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ANTHROPOMETRICAL CHARACTERISTIC OF BULGARIAN STUDENTS AT THE BEGINNING OF 21st CENTURY

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ABSTRACT. The aim of the present article is to characterize the specificity of physical development during the transitional age between adolescence and maturity (19-20 years old) and to determine the intersexual differences about basic somatometrical features. In 2002 at Sofia University – „Saint Kliment Ohridski“ and Technical University – Sofia are investigated 72 male students and 70 female ones at the age 19-20 years. The classical methods of Martin-Saller are applied. The programme includes 20 directly measured somatometrical features, 18 derivative indications, body proportions and indexes, and their distribution into rubrics and categories. In the present paper are interpreted the values of basic body indicators: stature, sitting height, lengths of extremities, body weight, body diameters and chest circumference. The generalized characteristic of somatometrical status of the investigated young men and women according to the commonly accepted rubrics is as follows: MEN: tall, with broad shoulders, narrow pelvis, proportionally narrower chest circumference, long lower extremities, the distribution is almost equal between long and short upper extremities with little predominance of the long ones. WOMEN: tall, with narrow shoulders, narrow pelvis, proportionally narrower chest circumference, long lower extremities, with almost equal frequency of short and long upper extremities, with little prevalence of the short ones. The intersexual differences assessed by the Index of Sexual Differences (ISD) data show that both sexes differ mostly on body weight, followed by the chest measurements (circumference and diameters) and shoulders' breadth. Relatively smaller are the intersexual differences of pelvis' size.

KEY WORDS. Anthropometry, students, stature, body weight, body diameters, extremities' length.

INTRODUCTION

The physical development of man is a complex of morphological and functional characteristics of organism, which determine the mass, thickness, and form of the body. The indicators of physical development depend as on the hereditary peculiarities so on the environmental factors.

The development of human organism in the present conditions of life is a medico-biological problem of a great importance. The anthropologists have to solve problems, connected with the characterization of individual's physical development; with definition and valuation of the critical periods and stages in his individual development; with the epochal changes which are closely connected with the individual life expectancy; with the relations within the rates of growth in the postnatal ontogenesis and etc. [1, 3, 5, 7]. The necessity for quantitative characterization of human body is determined by the fact that all his measurements possess continuous changeability in time and space. The data received by the anthropometrical investigation, their adequate mathematical-statistical processing and analysis allow to be discovered the objective regularities of this changeability.

The aim of the present article is to characterize the specificity of physical development during the transitional age between adolescence and maturity (19-20 years old) and to be determined the intersexual differences of basic somatometrical features in a generation of Bulgarian students at the beginning of 21st century.

MATERIAL AND METHODS

Within the period March-May 2002 in the Sofia University „St. Kliment Ohridski" and Technical University – Sofia, are investigated 72 Bulgarian male and 70 female students at the age 19-20 years. The mean age of male ones is 19,49 years and of females – 19,57 years. The programme includes 20 somatometrical features, 18 derivative indications, body proportions and indexes and their distribution by rubrics and categories. In the present article are analyzed the values of basic body measurements: stature, sitting height, upper and lower extremities' length, body weight, biacromial and bicrystal diameters, sagital and transversal chest diameters and chest circumference in pause. The classical methods of R. Martin and K. Saller [8] are applied, described by Bulgarian authors as well [2, 4]. A standard anthropometrical appliances, millimeter band and balance are used.

The following variation-statistical characteristics are calculated: mean value $\bar{x}$, error of mean value Sx, standard deviation SD, variation coefficient V, minimal and maximal value of the feature. The Index of Sexual Differences (ISD) is calculated by the formula:

$$ISD = (\bar{x}_{\text{females}} / \bar{x}_{\text{males}}) \times 100$$

The so called Index Units (IU) are calculated by the ISD index data:

$$IU = 100 - ISD$$

The significance of sexual differences is studied by the t-criterion of Student at $P \leq 0.05$.

The classification of body composition of the investigated individuals is made by the common accepted rubrics and categories [8].

RESULTS AND DISCUSSION

BODY AND EXTREMITY LENGTHS, BODY WEIGHT

The stature (S) is a basic anthropological feature possessing important meaning for the interpretation of metrical data in a great part of the rest anthropometrical indicators, as well. On the base of stature is determined the normal and proportional body development by the calculation of different body parts proportions. That sign could be characterized by the great individual changeability while displaying distinct sexual, age and territorial differences. The mean stature of the studied young men is 178,78±0,78 cm, and of the young women – 164,05±0,60 cm. The shortest male student has stature 165,10 cm and the highest one – 193,50 cm. Amongst the female students the stature ranges from 152,10 cm to 176,90 cm (Table 1, Fig. 1). The intersexual differences are statistical significant – the young women are with 14,73 cm shorter than the young men (t = 14,91). According to the accepted in the anthropology subdivision of Martin's rubrics (Fig. 2), the calculated mean values for both sexes belong to the category „tall" – respectively 51,38% from the male students and 58,57% from the female ones. On the second place are the cases which belong to the category „very tall" – respectively 41,67% of the young men and 22,86% of the young women. In the category „very short" and „short" non of the investigated male and female students could be referred, and in the category „under middle" is only one young woman (1,43%). In the category „middle" are respectively 1,39% of the young men and 2,86% of the young women. To the category „above middle" belong 5,56% of the male students and 14,28% of the investigated female ones.

The studied young men have **sitting height (SH)** 93,17±0,44 cm and the mean value for the young women is 87,22±0,37 cm (Table 1, Fig. 3). It ranges from 85,80 cm to 103,40 cm for the male students and from 80,30 cm to 93,40 cm for the female ones. The intersexual differences are statistical significant (t = 10,27). The sitting height for the young men is with 5,95 cm greater, which is due to their higher stature. The correlation between sitting height and stature has greater importance than the absolute torso length for the research of body proportions. The mean value of this derivative indicator for male students is 52,12±0,15% and for female ones – 53,17±0,15% (Table 3.1). In comparison with young men, in young women the mean value is a little bit greater, i.e. they have longer torso and shorter lower extremities. It is accepted that the difference at this proportion between both sexes is about one index unit [8], and according to our study it is 1,05%. By the rubrics of Guiffrida – Ruggeri (Fig. 4), the majority of investigated young people comes into the category „mesatiskel" – respectively 55,56% from the male students and 61,43% from the female ones, which reveals a proportionality that determine harmonious body development of the studied individuals. On the second place is the category „brachyskel" to which belong 25,00% of the young men and 21,43% of the young women. Lowest is the percent of cases, coming into the category „makroskel" – 19,44% of the male students and 17,14% of the female ones.

The mean **length of upper extremity (UEL)** in the investigated young men is 79,52±0,40 cm and of the young women – 71,92±0,42 cm. For male students the upper extremity length varies from 72,90 cm to 86,30 cm and for female students – from 61,10 cm to 80,40 cm (Table 1, Fig. 5). The intersexual differences are statistical significant – the upper extremity length for female students is with 7,60 cm smaller (t = 13,08). The proportion of this somatometrical feature in male students has mean value 44,49±0,18% and in female ones – 43,83±0,17% (Table 3.1), as the intersexual differences are statistical significant and the proportion of upper extremity length for young man is with 1,48% greater (t = 2,75). According to the values for upper extremity length and its proportion (Fig. 6), 47,22% from the young men are long-armed (after Brugsch's rubrics) and 40,28% are short-armed and hardly 12,50% from the studied male students belong to the category „middle". In the group of young women is observed the reverse tendency – most of them are short-armed – 50,00%, and 41,43% fall into the category „long-armed". Again the lowest is the percent of female students who belong to the category „middle" – 8,57%.

The mean length of lower extremity (LEL) for the investigated young men is 99,09±0,61 cm, and for the young women – 89,97±0,47 cm. For male students the lower extremity length varies from 87,90 cm to 111,90 cm, and for female students – from 76,00 cm to 99,90 cm (Table 1, Fig. 5). The intersexual differences are statistical significant (t = 11,86). The lower extremity length of young women is with 9,12 cm smaller. The proportion of this somatometrical feature for male students has mean value 55,41±0,19%, and for female ones – 54,83±0,16% (Table 3.1), as the intersexual differences are statistical significant (t = 2,32). According to Brugsch's rubrics (Fig. 7) more than half of the investigated young women are long-legged – 58,58% and hardly 25,71% are short-legged. This tendency is more clearly expressed in the young men – respectively 79,17% are long-legged, and only 13,89% are short-legged. Lowest is the percent of the cases belonging to the category „middle" – respectively 6,94% of the male students and 15,71% of the female ones.

The correlation index between upper and lower extremities' length in young men has mean value 80,33±0,31%, and in young women – 79,94±0,24% (Table 3.2), as the difference is not statistically significant (P>0.05).

The **body weight (BW)** is one of the basic features for human physical development, health and working capacity. It is a generalized characterization, which contains information about all body components (bones, muscles, fats, internal organs and etc.). The weight is an indicator, which varies and could be influenced by different factors out of the inherited determination (nutrition, physical activity and etc.). For the investigated young men the mean weight is 70,40±1,02 kg, and for the young women – 52,39±0,84 kg. In the male students the body weight ranges from 54,00 kg to 99,00 kg, and in the female students – from 39,00 kg to 73,50 kg (Table 1, Fig. 8). The intersexual differences are statistical significant and the young men are with 18,01 kg heavier (t = 13,68), which is due to the well developed skeleton and muscles' systems in them.

BODY DIAMETERS AND CHEST CIRCUMFERENCE

The biacromial diameter (BaD) is basic anthropological feature, which proportion gives a generalized notion about body structure of man. The mean value of biacromial diameter for the studied young men is 41,19±0,24 cm, and for the young women – 34,84±0,22 cm. In the male students this diameter varies from 34,80 cm to 46,20 cm, and in the female students – from 30,10 cm to 39,20 cm (Table 2, Fig. 9). The intersexual differences are statistical significant (t = 19,29). The biacromial diameter for the young women is with 6,35 cm smaller. The proportion of this somatometrical feature for male students has a mean value 23,06±0,14%, and for female ones – 21,24±0,12% (Table 3.1), as the intersexual differences are statistical significant and the proportion of biacromial diameter in the young man is with 7,89% greater (t = 9,58). According to Brugsch's rubrics (Fig. 10), half of the investigated male students (51,39%) belong to the category „broad shouldered", 31,94% are in the category „middle", and only 16,67% of them are with narrow shoulders. A greater part of the young women – 60,01% have narrow shoulders and only 4,28% of them fall into the category „broad shouldered", i.e. here is observed the contrary tendency.

The bicristal diameter (BcD) together with its proportion and index for the relation with biacromial diameter is a sign, which determine the transversal measurements and the proportionality of torso. In the investigated young men the mean value of bicristal diameter is 27,23±0,19 cm, and in the young women it is 25,45±0,17 cm. In the male students this diameter varies from 24,40 cm to 32,60 cm, and in the female students – from 22,50 cm to 29,70 cm (Table 2, Fig. 9). The intersexual differences are statistical significant (t = 6,81). The bicristal diameter for young women is with 1,78 cm smaller. The proportion of this somatometrical feature for male students has a mean value 15,24±0,11%, and for female ones – 15,52±0,10% (Table 3.1). According to Brugsch's rubrics (Fig. 11), 94,44% of the young men and 98,57% of the young women are with narrow pelvis. Only 2,78% of the male students and 1,43% of the investigated female students fall into the category „middle", and broad pelvis have 2,78% of the young men. None of the female students comes in the category „broad", which perhaps is due to the fact, that at this age the entire body development is still not completed.

The correlation between bicristal and biacromial diameters gives an additional spatial vision about body transverse configuration. This index of male students has mean value 66,22±0,52%, and of female ones – 73,16±0,56% (Table 3.2), the difference is statisticaly significant (t = 9,13), which is corollary to the greater shoulders' breadth of young men.

The sagital and transversal chest diameters are two features, whose values determine the form of chest. It depends on ribbons' slope and curving, on the positions of breastbone, collarbones, shoulders' blade and vertebral column. The form of chest could be influenced also by the character, type and continuality of individual's physical and labor activities. For the studied young men the mean value of **sagital chest diameter (SCD)** is 20,91±0,20 cm, and for the young women – 17,72±0,18 cm. This diameter in male students ranges from 17,60 cm to 25,00 cm,

and in female ones – from 14,30 cm to 21,90 cm (Table 2, Fig. 9). The intersexual differences are statistical significant – the sagital chest diameter in young women is with 3,19 cm smaller (t = 11,90).

The mean value of **transversal chest diameter (TCD)** in the studied male students is 29,51±0,24 cm, and in the females – 24,91±0,19 cm. In young men this diameter varies from 25,70 cm to 36,20 cm, and in young women – from 21,10 cm to 29,90 cm (Table 2, Fig. 9). The transversal chest diameter for female students is with 4,60 cm smaller (t = 15,31).

The correlation index between sagital and transversal chest diameters in male students has mean value 71,05±0,76%, and in female ones – 71,32±0,75% (Table 3.2). S. Stefanov [6] determines three chest forms: cylindrical, conical and flat according to the calculated mean values of this index. More of the investigated by us young men and women have conical chest form.

Chest circumference (CC) together with stature and body weight is an anthropometrical feature that has basic meaning for the evaluation of human physical development. By measuring the chest circumference could be accounted simultaneously the chest capacity and massiveness, the position of ribs, the development of breast and back muscular groups, the subcutaneous fat tissue, and the development of lungs and torso breadth, as well. The mean value of chest circumference in pause for the investigated men is 87,37±0,68 cm, and for the women – 73,05±0,53 cm. In the male students the chest circumference ranges from 74,20 cm to 106,50 cm, and in the females – from 64,40 cm to 85,00 cm (Table 2, Fig. 12). The intersexual differences are statistical significant (t = 16,55). The chest circumference in pause for young women is with 14,32 cm smaller, which probably is due to the more developed bone-muscle system of young men. The proportion of this somatometrical feature for male students has a mean value of 48,92±0,41%, and for female ones it is 44,55±0,32% (Table 3.1). The proportion of chest circumference in pause for young men is with 8,93% greater (t = 8,40). According to Brugsch's rubrics greater is the part of studied men (79,16%) having narrow chest, 16,67% belong to the category „middle" and only 4,17% of them have broad chest. All of the female students, studied by us have narrow chest (100,00%).

EVALUATION OF THE SEXUAL DIFFERENCES

All investigated features are with larger values in young men and the differences are statistical significant, which is a biological regularity (Fig. 13). The evaluation of ISD data shows that the sexual differences are biggest for body weight (25,58 IU). With close ISD values, between 10 IU and 20 IU, are the measurements of chest and shoulders' breadth, which is an indicator about bigger massiveness of shoulder's girdle and chest in the investigated young men. For the extremity lengths and stature the ISD values are between 8 IU and 10 IU. With smallest sexual differences, but with relatively high ISD values, are the rest two features – bicristal diameter (6,54 IU) and sitting height (6,39 IU).

The descendent formula about sexual differences extent is:

BW > CC > TCD > BaD > SCD > UEL > LEL > S > BcD > SH
25,58IU>16,39IU>15,59IU>15,42IU>15,26IU>9,56IU>9,20IU>8,24IU>6,54IU>6,39IU

CONCLUSION

1. The investigated young men and women in the transitional age 19-20 years have high and very high stature according to the categories for the European population.
2. The correlations between stature and its basic components (sitting height and lower extremity length), display that the investigated 19-20 years old young men and women have a proportionality that determine harmonious body development.
3. The males and females at the age of 19-20 are with narrow pelvis and proportionally narrower chest circumference. The young men have broad shoulders, and the young women have narrow shoulders according to the categories for the European population.
4. The young men and women at the age of 19-20 have long lower extremities, but for the upper extremities the distribution is almost equal between long and short. In young men the long upper extremities slightly prevail, while in young women lightly prevail the short upper extremities.
5. The intersexual differences assessed by the ISD data shows that both sexes differ mostly on body weight, followed by the chest measurements (circumference and diameters) and shoulders' breadth. Relatively smaller are the intersexual differences of pelvis' size.

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Table 1. Body and extremities' lengths, body weight

	Male students						Female students							
Feature	$\bar{x}$	**SD**	**Sx**	**V**	**min**	**max**	$\bar{x}$	**SD**	**Sx**	**V**	**min**	**max**	**t-test**	**ISD**
Stature [cm]	178,78	6,63	0,78	3,71	165,10	193,50	164,05	5,06	0,60	3,08	152,10	176,90	14,91*	91,76
Sitting height [cm]	93,17	3,76	0,44	4,04	85,80	103,40	87,22	3,12	0,37	3,58	80,30	93,40	10,27*	93,61
Upper extremity length [cm]	79,52	3,37	0,40	4,24	72,90	86,30	71,92	3,55	0,42	4,94	61,10	80,40	13,08*	90,44
Lower extremity length [cm]	99,09	5,18	0,61	5,23	87,90	111,90	89,97	3,91	0,47	4,35	76,00	99,90	11,86*	90,80
Body weight [kg]	70,40	8,63	1,02	12,26	54,00	99,00	52,39	6,99	0,84	13,34	39,00	73,50	13,68*	74,42

***P=0.05**

Table 2. Body diameters and chest circumference

	Male students						Female students							
Feature	$\bar{x}$	SD	Sx	**V**	**min**	**max**	$\bar{x}$	**SD**	**Sx**	**V**	**min**	**max**	**t-test**	**ISD**
Biacromial diameter [cm]	41,19	2,05	0,24	4,98	34,80	46,20	34,84	1,87	0,22	5,37	30,10	39,20	19,29*	84,58
Bicristal diameter [cm]	27,23	1,65	0,19	6,06	24,40	32,60	25,45	1,46	0,17	5,74	22,50	29,70	6,81*	93,46
Sagital chest diameter [cm]	20,91	1,71	0,20	8,18	17,60	25,00	17,72	1,48	0,18	8,35	14,30	21,90	11,90*	84,74
Transversal chest diameter [cm]	29,51	2,00	0,24	6,78	25,70	36,20	24,91	1,56	0,19	6,26	21,10	29,90	15,31*	84,41
Chest circumference - pause [cm]	87,37	5,79	0,68	6,63	74,20	106,50	73,05	4,45	0,53	6,09	64,40	85,00	16,55*	83,61

***P=0.05**

Table 3. Body proportions and indexes [%]

3.1. Proportions

	Male students			Female students				
Proportion	$\bar{x}$	**SD**	**Sx**	$\bar{x}$	**SD**	**Sx**	**t-test**	**ISD**
UEL x 100 / S	44,49	1,53	0,18	43,83	1,45	0,17	2,75*	98,52
LEL x 100 / S	55,41	1,67	0,19	54,83	1,32	0,16	2,32*	98,95
SH x 100 / S	52,12	1,31	0,15	53,17	1,26	0,15	5,00*	102,01
BaD x 100 / S	23,06	1,21	0,14	21,24	1,04	0,12	9,58*	92,11
BcD x 100 / S	15,24	0,91	0,11	15,52	0,84	0,10	2,00*	101,84
CC x 100 / S	48,92	3,49	0,41	44,55	2,70	0,32	8,40*	91,07

***P=0.05**

Abbreviations: **BaD** – Biacromial diameter
BcD – Bicristal diameter
CC – Chest circumference
LEL – Lower extremity length
SH – Sitting height
S – Stature
UEL – Upper extremity length

3.2. Indexes

	Male students			Female students				
Index	$\bar{x}$	**SD**	**Sx**	$\bar{x}$	**SD**	**Sx**	**t-test**	**ISD**
UEL x 100 / LEL	80,33	2,65	0,31	79,94	2,00	0,24	0,98	99,51
SCD x 100 / TCD	71,05	6,43	0,76	71,32	6,26	0,75	0,25	100,38
BcD x 100 / BaD	66,22	4,43	0,52	73,16	4,68	0,56	9,13*	110,48

***P=0.05**

Abbreviations: **BaD –** Biacromial diameter
BcD – Bicristal diameter
LEL – Lower extremity length
SCD – Sagital chest diameter
TCD – Transversal chest diameter
UEL – Upper extremity lenght

Fig. 1

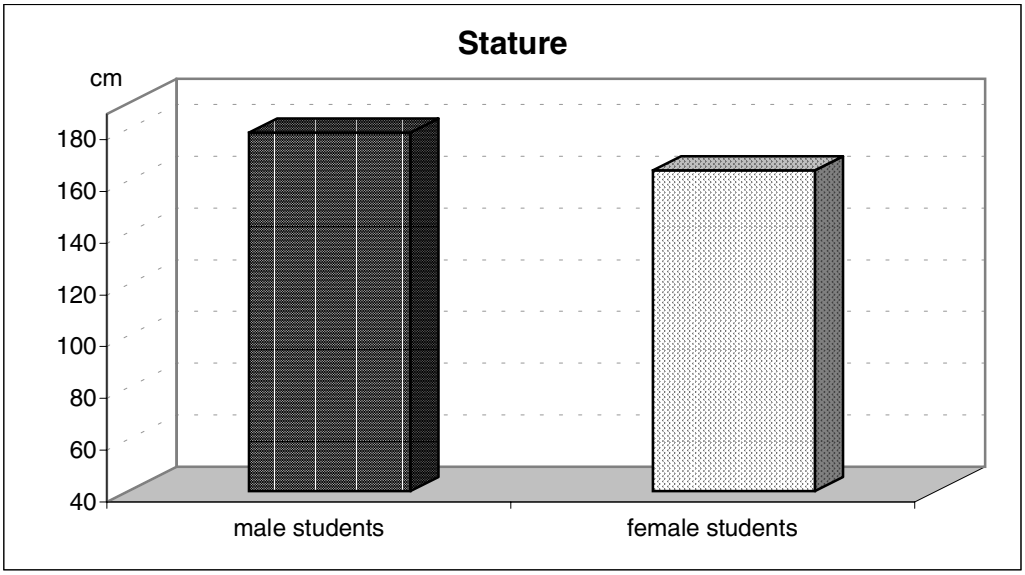


Fig. 2 Distribution according to the stature

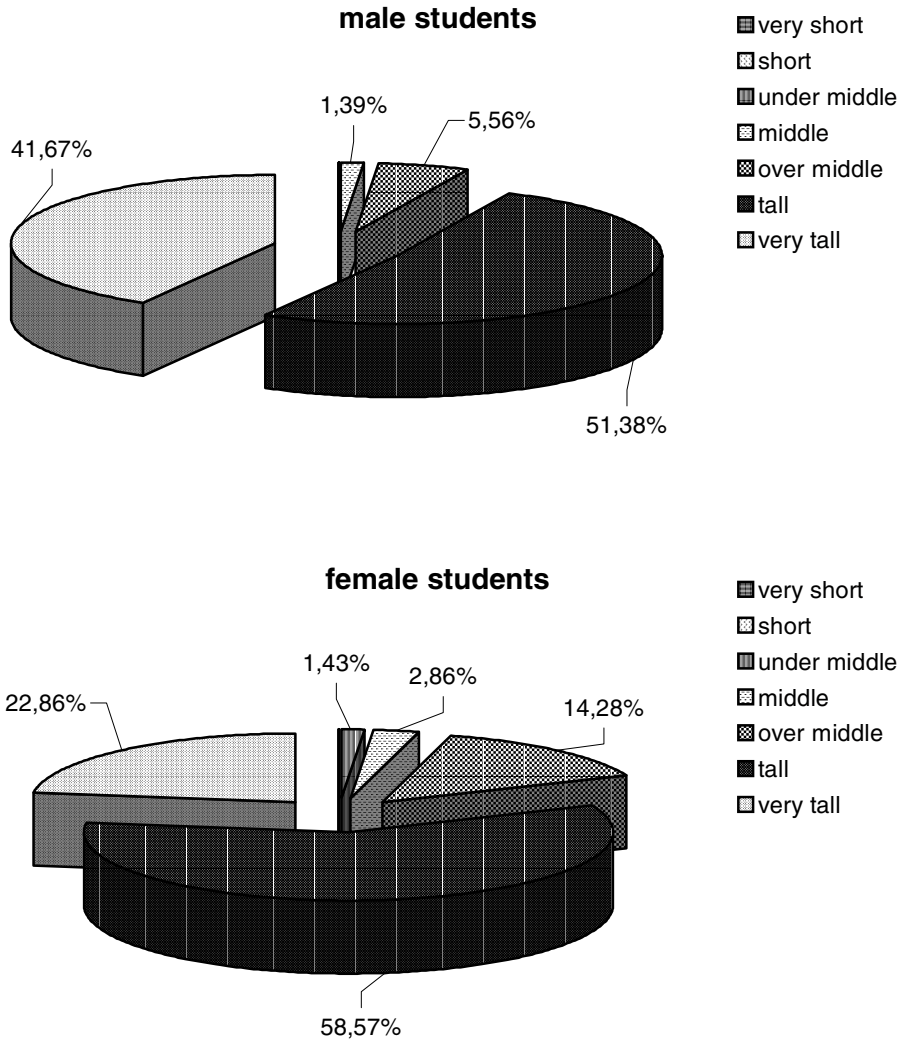


Fig. 3

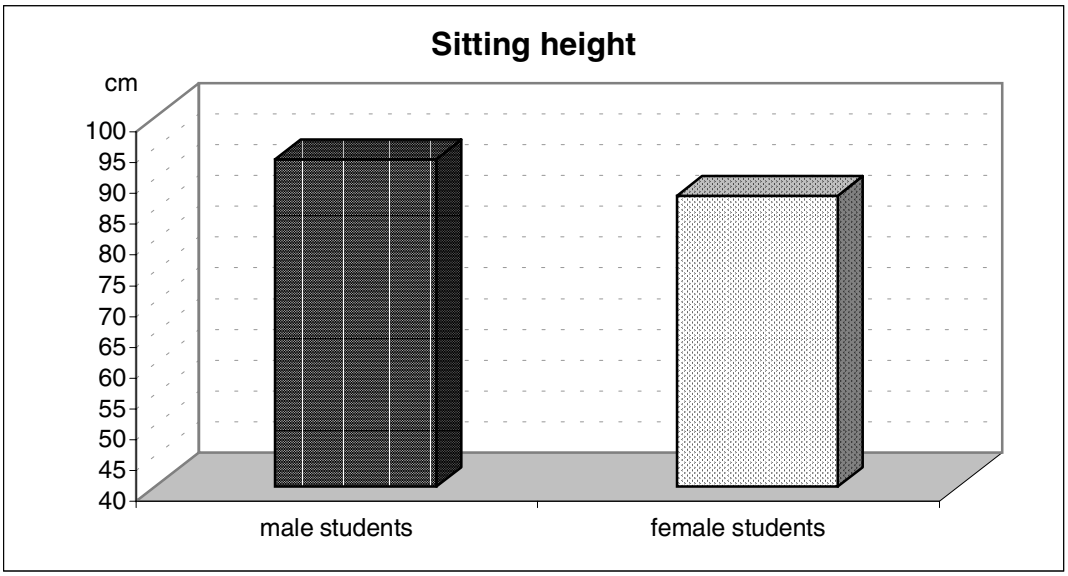


Fig. 4 Distribution according to the sitting height proportion

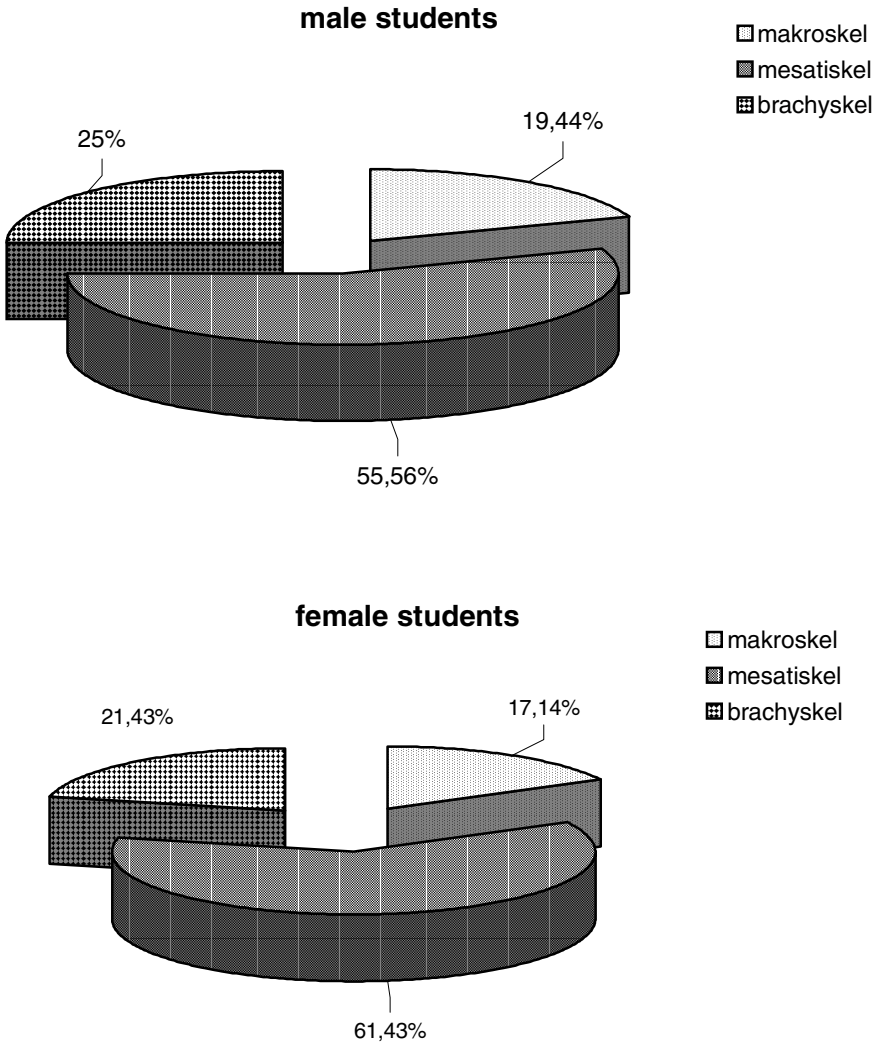


Fig. 5

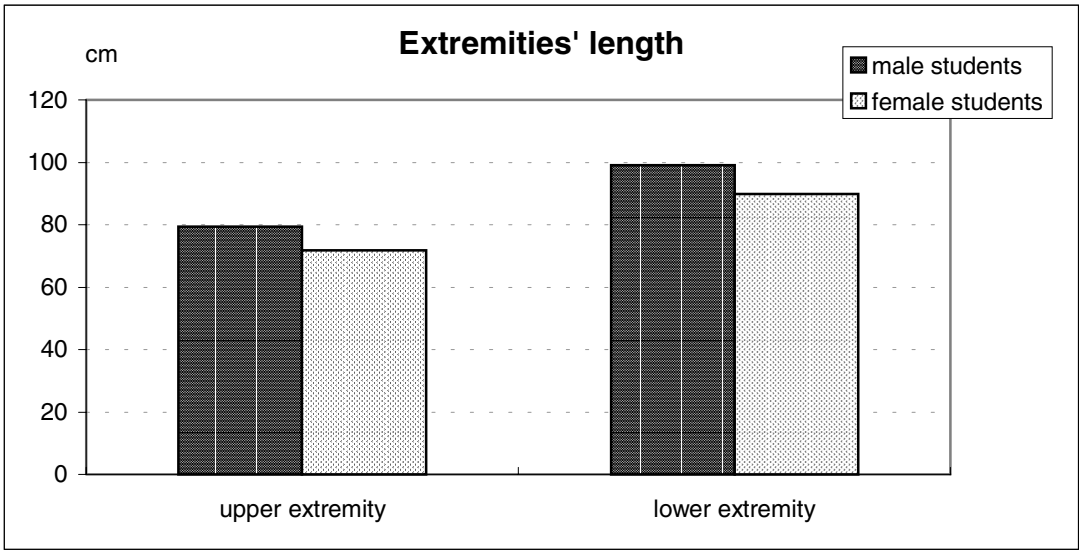


Fig. 6 Distribution according to the proportion of upper extremity's length

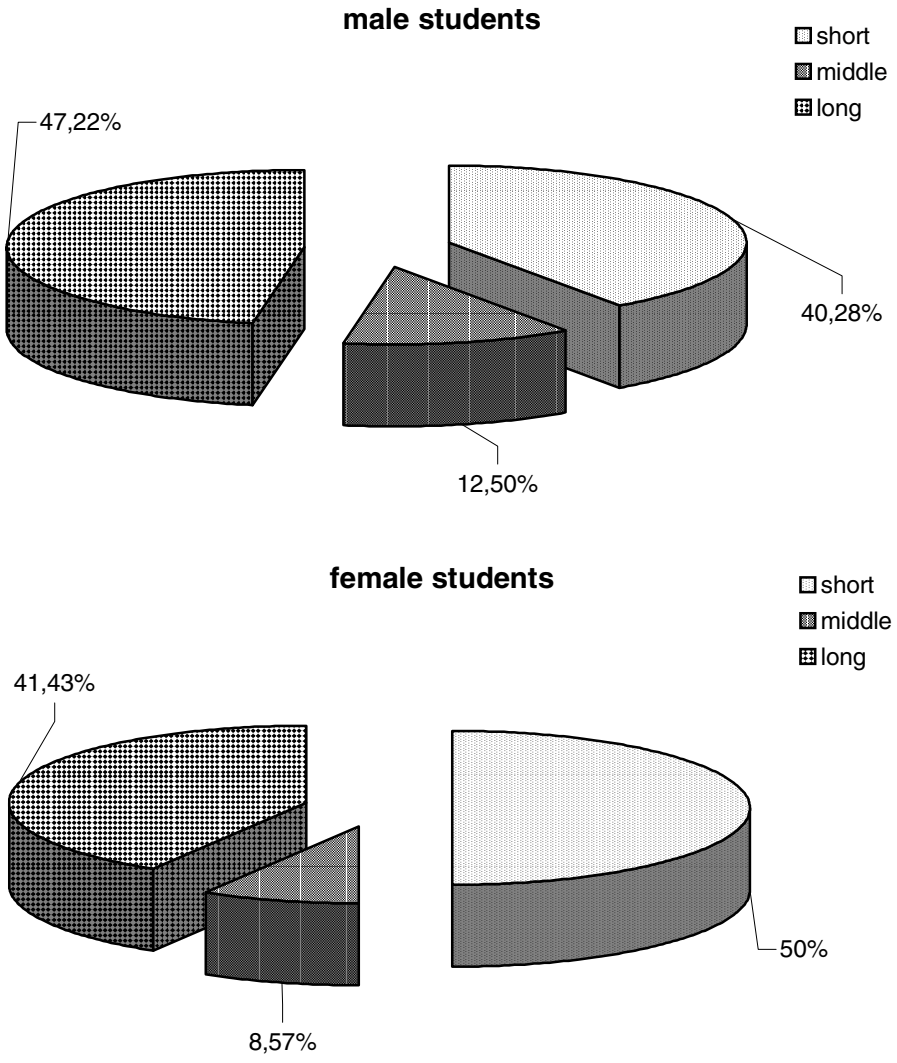


Fig. 7 Distribution according to the proportion of lower extremity's length

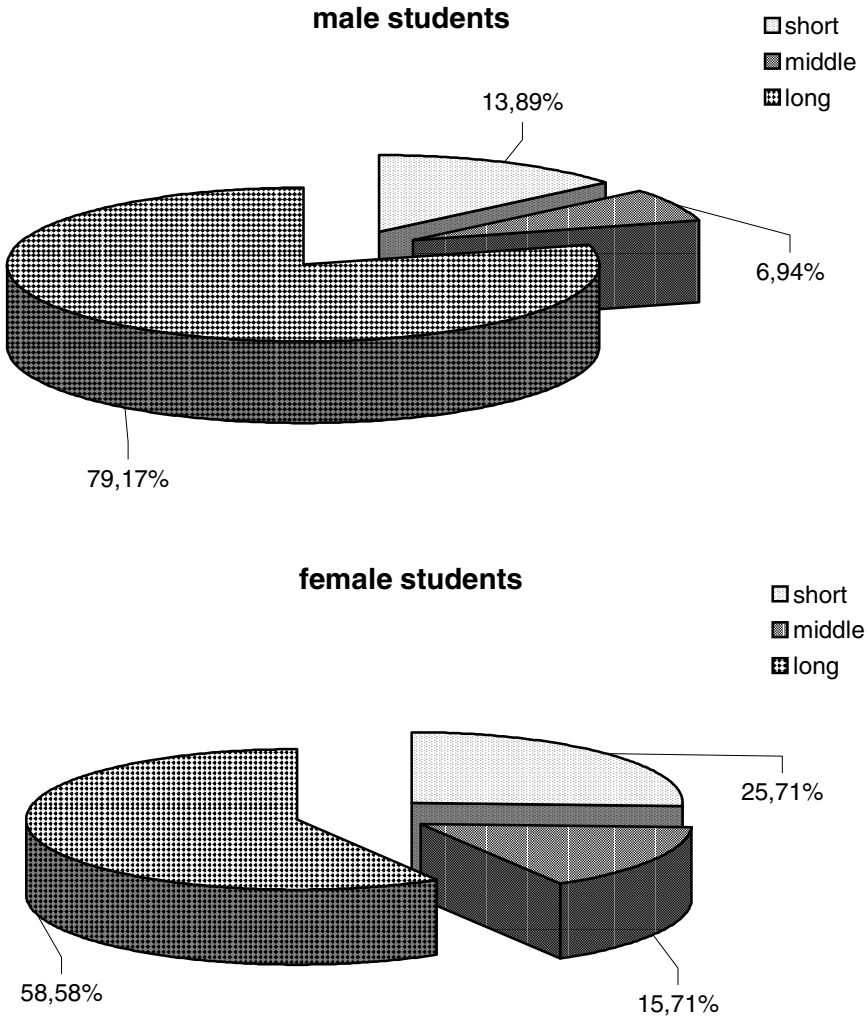


Fig. 8

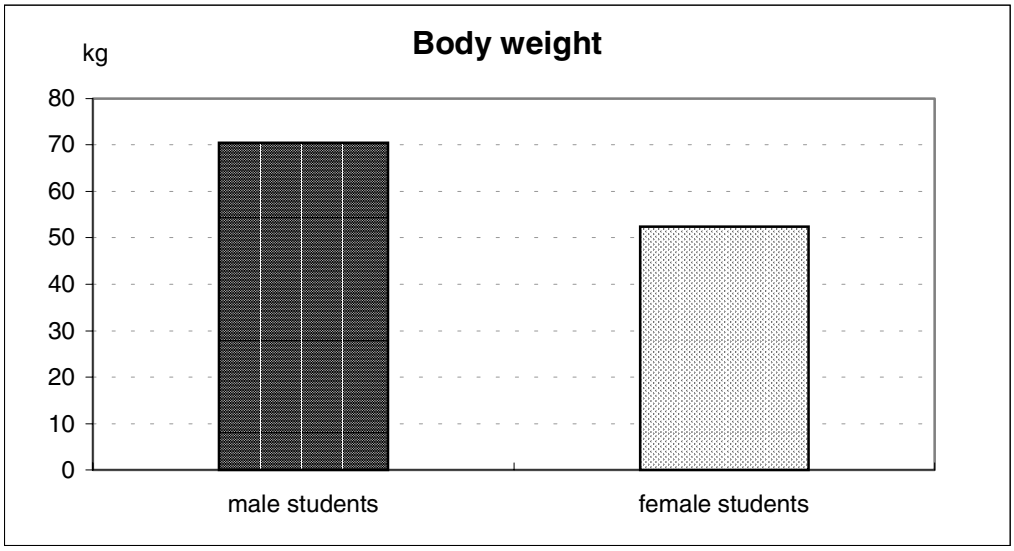

Body weight
kg
80
70
60
50
40
30
20
10
0
male students
female students

Fig. 9

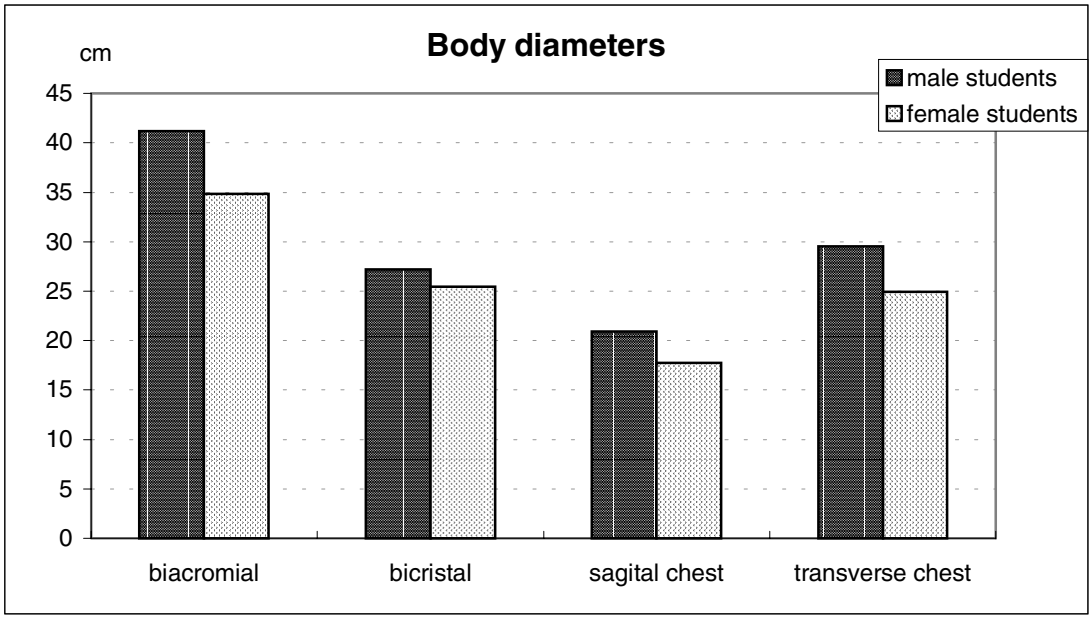

Body diameters
cm
male students
female students
45
40
35
30
25
20
15
10
5
0
biacromial
bicristal
sagital chest
transverse chest

Fig. 10 Distribution according to the biacromial diameter's proportion

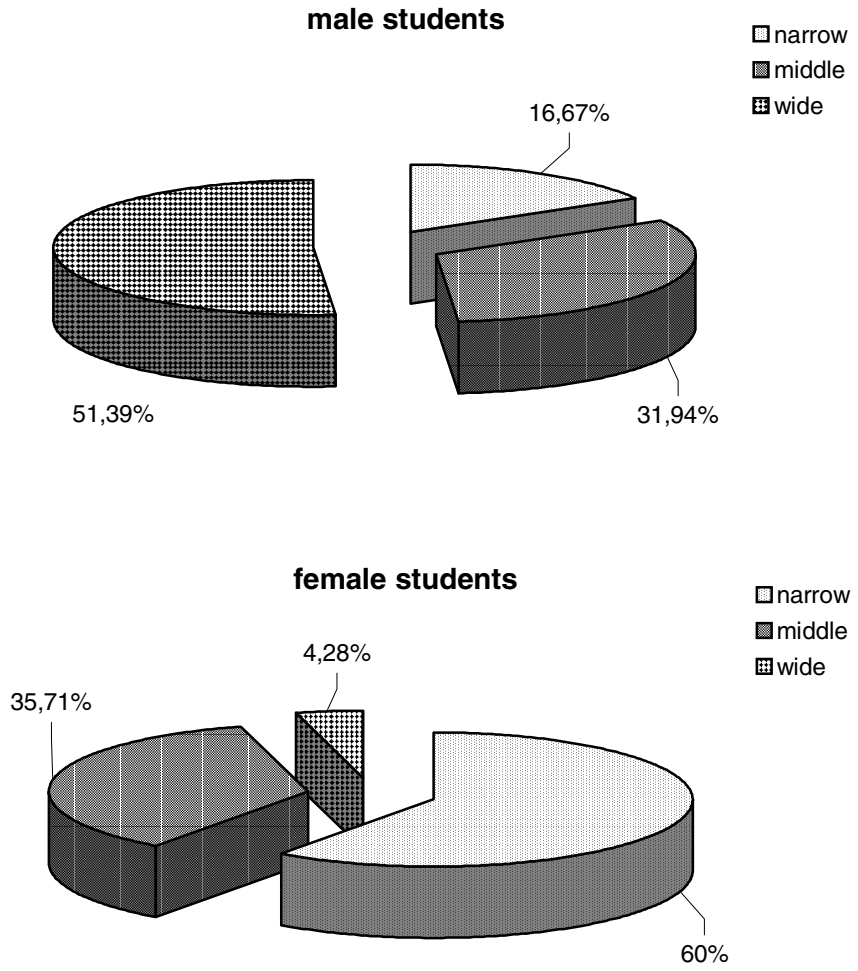


Fig. 11 Distribution according to the bicristal diameter's proportion

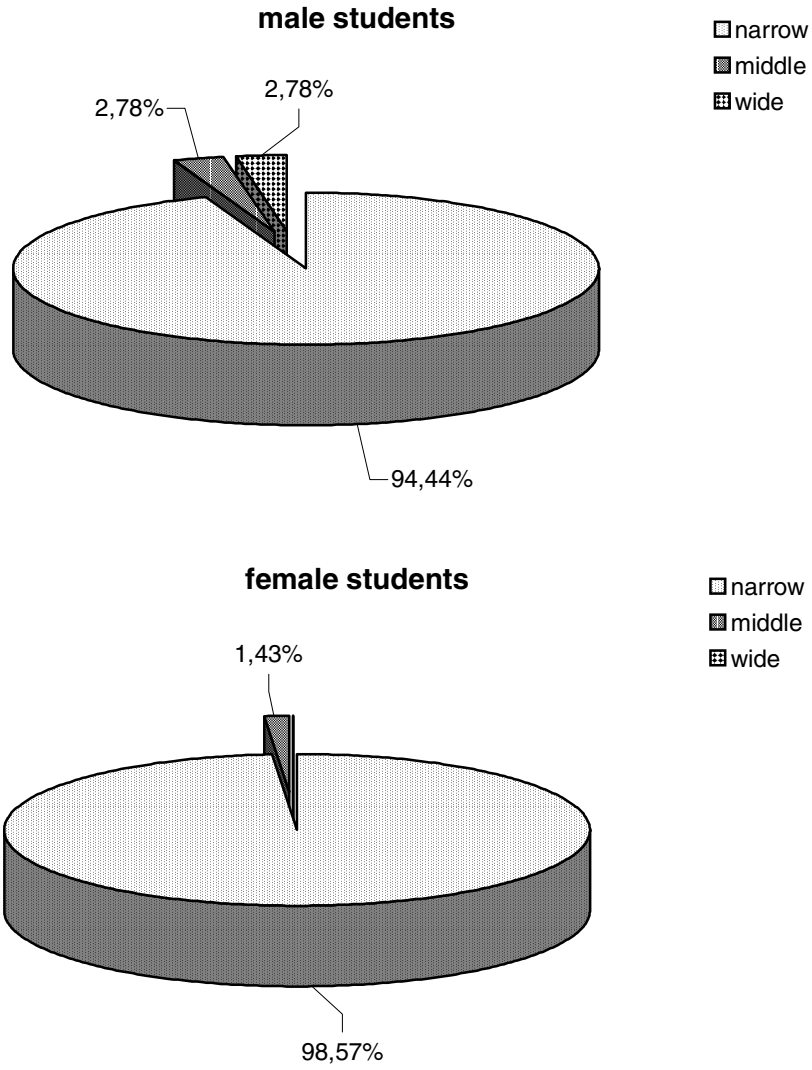


Fig. 12

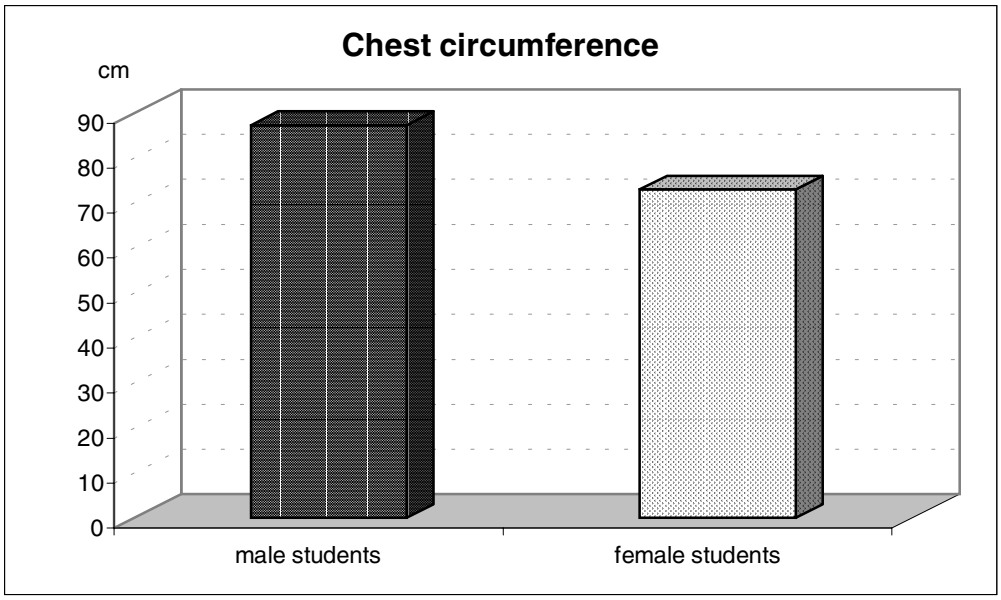
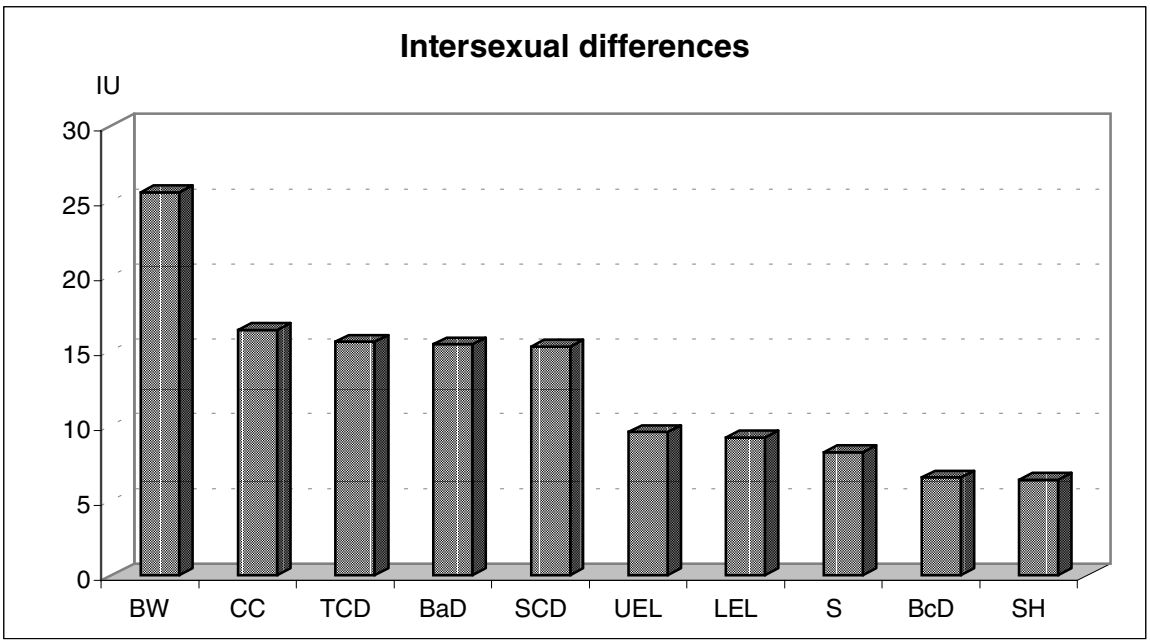

Chest circumference
cm
90
80
70
60
50
40
30
20
10
0
male students
female students

Fig. 13


Intersexual differences
IU
30
25
20
15
10
5
0
BW
CC
TCD
BaD
SCD
UEL
LEL
S
BcD
SH