanism. As the supporting rectangle is reduced, the body movements become more intensive, which still deteriorates the conditions of maintaining the upright posture. Maintaining balance while growing is possible by improved cooperation of antagonistic muscle which serve, for example, the tarsal joint, which improves the conditions of stability. This seems to have been corroborated in studies whose findings indicate that children of this age group have mastered functional patterns and they are only scaled by their body size [Album et al. 1976].

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 gender has 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 a 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 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 – 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.

The different thoracic kyphosis angle values reported by the cited authors result from different measurement systems and equipment. A comparison of the studies conducted by Iwanowski [1982], Łubkowska [2003] and Lewandowski [2006], in which the measurements were conducted with 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 the high reliability of the measurement methods, Sferosomatograf and Posturometr M. Slight irregularities which have been measured should be linked with violent ontogenetic transformations during the period, the secular tendency, 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, and achieved values which 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 the 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.

Different values of a lumbar lordosis angle reported by the cited authors result from different measurement systems 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 Posturometr M, Sferosomatograf, constructed by Iwanowski, and 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 measurement methods, Sferosomatograf and Posturometr M. 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 achieved values which lie within the normative range.

The aim of conducted research was to specify the values of parameters characterizing chest kyphosis and loin lordosis in sagittal plane in population of 17-year-old males 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 123 males 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 - The examination methodology and technique conforms to the adopted rules [Mrozkowiak 2003]. The obtained study results in form of a spatial, graphic image enabled to conduct a numeral description of the researched parameters.

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 enabled to determine mean values of parameters characterizing chest kyphosis and loin lordosis of the spine, lumbosacral segment inclination angle: 6,63 degrees, thoracolumbar segment inclination angle: 9,86 degrees, upper thoracic segment inclination angle: 11,5 degrees, trunk extension angle: 2,08 degrees, trunk bend angle: 0,52 degrees, length of chest kyphosis: 326,13 mm, angle of chest kyphosis: 158,75 degrees, height of chest kyphosis: 229,55 mm, depth of chest kyphosis: 20,57 mm, length of loin lordosis: 263,38 mm, angle of loin lordosis, 164,35 degrees, height of loin lordosis: 145,16 mm and depth of loin lordosis: 17,9 mm.

The greatest diversification in the obtained measurements occurs in: trunk bend and extension angle: coefficient of variability is, respectively: 221,64 and 91,9, lumbosacral segment inclination angle: 45,93 in depth of loin lordosis: 42,67. The smallest in the angle of chest kyphosis and loin lordosis, respectively: 3,38 and 3,33.

CONCLUSIONS

At the age of 17, the body posture of a male is characterized by: trunk slightly bent to the back and if bent to the front then to a very slight extent. Definitely the length, depth and height of chest kyphosis are greater than of loin lordosis. The angle of chest kyphosis is smaller than of loin lordosis.

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

Gamma: 8,38 – 14,63 degrees
DKP: 285,94 – 366,33 mm
KKP: 153,39 – 164,11 degrees
RKP: 196,8 – 262,3 mm
GKP+: 12,73 – 28,41 mm

Beta: 6,49 – 13,22 degrees

DLL: 232,4 – 294,37 mm
KLL: 158,87 – 169,82 degrees
RLL: 123,41 – 166,92 mm
GLL-: 10,26 – 25,54 mm

Alfa: 3,58 – 9,68 degrees

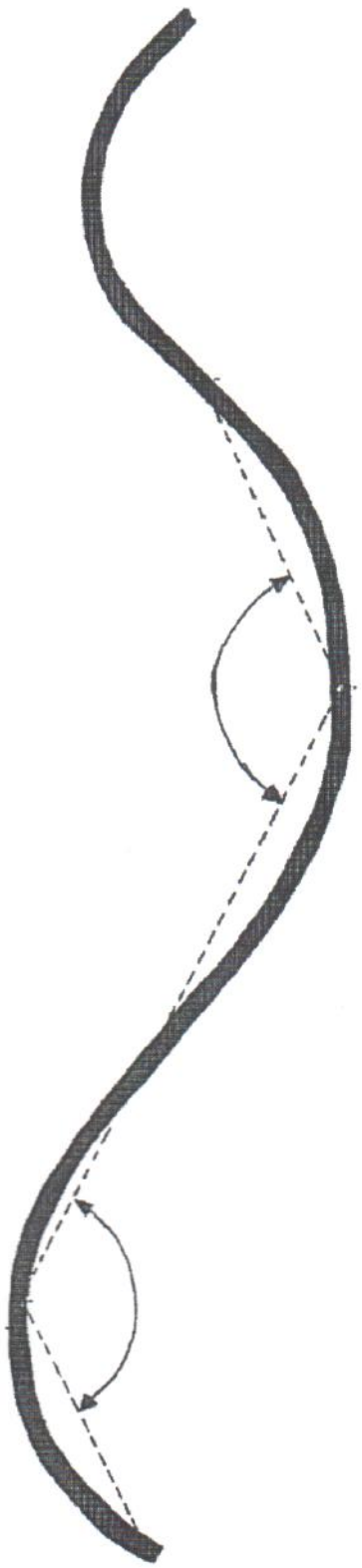

Fig. 1 Normative ranges of parameters describing chest kyphosis and loin lordosis in males aged 17

LITERATURE

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

Mean values, -+ mean value, standard deviation, coefficient of variability, -+ standard deviation, (n) 123

Feature Number	Feature	Mean value (r)	-+ r	Stand. dev. 4	Coeff. of var.	r – Stand. dev.	r + Stand. dev.
1	Alfa	6,63	0,58	3,04	45,93	3,58	9,68
2	Beta	9,86	0,64	3,36	34,11	6,49	13,22
3	Gamma	11,5	0,59	3,12	27,15	8,38	14,63
4	KPT+	2,08	0,36	1,91	91,9	0,16	3,99
5	KPT-	0,52	0,22	1,16	221,64	0,0	1,69
6	DKP	326,13	7,66	40,19	12,32	285,94	366,33
7	KKP	158,75	1,02	5,35	3,38	153,39	164,11
8	RKP	229,55	6,24	32,74	14,27	196,8	262,3
9	GKP+	20,57	1,49	7,84	38,12	12,73	28,41
10	DLL	263,38	5,91	30,98	11,77	232,4	294,37
11	KLL	164,35	1,04	5,47	3,33	158,87	169,82
12	RLL	145,16	4,14	21,75	14,99	123,41	166,92
13	GLL-	17,9	1,45	7,64	42,67	10,26	25,54

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 (Debres)
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 123 young males aged 17 from randomly selected schools from the province of Warmia and Mazury. At the age of 17, the body posture of a boy is characterized by: trunk slightly bent to the back and if bent to the front then to a very slight extent. Definitely the length, height and depth of chest kyphosis are greater than of loin lordosis. The angle of chest kyphosis is smaller than of loin lordosis. Normative ranges of parameters describing chest kyphosis and loin lordosis are presented in figure 1.

STRESZCZENIE

Badaniami objęto 123 chłopców w wieku 17 lat, z wybranych losowo szkół regionu Warmińsko - Mazurskiego. Postawa chłopca w wieku 17 lat jest o tułowiu lekko odchylonym w tył, jeśli w zgięciu w przód to w bardzo niewielkim stopniu. Zdecydowanie długość, głębokość i wysokość kifozy piersiowej jest większa niż lordozy lędźwiowej. Kąt kifozy piersiowej jest mniejszy niż lordozy lędźwiowej. Zakresy normatywne parametrów opisujących kifozę piersiową i lordozę lędźwiową zostały przedstawione na rys. 1.