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**Sexual dimorphism of cephalo- and somatometric parameters
and body components of rural children and youth from
the Subcarpathian region at the beginning of the 21st century**

**Dymorfizm płciowy parametrów cefalo- i somatometrycznych
oraz komponentów ciała dzieci i młodzieży wiejskiej
z regionu Podkarpacia na początku XXI wieku**

Summary

Sexual dimorphism is genetically determined dimorphism of organisms which is manifested by the morphological, physiological, motor, psychological and social differentiation of women and men. The size of dimorphic changes of numerous anthropometric features depends on the age of a person, the biological, climatic-geographical, social-economic or urbanization factors. The aim of this thesis was to define the intersexual differences of the chosen morphologic features of the head and out of the head and the tissue components of the rural children and youth from the Subcarpathian region in comparison with the city series. The anthropometric data of the 1,887 rural boys and 1,809 girls at the age of 6–19 from the Subcarpathian Voivodeship collected in the school year of 2004/05 were used in the thesis. The ratio of dimorphism of 19 parameters were taken into account in the study: 6 cephalometric ones, 9 somatometric ones and 4 body components. The evaluation of the size of the intersexual differences of the studied parameters in the rural population was made in comparison with the city series from Rzeszow examined between 2003 and 2004 by Radochońska, Perenc (2006, 2008, 2009). The size of the sexual dimorphism in the compared series depends on the type of the examined parameter and the age class. In about 50% of the age group the developmental differences between the boys and the girls were marked stronger in the rural population, and in the other half – in the city one. The above phenomenon was emphasized to a different degree. In conclusion, the lack of unequivocal tendencies in the scope of the sexual dimorphism of the analysed features between the rural and city children may be the effect of the influence of the civilisation changes taking place in our country on the developmental processes of the children and youth.

Key words: sexual dimorphism, anthropometric features, rural children and youth

Streszczenie

Dymorfizm płciowy jest to genetycznie zdeterminowana dwupostaciowość organizmów przejawiająca się zróżnicowaniem morfologicznym, fizjologicznym, motorycznym, psychicznym i społecznym kobiet i mężczyzn. Wielkość zmian dymorficznych cech antropometrycznych jest uzależniona od: wieku osobnika, czynników: biologicznych, klimatyczno-geograficznych, społeczno-ekonomicznych czy urbanizacyjnych. Celem pracy było określenie różnic międzypłciowych wybranych cech morfologicznych oraz komponentów tkankowych dzieci i młodzieży wiejskiej z Podkarpacia na tle serii miejskiej. W pracy wykorzystano dane antropometryczne 1887 chłopców i 1809

dziewcząt wiejskich w wieku 6–19 lat z województwa podkarpackiego zebrane w roku szkolnym 2004/05. W opracowaniu uwzględniono wskaźnik dymorfizmu 19 parametrów: 6 cefalometrycznych, 9 somatometrycznych oraz 4 komponentów ciała. Ocena wielkości różnic międzypłciowych badanych parametrów w populacji wiejskiej przeprowadzono na tle serii miejskiej z Rzeszowa przebadanej w latach 2003/04 przez Radochońską, Perenc (2006, 2008, 2009). Wielkość dymorfizmu płciowego w porównywanych seriach jest uzależniona od rodzaju badanego parametru oraz klasy wieku. W ok. 50 % grup wieku odrębności rozwojowe pomiędzy chłopcami i dziewczętami siniej zaznaczyły się w populacji wiejskiej, w drugiej połowie – w miejskiej. Powyższe zjawisko zostało zaakcentowane w zróżnicowanym stopniu. Podsumowując, brak jednoznacznych tendencji w zakresie dymorfizmu płciowego analizowanych cech pomiędzy dziećmi wiejskimi i miejskimi może być efektem wpływu przemian cywilizacyjnych zachodzących w naszym kraju na procesy rozwojowe dzieci i młodzieży.

Słowa kluczowe: dymorfizm płciowy, cechy antropometryczne, dzieci i młodzież wiejska

Introduction

Sexual dimorphism is a bidirectional formation connected with specimen's gender visible in morphological, physiological, motoric, psychical and social features of man (Drozdowski 2002 as cited in: Napierała 2007). Sex chromosomes in zygote decide on hermaphroditism of organism, and the level of its formation depends on biological, climate-geographical, socio-economic factors and on the lifestyle or physical activity (Wojtyna, Rodziewicz-Gruhn 2005, Napierała 2007, Krjaż et al. 2010).

In the world of animate nature, the above mentioned phenomenon was a subject of interest of various scientific environments (Tatarczuk 2002). Research aiming at acquiring knowledge on sexual dimorphism contributed to the development of human sciences. Interest in dimorphism in the last two centuries was connected with discrepancy between the process of sexual diversity of sociocultural functions and undertaking new occupations and fields of social activity by women (Krjaż et al. 2010). Previously conducted research focused mostly on metrical features, and in consequence they contributed to elaboration of standards of body structure of man and woman. Dimorphic differences are visible in many qualities, i.e. face features, type of adiposity, pigmentation, size of internal organs, shape of the line of hair base on forehead and nape or alignment of shoulders in cubital joint (Bednarska, Drozdowski 1982, Arska-Kotlińska, Drozdowski 1983, Malinowski 1994 as cited in: Bukszyński, Malinowski 2002).

In literature, the majority of works documents the intersexual diversification in the scope of bodily morphology. Dimorphism of physiological features or sport results is less explored (Jasiński 1993, Burdukiewicz et al. 1998, Bukszyński, Malinowski 2002, Rogowska, Orkwiszewska 2002, Tatarczuk 2002). The indicated phenomenon may also be analysed in context of: its size, environmental differences or secular changes (Bukszyński, Malinowski 2002, Rogowska, Orkwiszewska 2002, Perenc, Radochońska 2012).

With regard to considerable increase of population of elderly people, and to the prognosis of persistence of this tendency, in various countries research is conducted on sexual dimorphism on people of the second puberty period and of elderly and old age (Kim et al. 1997).

Aim of this paper

The aim of this paper was to:

- 1) define the intersexual differences of chosen cephalo- and somatomertic features in population of rural children and youth;
- 2) evaluate the size of sexual dimorphism of the analysed parameters in rural series in comparison with urban one from Rzeszów.

Material and methods

The basis for preparation of this paper is constituted by materials collected in school year 2004/05. They include the anthropometric data on rural children and youth in the age between 6-19 years old coming from centrally located poviats in the Subcarpathian Voivodeship. Part of data was printed (Nowak 2011a, b) the rest of them is still elaborated. Measurements of students attending to schools with all education profiles (primary school, gymnasium, secondary school of general education and technical high schools) were conducted with use of Martin's technique (Malinowski, Bożiłow 1997). 1887 boys and 1809 girls participated in the research, in total 3696 people, which constitutes not less than 3,5 % of the general population in each age and sex group. Detailed frequency distribution of the participants was presented in table 1.

Table. 1 Number of rural boys and girls in particular age classes

Age [years]	Boys	Girls
6	109	104
7	114	108
8	119	113
9	122	116
10	125	120
11	130	128
12	137	138
13	145	144
14	149	143
15	151	142
16	147	137
17	146	138
18	147	138
19	146	140
Total	1 887	1 809

Arithmetic average of 19 parameters were used in the research, including:

- 6 cephalometric (the head length (*g-op*), the head width (*eu-eu*), the morphological face height (*n-gn*), the face width (*zy-zy*), the nose height (*n-sn*) and the nose width (*al-al*))
- 9 somatometric (the body height (*B-v*), the length of the head and the neck (*v-sst*), the trunk length (*sst-sy*), the upper extremity length (*a-da*), the lower extremity length (*B-sy*), the shoulder width (*a-a*), the hip width (*ic-ic*), the chest circumference on the height of *xiphiale* (*xi*) point in relaxation state and body mass)
- 4 body elements (the thickness of three fat skinfolds (vertical fold), on abdomen (oblique fold located in $\frac{1}{4}$ of distance between navel and anterior superior iliac spine), below the lower shoulder blade (horizontal fold) and total fatness (sum of the above folds).

On the basis of absolute average arithmetical differences of each morphological feature between boys and girls, a dimorphism index (DI) was calculated according to the formula: $2 \cdot (\bar{X}_{\square} - \bar{X}_{\square}) \cdot 10000 / (\bar{X}_{\square} + \bar{X}_{\square})$, where: \bar{X}_{\square} and \bar{X}_{\square} – arithmetic average of particular features in group of boys and girls (Wolański 1975).

This index enables an objective evaluation of sexual dimorphism of the analysed parameters, especially in the scope of development, as well as to indicate the size of differences regardless to applied units or levels of development. Dimorphism index may be also used to compare other differences between features in order to state which one of them is relatively bigger, and which one is smaller (Wolański 1975). Positive values indicate higher absolute value of a given parameter in case of boys in comparison with girls, while the negative ones indicate the dominance of girls in that scope (Malinowski 1976).

On the basis of values of this index, three metres of intersexual differences were calculated (Zaworski, Młyńska 2004) and they are necessary to define the age groups and parameters characteristic with the highest dimorphism:

- dimorphism of the analysed metrical features in particular age groups as DI;
- average dimorphism of parameter in the analysed period of ontogenesis as arithmetic average of DI of all (14) analysed age classes;
- dimorphism of general (multi-feature) body size as arithmetic value of DI of 15 features in each age class (except for the thickness of fat skinfolds).

The evaluation of the size of sexual dimorphism of presented parameters in case of rural children and youth was conducted in comparison with urban series from Rzeszów in age of 6–18 analysed in the years 2003/04 by Radochońska, Perenc (2006, 2008, 2009).

The values of the above index calculated for analysed morphological features in rural and urban population were presented in tables 2–9.

Results

In table 2, a comparative list of values of dimorphism index: head length, head width and morphological face height of rural children and youth and from Rzeszów was presented, and in table 3 – face width, nose height and width.

Relatively small intersexual diversity in the scope of metrical features of head in case of rural children can be observed in ontogenesis period from 6 to 13 years old. Exceptions were

noticed in case of 6 year old children with regard to head width and in case of 11 year old children – nose height. The smallest dimorphism was stated in: 7 year old children in the scope of nose height, 10 y.o. – face width, 6 and 12 y.o. - head length and morphological face height, while between 10–11 years old – head width. Only in case of 10 year old children there is no intersexual difference between nose width. The prevalence of girls over boys was observed only in case of 6–7 year old children. Gradual increase of intersexual differences is generally observed in the period of ontogenesis 14–19 year old. The highest dimorphism was observed in case of subjects in age of: 11 (nose height), 18 (head length and nose width) and 19 (head width, morphological face height and face width). From among the cephalometric parameters, the biggest differences between genders, defined on the basis of average value of DI of feature, were indicated in case of nose width, and then of morphological face length. Dimorphism of head length, head width and nose height was smaller, and the face width – the smallest.

Tab. 2 Values of the dimorphism index (DI) related to the head length (g-op), the head width (eu-eu) and the morphological face height (n-gn) of rural and urban children and youth

Age [years]	Dimorphism index (DI)					
	(g-op)		(eu-eu)		(n-gn)	
	Rural area	Rzeszów	Rural area	Rzeszów	Rural area	Rzeszów
6	111,28	237,77	327,87	147,55	5,19	163,78
7	175,55	238,66	250,86	172,17	65,07	35,98
8	170,50	179,96	193,95	228,29	123,77	106,68
9	164,87	274,31	122,87	231,02	235,41	92,06
10	169,66	274,93	98,16	227,51	193,19	306,54
11	185,90	186,67	111,47	208,53	175,83	331,66
12	138,16	182,20	124,43	232,47	83,52	293,41
13	284,21	195,29	276,60	216,84	473,43	174,06
14	302,25	191,20	290,56	205,36	427,97	161,31
15	309,35	232,42	408,72	224,05	549,18	489,81
16	416,15	268,95	384,66	214,93	435,71	713,61
17	534,47	314,58	428,88	225,22	597,36	817,83
18	590,40	376,18	457,34	212,31	620,89	956,40
19	574,43	-	492,05	-	693,35	-
\bar{x}	294,80	242,55	283,46	211,25	334,28	357,16

Similarly as in case of rural series, also in urban series boys are characterized with higher absolute values of the majority of cephalometric features in comparison with girls. Exceptions are: nose height in age from 7 to 14 y.o. and nose width in age of 12 y.o. Generally, smaller dimorphic diversity of metrical features of head was indicated in case of subject from Rzeszów in the period between 6 to 14 years old (tables 2, 3), so it remains for a year longer than in case

of rural series. In urban population, the smallest values of index were registered in age of: 6 for head width, 7 for morphological face height, 12 for nose width, 11–12 for head length, 15 for nose length and 16 for face width. Developmental distinctions of cephalometric features conditioned by gender usually increase in the period from 15 to 18 years old. In the indicated period, one can observe relatively small dimorphic differences in the scope of head and face width. Dimorphism of face width is different in case of urban series in the period from 8 to 13 years old, in which bigger intersexual differences were observed than in age from 15 to 18 y.o. It is also worth to notice the fact that the dimorphism index for head width remains at similar level in the period from 6 to 18 years old. With regard to presented data of subjects from Rzeszów, the specifics of sexual dimorphism formation for certain cephalometric features is distinctive. In rural series, developmental distinctions connected with gender are usually formed in accordance with the majority of reports presented in literature, so in a slightly different way than in case of urban population. In urban series, the strongest dimorphism was noticed at: 10- (face width), 12- (head width), 17- (nose width) and 18-year olds (head length face and nose height).

Bigger intersexual differences of cephalometric parameters in rural series in comparison with the urban ones were observed in the scope of: head length (13–18 y.o.), head width (6–7 and 13–18 y.o.), morphological face height (7–9 and 13–15 y.o.), face width (15–18 y.o.), nose height (in 6 and 11 y.o. and 13–16 y.o.) and nose width (6–7 and 12–13 y.o. and in 16 and 18 y.o.).

Tab. 3 Values of the dimorphism index (DI) related to the face width (zy-zy), the nasal height (n-sn) and the nasal width (al-al) of rural and urban children and youth

Age [years]	Dimorphism index (DI)					
	(zy-zy)		(n-sn)		(al-al)	
	Rural area	Rzeszów	Rural area	Rzeszów	Rural area	Rzeszów
6	221,96	342,40	-163,63	38,53	370,23	159,25
7	199,25	385,31	-48,60	-356,17	275,94	75,01
8	207,21	480,96	132,78	-509,11	160,28	244,72
9	193,71	526,77	148,49	-470,99	192,47	301,65
10	52,51	608,86	258,57	-519,10	0,00	110,50
11	103,50	514,66	674,65	-593,46	116,96	222,49
12	133,38	563,75	188,09	-196,14	208,71	-10,02
13	191,88	471,70	337,74	-83,86	450,83	438,52
14	219,80	366,58	316,60	-193,89	383,29	486,56
15	310,87	290,52	370,66	18,26	395,91	682,14
16	352,07	278,74	349,20	346,82	827,14	737,08
17	432,36	307,33	495,63	682,26	806,74	840,44
18	446,87	320,53	527,89	832,13	887,11	815,77
19	470,23	-	467,31	-	744,24	-
\bar{x}	252,54	419,86	289,67	-77,28	415,71	392,62

In other age classes, dimorphism of the analysed features is the most noticeable in urban population in comparison with the rural one, so in case of: head length (6–12 y.o.), head width (8–12 y.o.), morphological face height (in 6 y.o., 10–12 and 16–18 y.o.), face width (6–14 y.o.) face height (7–10 y.o., 12 y.o. and 17–18 y.o.) and nose width (8–11, 14–15 y.o. and 17 y.o.).

In urban series, the highest dimorphism, defined on the basis of average values of DI of each parameter in all age groups, was indicated in the scope of morphological face width, slightly smaller in case of nose width. Smaller differences between genders were stated in the scope of face height, and then length and width of head. The smallest dimorphism, indicating the prevalence of girls over boys, is characteristic for nose height. Rural population is characterized with different order of average intersexual diversity of cephalometric features in comparison with urban one.

Tab. 4 Values of the dimorphism index (DI) related to the body height (B-v), the length of head and neck (v-sst) and the trunk length (sst-sy) of rural and urban children and youth

Age [years]	Dimorphism index (DI)					
	(B-v)		(v-sst)		(sst-sy)	
	Rural area	Rzeszów	Rural area	Rzeszów	Rural area	Rzeszów
6	56,97	156,51	119,57	802,70	242,27	-100,81
7	125,19	272,57	246,04	1205,96	169,82	136,42
8	142,90	122,98	115,83	631,67	220,92	194,59
9	-10,49	201,60	171,66	514,06	-68,87	297,21
10	-4,32	217,01	-527,18	-35,61	544,53	150,26
11	-52,20	15,05	-676,64	-59,68	7,28	172,70
12	-18,59	-115,88	-548,19	-246,73	138,00	44,28
13	-12,13	-44,37	-62,13	-602,68	-30,78	139,61
14	167,59	231,33	50,11	-313,52	188,72	284,99
15	340,38	505,10	204,51	-51,50	410,40	372,32
16	619,69	649,71	536,91	493,74	497,99	585,95
17	781,62	724,40	669,83	603,25	669,19	702,33
18	668,81	806,43	708,55	740,99	705,74	787,53
19	727,18	-	786,16	-	851,23	-
\bar{x}	252,33	287,88	128,22	283,28	324,74	289,80

Specification of values of dimorphism index in rural and urban series for body height, head and neck length and trunk length was presented in table 4, for the length of upper and lower extremities and circumference of chest in table 5, while for shoulders width, hips width and body mass in table 6. In rural population, the values of sexual dimorphism index of height parameters in the period from 6 to 13 years old are diversified. Generally, they are decreased in prepubertal phase, and in certain age classes, the index remains at

negative values, indicating the prevalence of girls over boys, e.g. in case of body height (9–13 y.o.), head and neck length (10–13 y.o.), trunk length (in 9 and 13 y.o.), lower extremity length (in 6, 9 and 10 y.o.). In age between 10–12 years old, rural girls have considerably bigger head and neck length in comparison with their peers. The smallest dimorphism was noted in case of: body height (9–10 y.o.), head and neck length (13 y.o.), trunk length (11 and 13 y.o.), upper extremity length (7 and 11 y.o.) and lower extremity length (7 and 13 y.o.).

In the period between 6–13 years old, intersexual differences of circumference of chest in rural series are at a relatively low level, while in the period from 14 to 19 years old, they considerably increase with age. Relatively small dimorphism of the shoulder width usually occurs in the period from 6–13 years old, while the hip width between 11–15 y.o.

In the age between 13–15 years old, rural girls have wider hips than boys. In the period from 11 to 13 years old, small dimorphism of body mass was observed, while considerable intersexual differences were noticed in case of: 7- 8- and 10-year old children. The smallest values of DI were registered in age of: 6 (shoulder width), 11 (hip width and circumference of chest) and 13 years old (body mass).

Tab. 5 Values of the dimorphism index (DI) related to the upper extremity length ($a-da_{III}$), the lower extremity length (B-sy) and the chest circumference (xi) of rural and urban children and youth

Age [years]	Dimorphism index (DI)					
	$(a-da_{III})$		(B-sy)		(xi)	
	Rural area	Rzeszów	Rural area	Rzeszów	Rural area	Rzeszów
6	171,80	163,95	-81,84	51,56	141,77	269,28
7	100,63	104,92	4,98	16,93	375,06	169,14
8	414,04	135,96	109,58	-88,21	336,25	152,18
9	304,15	324,00	-47,46	41,68	281,87	147,34
10	263,99	177,83	-104,32	337,32	407,19	195,96
11	98,89	46,62	150,50	-44,09	62,63	-46,81
12	278,01	-145,49	85,93	-156,04	328,20	-520,90
13	202,20	15,70	15,83	34,70	367,75	-439,12
14	368,34	361,72	196,45	380,81	554,90	-141,57
15	535,31	598,05	368,82	750,74	733,12	158,00
16	832,77	895,36	701,67	734,14	708,32	434,32
17	958,60	850,61	817,31	775,56	1106,50	440,75
18	891,70	970,49	653,75	837,38	1126,47	467,37
19	940,97	-	629,99	-	1335,00	-
\bar{x}	454,39	346,13	250,08	282,50	561,79	98,92

Dimorphic differences of indicated somatometric parameters considerably increase with age in the period above: 14 (body height, upper and lower extremity length, shoulder width, circumference of chest, body mass), 15 (trunk length) or 16 y.o. (head and neck length, hip width). Dimorphism of these features is the most visible in case of: 17-year olds (body height, upper and lower extremity length) and 19-year olds (lengths of: head and neck, upper and lower extremity, circumference of chest and body mass). The highest values of dimorphism index in the scope of the hip width were registered in case of 10 (245,26) and 19 year olds (231,57).

On the basis of the average value of DI in rural series it was stated that from among the non-head features, boys and girls are the most diversified by body mass (620,46), slightly less by – the circumference of chest, and finally by: upper extremity length and shoulder width (approximate absolute index values). Smaller dimorphism was observed in reference to the trunk length, and then successively: body height and lower extremity length. The smallest intersexual diversity was observed in the scope of: head and neck length and hip width. Domination of the male gender over the female one is the most visible in case of the body mass, slightly less in case of circumference of chest.

In urban series in the period from 9 or 10 to 12 years old (depending on the parameter), generally there is a decreasing tendency for the value of dimorphism index of body height features with age. The smallest values, indicating the lack of fundamental intersexual differences, were observed in age of: 10 (head and neck length), 11 (body length and upper extremity length), 12 (trunk length) and 13 years old (lower extremity length). The above observations are compliant with the data achieved for rural population – they result from developmental phenomena connected with puberty period. The prevalence of girls from the city over boys was registered in certain age classes: body height (12–13 y.o.), head and neck length (10–15 y.o.), trunk length (6 y.o.), upper extremity length (12 y.o.) and lower extremity length (8 y.o. and 11-12 y.o.). In the period of ontogenesis of 14-18 years old, dimorphic differences of the indicated parameters increase with age, which is also confirmed by results of research conducted in rural series.

In case of subjects from Rzeszów in ontogenesis periods: 6–11 and 14–15, relatively low level of intersexual diversity of the circumference of chest was noted, while in periods: 12–13 and 16–18 y.o., dimorphism is increased. In the age between 11 and 14 years old, girls from the city have higher values of a given feature than boys, which is not true in case of their rural peers.

Minor developmental distinctions conditioned by gender in the scope of shoulder width in case of subjects from the city were observed in the period from 6–13 years old. Prevalence of girls over boys was stated in case of 6 year old children and in the period from 10–13 y.o. Above 14 years of age, intersexual differences have tendency to increase with age. Dimorphism of hip width forms in a different way. The highest values of DI, indicating the higher values of this parameter for boys, were registered in the period from 7 to 10 years old. A smaller prevalence of girls over peers was noted in case of 6 and 11 y.o., and slightly more considerable in the age from 12–14 years old. In the ontogenesis period from 15 to 18 years old, the values of dimorphism index of hip width increase, but they are lower than in case of 7–10 y.o. The formation of chosen width dimensions in municipal series occurs according to approximate developmental regularities, like

in case of rural population. The values of DI of body mass for 7–11 y.o. remain on a relatively high level. Smaller intersexual differences in urban series are visible in case of: 6 y.o. and 12–14 y.o., while the biggest ones were noticed for 16–18 year olds. In urban population, the strongest dimorphism was indicated in case of: 7 (head and neck length), 8 (hip width), 12 (circumference of chest) and 18 y.o. (body height, trunk length, upper and lower extremity length, shoulder width and body mass).

Tab. 6 Values of the dimorphism index (DI) related to the shoulder width (a-a), the hip width (ic-ic) and the body mass of rural and urban children and youth

Age [years]	Dimorphism index (DI)					
	(a-a)		(ic-ic)		masa ciała	
	Rural area	Rzeszów	Rural area	Rzeszów	Rural area	Rzeszów
6	11,76	-42,86	149,33	-42,44	-45,02	295,61
7	155,39	67,44	150,92	423,58	721,48	809,82
8	154,98	70,36	123,30	468,36	568,16	705,31
9	187,26	67,89	190,48	443,81	325,73	1224,36
10	53,52	-55,88	245,26	444,44	497,60	1037,46
11	262,93	-78,67	43,48	-18,21	-409,63	696,49
12	244,50	-92,81	84,92	-254,72	131,51	-373,51
13	71,60	-84,76	-97,13	-193,85	15,41	-75,23
14	395,23	245,07	-98,76	-280,92	473,84	321,70
15	495,12	609,58	-65,47	82,67	599,82	669,34
16	818,13	891,36	213,84	152,44	791,00	1282,70
17	1081,96	971,31	149,36	313,36	1633,75	1491,95
18	1065,41	1070,19	177,38	356,81	1596,41	1950,60
19	1234,77	-	231,57	-	1786,40	-
\bar{x}	445,18	279,86	107,04	145,79	620,46	772,05

On the basis of average values of DI of the analysed somatic features it was indicated that boys and girls from the city are the most diversified by body mass, less by length of upper extremity, then: trunk length, head and neck length, body height, lower extremity length and shoulder width. The dimorphism is smaller for the hip width, and the smallest for circumference of chest. The average sexual dimorphism of all analysed somatometric parameters indicated their higher values in case of boys in comparison with girls.

Stronger developmental distinction connected with gender in rural series in comparison with the urban one were noticed in the scope of: body height (8, 11 and 17 y.o.), neck and head length (10–12 and 15–17 y.o.), trunk length (6–8 and 10, 12 and 15 y.o.), upper extremity length (in 6 and 8 y.o., 10–14 years and 17 y.o.), lower extremity length (6 y.o. and 8–9 years old and 11 and 17 y.o.), circumference of chest (7–11 and 14–18 y.o.), shoulder width (7–9 and 11–12 y.o. and 14 and 17 y.o.), hip width (6, 11 and 16 y.o.) and body mass (14 and 17 y.o.).

In other age groups in rural population in comparison with the urban one smaller dimorphic differences were registered in the scope of the analysed non-head features, i.e. body height (6–7, 9–10 and 12–16 and 18 y.o.), head and neck length (6–9, 13–14 and 18 y.o.) trunk length (9 and 11 y.o. and 13–14 and 16–18 y.o.), upper extremity length (7 and 9 y.o. and 15–16 and 18 y.o.), lower extremity length (7 and 10 y.o. and 12–16 y.o. and 18 y.o.), circumference of chest (6 y.o. and 12 – 13 y.o.), shoulder width (6, 10, 13 y.o. and 15–16 y.o. and 18 y.o.), hip width (7–10, 12–15 and 17–18 y.o.), as well as body mass (6–13 and 15–16 y.o. and 18 y.o.).

The value of dimorphism index of fatness features for both series were presented in table 7 and on figure 1. In rural population, almost in the entire analysed period, there is a decisive prevalence of girls over boys with regard to thickness of three fat skinfolds and their total thickness (except for the fold located on abdomen in 10 and 12 y.o. and total fatness in case of 12 year olds). In ontogenesis periods: 6–10 y.o. (abdominal fold and total fatness), 7–10 y.o. (triceps skinfold) and 6–9 y.o. (subscapular skinfold) the dimorphic differences of indicated parameters decrease with age. In the period from 10–13 years old one can observe considerable fluctuations of DI values. In the period from 13–16 y.o., dimorphism of thickness of three fat skinfolds increases, while in the period from 16–19 years old, it decreases. Bigger intersexual differences were registered in periods: 14–18 years old in the scope of abdominal skinfold and total fatness, 14–19 y.o. – triceps skinfold and 15–17 years old – subscapular skinfold. The biggest dimorphism of skinfolds located on the shoulder and under shoulder blade and total fatness in rural series were observed in 16 y.o., and when it comes to skinfold measured in the area of navel – in age of 17 years old.

From among all parameters (19) analysed in this paper for rural population, generally the biggest sexual dimorphism, defined on the basis of average value of DI, is the dimorphism of thickness of fat skinfolds – in order: triceps skinfold (-2746,66), abdominal skinfold (-2346,49) and total fatness (-2289,35), and the smallest one – subscapular skinfold (-1747,88).

Tab. 7 Values of the dimorphism index (DI) related to the thickness of skinfolds and the total adiposity of rural and urban children and youth

Age [years]	Dimorphism index (DI)							
	The triceps skinfold		The abdominal skinfold		The subscapular skinfold		The sum of three skinfolds	
	Rural area	Rzeszów	Rural area	Rzeszów	Rural area	Rzeszów	Rural area	Rzeszów
6	-1542,31	-944,21	-2997,12	-1452,51	-2152,30	0,00	-2194,40	-842,10
7	-1609,39	374,53	-2061,96	-181,82	-1510,49	307,69	-1528,24	175,95
8	-1440,54	371,75	-1087,56	84,39	-151,13	-92,16	-982,75	138,31
9	-490,51	1224,49	-388,35	714,28	-432,69	-1106,38	-442,79	370,83
10	-402,98	1548,39	165,68	1288,14	-909,58	-1538,46	-333,05	563,38
11	-1435,62	-361,01	-2304,72	847,46	-2184,02	-1509,43	-1715,23	-303,45

12	-270,68	-959,41	382,16	-448,43	-47,37	-2769,23	29,56	-1306,24
13	-1596,54	-2020,91	-1615,27	-1802,58	-2303,77	-3564,36	-1798,06	-2382,27
14	-3101,36	-3589,74	-3133,67	-3481,78	-2343,17	-3551,40	-3275,77	-3544,63
15	-4872,99	-4705,88	-4293,86	-3904,38	-3235,67	-3177,57	-4189,74	-4020,75
16	-5921,86	-3178,81	-4706,94	-4833,33	-3647,51	-2748,82	-4795,03	-3585,66
17	-5792,43	-625,00	-4750,59	-2941,18	-2620,79	-786,03	-4432,53	-1437,27
18	-5010,13	298,51	-3917,06	-2206,41	-1911,49	-1422,59	-3685,87	-1005,85
19	-4965,92	-	-2141,54	-	-1020,27	-	-2707,03	-
\bar{x}	-2746,66	-966,72	-2346,49	-1409,09	-1747,88	-1689,13	-2289,35	-1321,52

In urban population, in the overwhelming part of the analysed period of ontogenesis, girls also are the ones who achieve higher average values of thickness of particular fat skinfolds majority and their total thickness in comparison with boys. The exceptions are the subjects in age of: 7–10 and 18 y.o. (triceps skinfold), 8–11 y.o. (abdominal skinfold), in 7 y.o. (subscapular skinfold) and 7–10 (total fatness). In case of 6-year olds there are no intersexual differences in the scope of thickness of subscapular skinfold. Dimorphism in case of children in age from 6–12 years old is formed in a diversified manner (increase or decrease of the index value). In the period from 13–15 y.o., from 13–16 y.o. in case of abdominal skinfold and 12–13 y.o. for subscapular skinfold, the intersexual differences have an increasing tendency. In the period from 15–18 years old, the values of DI generally decrease with age or slightly fluctuate. The biggest dimorphism in the scope of fatness features was registered in case of: 13- (subscapular skinfold), 15- (triceps skinfold and total fatness) and 16-year olds – abdominal skinfold).

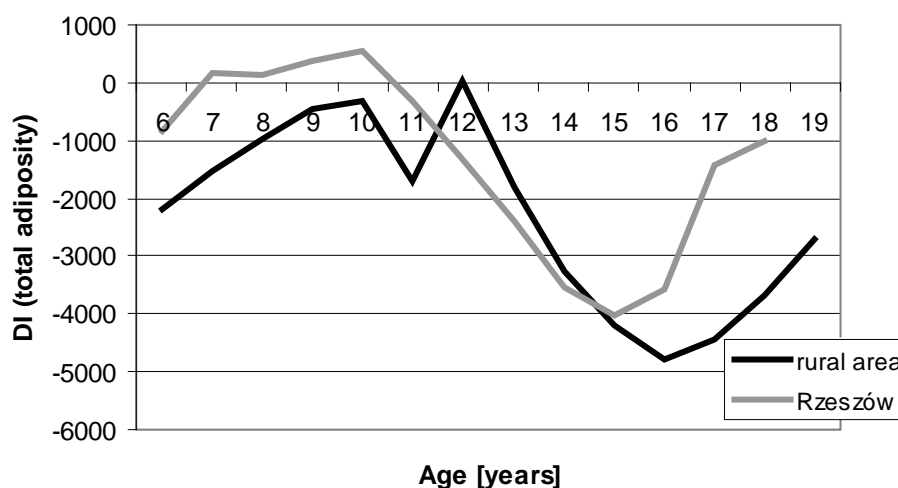


Fig. 1 The dimorphism index related to the total adiposity of rural and urban children and youth

In result of analysis of average values of DI of the tested body elements, it was indicated that boys and girls from the city are the strongest diversified with subscapular skinfold (-18689,13), less by abdominal skinfold (-1409,09) and total fatness (-1321,52), and in the smallest degree by triceps skinfold (-966,72). Except for the skinfold located under the shoulder blade, intersexual differences in the scope of level of subdermic fatness are much higher in case of rural population in comparison with the municipal one. The order of size of dimorphism in the scope of thickness of skinfolds and other morphological features is also slightly different for both series.

Consideration of DI value in comparison enables to state that the bigger dimorphism in urban population in comparison with the rural one is typical for subjects in age of: 9–10 and 12–14 years old. Moreover, in case of youth from Rzeszów in the age of 16, bigger intersexual differences in the scope of abdominal skinfold were indicated in comparison with their rural peers. Total fatness is more diversified in case of boys and girls from the city in age of 10 and in the period from 12–14 y.o. than in case of rural children.

In other age classes, bigger sexual dimorphism in the scope of fatness features was stated for the rural series. The above mentioned observations were made in the scope of thickness of the following skinfolds: triceps and subscapular (6–8, in 11 y.o. and 15–18 y.o.), abdominal (6–8, and 11 and 15 y.o. and 17–18 y.o.) and total fatness (6–9 and 11 y.o. and 15–18 y.o.).

A dimorphism index of multi-feature body size for 15 morphological features of head and non-head in particular age classes in rural and urban series with exclusion of body components was calculated for comparison purposes (Table 8, Figure 2).

Tab. 8 Values of the dimorphism index (DI) related to the multi-feature body size (general) for 15 morphological parameters of rural and urban children and youth

Age [years]	Dimorphism index (DI)	
	Rural area	Rzeszów
6	109,30	176,18
7	197,84	250,52
8	211,63	208,31
9	159,48	281,12
10	143,22	231,87
11	57,04	103,60
12	106,70	-53,07
13	165,69	10,84
14	282,46	153,78
15	397,78	375,43
16	565,68	578,66
17	744,24	670,74
18	741,65	766,74
19	797,66	-

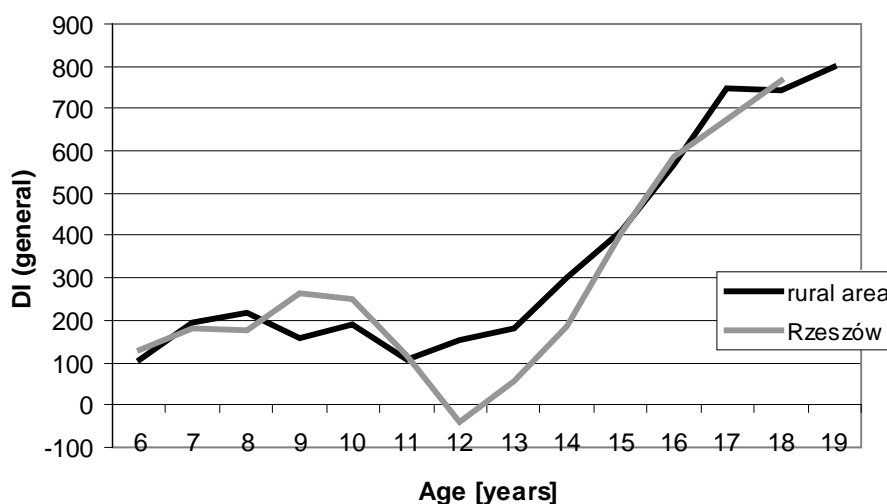


Fig. 2 The dimorphism index related to the general (multi-feature) body size of rural and urban children and youth

In rural and urban population, dimorphism of general body size has diversified values depending on the class age of subjects. In the group of rural children, low values of DI were noted in 6 y.o., while between 7 and 8 years old they were relatively high. In the age from 8–11 years old, decrease of multi-feature dimorphism of body size with age was observed. In 11 y.o. the DI has the lowest value, which indicates a small prevalence of boys over girls. Lack of fundamental intersexual differences in this age results from earlier puberty period in case of girls in comparison with their peers. In the period from 12–19 years old, gradual intensification of dimorphic differences was observed, which is the most visible in case of teenagers over 14 years old. Its highest value was stated for 19 year old teenagers.

Tab. 9 Mean values of the dimorphism index (DI) related to all examined parameters of rural and urban children and youth aged 6–18 years

Parameter	Dimorphism index (DI)	
	Rural area	Rzeszów
(g-op)	273,29	242,55
(eu-eu)	267,41	211,25
(n-gn)	306,66	357,16
(zy-zy)	235,80	419,86
(n-sn)	276,00	-77,28
(al-al)	390,43	392,62
(B-v)	215,80	287,88

(v-sst)	77,60	283,28
(sst-sy)	284,25	289,80
(a-da _{III})	416,96	346,13
(B-sy)	220,86	282,50
(xi)	502,31	98,92
(a-a)	384,44	279,86
(ic-ic)	97,45	145,79
m.c.	530,77	772,05
the triceps skinfold	-2575,95	-966,72
the abdominal skinfold	-2362,25	-1409,09
the subscapular skinfold	-1803,84	-1689,13
the sum of three skinfolds	-2257,22	-1321,52

In the period of ontogenesis from 6–10 y.o., dimorphism of general body size in urban series is on medium level. In the period from 10–12 years old, a decreasing trend was observed for the index value. Its lowest values, indicating the small intersexual differences, were registered for 12 and 13 y.o. In the age of 12, the DI has a negative value, which indicates the prevalence of girls over boys. In rural series there is no such phenomenon (negative value). In the period of ontogenesis from 12 to 18 years old, intersexual diversity of subjects from Rzeszów increases with age, which is especially noticeable in the period from 15 y.o. In rural series, essential increase of value of the above index can be observed in the age between 14 and 19 years old, so it starts a year earlier than in case of subjects from Rzeszów.

In result of comparative analysis it was indicated that in rural population, the index of multi-feature body size of the analysed parameters remains at lower level in the following periods: 6–7, 9–11 and 18 y.o., in comparison with urban series. In the period of ontogenesis from 12 to 15 and in case of 17-year olds, general dimorphism was more noticeable in rural group, although in that period the index values systematically decrease with age. The approximate DI values in compared series were registered for: 8, 15 and 16 y.o.

Discussion

Sexual dimorphism is variable and it depends from the phase of ontogenetic development. Proportions of human body during personal development change irregularly. The speed of these changes depends from the status of person's advancement in development, as well as from gender and genetic differences connected with it, which result in differences of body composition and functions of endocrine glands. Intersexual differences are visible already in the period of foetal life, they increase during progressive development and they are the most manifested in case of adults (Wojtyna, Rodziewicz-Gruhn 2005, Napierała 2007, Gworys et al. 2010).

At birth, boys have bigger dimensions of body in comparison with girls, and the difference amount to 1-3% with regard to body length and other linear dimension and 4% in the scope of body mass. During the first year of life, boys may present higher speed of development

than girls, but in the age from 1–9, the development speed of both genders is similar. In result of that, in the period from 5-10years old, dimorphic differences in the scope of almost all body dimensions, except for head diameters, are small in comparison with the ones observed for adults (7,8–8,2 %). From the moment of pubertal spurt, girls have temporarily higher values of almost all metrical features, including the dimensions of lower part of face. The width of the upper part of face and calvaria indicate small dimorphic differences estimated to about 3–5 %, with regard to small size of pubertal spurt of these dimensions. Before puberty period girls have higher content of fat tissue, and after that period, their amount is considerably increased. In the age from 1-6, the loss of subdermic fatness is slower in case of girls, and its gain is faster from 6 y.o. in comparison with boys (Tanner 1963).

Sexual dimorphism is not only limited to structural and functional features of human organism, but it also includes the psychical sphere. Results of endocrinological, neurological, psychological and ethological tests indicate the influence of sex hormones on brain organisation at male or female direction already from the 6th week of intrauterine life, which results in differences between both genders in the scope of: cognitive skills (e.g. spatial orientation, perception speed, articulation), motor functions, behaviours or inclinations (Berenbaum, Hines 1992, Kimura 1992, Grabowska 2003 for: Gołąb 2009).

Results of research of Gołąb (2009) conducted in a group of students indicated the phenomena of coexistence of certain somatic features and motor properties with diversification of the so called “brain gender” within a given gender. In case of men, somatic differences between extreme groups were stronger in the scope of such features as: body height, height while sitting, and their direction was compatible with anatomic symptoms of sexual dimorphism. When it comes to extreme groups of “brain gender”, women indicated small, but consequent differences in: circumferences of limbs, trunk, especially neck and in distribution of subdermic fatness.

Morphological and functional dimorphic differences are the reason for different formation of physical efficiency of both genders. In categories of absolute values, women have lower: speed, power, strength, endurance, but higher: flexibility, agility, precision and accuracy of movement in comparison with men. In case of male students of physical education from Bydgoszcz, the results of test of motor skills were better than in case of female students (Napierała 2007).

Socio-cultural modifiers have a different and directed influence on variability of absolute body dimensions, which results in change of proportions, separate for both genders (Gworys et al. 2010). Women are characterized with relatively shorter upper extremities in comparison with the lower ones, bigger subdermic fatness, smaller development of skeleton and muscles in comparison with men (Drozdowski 1998 as cited in: Napierała 2007, Wolański 2006, Vercellotti, Piperata 2012). The influence of various factors on human organism contributes to creation of bigger intersexual diversity, and even more to intersubject diversification of population (Gworys et al. 2010). Phenotypic variability of human populations inhabiting various regions of the world is probably the result of long-term selection and adaptation to environment (Vercellotti, Piperata 2012).

Various factors are stated to form the phenotypic sexual differences, which mechanism has not been explained. They include among others the type of diet – big dimorphism occurs in case of average protein consumption, the biggest one – with considerable

consumption. Considerable intersexual differences occur in polygamous populations, small – in monogamous, however it does not influence the level of dimorphism. Bigger dimorphism of body height occurs in populations with small growth of women. Perhaps the above mentioned facts are connected with diversified sensitivity of both genders to environmental factors, which results in various formation of dimorphism depending on the stage of economic development of population (Wolański 2006).

Analysis of the value of sexual dimorphism index of the researched cephalo- and somatometric features generally allows to confirm the consistency of tendencies of developmental changes in the analysed rural population, and in compared urban one from Subcarpathia, with information from auxological literature (Bukszyński, Malinowski 2002, Tatarczuk 2002, Zaworski, Młyńska 2004, Zaworski 2006).

As it was already mentioned, the age of specimen is one of the main dynamic factors of dimorphic changes. As it results from literature overview, intersexual differences in the scope of somatic features are the most visible during puberty and in postpuberty period, the less visible in group of young children – before the puberty period (Jedlińska, Waliszko 1981, Burdukiewicz et al. 1998, Bukszyński, Malinowski 2002).

Migasiewicz (2006) noticed small intersexual differences in the scope of height and body mass in the period from 7.5 to 12.5 years old in population of children and teenagers from Wrocław. From 13 y.o., dimorphism of body height and since 14 y.o. – of body mass has systematically and progressively increased for the benefit of boys. Similar image of dimorphic changes was also achieved by Mleczek, Cieśla (1999) in group of children and youth from Małopolska. Compliance with data of Migasiewicz (2006) was indicated in rural series from the Subcarpathian Voivodeship with reference to minor dimorphism of body height in the period from 7-12 y.o. Intersexual differences of the body mass in the age from 7 to 10 years old on the other hand remain on average level, while during 10-12 y.o. they are considerably decreased, which does not confirm the results presented by the mentioned author. Similar relation concerning the body mass was noticed in subjects from Rzeszów. The increase of dimorphism of both parameters in rural and municipal population from Subcarpathia is observed from 14 y.o. As opposed to data presented by Żak (1994) for children from Wrocław, sexual dimorphism of body height for both series from Subcarpathia is much lower than the one for body mass almost in the entire analysed period, except from rural 6-year olds.

Czaja (2004 as cited in: Gworys et al. 2010) did not register considerable intersexual differences in the scope of the trunk length to 16 y.o., while after 16 y.o. he noted a considerable increase of dimorphism. The length of upper and lower extremity on the other hand, indicated bigger dimorphic differences in the previous period (14–15 y.o.) and increased until 20 y.o. in result of quicker increase of these dimensions for boys in comparison with girls. Similar conclusions were drawn from the results of research of Bożilow et al. (2003). The results of research of rural population from Subcarpathia are confirmed by the data achieved by the above mentioned authors. Except for rural 10 year olds that indicated big dimorphism of (*sst-sy*) dimension, increase of intersexual differences in the scope of the trunk length, upper and lower extremity length is observed since 15 y.o.

The nature of intersexual differences in human body structure depends on: mass and strength of muscles, spine flexibility, growth of shoulders and chest together with respiratory system (bigger in case of men) and fatty tissue mass (bigger in case of women). When it comes to the width of pelvis, dimensions of face and head, there is no considerable sexual dimorphism (Wolański 2006).

Similar character of intersexual differences was stated by Wojtyna, Rodziewicz-Gruhn (2005) in two groups: candidates for the faculty of pedagogy with physical education in Częstochowa and students of the I year of Academy of Physical Education in Katowice, with the average age of 19.5 y.o. In case of subjects from Częstochowa, the biggest dimorphism was noticed in the scope of width dimensions: chest, shoulders, hips or chest depth. Female and male students from Katowice were the most diversified by: the body mass, shoulder width, chest width and circumference of chest. The above data are compliant with results of research achieved for 19-year olds from villages in the Subcarpathian Voivodeship. From among the analysed somatic features, the biggest dimorphism was registered in the scope of: body mass, circumference of chest and shoulder width.

Similarly, Napierała (2007) in a group of students of the 1st year of physical education from Bydgoszcz observed the biggest intersexual differences in shoulder width (bigger in case of men) and in thickness of three fat skinfolds (bigger in case of women). However, as opposed to own materials, the hip width was higher for women than for men.

Compliance with the statement of Wolański (2006) was indicated in reference to a part of the analysed metric features of rural and urban population from Subcarpathia. Definitely the biggest dimorphism, presented in form of arithmetic average of all age classes (in rural series 6–19 y.o., in urban series 6–18 y.o.), is characteristic of the thickness of three fat skinfolds and total fatness indicating the prevalence of girls. From among the cephalo- and somatometric features, girls and boys in compared populations are the most diversified by the body mass. In group of rural children, slightly smaller intersexual differences were registered with regard to the length of upper extremity and circumference of chest, and then to– remaining at similar level – the shoulder and nose width. The values of dimorphism index for: morphological face height, trunk length, head length, nose height and head width in rural series are on medium level.

In case of subjects from Rzeszów, three cephalometric features (head width, morphological face height and nose width), as well as the length of upper extremity, quite essentially diversify boys and girls. Slightly smaller diversities conditioned by gender, although remaining on lower level in comparison with the above mentioned parameters, were noted in the scope of body height and shoulder width parameters.

In rural series, slightly less expressed dimorphism was registered in the scope of features such as: head width, body height and the length of lower extremity. Both genders are the less diversified by the hip width and neck and head length. In urban population on the other hand, the values of dimorphism index that also remain on low level are the hip width and, surprisingly, the circumference of chest, as well as nose width, which indicate the prevalence of girls over boys.

The achieved test results are not completely confirmed by information from Tanner (1963) and Wolański (2006) on minor intersexual diversity of width dimensions of head

and face – in rural series, the values of index remain on average level, while on the urban one the face width indicates quite big dimorphism. It is also worth to notice small intersexual differences in the circumference of chest in urban series.

Malinowski (2010) indicated quite a different order and intensity of dimorphic differences in the scope of morphological features of head for adult representatives of white race in comparison with the data achieved for rural 19-year old youth from Subcarpathia. Taking into consideration the parameters included in this paper, author achieved the following order, according to the decreasing level of dimorphism: head length, morphological face height, face width, nose width, head width and nose height. Rural boys and girls in the age of 19 y.o. are the most diversified by the nose width, then by morphological face height, head length, then, on similar level: head width, face width and nose height.

In group of rural children from Kaszuby, Zaworski (2006) indicated the highest sexual dimorphism in the scope of thickness of fat skinfold on triceps, then on the abdominal skinfold, and slightly lower – on subscapular skinfold. The results of research conducted in rural series from the Subcarpathian Voivodeship confirmed the above relations. The intersexual diversity of subdermic fatness in series from Rzeszów on the other hand, is slightly different (subscapular skinfold – abdominal skinfold – triceps skinfold).

Many authors states that the intensification of dimorphic changes depends on influence of urbanization factor. The biggest intersexual diversity is typical of children and youth from big cities, the average one for those from small towns, and the smallest one for those from rural areas (Malinowski 1976, Zaworski, Młyńska 2004). The above phenomenon is the result of smaller speed of development of rural populations in the scope of body dimensions and biological maturity and of a different way of spending free time by children from various environments (Jedlińska, Waliszko 1981, Bukszyński, Malinowski 2002). In rural environment, character of domestic and household activities for both genders is more similar, the load of physical work is also bigger (Wolański 2006).

The results of conducted comparative analysis of average values of dimorphic index of particular parameters in the period from 6 to 18 years old (Table 9) enable a partial confirmation of the statements of other authors on smaller intersexual diversification of morphological parameters in rural populations in comparison with the urban ones. Bigger dimorphism in rural series was registered with regard to: upper extremity length, shoulder width, head length, head width, hip width, nose height and thickness of fat skinfolds and their total thickness, in comparison with the subjects from Rzeszów. Urban girls and boys in comparison with the rural ones are more diversified by: body mass, face width, morphological face height, body height, head and neck length, lower extremity length, circumference of chest. Dimorphism of the nose width and trunk length remains on similar level in both series.

Perhaps an explanation for the achieved results of comparison of sexual dimorphism in both series may be the tendency for fading of intra-environmental differences caused by civilizational changes in our country during the last 25 years, which could affect the analysed children and youth in some extent. Fading of social differences have existed in some Nordic countries, e.g. in Sweden or Norway, for several years already (Lindgren 1976, Brundtland et al. 1980, Liestol 1982, Cernerud 1994). The anthropologists' opinions on the phenomenon of decreasing or fading of environmental differences

during the last several years in our country are divided. Some of them are of the opinion that environmental distances between city and rural areas still remain, or even deepen, so the research on developmental phenomena of children shall be continued (Szopa et al. 1999, Malinowski 2004). Some research result confirm the elimination of differences between populations: urban and rural (Nowak-Starz 2002, Śliwa et al 2003, Jopkiewicz et al. 2004, Saczuk, Saczuk 2004), of small and big cities (Charzewska et al. 1999), or environments of rural areas and small towns (Mleczeko 2004).

Treating the analysed material in general, one can state that in case of about 50% of age groups, bigger developmental differences between boys and girls occur in urban series, and in the other half, in rural one. The above phenomenon occurs in a diversified level. The achieved results should be verified after the second series of research.

Conclusions

1. Image of dimorphic changes in the scope of majority of cephalo- and somatometric features and tissue elements in rural and urban series generally complies with well-known developmental regularities.

2. The size of intersexual differences in compared populations is diversified and it depends on the type of parameter and age class of subjects.

3. Lack of unambiguous tendencies in the scope of sexual dimorphism of the analysed features between rural and urban children from the Subcarpathian Voivodeship may be the result of civilizational changes in our country (e.g. political system transformation or unification of living conditions) which should be verified in the second series of research.

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