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An attempt for anthropometric assessment of morpho-functional adaptation specific for different labour physical activities

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The aim of the paper is to assess the metrical changes in basic morpho-functional anthropological limbs' features, depending on the specificity of the physical activity in three professions in which the movements, the loading and the static efforts are combined in different manner. Nine representative male groups, each consisting of 100 persons, defined by profession and length of service are investigated. Data about 5 standard circumferences and 5 features which characterized the muscles and the muscles-fat ratio are studied. The changes in the investigated features are evaluated as according to the specificity of labour physical activity, and so according to the length of service — respectively up to 10, 20 and over 20 years. The results show that in work connected more with motor activity dominates the muscle component and in work connected mainly with loading and static efforts dominates the fat component in the muscle-fat ratio.

Key words: anthropometry, morpho-functional adaptation, different labour physical activi limbs' features.

Introduction

The limbs' circumferences are among the most ecosensitive features in man's anthropometric characteristics. The main factors, which contribute to metrical changes in the postnatal onthogenesis of these features are age and specificity of the physical activity in life, labour and sports [1, 2, 4, 5]. While age changes are comparatively well studied [3, 6], data on morpho-functional adaptation which is influenced by different physical activity are scarce.

The aim of this study is to assess the metrical changes in basic morpho-functional anthropological limbs' features, depending on specificity and duration of impact in three professions in which the motive activity, loading and static efforts are combined in different manners.

Materials and methods

A part of the data from a general anthropological investigation of representative groups of workers with different professions, distinguished by the specificity of the labour physical activity, is used for analysis and assessment in this paper. The analyzed data cover 900 males grouped in 9 age-professional groups, each 100 persons, as follows: clerks (financial-accounting personnel — C), millwrights (fitters and mechanics — M) and builders (brick-layers and plastereres — B). The professions are chosen so that each of them has specific physical activity in the work process. Three age groups of each profession are investigated: I (20—30 years), II (31—40 years), and III (41—55 years). These age groups give information also about the length of service in the corresponding profession, as by stipulation all the tested workers have not changed it. That is how the representatives from the first age group have 10 years of experience, from the second age group — 20 years of experience and from the third age group — more than 20 years of experience. Each person's data about 10 features are investigated: Arm circumference — relaxed, Arm circumference — contracted, Contractive difference, Muscle circumference of arm (MCA), Muscle-fat ratio of arm (MFRA), Forearm circumference, Muscle circumference forearm (MCF), Muscle-fat ratio of forearm (MFRF), Thigh circumference, Leg circumference. The muscle circumferences and the Muscle-fat ratios are calculated by formulas, used in the sports anthropology [7], and the results from their study are new in the general physical anthropology. In their calculations, data about the corresponding standard skin folds (SF) are used. The SF values are taken from the general investigation, but as they are not analyzed in this paper, their metrical values are not included in the Table 1. These are the formulae:

$$\mathrm{MCA} = \pi\left(\frac{\text{Arm circumference}}{\pi} - \frac{\mathrm{SF}_{\text{triceps}} + \mathrm{SF}_{\text{biceps}}}{2}\right),$$

$$\mathrm{MFRA} = \mathrm{MCA}\Big/\left(\frac{\mathrm{SF}_{\text{triceps}} + \mathrm{SF}_{\text{biceps}}}{2}\right),$$

$$\mathrm{MCF} = \pi\left(\frac{\text{Forearm circumference}}{\pi} - \mathrm{SF}_{\text{forearm}}\right),$$

$$\mathrm{MFRF} = \mathrm{MCF}/\mathrm{SF}_{\text{forearm}}.$$

The data for the studied features are processed variational-statistically and the measurement unit for circumferences is cm, and for the Muscle-fat ratio — per cent.

Analysis, discussion and results

To give an account of and to evaluate the presence or absence of morho-functional adaptation, depending on the specificity of labour physical activity, we analyzed comparatively the metrical differences in the particular features in interage as well as in interprofessional aspect. The graphics representing age curves for the particular features in the three professional groups give clear idea about the biological meaning

T a b l e 1. Metrical data

Features	Professional groups	21—30 years				31—40 years				41—55 years			
		$\bar{x}$	σ	m	v	$\bar{x}$	σ	m	v	$\bar{x}$	σ	m	v
Arm circumference — relaxed	C	28,92	2,37	0,23	8,19	30,50	2,81	0,27	9,19	30,83	2,52	0,24	8,17
	M	29,18	2,42	0,24	8,29	31,31	2,32	0,22	7,40	30,22	2,51	0,24	8,30
	B	29,53	2,89	0,28	9,78	30,09	2,90	0,28	9,63	30,60	2,74	0,26	8,95
Arm circumference — contracted	C	32,06	2,64	0,26	8,23	33,71	2,97	0,28	8,81	33,80	2,74	0,27	8,10
	M	32,42	2,59	0,25	7,98	34,37	2,51	0,24	7,30	33,12	2,69	0,26	8,12
	B	32,84	3,22	0,31	9,80	33,02	3,10	0,30	9,38	33,79	2,90	0,28	8,58
Contractive difference	C	3,14	0,99	0,10	31,52	3,15	0,91	0,09	28,88	2,97	0,89	0,09	29,96
	M	3,23	0,92	0,09	28,48	3,06	0,94	0,09	30,71	2,90	0,84	0,08	28,96
	B	3,31	0,98	0,09	29,60	2,93	0,80	0,08	27,30	3,19	0,97	0,09	30,40
Muscle circumference of arm	C	28,25	2,28	0,23	8,07	30,41	2,47	0,25	8,12	30,26	2,48	0,24	8,20
	M	28,54	2,24	0,22	7,85	30,68	2,22	0,22	7,24	29,47	2,19	0,22	7,43
	B	28,90	2,69	0,26	9,31	30,02	2,48	0,25	8,26	29.73	2,81	0,28	9,72
Muscle-fat ratio of arm	C	10,93	4,02	0.41	36,78	15,52	4,39	0,45	28,29	10,34	3,65	0.36	35,30
	M	13,66	5,08	0,51	37,19	13,90	3,99	0,40	28,70	10,64	3,73	0,37	35,06
	B	11,71	4,66	0,46	39,80	16,18	4,56	0,46	28,18	10,21	4,27	0,41	41,82
Forearm circumference	C	26,59	1,57	0,15	5,90	28,00	1,87	0,18	6,67	28,04	1,71	0,17	6,09
	M	27,38	1,64	0,16	5,98	28,83	1.78	0,17	6,17	27,92	1,60	0.16	5,73
	B	27,59	2,03	0,20	7,35	28,16	1.98	0,19	7,03	28,28	1,82	0,17	6,43
Muscle circumference of forearm	C	24,87	1,44	0,14	5,79	26,44	1,73	0,17	6,54	26,02	1,42	1,38	4,57
	M	25,86	1,39	0,14	5,38	27,14	1,63	0,16	6,00	25,92	1,50	0,15	5,79
	B	25,77	1,68	0,16	6,52	26,76	1,78	0,17	6,65	26,26	1,52	0,15	5,79
Muscle-fat ratio of forearm	C	16,22	5,46	0,54	33,66	18,47	5,56	0,54	30,10	14,32	4,68	0,45	32,68
	M	19,14	6,24	0,61	32,60	17,27	4,57	0,44	26,46	15,73	6,68	0,65	42,47
	B	16,18	5,72	0,56	35,35	19,56	5,00	0,49	25,56	16,16	6,12	0,50	37,87
Thigh circumference	C	53,37	4,01	0,39	7,51	55,14	4,13	0,39	7,49	54,28	3,82	0,37	7,03
	M	52,34	4,51	0,44	8,61	54,80	4,73	0,46	8,63	52,83	3,96	0,39	7,49
	B	53,29	4,42	0,43	8,29	51,93	4,49	0,43	8,64	53.73	4,02	0,39	7,48
Leg circumference	C	36.80	2,60	0,25	7,06	37,61	2,87	0,27	7,63	37,63	2,48	0,24	6.59
	M	35,85	2,46	0,24	6,86	37.24	2,66	0,26	7.14	36,52	2,63	0,26	7,20
	B	35,60	2,60	0,25	7,30	36,24	3.28	0,32	9,05	36,67	2,79	0.27	7,60

of the found intergroup differences (Fig. 1). In interage aspect the three professional groups show that both arm circumferences, relaxed and contracted, have lowest values in the first age group, and in the second age group they increase remarkably. In the third age group the increase continues in a smaller degree for millwrights and clerks, while for the builders Arm circumferences sharply decrease. The other three circumference of the upper limb — Muscle circumference of arm, Forearm circumference and Muscle circumference of forearm — show similar to the described age changes, but for them in the last age group a general trend to decrease is present. In medical-biological aspect this decrease of the circumferences of the upper limb in the third age group reflects age conditioned changes much more than changes caused by professional impact. After analyzing the data for the five Circumference features of the upper limb in interprofessional aspect, again most interesting biological information is given from the metrical interprofessional differences in the second age group. Millwrights are with highest values for the three Arm Circumferences, builders are with lowest ones, and the clerks take medial position. But the clerks still have lowest values for the Forearm circumference in the first and third age groups, the millwrights keep the leading position and the builders are in the middle. Obviously the Arm and the Forearm participate in different ways in the realization of the three types of labour physical activity, and they show differentiated interprofessional distinctions. On the other hand, the similarity of the interage and interprofessional differences among the values for Muscle circumferences and these for relevant segments of the upper limb general Circumferences, shows that these features give biological information, wich is relatively more dependent on the wholebody measures.

The Leg and Thigh circumferences' values show specific type of interprofessional differences. They are highest for the clerks, lowest for the builders and middle for the millwrights. Hypodynamics in office work, whis is accompanied with many static efforts, has definitively contributed to bigger circumferences of the clerk's lower limbs. For the builders, whose work is accompanied with big and various motive activity of the lower limbs, a trend to optimum reduction of their volume is determined. The millwrights most often work standing and their lower limbs take up indirectly the weights accompanying their work. The heavy static efforts needed to keep the standing work pose, additionally complicated with the weights, has probably contributed to the lower limbs' mass increase.

The results, at present available, generally describe the upper and lower limbs' volume and definitively give information about professionally dependent metrical changes. But using them it is not possible to specify which of the components of the circumference features contribute to the difference found. Such a possibility occurs after the Muscle-fat ratio of arm and forearm data analysis. In interage and in interprofessional aspect these data show specific intergroup differences and enriches the information about the upper limbs' morpho-functional adaptational possibilities. According to the MFR calculating formulae — MC/SF — the higher index values refer to muscle component superiority over the fat component in the ratio. The age curves for both Muscle-fat ratios show lowest values in the last, third, age group in all three professional groups, which means that during the period 40—55 years the subcutaneous fat tissue's relative share is higher than the corresponding muscles of the upper limbs. This muscles have their most vigorous growth among 30 and 40 years, when both work and life physical loading are biggest and in general stimulate superiority of the muscle component over the fat one. The only exception is the Muscle-fat ratio of Forearm for the millwrights, where it dominates since first age group. Interprofessional differences of these features are also mostly pointed in the second age group. But during this period every feature shows specific, according to

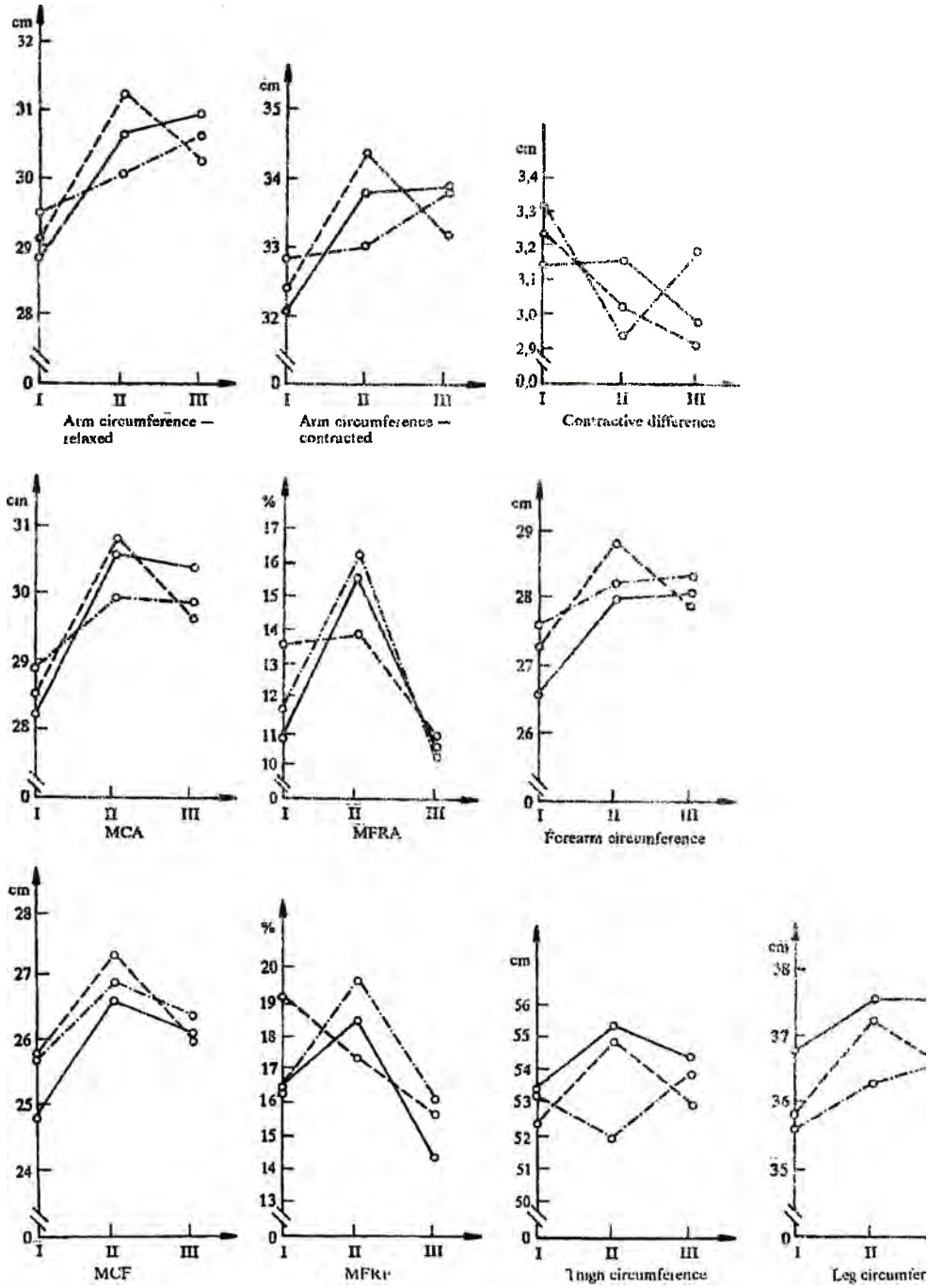

Fig. 1. Metrical differences (about 10 features) according to age and profession
Profession groups: — C; — — —M; —.—.—B; Age groups: I — 20÷30; II — 31÷40; III — 41÷55

us, professionally conditioned ratio of muscle and fat component of the Arm and Forearm circumferences. Millwrights, who are representatives of the physical labour, consisting of dominating static efforts for lifting and holding up heavy weights and comparatively little motive activity, have biggest part of the fat component in the Muscle-fat ratio in intergroup aspect. Obviously their fat tissue is necessary as a specific energy source for the work of mostly weighty and statically loaded up relevant muscles. For the builders the circumferences of the upper limb have least subcutaneous fat tissue, which reflects their labour physical activity, mainly connected with motive operations of higher volume, and the weights are smaller than these for the millwrights. For the clerks the Muscle-fat ratio has medial values, i. e. the participation of both circumference components is relatively equivalent. This ratio seems to be optimal for performing physical labour, mainly connected with static efforts, which must provide the precise manipulations in manuscript, typescript and calculation.

The contractive difference of the arm has independent type of interage and interprofessional metrical distincts. Though at first sight it may seem illogical, in the second age group, man's most active labour period, the clerks have biggest contractive difference and the builders — smallest. From other representative and extended comparative examinations we received similar data, showing the non-conformity to the name of the feature and the biological information which it gives. That gives us the reason to suggest a new meaning to this feature's name. The received information about the contractive difference, compared with the one about the Muscle-fat ratio of arm shows that it does not describe the functional possibilities of the armpit muscle independently, but the possibilities of all arm's soft tissues skin, hypodermic tissue, muscles, blood-vessels to strain and increase their mass as much as possible.

Summarized the results in this study show that the limbs' circumference features and the proportions between the muscles and the subcutaneous fat tissue definitely have the abilities for specific adaptational changes under the various labour physical activities influence. Muscle-fat ratio of arm and forearm are with highest ecosensibility, and in labour activity, connected more with motive operations the muscle component dominates in these proportions, while in labour activity, connected mainly with static efforts and weight loading, the fat component dominates.

In medical-biological aspect these results show that the purposive anthropologic investigations can be useful in evaluating the adaptation-compensatory changes in the locomotory system under the circumstance of different labour physical activity.

References

1. Bowen, Ph. E., P. B. Custer. Reference values and age-related trends for arm muscle, arm fat and sum of skinfolds, for US adults. — J. Amer. Coll. Nutr., 3, 1984, No 4, 357-376.
2. Eiben, O. The phisique of women athlets. — The Hung. Sci. Conn. Physic Educ., Budapest, 1972, p. 190.
3. Malino, R. M. Kinanthropometric research in human auxology. — In: Hum. Growth and Dev. New York — London, 1984, 437-451.
4. Nacheva, D. Estimation of the infuence of physical activity type on the manifestation of body asymmetry. — Acta Morphologica, 6, 1987, 81-85.
5. Мартиросов, Э. Г. Влияние спортивного амплуа на формирование телосложения. — Вопр. Антр., 74, 1984, 9—24.
6. Никитюк. Б. А., В. П. Чтецов. Морфология человека. М., МГУ, 1983. 320 с.
7. Томов, Л. Проучване на развитието на мастната тъкан и активната телесна маса при спортисти в юношеска възраст. Канд. дис. С., 1978.