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AGE FEATURES IN THE DEVELOPMENT OF THE SUBCUTANEOUS FAT TISSUE, MUSCULARITY AND MUSCLE-FAT RATIOS IN MEN WITH DIFFERENT PHYSICAL ACTIVITY

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ABSTRACT

The purpose of the present work is to study and assess the age features in the development of the subcutaneous fat tissue, limbs' muscularity and interactions between muscles and fat in men at active-working ages from different professional groups. The data about 9 standard skin folds, 7 circumference of body and limbs as well as muscle-fat relation of arm and thigh in 786 men at the age of 30-50 have been analyzed. The subjects were from 4 professions with different physical activity (smelters, carpenters, fitters, and drivers). They were divided in two age groups: 1st group -30-40 years old, and 2nd group –41-50 years old. The results show that the men from all professions with the age advancing have bigger circumference body sizes but their limbs sizes are not considerably changed. The age changes are not more than 10% in the absolute quantity of measured subcutaneous fat tissue in all professional groups. More definite differences in the age aspect have been observed regarding the topical distribution of subcutaneous fat tissue in the body and limbs in the separate professional groups.

Keywords: circumferences, skin folds, muscle-fat ratios, profession, age, adult population

INTRODUCTION

Body circumference sizes and the thickness of skin folds at some body areas are morphological features that are studied mostly as a component part of the overall anthropological status of individuals. These features give the general notion of a body size, the massiveness of some skeletal segments, as well as the rate of soft tissues development – muscle and fat tissue. From the anthropological point of view, the muscle and fat tissues are the characteristics which are the least dependent on the genetic datum and the most susceptible to the surrounding environment. Adaptation changes of a human organism to different life conditions - climatic (Belkin 1999), socio-economic (Rebato 2001, Santos and Barros 2003) or labour-professional (Начева и Лазарова 1999, Пурунджан 1990) are possible only due to the eco-susceptibility of these

characteristics. The purposeful research on the development of SFT and its contiguous muscularity give a lot of information about the dynamic changes in the two types of tissue according to the age and sex (Томов 1987, Саливон и Копыток 1999, Начева и Колева 1999, Mladenova, Nikolova and Boyadzhiev 2005, Mitova 2005, Rakić, Kristić and Pavlica 2007), to life and labour conditions (Toteva et al. 1999, Mabruk and Toteva 2005), to food regimen (Година и Задорожная 1990, Erikson 2003), etc. The results of such research are not only theoretically important but they are of great significance to the clinical practice of many pathological conditions (Attvall 2003, Baltadjiev et al. 2005, Cigali 2005).

The purpose of the present work is to study the age features in the development of SFT, limbs muscularity and muscle-fat ratios in men at active-working ages from different professional groups.

MATERIAL AND METHODS

786 men, 30-50 years old, were examined anthropometrically; they are representatives of four different labour activities and they work as: smelters, fitters, carpenters and drivers. All of them have had working experience in their jobs for not less than 10 years. The records are part of transversal anthropological survey covering the working people from different enterprises in Plovdiv (Bulgaria). The contingent of men in this study is divided in two age groups: I - from 30 to 40 years old and II – from 41 to 50 years old. We measured the thickness of 9 skin folds by a set of GPM caliper at the constant pressure of -10g/мм^2. The skin folds are at standard body areas (SF under the scapula, SF X-rib, SF abdomen, SF suprailiac) and over the limbs (SF triceps, SF biceps, SF forearm, SF thigh, SF calf). The sum of 9 SF has been calculated and also the values of the middle skin fold. The records of body weight and the basic circumference features of the body (chest circumference, waist circumference, circumference abdomen) and of limbs (circumference arm, forearm, thigh and calf). The assessment of the muscularity of the arm and thigh was done by calculating the „muscle" circumferences and the „muscle-fat" ratios with the responding formulas [1]:

MCA (*Muscle circumference of the arm)*

$$MCA = \pi \cdot \left(\frac{\text{circumference arm}}{\pi} - \frac{\text{SF triceps + SF biceps}}{2}\right)$$

MFRA (*Muscle-fat ratio of the arm*)

$$MFRA = \left(\frac{\text{circumference arm}}{\pi}\right) : \left(\frac{\text{SF triceps + SF biceps}}{2}\right)$$

MCT (*Muscle circumference of the thigh*)

$$MCT = \pi \cdot (\text{circumference thigh} - \text{SF thigh})$$

$$\textbf{MFRT}\ (\textit{Muscle-Fat ratio of the thigh}) \qquad \text{MFRT} = \textbf{(}\frac{\text{circumference thigh}}{\pi}\textbf{:}\ \frac{\text{SF thigh}}{\pi}\textbf{)}$$

The material was statistically processed with a computer program SPSS-11 and the data from the Descriptive Analysis were used. We compared the average quantities of the different features in the two age periods by Student's t– criteria. For more objective and comparative assessment of the results, the percentage changing of each age characteristic was calculated in addition.

RESULTS

The results from the descriptive statistical analysis of age changes in the values of the basic body circumference sizes are presented in Table 1.

The average values of the three body circumferences increase in the second age period. That refers mostly to the waist circumference (between 2,50-7,32 %), then the chest circumference (between 1,70-3,26 %) and abdomen circumference (between 1,57-2,07 %). The increase in smelters is statistically significant in the three circumferences ($p<0,05$). In fitters and drivers, the increase is considerable regarding the chest circumference and waist circumference ($p<0,05$). In carpenters, the percentage increase of the three circumferences is insignificant with years advancing ($p>0,05$).

Age changes in the values of circumference sizes of the upper limb and muscle-fat ratio of the arm are presented in Table 2.

The average values of the total and muscle circumference of the arm, as well as the circumference of the forearm do not differ in the two age periods in all professional groups ($p>0,05$). In smelters, fitters and drivers, the values of the muscle-fat ratio of the arm decrease with years advancing, but in drivers, it is mostly clear (10,07%) and statistically significant ($p<0,05$). We found only in carpenters a statistically significant increase of MFRA value in the second age period which is more than 10 % ($p<0,05$).

Table 3 presents the age changes in the values of the circumference sizes of the lower limb and the muscle-fat ratio of the thigh.

The table shows that even inconsiderably the average values of the total and muscle circumference of the thigh and the circumference of the calf get smaller with years advancing in all professional groups, but muscle-fat ratios of the thigh get bigger. The decrease of the muscle circumference is the most distinct in smelters from the second age group (5,58%), and their differences with the younger smelters reach statistical value ($p<0,05$). The increase of MFRT is the biggest in carpenters from the second age period (14,08 %), and the result is also statistically significant ($p<0,05$).

Table 4 shows the results of the descriptive statistical analysis of age changes in body weight, the total amount of measured SFT (the sum of 9 SF), and also the thickness

of the average SF. The differences of the average values of body weight in men from both age periods in each professional group are less than 2,5 % and they are statistically insignificant ($p>0,05$). The older smelters, fitters and drivers do not differ from the younger men regarding the total amount of measured SFT, as well as regarding the thickness of the middle layer SFT. In carpenters only, there is a statistically significant decrease of the sum of 9 SF (8,61%) and the average SF (8,61%) with the age advancing ($p<0,05$).

Table 5 presents the average values of thicknesses of the examined 4 body SF. The thickness of SFT at the area of the back gets bigger with the age advancing. The biggest percent is in drivers at the age of 41-50. They have a thicker SF with 12,16 % in the area of the scapula in comparison with 30-40-year-old drivers. The differences are statistically significant ($p<0,05$). In older smelters and fitters, there is such an increase of SFT at the sub scapular area with more than 10 %, as the differences from the younger ones get to a statistical quantity. The least significant increase of SFT is in the back area in older carpenters.

The SF thickness at the X rib gets bigger in men from every professional group in the second age period. It is the clearest ($p<0,05$) in the group of smelters (16,63%), and especially in the group of drivers (24,96%).

The SF thicknesses at the suprailiac area of the men in the two age periods are not considerably different. The age changes in the SFT thickness at the abdomen are also inconsiderable, except the drivers. The abdominal SF of drivers at the age of 41-50 is 12,24 % thicker than this of 30-40-year-old men. The result is statistically significant ($p<0,05$).

The age changes in the SF thickness of limbs in men from the examined professional groups are in Table 6. The thickness of almost every SF of the upper and lower limb gets statistically significantly smaller with the age advancing in carpenters. The biggest decrease is at the thigh – 18,98%, at the triceps it is 18,27%, at the calf – 15,92% and the forearm – 11,56 %. There is such a decrease of SFT with more than 10 % at the lower limb in older fitters.

There is a decrease of the SF thickness at the biceps, with the age advancing, only in smelters (15,28%) and fitters (14,25%).

DISCUSSION

In Bulgaria anthropological testing of SFT development and its surrounding muscularity has been done, in a comparative inter-age aspect, mostly of children and adolescents. Very little research has been done on the dynamic changes of SFT of grown-up individuals in respect of their motive activity. There are a few publications on the problem in scientific papers and this made us more interested in such kind of research. As a whole, we found that men from every professional group have an increase of the average values of the three body circumferences in the second age period, and it is big in

smelters, fitters and drivers ($p<0,05$), and small in carpenters ($p>0,05$). The circumferences in drivers change with the highest percentage (the chest circumference with 3,26%, the waist circumference - 7,32%, the abdomen circumference - 2,07%). The bigger values in older men are probably due to the stronger development of soft tissues with years advancing and mostly due to SFT in the body area.

The circumference sizes of limbs are morphological characteristics like all circumference features, which naturally depend on the development of muscularity and SFT. In our testing, the circumference sizes of both limbs do not change considerably with the age advancing in every professional group. The two derivative characteristics - muscle-fat ratios of the arm and muscle-fat ratios of the thigh – give a clearer idea for the development rate of the muscle tissue and its ratio to the subcutaneous fat tissue. Carpenters have an increase of MFRA in the second age period with 10,72%, and drivers on the contrary – a decrease with 10,07%. The results are statistically significant ($p<0,05$), which means that, with the age advancing, the ratio of the two components of the arm soft tissues changes – in carpenters it is the muscularity, and in drivers – SFT. The other professional groups have a comparatively similar ratio of muscularity to SFT of the arm in both ages. In the case of the thigh, there is a tendency of a stronger development of the muscle component in carpenters, with the age advancing, and respectively a smaller amount of SFT is kept. Only for them the value of MFCT, in the second age period, rises with 14,08 % ($p<0,05$). In the other professional groups the changes are insignificant, with the age advancing.

There are not any statistically significant differences in body weight ($p>0,05$) between the men of both age periods from all professional groups. The result is the same for the total amount of the measured SFT, as well as the thickness of the middle layer SFT ($p>0,05$). Carpenters are the exception, because the two components get smaller in them in the second age period ($p<0,05$).

There are significant age changes in the topical distribution of SFT. The men from every professional group, in the second age period, accumulate more SFT in the upper part of the body – the back and chest. In the area of the scapula in smelters and fitters, the thickness of SF rises with more than 10%, and in drivers – more than 12%. In the area of the X rib, the increase is even bigger in the same professional groups, as in drivers it gets to 25%. There are similar results about the age changes of SFT in a study by Nacheva and Koleva, 1999, where they transversally examined working people from enterprises in the town of Vratsa. The test contingent is divided in two age groups: I - between 20-40 years old and II – between 41-60 years old. The authors also report that the men from the second age period have a considerable increase of SFT on the trunk, and this is a sort of obesity which is a risky factor in the clinical practice of cardiovascular diseases.

In our study the drivers, 41-50 years old, accumulate more SFT not only in the upper part of the body but in the lower as well - in the central area of the abdomen -12,24% and in the suprailiac area - 8,62%. This unfavorable fact in older drivers can be due to the specificity of their professional labour. Maybe, the sitting pose of work, and therefore the

body stiffness, has a more adverse effect than the other types of work and this causes the big amount of fat tissue with the age advancing.

The results we got about the age changes of SFT on the limbs in the professional groups are as follows: in smelters the layer SFT of the upper limb considerably increases (biceps area with 15,28%). The changes in fitters are varied – in the upper limb area SFT increases (biceps area with 14,25%), and in the thigh and calf area – it decreases (relatively with 11,18% and 10,31%). In drivers, the changes of SFT on the limbs are little with the age advancing. The changes are the most significant in carpenters. The thickness of all SF of both limbs decreases statistically significantly with the age advancing, as it mostly concerns SF of the thigh (18,98%) and SF of triceps (18,27%). This result confirms the assumption about the functional-dynamic advantage of the muscle component in comparison to the fat component in the circumference sizes of the limbs in older carpenters. This fact definitely shows the adaptation possibilities for a change in the thickness of SFT according to the specific type of labour activity. There are similar results about the interrelation between SFT and the type of labour activity in Nacheva and Lasarova's study, 1999. After caliper-metrically testing of 30-40-year-old office workers and machine-building workers, they reckon that labour activity is a specific morphogenic factor for the amount and the type of SFT distribution in limbs; according to their study, the purely motive activity contributes to less SFT. Loading with weights or static efforts require just the opposite – more SFT over the muscularity which most directly provides this type of physical activity.

Having done these commentaries and analyzing the received results we can summarize the following conclusions:

1. The men from every profession, with the age advancing, have bigger circumference body sizes but those of limbs do not change significantly.
2. Age changes in the body weight, in the absolute amount of measured SFT, as well as in the middle layer SFT are insignificant in smelters, fitters and drivers.
3. There are age differences referring to the topical distribution of SFT. The men from every professional group, in the second age period, accumulate more SFT in the upper part of the body – the back and chest.
4. Drivers have age increase of SFT in the upper part of the body as well as in the abdomen area, which gives us a reason to presume that the hypodynamic of their profession has an adverse effect.
5. Carpenters have much smaller total amount of SFT and thinner SF of both limbs, with the age advancing. They also have statistically significant increase of muscle-fat ratio of the arm and the thigh. Maybe, in this profession the specific motive activity of limbs has a differential effect as a stimulator for increasing the functional-dynamic opportunities of both limbs muscularity.

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Table 1 Age changes in the values of the basic body circumferences

Features	Profession	30-40 years			41-50 years			t-value	%
		N	X	SD	N	X	SD		
Circumference-chest (pause)	Smelters	111	101,77	8,45	79	104,97	8,29	**2,61****	+3,05
	Carpenters	86	101,47	7,81	105	103,23	7,78	1,56	+1,70
	Fitters	111	100,13	8,22	89	102,96	7,58	**2,53***	+2,75
	Drivers	105	102,10	9,21	100	105,54	8,95	**2,71****	+3,26
Circumference-Waist	Smelters	111	92,75	10,30	79	97,56	10,58	**3,12****	+4,93
	Carpenters	86	94,37	9,55	105	96,75	10,65	1,63	+2,50
	Fitters	111	89,44	10,47	89	94,49	9,89	**3,49****	+5,34
	Drivers	105	92,96	11,12	100	100,30	11,96	**4,55****	+7,32
Circumference-abdomen	Smelters	111	106,16	7,48	79	107,85	8,35	1,43	+1,57
	Carpenters	86	102,50	6,70	105	102,90	6,07	0,43	+0,39
	Fitters	111	104,55	6,92	89	105,19	6,69	0,66	+0,61
	Drivers	105	104,39	8,12	100	106,60	7,48	**2,03***	+2,07

*$P_{0,05}$ >1,96 **$P_{0,01}$ > 2,58

Table 2 Age changes in the values of the circumference sizes of the upper limb and muscle-fat ratio of the arm

Features	Profession	30-40 years			41-50 years			t-value	%
		N	X	SD	N	X	SD		
Circumference-arm	Smelters	111	33,11	3,05	79	33,01	3,23	0,22	-0,30
	Carpenters	86	32,43	2,98	105	32,11	2,78	0,76	-0,99
	Fitters	111	32,12	2,92	89	32,37	2,88	0,60	+0,77
	Drivers	105	33,19	3,58	100	33,47	3,53	0,55	+0,84
Muscle-circumference arm	Smelters	111	30,24	2,53	79	29,91	2,62	0,86	-1,10
	Carpenters	86	29,26	2,46	105	29,36	2,36	0,29	+0,34
	Fitters	111	29,22	2,38	89	29,33	2,33	0,33	+0,38
	Drivers	105	30,02	2,67	100	30,20	2,95	0,45	+0,59
Muscle-Fat ratio of the arm	Smelters	111	12,92	4,02	79	12,03	4,34	1,43	-7,39
	Carpenters	86	11,41	3,92	105	12,78	3,72	**2,46***	+10,72
	Fitters	111	12,45	4,32	89	11,58	3,05	1,66	-7,51
	Drivers	105	12,35	4,64	100	11,22	3,33	**2,01***	-10,07
Circumference-forearm	Smelters	111	29,68	2,26	79	29,63	2,19	0,13	-0,17
	Carpenters	86	29,19	1,94	105	28,85	1,95	1,23	-1,18
	Fitters	111	29,04	2,48	89	29,18	1,82	0,47	+0,48
	Drivers	105	29,95	2,69	100	30,04	2,40	0,25	+0,29

*$P_{0,05}$ >1,96 **$P_{0,01}$ > 2,58

Table 3 Age changes in the values of the circumference sizes of the lower limb and the muscle-fat ratio of the thigh.

Features	Profession	30-40 years			41-50 years			T	%
		N	X	SD	N	X	SD		
Circumference-thigh	Smelters	111	55,06	4,87	79	52,61	5,39	0,49	-4,66
	Carpenters	86	52,53	4,62	105	50,78	4,89	1,37	-3,45
	Fitters	111	53,13	5,66	89	52,06	5,59	0,91	-2,06
	Drivers	105	54,69	5,93	100	53,98	4,62	0,54	-1,32
Muscle-circumference thigh	Smelters	111	49,91	4,48	79	47,27	4,72	**3,86****	-5,58
	Carpenters	86	47,02	4,24	105	46,32	4,93	1,06	-1,51
	Fitters	111	47,96	5,80	89	47,47	5,47	0,62	-1,03
	Drivers	105	48,62	5,54	100	48,11	4,23	0,75	-1,06
Muscul-Fat relation of thigh	Smelters	111	11,82	3,89	79	11,54	4,72	0,43	-2,43
	Carpenters	86	10,68	3,92	105	12,43	4,16	**2,98***	+14,08
	Fitters	111	11,42	4,53	89	12,26	3,55	1,46	+6,85
	Drivers	105	10,18	3,84	100	10,35	3,67	0,31	+1,64
Circumference-calf	Smelters	111	37,83	3,11	79	37,61	3,06	0,49	-0,58
	Carpenters	86	37,85	2,98	105	37,29	2,62	1,37	-1,50
	Fitters	111	38,10	2,97	89	37,69	3,41	0,91	-1,09
	Drivers	105	38,75	3,77	100	38,46	3,89	0,54	-0,75

*$P_{0,05}$ >1,96 **$P_{0,01}$ > 2,58

Table 4 Age changes in body weight, the total amount of measured SFT and the thickness of middle layer SFT

Signs	Profession	30-40 years			41-50 years			T	%
		N	X	SD	N	X	SD		
Weight	Smelters	111	81,51	14,08	79	83,27	13,22	0,88	+ 2,11
	Carpenters	86	78,79	11,93	105	78,69	10,23	0,06	- 0,13
	Fitters	111	79,93	12,28	89	80,93	11,82	0,58	+1,24
	Drivers	105	81,02	14,60	100	83,12	14,65	1,03	+2,53
Sum of 9 Skin fold	Smelters	111	125,16	44,67	79	130,22	46,85	0,75	+ 4,04
	Carpenters	86	130,71	38,59	105	119,45	33,44	**2,13***	- 8,61
	Fitters	111	120,76	38,22	89	124,19	35,01	0,66	+ 2,84
	Drivers	105	132,70	51,83	100	142,61	43,86	1,48	+7,48
Average Skinfold	Smelters	111	13,91	4,96	79	14,47	5,21	0,75	+ 4,03
	Carpenters	86	14,52	4,29	105	13,27	3,72	**2,13***	- 8,61
	Fitters	111	13,42	4,25	89	13,80	3,89	0,66	+ 2,83
	Drivers	105	14,74	5,76	100	15,85	4,87	1,48	+ 7,53

*$P_{0,05}$ >1,96 **$P_{0,01}$ > 2,58

Table 5 Age changes in the values of body SF

Skin folds	Profession	30-40 years			41-50 years			T	%
		N	X	SD	N	X	SD		
Skin fold-subscapu-lar	Smelters	111	15,91	6,73	79	17,65	7,48	1,65	+ 10,94
	Carpenters	86	14,45	4,79	105	14,59	4,61	0,20	+ 1,38
	Fitters	111	15,93	5,93	89	17,56	6,22	1,94	+ 10,23
	Drivers	105	15,05	6,93	100	16,88	6,29	**1,99***	+ 12,16
Skin fold-X rib.	Smelters	111	14,67	7,69	79	17,11	7,94	**2,12***	+ 16,63
	Carpenters	86	14,83	6,54	105	15,15	6,66	0,33	+ 2,16
	Fitters	111	14,80	7,05	89	16,24	6,77	1,47	+ 9,73
	Drivers	105	14,22	7,74	100	17,77	7,01	**3,45****	+ 24,96
Skin fold-abdomen	Smelters	111	24,61	10,08	79	25,81	11,56	0,74	+ 3,66
	Carpenters	86	22,59	7,18	105	21,85	7,18	0,70	- 3,28
	Fitters	111	21,99	8,51	89	22,42	7,39	0,38	+ 1,96
	Drivers	105	22,80	9,55	100	25,59	8,74	**2,18***	+ 12,24
Skin fold-suprailiac	Smelters	111	16,69	8,53	79	14,86	6,72	1,65	- 10,96
	Carpenters	86	20,73	7,08	105	18,66	7,53	1,95	- 9,98
	Fitters	111	14,29	7,11	89	15,77	6,67	1,51	+ 10,36
	Drivers	105	19,72	7,62	100	21,42	7,88	1,57	+ 8,62

*$P_{0,05}$ >1,96 **$P_{0,01}$ > 2,58

Table 6 Age changes in the values of limbs SF

Skin folds	Profession	30-40 years			41-50 years			T	%
		N	X	SD	N	X	SD		
Skin fold-biceps	Smelters	111	7,46	3,22	79	8,60	3,64	**2,24***	+ 15,28
	Carpenters	86	8,05	2,94	105	7,56	2,92	1,15	- 6,09
	Fitters	111	7,58	3,07	89	8,66	3,52	**2,28***	+ 14,25
	Drivers	105	8,54	4,26	100	9,46	3,36	1,72	+ 10,77
Skin fold-triceps	Smelters	111	10,80	4,45	79	11,11	4,21	0,48	+ 2,87
	Carpenters	86	12,15	4,52	105	9,93	3,23	**3,82****	- 18,27
	Fitters	111	10,89	4,12	89	10,69	4,09	0,34	- 1,84
	Drivers	105	11,68	5,61	100	11,38	4,09	0,45	- 2,57
Skin fold-forearm	Smelters	111	7,76	3,47	79	7,77	2,95	0,02	+ 0,13
	Carpenters	86	8,13	3,25	105	7,19	2,30	**2,27***	- 11,56
	Fitters	111	7,39	2,95	89	7,97	3,08	1,36	+ 7,85
	Drivers	105	8,15	4,22	100	8,58	3,26	0,82	+ 5,28
Skin fold-thigh	Smelters	111	16,42	5,72	79	16,98	7,19	0,57	+ 3,41
	Carpenters	86	17,54	5,98	105	14,21	4,07	**4,39****	- 18,98
	Fitters	111	16,45	5,42	89	14,61	4,53	**2,60****	-11,18
	Drivers	105	19,33	7,14	100	18,69	6,89	0,65	- 3,31
Skin fold-calf	Smelters	111	10,84	4,58	79	10,32	4,44	0,77	- 4,79
	Carpenters	86	12,25	4,89	105	10,30	3,82	**3,00****	- 15,92
	Fitters	111	11,45	4,39	89	10,27	3,89	**2,01***	-10,31
	Drivers	105	13,21	5,55	100	12,85	5,18	0,48	-2,73

* $P_{0,05}$ – 1,96 ** $P_{0,01}$ – 2,58