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Dependence between hand strength and mobility and the specifity of its physical activity

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The connection between hand-mobility and hand-strength and the specificity of labour physical activities in the individual are investigated. The strength and the mobility of both hands are studied in a quantitative aspect. The hand mobility is determined commonly by the possibilities of hand adduction and abduction, hand flexion and extension, and hand-forearm pronation and supination. 432 men, who are representatives of 4 different types of labour physical activities are investigated. The groups consist of men during 30 and 40 years of age that have worked respectively at least 10 years in the same profession, and are functional right-handed persons.

The results obtained show that the hand-strength and hand-mobility are interconnected characteristics about the functional possibilities of the hand. They form a specific biometrical model of an optimum proportion between motor and strength possibilities of hand, which model ensure the hand firmness, the hand solidity and its functional adaptability for doing different physical activities.

Key words: Hand strength and mobility, different physical activities, adaptive possibilities.

Introduction

The motor and strength possibilities of the hand are most important functional features that are directly connected with the physical activity of man. Their quantitative assessment is of a great meaning for the characterization of the hand's adaptive possibilities by doing different activities, as well as for the norm and pathology borderlines in the clinical practice [1, 3, 4, 5].

The complicated anatomy of the bone-joint-muscular hand's apparatus embarrasses very much the quantitative study of its motor possibilities as a whole. But it is known also that the common mobility of the hand is ensured of a complicated kinematics chain that includes some joints with different functional-dynamic characteristics, and which fit together the bones of the wrist, the forearm and humerus [2]. These difficulties determine probably the scanty information in the literature about this question and the available data are more often in a pure anatomical aspect. They present usually the likely possible movements in every

separate joint, not giving the common data about the real summary movements of the hand. A unified standard method and appliances for an objective assessment of the movement's capacity of the human hand cannot be find in the literature [2, 3, 6, 7].

The Aim of the present work is to investigate comparatively the functional-dynamic possibilities of the hand-strength and hand-mobility in the conditions of work for four kinds of labour physical activities.

Material and methods

Four models as different physical activities in labour are chosen:

Builders — mason-white washers (marked on the tables and the figures as **B-**). Their hands physical activity in labour is connected with weight-lifting movements. The weights they lift in their work are from 5 to 10 kg. Both hands take part actively in the working process. The static efforts are very few.

Millwrights — machine-building workers (briefly **M-**). The right hand has a specific labour loading in this kind of work. The movement's capacity is little, but the static effort is big. The left hand has more holding up and supporting functions. The working objects and instruments weight over 10-15 kg.

Agricultural workers — market-gardeners and crop-raisers (briefly **A-**). The hands physical activity in this kind of work is connected with different static-strength efforts.

Officials — financial and book-keeping specialists (briefly **O-**). Their hands physical activity in labour is connected with keyboard technical, and they work with both hands. The physical activity in them consists of very precious motive operations covering a little movement's capacity, but which demand continuously static efforts.

We study quantitatively the strength and mobility of both hands for the assessment of the hand's functional-dynamic status. The hand-mobility as a hole we render on the wrist's level by the goniometrical method and the appliances of Mutafov et al. [3]. We use the standard position of the hand plotted horizontally in semipronation according to the method applied, which is the usual position while working. The studied features are: *the hand's abduction, adduction, flexion and extension, and the hand-forearm's pronation and supination.*

We investigate 432 men delivered equally into 4 groups according to the kind of their work. All men are clinically healthy and functional right-handed persons. They are among 30 and 40 years of age, and have at least 10 years experience in the corresponding profession.

The analysis and the assessment of the intergroup differences we made by the variation-statistical method. Comparisons between the groups are carried out by Student's "t" criterion at $P \leq 0.05$. We also use an own method for the objective quantitative assessment of the metrical differences between the values of right and left hand for the investigated features [5]. The evaluation is made according to the standard units of asymmetry (UA), whose positive values show a right-sided, and the negative values — a left-sided one.

Analysis, discussion and results

As we know, the human being realizes his physical activities particularly with the hands, which is own to their strengthening and movable possibilities. In the present study we try to find the interconnection between these functional-dynamic

T a b l e 1. Metrical data of investigated features

Features	Profession groups	Statistical data				Data of asymmetry Unitis of Asymmetry (UA)
		$\bar{X}$	$S\bar{x}$	S	V	
Hand strength	Builders — B	54.01	2.24	11.31	20.94	+3.21
	Millwrights — M	54.86	1.87	9.47	17.26	+4.90
	Agriculturals — A	52.98	2.01	10.17	19.20	+3.97
	Officials — O	57.84	2.01	10.13	17.50	+8.46
Adduction	B	27.20	0.95	4.81	17.69	−5.57
	M	26.77	0.99	5.04	18.82	−9.55
	A	26.03	0.70	3.51	13.48	−5.05
	O	29.51	1.02	5.17	17.50	−1.43
Abduction	B	37.00	0.94	4.73	12.78	−8.22
	M	36.35	1.12	5.65	15.55	−7.34
	A	35.43	0.88	4.44	12.52	−4.97
	O	41.99	1.21	6.12	14.57	−2.61
Flexion	B	73.84	1.76	8.89	12.03	−2.21
	M	70.92	1.86	9.40	13.41	−1.59
	A	71.46	1.82	9.19	12.85	−3.93
	O	83.56	1.61	8.12	9.72	−0.68
Extension	B	54.91	1.55	7.81	14.23	−4.77
	M	52.78	1.51	7.63	14.45	−9.64
	A	47.74	1.73	8.76	18.35	−9.06
	O	60.81	1.75	8.84	14.53	−4.50
Pronation	B	21.76	0.91	4.58	21.07	−6.72
	M	20.90	0.76	3.82	18.29	−4.61
	A	19.31	0.71	3.60	18.66	−0.55
	O	20.73	0.96	4.86	23.46	−4.02
Supination	B	155.44	2.78	14.02	9.82	+6.82
	M	149.15	2.89	14.62	9.80	+6.08
	A	143.82	2.61	13.20	9.18	+2.29
	O	156.29	2.83	14.31	9.16	+3.85

T a b l e 2. Significant intergroup differences according to the t-test ($P<0.05$)

Intergroup ratio			B/M	B/A	B/O	M/A	M/O	A/O
FEATURES	Hand strength	1	—	—	2.64	—	2.26	3.54
		2	—	—	—	—	1.97	2.64
	Adduction	1	—	2.05	3.53	—	3.78	5.87
		2	—	—	—	2.07	1.90	—
	Abduction	1	—	2.88	5.96	—	7.04	9.03
		2	—	1.90	3.08	—	2.41	—
	Flexion	1	2.35	—	8.39	—	10.58	10.25
		2	—	—	2.26	—	—	3.35
	Extension	1	2.03	5.92	5.20	4.13	7.15	10.40
		2	2.52	2.66	—	—	3.43	3.35
	Pronation	1	—	4.49	—	3.30	—	2.65
		2	—	2.92	—	1.93	—	1.96
	Supination	1	3.23	6.28	—	2.81	3.63	6.66
		2	—	6.38	4.12	4.92	2.70	2.40

1 For metrical data 2 For data of manifested asymmetry

characteristics of the hand during its adaptation in labour while doing different physical activities.

The variation-statistical analysis data (Table 1) illustrated on Figs 1, 2, 3, 4 show that there are formed two basic types of functional-dynamic status of the hand in the investigated men. The first type combine the representatives of the three groups physical workers that have less strengthening and movable characteristics, and the other type combine those of the officials in which all the investigated features have bigger values.

These results show that the hand, which is not burdened with physical efforts has potentially bigger strengthening and movable possibilities. Obviously, the regular weight's burdenings and strengthening movements require a special biomechanical transformation that forms an optimal proportion between their quantitative characteristics. This interrelationship explains the specificity of corresponding physical activity. The conclusion obtained, is substantiated also by the character of the intergroup differences in the representatives of the three types of physical work. Every group of physical workers differs in the combination of strengthening and movable hand's possibilities. These combinations logically can be connected with the corresponding movable, static and weight burdening of the hand during the working process.

The agricultural workers have the lowest common capacity of hand-strength and the greatest parts of the intergroup differences are statistical significant (Table 2). The extension and pronation of the hand are more limited in these workers.

The differences between the hand's functional-dynamic characteristics in builders and millwrights also show a tendency about a formation of specific biomechanical models.

The millwrights have less motive possibility than the builders (statistical significant are the differences for flexion, extension and supination), but in them the values are bigger for the hand's strength. Obviously, the specific, regular physical loading of the hand in their kind of work wants more limited capacity of mobility, and middle strength possibilities. This biomechanical model shows a necessity for the application of big static efforts while backing and moving attendant loads that they use continuously in their work.

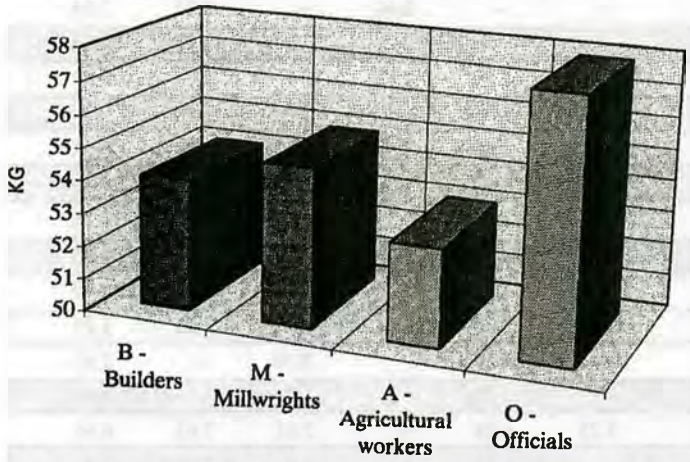

Fig. 1. Metrical data of hand strength

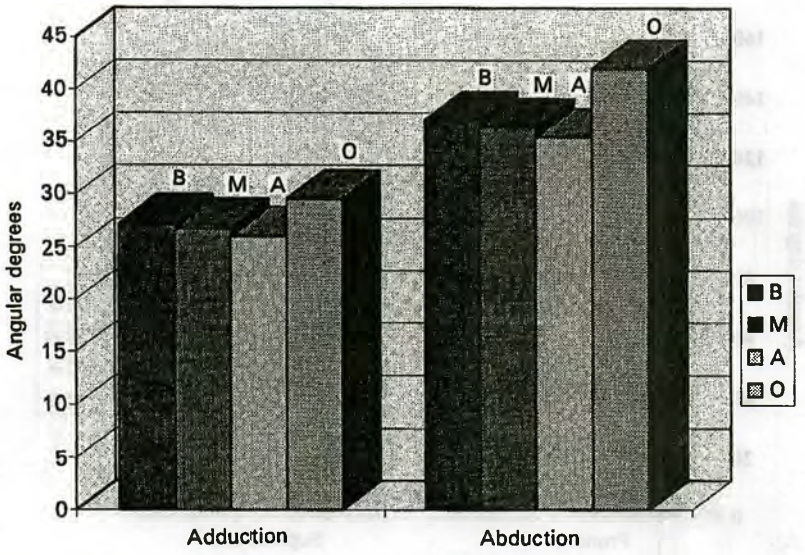

Fig. 2. Metrical data of adduction and abduction

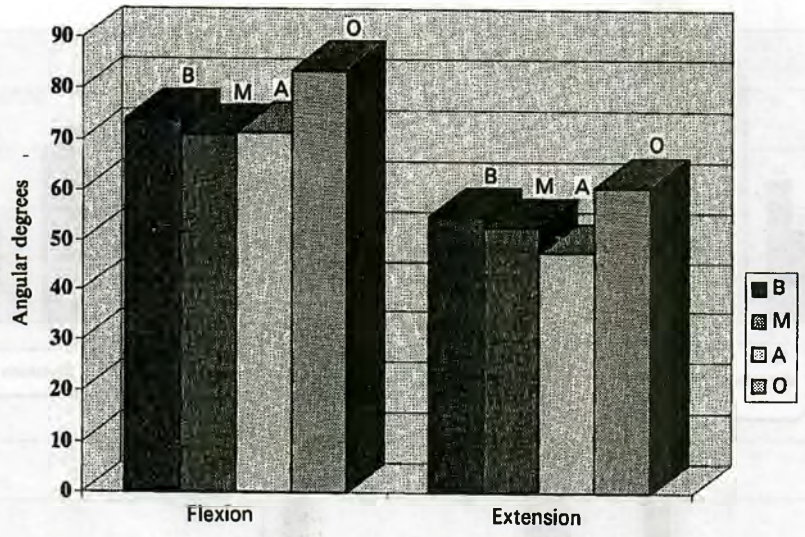

Fig. 3. Metrical data of flexion and extension

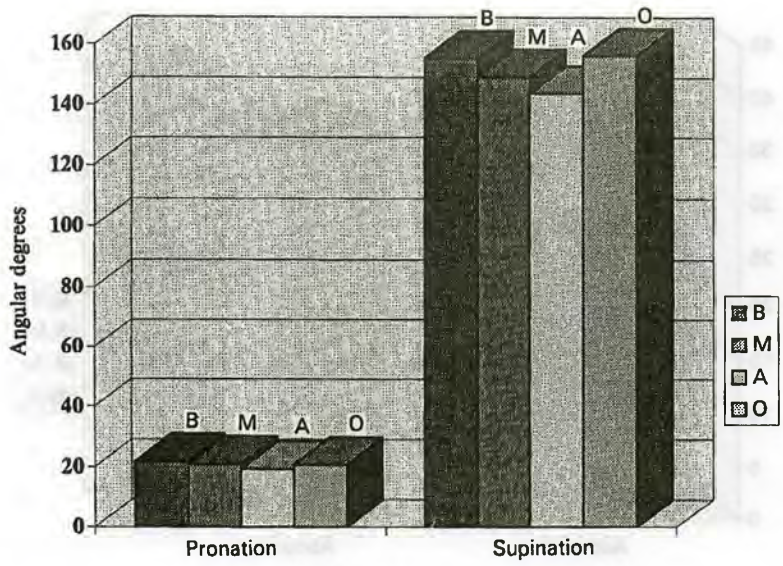

Fig. 4. Metrical data of pronation and supination

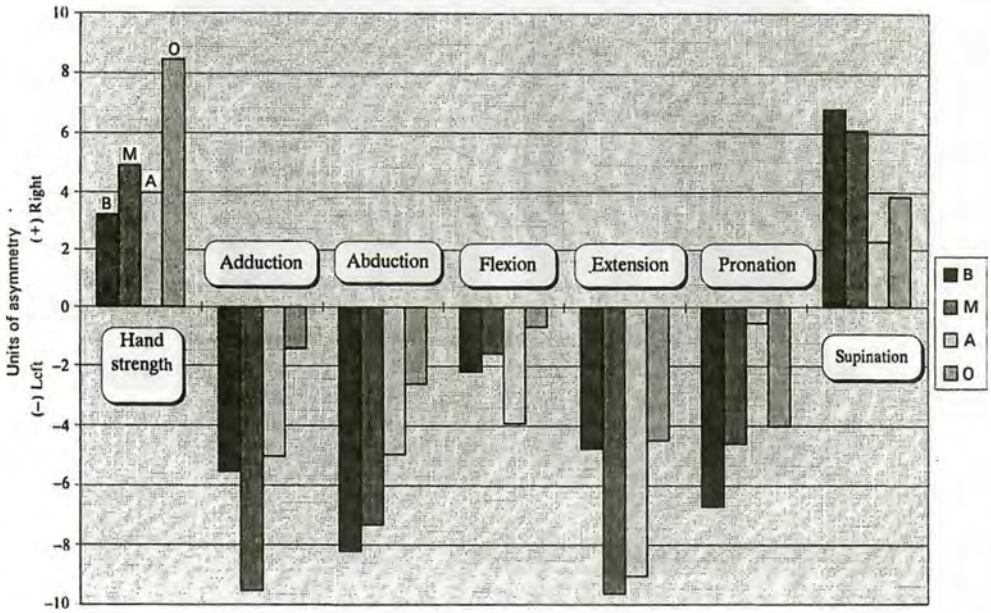

Fig. 5. Manifestation of asymmetry

The builder's hand has relatively bigger motive possibilities and less strength one in comparison with those of millwright. This biomechanical model corresponds with the regular bigger capacity of the movements in their work, and less weight's burdening.

The results from the analysis obtained are corroborated with the assessment of the metrical differences between the left hand and right one. The established differences logically can be connected with the specificity of various burdenings of both hands during the working process. The general data analysis about the manifestation of asymmetry (Fig. 5) shows that the hand's strength and its supination have right-sided asymmetry in all the investigated men, i.e. the right hand possesses more possibilities for this features. The left hand, however, has more possibilities for all other studied features. This general model of asymmetry led us to think, that the more burdened right hand possesses more possibilities for strength and supination movements and the left hand possesses more possibilities for all other movements.

Analysing the data for asymmetry in intergroup aspect, we see that they trace out a tendency for an inversely proportional correlation between the asymmetry size for hand-strength and the characteristics for its mobility. The officials differ again from the other 3 group of workers by the manifestation of asymmetry. They have the biggest right-sided asymmetry for the hand-strength, and the lowest left-sided one for the movement's abduction — adduction and flexion — extension. This kind of asymmetry in the officials that characterize the relatively the relatively equal motive possibilities for both hands in them can be connected with the relatively equivalent participation of the hands while working with keyboard technics.

The right-sided asymmetry is bigger for the hand-mobility of all other three groups manual workers in comparison with the officials. The lower movable possibilities of the right hand in the manual workers can be accepted as an indicator for a biomechanical restructures of the functional-dynamic possibilities of the right hand while doing a specific manual work. Moreover, the reduced mobility of the right hand in the manual workers shows also the weak points in the biomechanical model, where the adaptive changes while working, can easily transform into a pathological limitation, if there is no effective prophylaxes:

- in the **mason-whitewashers** there is a danger for pathological limitations in the abduction and pronation movements;
- in the **machine-building workers** it is for the abduction-adduction and extension movements;
- in the **agricultural workers** — for the extension movements.

Conclusions

The results obtained, while evaluating the functional-dynamic status of the hand under the condition of different physical activities, are of great meaning for:

the determination of the hand's working capacity for doing different kinds of physical activities;

the determination of a borderline between the adaptive and the pathological changes in the functional-dynamic status of the hand under the conditions of a regular and specific physical burdening of it;

The results obtained can be used also making norms for a diagnose and a quantitative assessment of the medicinal effect in different hand's diseases that limit the hand-mobility and the hand-strength.

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