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Body build of children and youth with cerebral palsy

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Abstract

The material consists of the results of anthropometric measurements of 16 somatic traits of 155 children and youth (83 boys and 72 girls) at the age of 7–18 years. The analysis of *z*-score values showed that the low body height, narrow hips, laterally flattened chest and low body mass, in spite of slight differences make boys and girls with cerebral palsy more similar to one another with respect to body proportions than to their healthy peers.

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Introduction

Cerebral palsy (*paralysis cerebralis infantum*) is a term used for a chronic, non-progressive disorder of the central motor neurons, which is a consequence of abnormal development of brain damage in pregnancy or during the delivery. There is no dependence between the etiology and the clinical picture of the illness. A significant factor in this case is the level of development and maturity of the central nervous system at the time when it is affected by harmful stimuli, such as serologic incompatibility, prematurity, anoxia, intracranial and intracerebral haemorrhage, or meningitis. The frequency of occurrence of cerebral palsy is estimated at 2 promille, which means that about 1400 children are born with this disease every year [ŁOSIOWSKI, SEREJSKI 1985].

Cerebral palsy is not a separate disease entity, but a clinically heterogeneous complex of symptoms, the most important of which is the dysfunction of the kinetic system. Motor disturbances can have different forms depending on the kind, location, extent and degree of intensity of such symptoms as: spasticity, flaccidity, dyskinesia (atetosis), ataxia, paralysis and paresis. They can affect four limbs (tetraplegia), three limbs (triplegia), two limbs (hemiplegia – diplegia), or only one (monoplegia). It often happens that defects in motor activity are accompanied by disturbances of eye-movement coordination, visual and auditory analysis and synthesis, sensibility, swallowing and chewing, as well as mental deficiency and epilepsy [MICHAŁOWICZ 1986].

The estimation of physical development of children and youth with cerebral palsy poses many specific problems. From the scanty information in professional literature [SPIONEK 1981, MICHAŁOWICZ 1986, KAISER-GRODECKA

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1987, CAMPBELL *ET AL.* 1989] we can draw the conclusion that the body height of the persons suffering from this disease is usually lower than that of their healthy peers. It may be the result of the abnormal formation of spinal curvatures, especially lumbar lordosis or strong lower limb contractures. Patients with a mixed type of cerebral paralysis usually show the tendency to obesity, whereas those with severe cases of spasticity are hypotrophic.

The purpose of the research was to find out whether there were differences in body dimensions between individuals with cerebral palsy and their healthy peers and to what degree these differences depended on the sex, age and degree of motor activity dysfunction.

Material and methods

The material consists of the results of single anthropometric measurements. The subjects were 155 children and youth (83 boys and 72 girls) at the age of 7–18; pupils and patients of 11 educational and health care institutions from the Warsaw district. The evaluation of body build was based on the measurements of 16 somatic traits (see fig. 1, tables 2, 3) and was presented in the form of standardized values (*z*-score values) with reference to the arithmetic mean and standard deviation of a random sample of children and youth from Warsaw [KURNIEWICZ-WITCZAKOWA *ET AL.* 1981] as well as all-Polish data [NOWAK 1985]. The data obtained in this way make possible the use of the entire material independently of age categories.

In 7, 11–12 and 15–16 years old examined children with cerebral palsy the authors evaluated the level of development (in %) to healthy population at the age of 18 years.

Results and discussion

The analysis of *z*-score values (fig. 1, table 2 – boys, table 3 – girls) showed significant differences in body build between the group with cerebral palsy and their healthy peers. The differences concern all the analysed measurements and the majority of them deviate in the negative direction, considerably exceeding the value of – 1 SD. The result is a direct consequence of the distribution of individual values of somatic traits within percentile grids of the reference population [KURNIEWICZ-WITCZAKOWA 1981, NOWAK 1985]. As follows from table 1, the somatic traits considerably exceed the limits in healthy children.

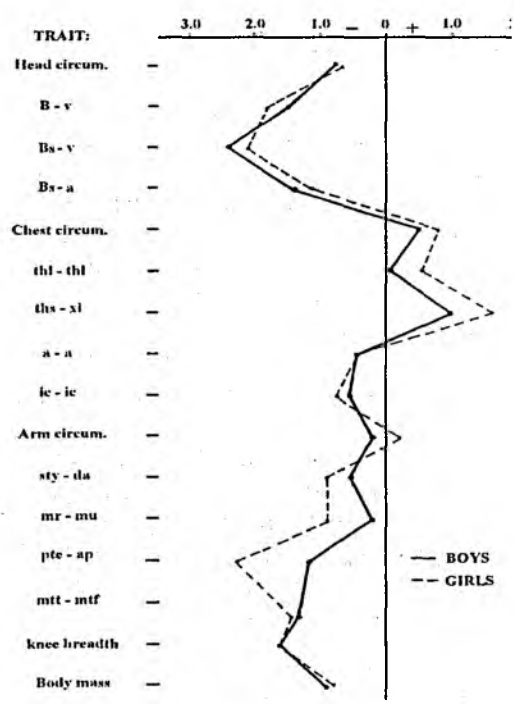

Fig. 1. *z*-scores of somatic traits of boys and girls with cerebral palsy; whole material

Table 1. Distribution frequency (in %) of boys and girls with cerebral palsy according to category of development standard

Trait	Sex	Standard deviations						
		+3	+2	+1	–1	–2	–3	
B–v	Male	–	–	–	32	36	22	10
	Female	–	–	–	40	30	30	–
Knee breadth	Male	–	–	–	32	34	28	6
	Female	–	–	2	36	25	23	14
ic–ic	Male	–	–	7	41	30	14	8
	Female	–	–	8	50	22	20	–
thl–thl	Male	–	8	11	61	19	–	–
	Female	–	9	21	68	3	–	–
ths–xi	Male	11	15	23	48	3	–	–
	Female	14	24	24	38	–	–	–

Slight differences between both sexes in the *z*-score values as well as a similar tendency in the deviation of the same traits show the same type of developmental disturbances. They are the result of the influence of the disease on the body. A greater degree of deviation in girls suggests on the one hand a higher intensity of the disease process, and on the other hand, a greater susceptibility of the female sex to disturbances of the growth of those traits in the case of damage of the central motor neurons. The highest negative deviations from the reference population (fig. 1) were noticed in body height (*B–v*) and in the closely correlated sitting height (*Bs–v*) as well as in shoulder height (*Bs–a*). The differences in stature were –1.5 SD for boys and –1.8 for girls.

The values of *z*-scores for sitting height are higher (in both sexes) than stature (*B–v*) itself (–2.4 SD for boys and –2.2 SD for girls). It is caused by a smaller height of the head with neck because the height of the trunk itself (as measured from the *Bs* point to the acromion (*a*)) is lower (–1.4 and –1.1 SD) than that body measurement in the healthy population.

High values (–1.5 SD) of *z*-scores in both sexes for the bicondylar femur width prove the theory that cerebral palsy impairs not only the growth in length of body dimensions, but also massiveness of the bones of the skeleton.

The group of traits with the negative direction of deviation comprises body mass (–0.9 for boys and –0.9 for girls) and both measurements of the hand and foot (with the length dimensions more shortened than breadth dimensions).

The highest disproportion in the body build – apart from the height measurements – between the group of children with cerebral palsy and their healthy peers were noticed in the structure of the trunk. In the biacromial (–0.4 SD) and biiliac (–0.6 SD) breadths the deviations were negative, whereas for the depth (+1.0; +1.6 SD) and breadth (+1.5; +0.5 SD) of the chest and its circumference the values were positive (fig. 1).

Narrow hips and a laterally flattened chest are probably the results of the limitation of the locomotive function of lower limbs, and of the fact that this function is taken over by upper limbs in persons using a wheelchair or orthopedic equipment.

As regards motor efficiency, the group under research was not uniform. All the patients had greater or smaller problems with walking, used orthopedic equipment and some of them were completely unable to move about by them-

selves. They were all evaluated according to the following 4-degree Katz's scale [GARREFT, LEWINE 1972] concerning the efficiency of locomotion:

	Boys	Girls	%
II^0 mild	21	34	35.5
III^0 moderate	36	19	35.5
IV^0 serious	26	19	29.0

For a considerable number of measurements there is in both sexes an interdependence between the values of *z*-score (regardless of its direction) and the degree of impairment of the efficiency of locomotion. The higher the degree of impairment of motor efficiency, the higher the value of the deviation (fig. 2, tables 2, 3). The values of *z*-score of some measurements were also higher in girls than in boys. This applies to the measurements of body height, the three somatic traits of the thorax, and the length and breadth of foot. The division of the patients into groups according to the degree of motor function impairment did not influence the direction, neither changed the arrangement of the traits in comparison with the healthy children norm.

The division of the patients into three age groups according to the biological maturity (table 2 – boys, table 3 – girls) did not reveal such a clear trend of deviation from the developmental norms as could be seen when the group with different levels of motor efficiency was discussed (fig. 3).

As regards some of the measurements (head circumference, height features, knee breadth), it has been noted that the degree of deviation decreased as the age of patients increased. These differences should be interpreted as a consequence of morphological delay resulting from a different rate of maturation of persons with cerebral palsy as compared to the healthy population. According to

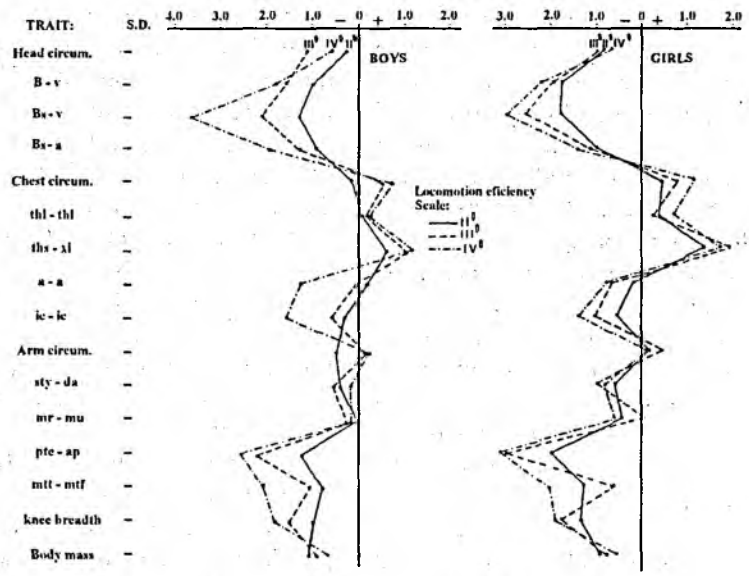

Fig. 2. *z*-scores of somatic traits of boys and girls with cerebral palsy; the division into groups with different degree of efficiency of locomotion (Katz's scale): II° – mildly impaired, III° – moderately impaired, IV° – seriously impaired

Table 2. Boys with cerebral palsy, *z*-scores of somatic traits

Trait	Whole	Locomotion effictiency scale			Age category		
	MATERIAL	II°	III°	IV°	7 – 11	12 – 15	16 – 18
N	83	21	36	26	48	19	16
Head circumference	–0.77	–0.27	–1.16	–0.56	–0.97	–0.66	–1.26
Stature (B–v)	–1.50	–1.02	–1.64	–1.76	–1.58	–1.45	–1.32
Sitting height (Bs–v)	–2.40	–1.37	–2.17	–3.70	–2.55	–2.25	–2.13
Shoulder height (Bs–a)	–1.40	–0.98	–1.29	–1.93	–1.11	–1.31	–2.03
Chest circumference	+0.51	+0.18	+0.52	+0.70	+1.02	–0.08	–0.25
Transverse chest (thl–thl)	+0.06	+0.03	+0.05	+0.19	+0.28	–0.26	–0.73
Chest depth (ths–xi)	+1.00	+0.56	+1.11	+1.17	+1.39	+0.21	+0.61
Bi-acromial breadth (a–a)	–0.38	+0.12	–010	–1.28	–0.23	–0.96	–0.12
Bi-iliocristal breadth (ic–ic)	–0.51	–0.32	–0.61	–1.65	–0.34	–1.48	–0.01
Arm circumference	–0.02	–0.55	+0.13	+0.20	+0.38	–0.46	–0.73
Hand length (sty–da$_{III}$)	–0.50	–0.46	–0.59	–0.39	–0.81	–0.28	+0.15
Hand breadth (mr–mu)	–0.21	–0.12	–0.28	–0.18	+0.09	–0.80	–0.43
Foot lenth (pte–ap)	–1.13	–1.38	–2.29	–2.69	–0.04	–1.70	–2.73
Foot breadth (mtt–mtf)	–1.31	–0.86	–1.11	–2.13	–1.03	–1.30	–1.72
Knee breadth	–1.54	–1.05	–1.57	–1.91	–1.69	–1.60	–1.02
Body mass	–0.92	–1.15	–0.92	–0.79	–0.77	–1.12	–1.20

Table 3. Girls with cerebral palsy, *z*-scores of somatic traits

Trait	Whole	Locomotion effictiency scale			Age category		
	MATERIAL	II°	III°	IV°	7 – 10	11 – 14	15 – 18
N	72	34	19	19	33	18	21
Head circumference	–0.69	–0.69	–0.70	–0.67	–1.11	–0.35	–0.34
Stature (B–v)	–1.79	–1.64	–1.83	–2.13	–1.54	–2.37	–1.70
Sitting height (Bs–v)	–2.19	–1.67	–2.48	–2.82	–2.54	–2.23	–1.68
Shoulder height (Bs–a)	–1.13	–0.96	–1.18	–1.25	–1.40	–1.01	–0.89
Chest circumference	+0.76	+0.50	+0.80	+1.22	+0.56	+0.78	+1.06
Transverse chest (thl–thl)	+0.54	+0.41	+0.37	+0.73	+0.53	+0.51	+0.57
Chest depth (ths–xi)	+1.65	+1.38	+1.93	+1.89	+1.98	+1.01	+1.68
Bi-acromial breadth (a–a)	–0.37	–0.12	–0.60	–0.63	–0.49	–0.44	–0.11
Bi-iliocristal breadth (ic–ic)	–0.69	–0.24	–0.93	–1.32	–0.63	–0.97	–0.60
Arm circumference	+0.23	+0.10	+0.50	+0.17	–0.05	–0.14	+0.98
Hand length (sty–da$_{III}$)	–0.91	–0.55	–0.97	–0.77	–1.09	–0.95	–0.66
Hand breadth (mr–mu)	–0.84	–0.44	+0.01	–0.47	–0.09	–0.85	–0.65
Foot lenth (pte–ap)	–2.26	–2.00	–2.93	–3.02	–2.08	–2.70	–2.19
Foot breadth (mtt–mtf)	–1.41	–1.29	–0.59	–2.00	–1.34	–1.86	–1.22
Knee breadth	–1.59	–1.34	–1.73	–1.79	–1.91	–1.14	–1.48
Body mass	–0.76	–0.90	–0.79	–0.56	–0.31	–1.16	–1.29

TANNER [1963], the mechanism slowing down the rate of maturation should be connected with the increase in the general body dimension rather than with the change in body proportions caused by the pathologic factor. This regularity is illustrated by the values of sitting height or chest depth in the group of boys. The difference in these measurements between the examined boys and their healthy peers does not decrease with age; on the contrary, it increases.

Although making use of the *z*–score values enables the researchers to utilize the whole material together (regardless of the patient's age), it only gives information about the general trend in the deviation of body proportions in relation

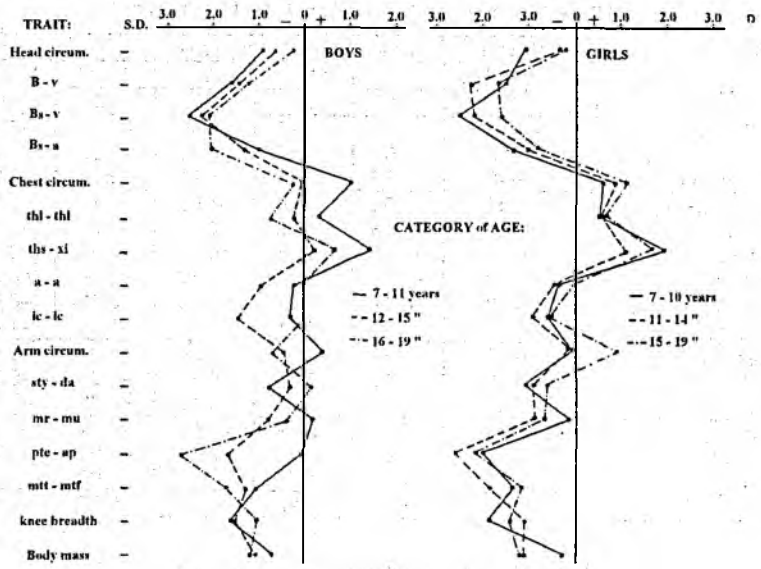

Fig. 3. *z*-scores of somatic traits of boys and girls with cerebral palsy; the division into categories of age

to the reference population. An attempt has therefore been made to check the developmental regularities also using mean arithmetic values. The developmental advancement was estimated in percentages in relation to the mean arithmetic value of each chosen trait achieved by the healthy population at the age of 18. Because of the different rate of maturation of both sexes, the age categories chosen for the girls were 7, 11 and 15, and for the boys 7, 12 and 16.

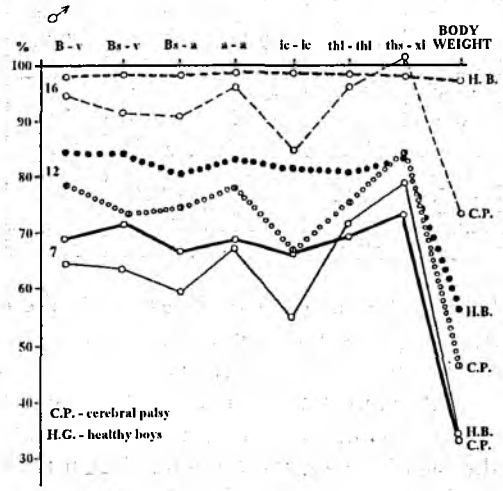

Fig. 4. The advancement (%) of development of somatic traits in boys with cerebral palsy and healthy boys of 7, 12, and 16 in relation to the arithmetic means of measurements in the healthy population at the age of 18

As can be seen from fig. 4, the retardation in the development of height measurements remains at a similar level, regardless of the age of the examined boys. The chest, which is larger in boys of 7, gets markedly flattened laterally as compared to the healthy peers when the boys become 16 years old. Changes in the hip breadth dimensions (*ic–ic*) with age show the widening of differences between the group with the cerebral palsy and the healthy population in the comparable age categories. The lower body mass indicates emaciation with spastic paralysis.

Also the level of the developmental advancement of girls in the three age

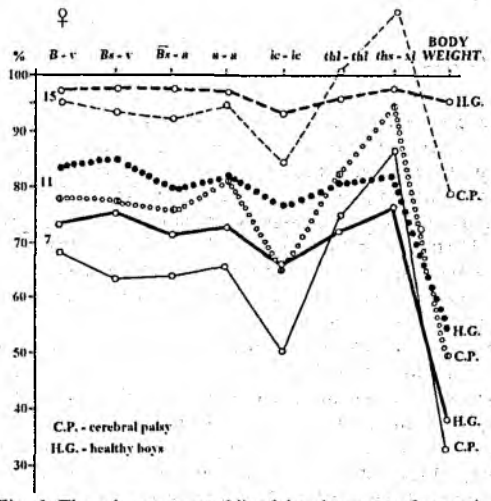

Fig. 5. The advancement (%) of development of somatic traits in girls with cerebral palsy and healthy girls of 7, 11, and 15 in relation to the arithmetic means of measurements in the healthy population at the age of 18

categories shows differences in the formation of their body build, fig. 5. The low body mass indicates the spastic kind of palsy. The greatest delay in the hip development in all the age categories: 7, 11 and 15, show the difficulty in the rehabilitation of this part of the body. Differences in the height measurements decrease with age, but a bigger, laterally flattened chest is noticed both in the youngest and oldest of analysed age groups.

Thus, in all the compared age groups, regardless of sex, children with motor impairment are shorter, they have very narrow hips and a laterally flattened chest (with the bi–acromial breadth similar to that of the healthy population) as well as a low body mass – this deficiency increases with age. Whereas healthy boys at the age of 16 still need to increase their height measurements by about 2% and the body mass by about 4% before their development is completed at the age of 18, the stature of boys with cerebral palsy would have to increase by about 5% and their body mass by about 25% if they were to achieve the same parameters in a similar period of time. The same deficit of stature (about 5%) remains in the compared age periods both in the boys' and the girls' groups, although in the girls' group there is a tendency for the differences in sitting height, bi–acromial breadth, and even bi–iliac breadth to decrease.

The low body height, narrow hips, laterally flattened chest and low mass, in spite of slight differences, make boys and girls with cerebral palsy more similar to one another with respect to body proportions than to their healthy peers.

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Streszczenie

Celem opracowania jest uzyskanie odpowiedzi na pytanie, czy istnieją różnice w wymiarach ciała osób z mózgowym porażeniem dziecięcym w stosunku do ich zdrowych rówieśników oraz na ile różnice te są zależne od płci, stopnia zaawansowania dojrzewania płciowego oraz stopnia dysfunkcji narządu ruchu. Materiał to grupa 155 dzieci i młodzieży (83 chłopców i 72 dziewczęta) w wieku 7–18 lat, uczniów i pacjentów placówek oświatowych i leczniczych z województwa warszawskiego. Ocenę budowy oparto o pomiary 16 cech somatycznych (ryc. 1, tab. 2 i 3), przekształconych do postaci cech unormowanych w relacji do średniej arytmetycznej i odchylenia standardowego próby losowej dzieci i młodzieży warszawskiej [KURNIEWICZ-WITCZAKOWA *ET AL.* 1981] i danych ogólnopolskich [NOWAK 1985]. Dokonano też oceny zaawansowania w rozwoju poszczególnych cech somatycznych w wybranych kategoriach wieku u obu płci w stosunku do wartości tych cech w 18 roku życia.

Ocena analizowanych cech wykazała, iż największe dysproporcje w budowie ciała pomiędzy grupą chorych a ich zdrowymi rówieśnikami dotyczą samej wysokości ciała oraz jej składowych (zwłaszcza pomiaru *Bs–v*), a także budowy tułowia; wąskie biodra i boczne spłaszczenie klatki piersiowej interpretować należy jako skutek ograniczenia funkcji lokomocyjnych kończyn dolnych i przejęcia tej funkcji przez kończyny górne (ryc. 1). Odnotowano zależność – im wyższy stopień zaburzenia sprawności ruchowej tym większe odchylenie od zdrowej populacji (ryc. 2). Badani z mózgowym porażeniem dziecięcym cechują się odmiennym poziomem zaawansowania rozwoju, o czym świadczą różnice w kształtowaniu się budowy ciała (obu płci) w analizowanych kategoriach wieku, w stosunku do wartości tych cech osiąganej w zdrowej populacji w wieku 18 lat (ryc. 4 i 5).