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An attempt to determine the professional differentiation in anthropometric characteristics of various groups of workers

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Factor analysis has been applied to metric data of two men groups, practising two types of physical activity: machine-building and office workers. Set of anthropometric features, responsible for the adaptation of the organism to different working conditions was investigated.

Key words: anthropometric characteristic, professional differentiation, factor analysis, mobile features.

The establishment of biological laws governing the system of relations between anthropometric morpho-functional characteristics, exogenic factors and variability is one of the basic problems of the physical anthropology [1, 2, 3, 4].

This paper makes an attempt to discover the differentiation in anthropometric characteristics investigating individuals with different physical activity.

Material and methods

Two models of different physical activity (groups of workers execising two different types of labour – machine-building and office workers) have been used. 108 men from each professional group have been studied, their age varying between 30 and 40 years, everyone having exercised his profession for 10 years. The study included 60 static and functional-dynamic anthropometric features and 7 indices derived on their basis and characterising the asymmetry in the constitution and function of the body and its parts (Table 1).

In order to study the influence of labour as a factor for the professionally determined differentiation in the anthropometric characteristics we applied factor analysis with a subsequent varimax rotation of the factor matrix following Kaiser

Table 1. Investigated features

1. Stature
2. Sitting height
3. Trunk length
4. Upper limb length
5. Arm length
6. Forearm length
7. Hand length
8. Wrist length
9. Finger IIIth length
10. Hand breadth at thumb
11. Hand thickness
12. Spread of the fingers
13. Envelopment of the Ist and IInd fingers
14. Lower limb length
15. Thigh length
16. Leg length
17. Sphirion length
18. Height to the arch of foot
19. Foot length
20. Foot breadth
21. Biacromial breadth
22. Bideltoid breadth
23. Chest depth
24. Chest breadth
25. Chest circumference – pause
26. Chest circumference – in
27. Chest circumference – out
28. Medium chest circumference
29. Respiratory difference 26-27
30. Respiratory difference 26-25
31. Respiratory difference 25-27
32. Bicristal breadth
33. Bitrochanteric breadth
34. Waist circumference
35. Hip circumference
36. Arm circumference contracted
37. Arm circumference relaxed
38. Contractive difference
39. Forearm circumference
40. Thigh circumference
41. Leg circumference
42. Weight
43. Skinfold-triceps
44. Skinfold-biceps
45. Skinfold-forearm
46. Subscapular skinfold
47. Skinfold at the X-th rib
48. Abdominal skinfold
49. Vital capacity
50. Pulse
51. Hand force
52. Hand flexion
53. Hand extension
54. Flexion-extension volume
55. Hand adduction
56. Hand abduction
57. Adduction-abduction volume
58. Hand pronation
59. Hand supination
60. Hand rotation
61. Asymmetry index – height
62. Asymmetry index – upper limb
63. Asymmetry index – lower limb
64. Asymmetry index – circumferences
65. Asymmetry index – skinfolds
66. Asymmetry index – movements – partial
67. Asymmetry index – movements – common

(1952). Maximum number of selected factors was determined using the eigenvalue criterium – the factors with eigenvalues equal or greiter than 1 have been included. For the identification of the different factors we assumed that features having the highest factor loadings which do not participate in other factors as well should be accepted to be the features with taxonomic importance.

Results and discussion

Results from the analysis of the factor matrix of machine-building workers

The factor structure of the anthropometric characteristics of the machine-building workers is determined by 17 factors explaining 79,7% of the variance of the data (Table 2). Remaining unexplained variance is 20,3%.

I. The features participating in factor I identify the factor as a factor determining the body fatness and the massiveness of the body. The instable features of this group are the basic breadths of the body, skinfolds and weight, which are shared by other factors as well. This shows that the physical activity connected with the labour of the machine-building workers has a modelling effect on these features.

Table 2. Factor structure of investigated features (machine-building workers)*

Factors	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings
I	28	0,95	26	0,94	27	0,94	42	0,90	36	0,89	35	0,87	34	0,86
	37	0,86	39	0,83	22	0,82	40	0,81	41	0,81	24	0,74	46	0,73
	48	0,71	32	0,70	23	0,68	47	0,67	21	0,62	33	0,58	45	0,57
	43	0,54	44	0,51	20	0,49	12	0,43						
II	1	−0,92	4	−0,91	14	−0,88	19	−0,75	5	−0,72	2	−0,66	6	−0,64
	16	−0,62	13	−0,60	33	−0,53	12	−0,46	32	−0,41	10	−0,39	21	−0,34
	17	−0,33	42	−0,33										
III	57	−0,90	55	−0,71	56	0,70	60	−0,70	59	−0,65	58	−0,38		
IV	9	−0,95	62	−0,95	15	0,39	16	0,62	63	−0,53				
V	8	0,88	7	0,81	6	−0,52	10	0,35						
VI	18	−0,76	17	−0,60	50	0,60	2	−0,31						
VII	11	0,84	31	−0,40	3	0,38	25	−0,33	40	0,30				
VIII	54	−0,91	52	−0,81	53	−0,58								
IX	67	−0,94	66	−0,93										
X	51	0,67	25	0,42	21	0,30								
XI	29	0,92	30	0,73	31	0,50								
XII	61	−0,82	31	0,31										
XIII	43	−0,61	44	−0,61	47	−0,56	45	−0,52	48	−0,51	46	−0,40	10	0,32
XIV	20	0,31												
XIV	64	0,77	50	−0,39	65	0,30								
XV	49	−0,73	65	−0,54	60	−0,37	59	−0,33						
XVI	13	−0,45	63	−0,43	12	−0,40	21	−0,37						
XVII	38	0,75	3	−0,43	53	−0,33	59	−0,33	60	−0,32	55	0,30		

* For names of features see Table 1.

II. The second factor is identified as factor responsible for the restriction of the length dimensions of the body; as well as the mobile, with respect to factor Ist, breadths of the body and weight. The negative factors loading of all features participating in this factor is enough reason to suppose that the type of labour activity of the machine-building workers has a suppressing influence on the formation of the length dimensions of the body at the expense of its massiveness.

III. Participating with negative factor loading in factor III are abduction-adduction movements of the hand as well as hand rotation. This fact is in conformity with some others our investigations and shows that the greater loading of the hand leads to the restriction of its mobility.

IV. The fourth factor is identified by the asymmetry of the length dimensions of upper and lower limbs; the negative loadings show that the bilateral loading (weight and motion) in the process of labour restricts and suppresses the development of asymmetry in these features.

V. Factor V determines the relatioships between the dimensions of the hand and the forearm; the negative loading of the forearm shows that the internal structuring in the length dimensions of the hand and the forearm develops at the expense of the forearm.

VI. Factor VI consists of the heights of the foot and the negative loadings show that the erect gate and the weight loading are the reason for the lowering of the arch of the foot.

VII. The taxonomic features of factor VII is the thickness of the hand; which depends positively on the character of labour.

VIII. Factor VIII restricts the flexion-extension movements of the hand.

IX. This factor restricts the development of bilateral differences in the mobility of the hand which is probably due to the participation of the left hand in the process of labour.

X. Factor X is the hand force.

XI. This is the factor of the respiratory excursions of the chest.

XII. Factor XII restricts the asymmetry in the body heights.

XIII. This factor restricts the body fatness. The fact that the skinfolds are grouped in a separate group shows the dependence of the distribution of body fatness from the type of labour.

XIV. This is the factor of the asymmetry in circumferences and skinfolds.

XV. The taxonomic feature of this factor is the vital capacity of the lungs.

XVI. This is the factor of the functional features of the hand.

XVII. This factor determines the relationship between the contractive difference and the mobility of the hand.

Results from the analysis of the factor matrix of office workers

The factor structure of the anthropometric characteristics of the office workers consists of 16 factors (Table 3). They explain 82,1% from the variance of the data.

I. The features participating in the first factor identify it as a factor determining the fatness and the massiveness of the body. The mobile features in this group are skinfolds. They have relatively high factor loading and participate in other factors as well. This shows that the distribution and the quantity of body fatness depends on the hypodynamy connected with this kind of labour.

II. The factor is identified by the length dimensions of the body which are relatively stable.

III. This is the factor of the mobility of the hand, determined chiefly by the abduction-adduction movements which form the biomechanical model of the mobility of the hand in the case of labour requiring to physical efforts.

IV. Factor IV is comprised of the partial dimensions of the foot and the hand, having negative factor loadings.

V. This is the factor responsible for the length dimensions of the hand only.

VI. The sixth factor is identified by the respiratory differences of the chest-inhalation.

VII. Factor VII has differentiated skinfolds with negative loadings and some basic functional features such as vital capacity and contractive difference of the arm. The way these features are grouped shows that in order to ensure the necessary vital capacity and functional abilities, the formation of body fatness should be suppressed.

VIII. This is the factor of the supination of the hand.

Table 3. Factor structure of investigated features (office workers)*

Factors	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings	Features	Factor loadings
I	27	0,96	28	0,96	25	0,94	26	0,94	34	0,92	42	0,92	35	0,89
	36	0,89	37	0,87	39	0,86	22	0,85	40	0,83	41	0,83	32	0,82
	47	0,82	24	0,80	23	0,77	48	0,76	46	0,75	33	0,70	45	0,70
	43	0,62	21	0,59	44	0,53	10	0,40	20	0,33	1	0,32	2	0,30
II	5	0,85	4	0,83	16	0,80	14	0,76	1	0,74	19	0,56	2	0,46
	21	0,41	49	0,40	6	0,33	15	0,33	33	0,32	11	0,30		
III	57	0,89	55	0,84	66	0,73	67	0,70	56	0,67	53	0,47	58	0,44
	54	0,40												
IV	12	−0,81	13	−0,81	20	−0,58	10	−0,56	20	−0,50	51	−0,45	49	−0,36
	64	−0,34	6	−0,32										
V	8	0,86	7	0,70	38	0,30								
VI	30	0,82	29	0,72	38	0,41	66	0,35	67	0,33				
VII	44	−0,70	43	−0,57	45	−0,52	38	0,46	49	0,35	47	−0,34	46	−0,33
	48	−0,30												
VIII	59	0,94	60	0,92										
IX	17	0,84	18	0,69	6	0,32								
X	31	0,86	29	0,49	51	0,36	58	0,33						
XI	54	0,78	52	0,75	50	0,56	53	0,39						
XII	9	0,90	7	0,44										
XIII	63	−0,74	64	0,52	58	−0,45	65	0,44						
XIV	62	0,74	53	−0,39	15	0,39								
XV	61	0,75	3	−0,47	15	−0,40								
XVI	11	−0,59	65	0,33	3	−0,32	32	0,30						

*For names of features see Table 1.

IX. The height dimensions of the foot are grouped in this factor.

X. Factor X is identified by the respiratory differences of the chest – exhalation.

XI. This is the factor of the flexion-extension movements of the hand, the hand extension being more mobile (it participates in another factor as well).

XII. Factor XII controls the relationship between wrist and finger IIIth lengths.

XIII and XIV. Both factors have differentiated various features but they could be conditionally identified as factor of asymmetry of lower and upper limbs respectively.

XV. The greatest factor loading in this group of features has the asymmetry index – heights.

XVI. Because of the nonhomogeneous character of the features participating in this factor it is difficult to identify it.

Conclusions

1. The comparative analysis of the factor structures of the anthropometric characteristics of both groups of workers as well as the consideration of the differences in the identification of the factors show that the variability of the organism in the process of labour is carried out through the adaptive-compensatory changes of interrelated in their reactivity mobile features.

2. The mathematical method used to analyse the differentiation in the anthropometric characteristics of groups of individuals having different level of physical activity (in our study different kind of labour) is highly informative and contributes highly to discover biological laws; it has much better performance than the methods used up to now which prove to be inadequate.

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