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CORRELATION BETWEEN THE LONGITUDINAL ARCH OF THE FOOT AND THE STATE OF NUTRITION

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In the available literature dealing with obesity we can find mention about the fact that in obesity we meet more and more frequently with flat-foot. Yet, papers discussing and demonstrating this absence of the normal arch of the sole of the foot objectively are rather few in number (Štěpánek, 1961, Štěpánek, Křížek, 1966).
In a total of 900 persons, comprising 500 men and 400 women, we have tried to evaluate objectively the correlation between the longitudinal arch of the foot and the weight or the relative excess weight of the examined persons, respectively. Owing to the anticipated differences between men and women, we performed the final evaluation separately according to the sex.

METHODS

For all persons under study we made a plantogram of the right sole. With the aid of an alcoholic tannin solution we took foot prints on paper so that the examined person with all the weight stood on the right lower extremity. When the print had dried, it was "developed" with an iron solution of the following composition:

Tinctura ferri chlorati	50.0
Alcohol, 80 %	45.0
Glycerin	5.0

In each plantogram we registered the name, sex, age, body height and weight of the examined person. According to Broca's formula we determined from the height and the weight the possible deviation from the so-called "ideal weight".

"Ideal weight" in kg = height in cm − 100

Deviations from the ideal weight, no matter whether already in the sense of plus or minus, were expressed in per cent. In our set — involved were patient of the Institute of Balneology in Mariánské Lázně (Marienbad) — the relatively great share of obesity of a high degree was by no means a product of chance. A number of plantograms were obtained from persons heavier than 150 kg and with a relative excess weight of up to + 150 %!
In the plantograms we determined, on the one hand, the so-called "index of longitudinal arch of the foot" according to Bradna and Srdečný (Bradna, Srdečný, 1956) on the other hand, the "footprint angle" according to Clarke (Clarke, 1933, 1967).

Both obtained indices we evaluated separately in the men and the women of our experimental set, in dependence on the weight and the excess weight. Furthermore, we studied the mutual correlation between these two indices.

The index of the longitudinal arch of the foot (ILAF) was determined in agreement with its author so that we measured the length of the foot print without toes and the breadth (at the level of the base of the fifth metatarsus). The index is calculated according to the formula:

$$\text{ILAF} = \frac{\text{breadth of sole in mm} \times 10}{\text{length of footprint in mm}}.$$

The reproducibility of the result was verified by calculation in a ten times repeated plantogram of

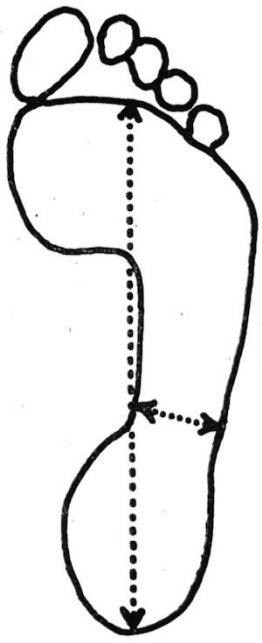


FIG. 1
Scheme of measuring the length and the breadth of the footprint in the determination of the index of the longitudinal arch of the foot

a person with a low index and a person with a high index. The coefficient of variation made 6 per cent on the average.

The footprint angle (FA) is determined as follows: on the medial edge of the print we run a straight line which is the tangent of the plantogram at the level of calcaneum and the first metatarso-phalangeal joint. From the point of contact (at the level of the matatarso-phalangeal joint) we run another straight line which is the tangent of the plotted arch. The line runs along the area of the print and n o t on the empty paper. Preferable is the mode of locating both straight lines depicted in Fig. 2.

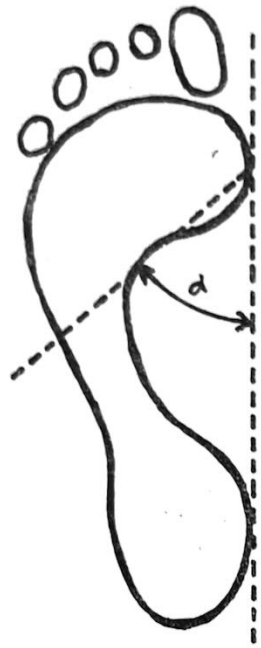


FIG. 2
Scheme of determination of the footprint angle according to Clarke

The footprint angle (FA) is measured with a protractor and corresponds to the angle enclosed by the two straight lines.

RESULTS

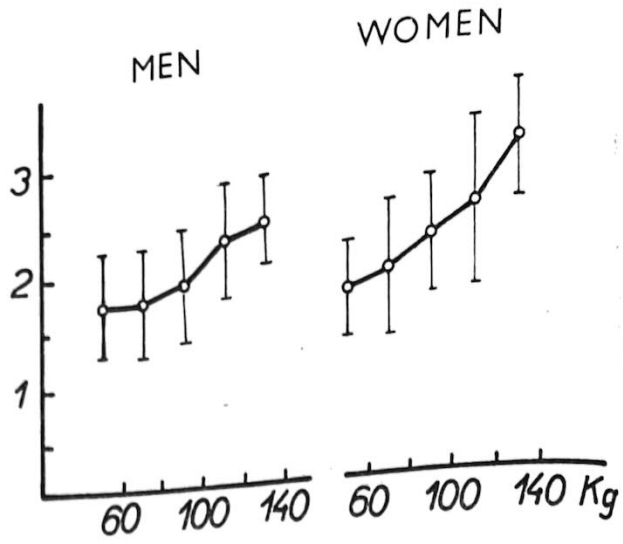
Graph 1 shows the ILAF values in dependence on the weight of the examined persons (arithmetic mean with band of ± standard deviation). It appears that with a rising weight, the mean index values are higher (longitudinal arch less vaulted).

In Graph 2, the correlation between ILAF and relative excess weight is illustrated.

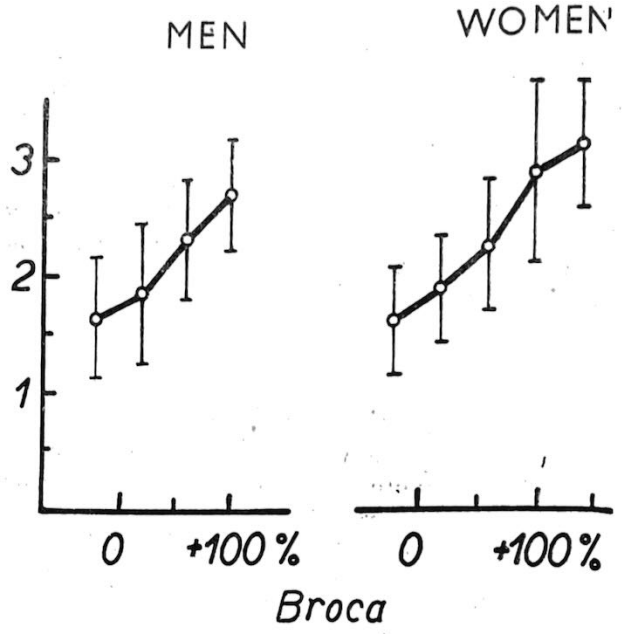
Graph 3 shows the correlation between FA (footprint angle) and the weight of the examined persons. With a rising weight, the mean FA values diminish — the trend to a longitudinal-transversal flat-foot increases.

Similarly, but still more markedly, diminish the mean FA values with growing excess weight, as can be seen from Graph 4.

The numerical correlations of the weight and the excess weight of the examined persons to the ILAF



GRAPH 1
Correlation between the index of the longitudinal arch of the foot (ILAF) and the weight of the examined person. Plotted are the mean values and the band ± of one standard deviation



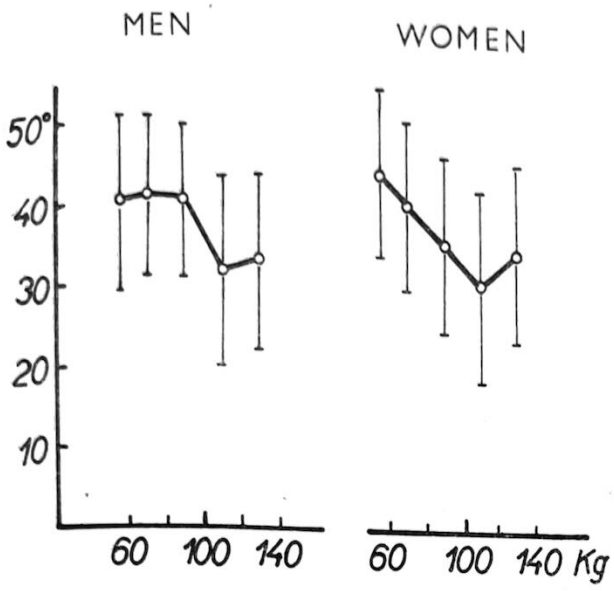
GRAPH 2
Correlation between the index of the longitudinal arch of the foot and the excess weight expressed by Broca's index

TAB. 1
Correlation of weight and excess weight to ILAF and FA values

	Men: $n = 500$		Women: $n = 400$	
ILAF	r	significance	r	significance
weight	+0.258	$p < 0.010$	+0.414	$p < 0.001$
excess weight	+0.961	$p < 0.001$	+0.501	$p < 0.001$
FA				
weight	—0.191	$p < 0.010$	—0.295	$p < 0.001$
excess weight	—0.295	$p < 0.001$	—0.381	$p < 0.001$

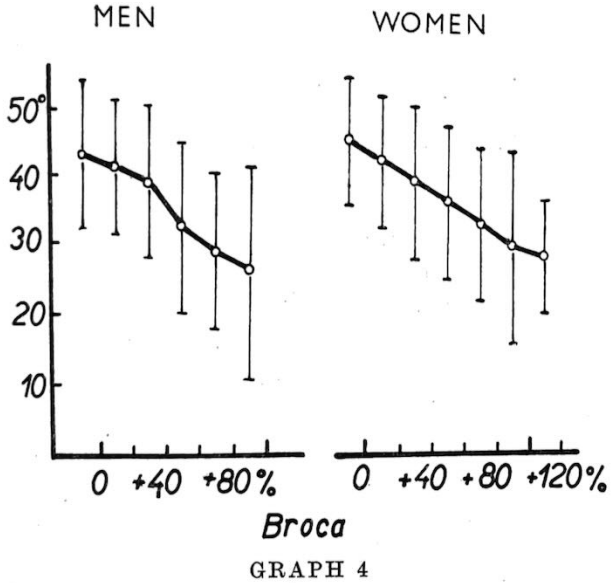
and FA values are given in Tab. 1. All the correlations are statistically significant, but much closer is the correlation to the relative excess weight than to the absolute weight in kilograms.

Graphs 5 and 6 show the mutual correlations of both indices under study, i.e. ILAF and FA — separately for men and for women. Between the index of the longitudinal arch of the foot and the footprint angle there exists a very significant negative correlation: for men $r = -0.721$, while for women $r = -0.687$. In either case is $p < 0.001$.



GRAPH 3

Correlation between the footprint angle and weight of the examined person

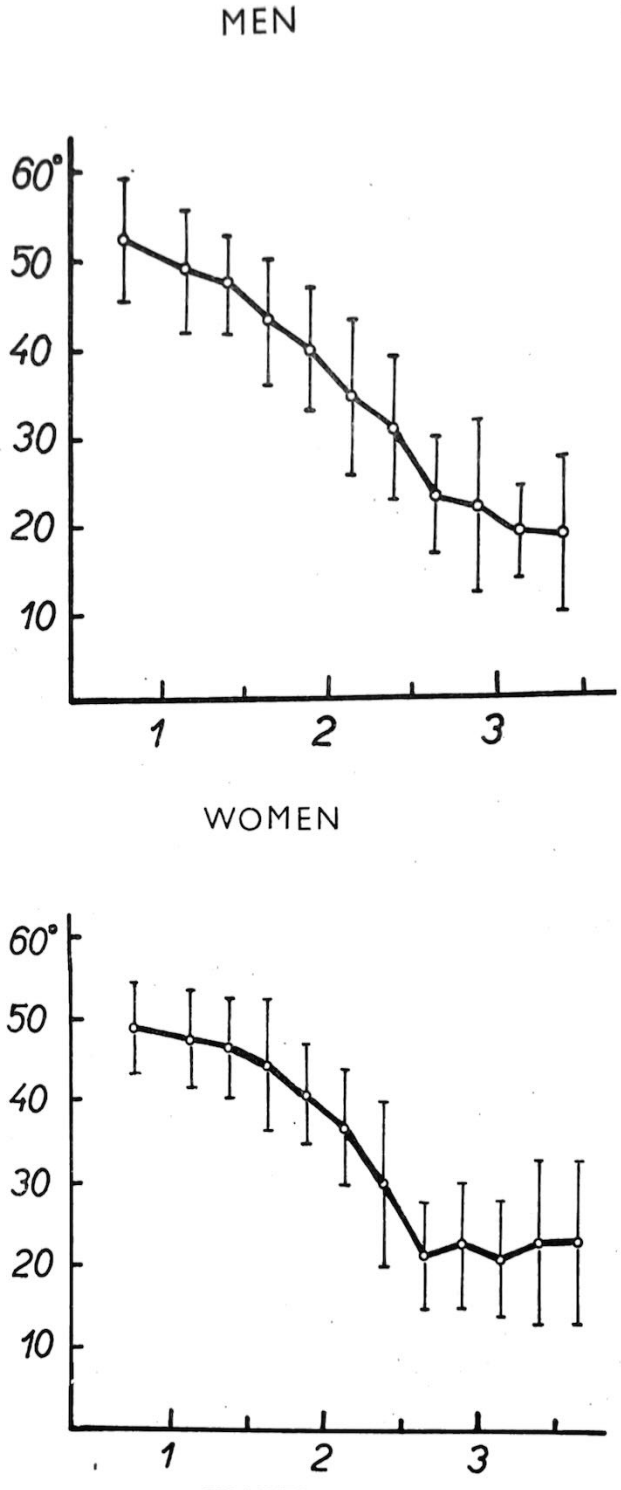


GRAPH 4

Correlation between the footprint angle and the excess weight of the examined person, expressed by Broca's index

SUMMARY

The authors made plantograms of five hundred men and four hundred women. In the plantograms they evaluated the index of the longitudinal arch of the foot according to Bradna and Srdečný $\left(\frac{\text{breadth in mm} \times 10}{\text{length in mm}}\right)$ cf. Fig. 1. Furthermore, they measured the footprint angle according to Clarke (Fig. 2). The arch of the foot evaluated by both methods exhibits lower mean values with growing body weight and excess weight, both in men and in women (Figs. 1, 2, 3, and 4, Tab. 1). Between the index of the longitudinal arch of the foot and the fottprint angle there is a strongly significant correlation (Figs. 5 and 6).



GRAPHS 5 and 6

Correlation between the index of the longitudinal arch of the foot (axis x) and the footprint angle (axis y)

REFERENCES

BRADNA, J., SRDEČNÝ, M., 1959: Objektivní zjišťování vad školní mládeže pro zařazování do zvláštní tělesné výchovy. Teorie a praxe tělesné výchovy. *Sport. a turist. nakl., Praha. Special issue, 363—366.*

CLARKE, H. H., 1933: An objective method of measuring the height of the longitudinal arch of the foot. *Research Quarterly 4 : 99. (After H. H. Clarke, 1967.)*

CLARKE, H. H., 1967: Application of measurement to health and physical education. *Prentice-Hall Inc. New Jersey.*

ŠTĚPÁNEK, P., 1961: K otázce vlivu otylosti na podélnou chodidla. *Vnitř. lék. 7: 8. 898—9.*

ŠTĚPÁNEK, P., KŘÍŽEK, V., 1966: Über die Häufung von Plattfüssen bei Fettleibigen. *Heilkunst 79: 12, 373—4.*

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