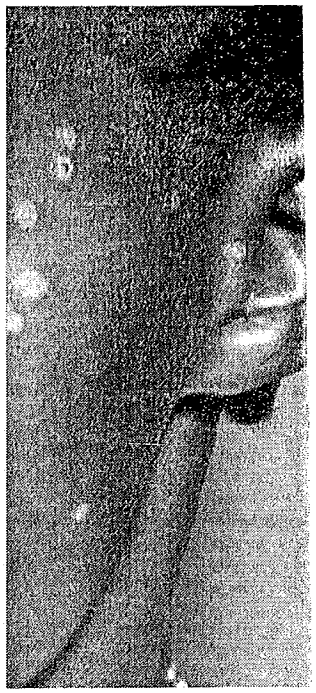

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THE HALLUX POSITION IN
NATIVES OF MADAGASCAR
By B. Kalcev, M.D. (Vienna)

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INTRODUCTION

A STRIKING feature in the natives' feet is the position of the great toe. The observer's eyes are probably first attracted by the fact that this part of the body in a person walking barefoot has individual characteristics in much the same way as has his face and hands. Besides that, the position of the great toe in natives shows such a large scale of variations that the newcomer is amazed to find first hallux varus, unusual in Europeans, and second hallux valgus, regarded as common only in "civilized" races.

This variability of the position of the great toe and the suggestion (Booth, 1952; Hardy and Clapham, 1952) that investigation of its position in people who have never worn shoes might provide some explanation of certain foot disorders common in civilized (i.e., shod) man appeared to justify a larger survey. The object of this paper is to report the results of such a survey.

Sir Arthur Keith (1923) examined footprints of natives and unshod races. He found that the healthy and unblemished great toe may vary in position between two extremes, i.e. it may be parallel to "the inner or outer directional lines". These are the lines drawn in a footprint from the inner or outer border of the heel towards the imprints of the heads of the first or the fifth metatarsals.

Wells (1930–31) published a study of the foot of the South African native in which he concludes that there is a slight tendency to a postural opposition of the hallux to the other digits in the Bantu's foot.

In the former Belgian Congo Engel and Morton (1931) examined thousands of feet of natives who had never worn shoes and found some typical characteristic features but made no mention of the hallux position.

C. J. James (1939) examined the feet and footprints of 65 unshod natives from the Solomon Islands. He noticed that the inner border of their feet was a straight line but that occasionally the great toe was abducted so that the inner border of the foot was concave medially.

A larger survey among natives from West Africa was reported by Barnicot and Hardy (1955). They examined the footprints of 327 males and females and found a mean hallux angle of $+0 \cdot 24°$ for the females and $+1 \cdot 88°$ for the males with a statistically significant sex difference. They did not find any evidence that the mean hallux angle changes between adolescence and later life but they suggest that the dispersion is greater in older subjects than in younger.

MATERIAL

The footprints for this survey were taken in the south-west districts of Madagascar. The people examined were all Malagasy belonging to the tribes

native to those areas. The footprints were taken at various places where large numbers of people assembled: schools, antimalarial centres, army recruiting offices, etc. This explains the irregularity of the size of the different age and sex groups.

While the school samples up to the age of 13 have a regular age and sex distribution, the age group 14–15 is smaller because many children leave school at that age. Usually the children knew their age but an error of one year is not impossible. Since for the rest of the sample the age of the people examined was assessed approximately it is more convenient to divide it into three groups: adolescent, mature and old.

Thus the male group 16–25 is mainly composed of recruits aged approximately 18–20. The females in the same age group were supposed initially to be composed of girls after school-leaving age and before child-bearing but girls of up to 25, even if they had children, were included in this group. The group of 26–40 is composed of men of adult age and women of child-bearing age.

The age group 41 and over includes the old people. Most of the footprints were taken during tax exemption and since women don't pay taxes the males are in excess. The real age in this group is nearer 55–65 than 41–50.

No person included in the survey had ever worn shoes and none of them had any foot complaints.

Since there are sometimes significant differences between the hallux angles of the two feet in the same individual, footprints of both feet were taken. Thus Table 1 shows the number of feet examined but the number of persons examined is half.

Table 1

Distribution of Number of Feet and Their Mean Hallux Angle Among Age Groups

Age	*Number of feet*			*Mean hallux angle in degrees and its standard deviation*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
6–7	364	400	764	−0·39±5·03	−0 88±5·36	−0.64±5·20
8–9	396	452	848	−0·23±5·00	−0·66±5·34	−0·45±5·17
10–11	392	332	724	+0·02±5·35	+0·55±5·59	+0·29±5·47
12–13	364	274	638	+1·86±5·18	+1·49±5·32	+1·68±5·25
14–15	200	168	368	+2·48±5·11	+2·55±5·02	+2·52±5·07
16–25	1,768	498	2,266	+2·44±5·94	+2·06±5·97	+2·25±5·95
26–40	474	810	1,284	+2·56±5·89	+2·05±6·43	+2·32±6·16
41 and over	1,966	322	2,288	+2·36±7·40	+2·14±6·78	+2·25±7·09
6–15	1,716	1,626	3,342	+0·54±5·13	+0·61±5·32	+0·68±5·28
16 and over	4,208	1,630	5,838	+2·45±6·41	+2·08±6·39	+2·27±6·40
Total	5,924	3,256	9,180	+1·38±5·61	+1·16±5·37	+1·25±5·67

METHODS

The footprints were taken while the subject was standing or supported, when necessary, by a friend. He was asked to stand on one foot and to relax the other. The examiner moved the relaxed foot, pressed it over a napkin soaked in methylene blue solution and then over a piece of paper.

For measuring the hallux angle the method given by Barnicot and Hardy (1955) was used (Fig. 1). Thus the plus angle corresponds to a valgus position and the minus angle to a varus position of the hallux.

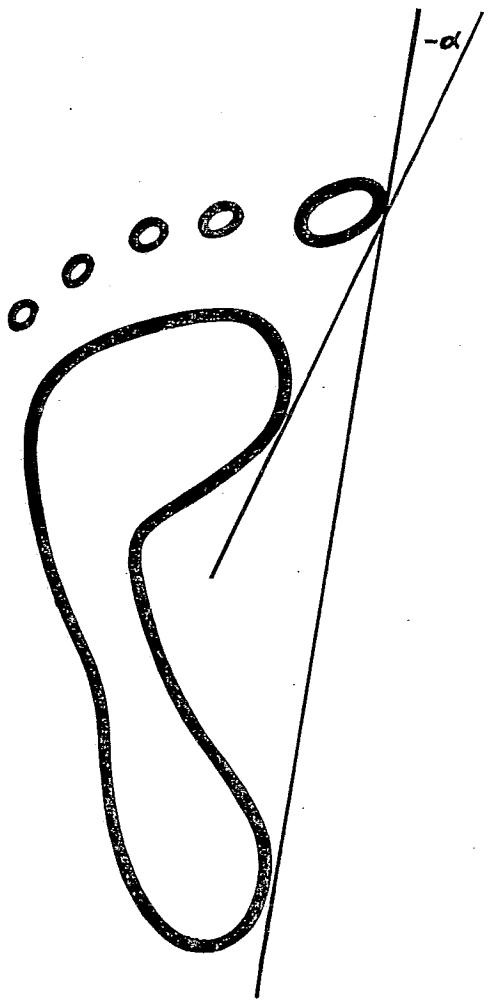


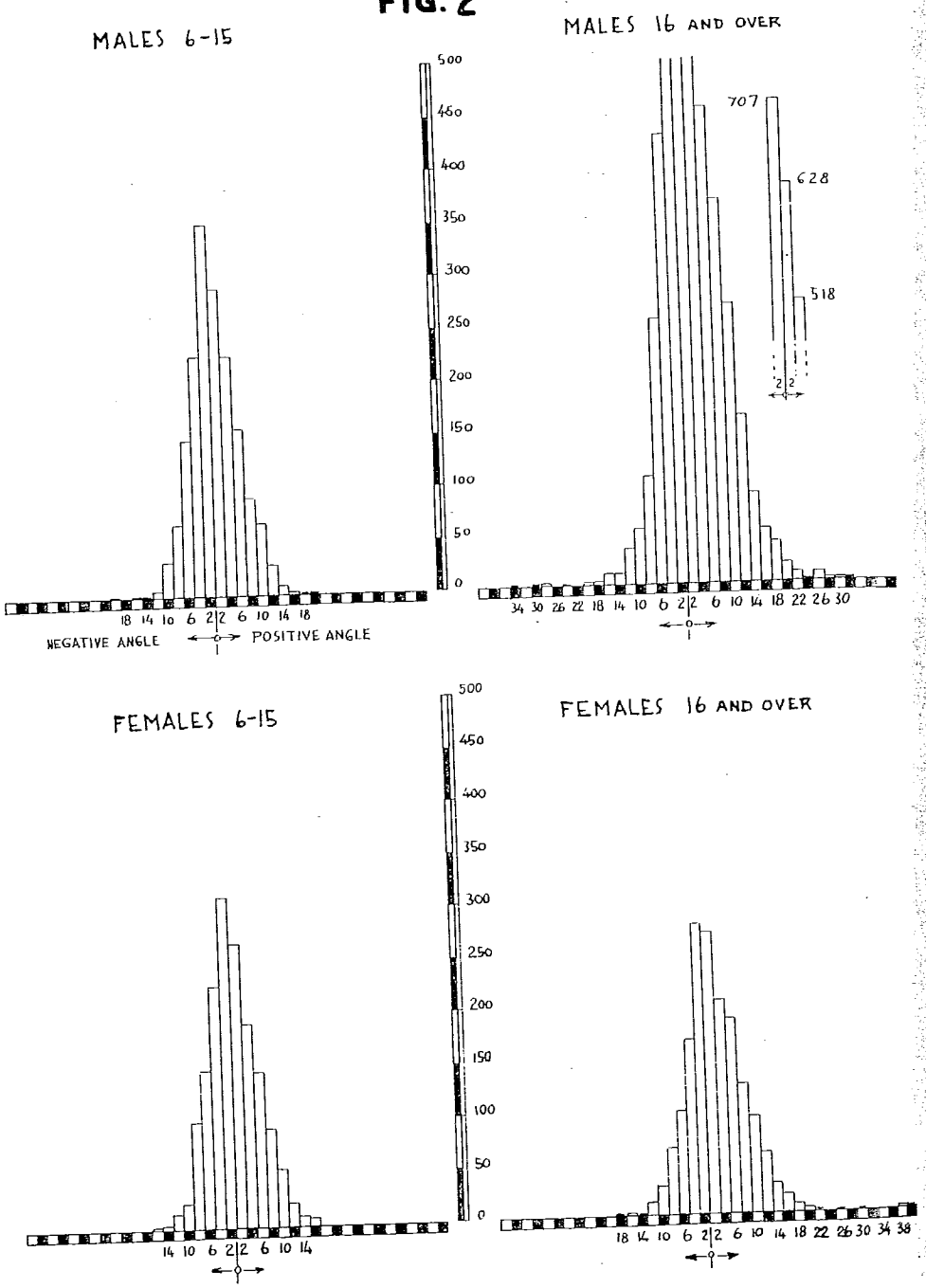
Fig. 1.

RESULTS

The distribution of the hallux angle as shown in Fig. 2 follows a normal curve.

Table 1 shows the mean hallux angle (MHA) and its standard deviation (SD) for the different age and sex groups.

FIG. 2



The MHA and its SD for the whole sample are $+1{\cdot}25° \pm 5{\cdot}67°$. It rises with age from $-0{\cdot}64°$ at the age of 6–7 to $+2{\cdot}52°$ at the age of 14–15 but does not change significantly after that age. There is no statistically significant difference between the MHA of both sexes in the same age group.

In the male sample the only statistically significant increase of the MHA is in the age group 12–13 ($+1{\cdot}86°$) compared with that of the age group 10–11 ($+0{\cdot}02°$) ($t=4{\cdot}8$ for $DF=754$).

In the female group significantly increasing MHA is found in the following age groups: the MHA of $+0\cdot55°$ for the age group 10–11 compared with that of $-0\cdot66°$ for its preceding age group shows a significant increase ($t=3\cdot1$ for $DF=782$). The MHA of $+1\cdot49°$ for the age group 12–13 compared with that of $+0\cdot55°$ for the preceding group is also significantly different ($t=2\cdot1$ for $DF=604$). The MHA of $+2\cdot55°$ for the age group 14–15 compared with that of its preceding group $+1\cdot49°$ shows a significant difference ($t=2\cdot0$ for $DF=440$).

The MHA of $+0\cdot54°$ for boys aged 6–15 is not significantly different from the MHA of $+0\cdot61°$ for girls of the same age.

The MHA of $+0\cdot54°$ for boys aged 6–15 is significantly different from the MHA of $+2\cdot45°$ for males aged 16 and over ($t=12\cdot0$ for $DF=5,922$) and the corresponding MHAs of $+0\cdot61°$ and $+2\cdot08°$ in the females of the same age groups are also significantly different ($t=7\cdot4$ for $DF=3,254$).

The MHA of $+2\cdot45°$ for males aged 16 and over is significantly different from the MHA of $+2\cdot08°$ for females of the same age group ($t=2\cdot0$ for $DF=5,836$).

It was found that a clinically obvious valgus deflection corresponds to about $+10°$. Thus for the purpose of this survey all feet with a hallux angle of $+9°$ and over will be considered as hallux valgus. Conversely those with a hallux angle of $-9°$ and over will be considered as hallux varus.

The percentage of feet showing a hallux valgus in the male sample ranges from 3·0 for the age group 6–7 to 17·0 for the age group of 41 and over. There is a progressive increase with age. The same correlation is found in the female group with a range of 3·5 to 15·2 respectively.

The hallux varus group shows a range of 1·1 per cent to 4·7 per cent for the male group and 1·2 per cent to 3·7 per cent for the female group. There is, however, no correlation between percentage of hallux varus and age.

Table 2 gives the percentages of hallux valgus and hallux varus in the whole sample taken as two age groups. There is no significant difference between the percentages in hallux varus either with sex or age. In the hallux valgus group there is a significant difference between the percentages of the age groups in both sexes, i.e. there are more hallux valgus cases in the older group. While the percentages of males and females in the age groups 6–15 are not significantly different (6·5 per cent and 5·6 per cent with an S.E.$=\pm0\cdot82$), those in the age group 16 and over show that there are significantly more hallux valgus cases in the male group (15·1 per cent for the males and 13·0 per cent for the females with an S.E.$=\pm0\cdot99$).

Table 2

Percentage of Feet with Hallux Angle of 9° and Over

Age groups	*Valgus*			*Varus*		
	Males	*Females*	*S.E.*	*Males*	*Females*	*S.E.*
6–15	6·5	5·6	±0·82	2·3	2·3	±0·53
S.E.	±0·80	±1·0		±0·44	±0·54	
16 and over	15·1	13·0	±0·99	2·8	2·4	±0·45

It has been mentioned already that there are sometimes large differences between the hallux angles of the same individual. Table 3 shows in the two age groups the percentage of persons with a difference of 10° and over. The difference of these percentages suggests that this condition is more common in old people than in young and that there are significantly more cases amongst older males than older females.

Table 3

Percentage of Persons Showing a Difference of 10° and Over between the Hallux Angle Left and Right

Age groups	Number of persons examined			Percentage and its S.E.		
	Males	Females	Total	Males	Females	S.E.
6–15	858	813	1,671	3·8	4·4	±0·97
S.E.				±0·90	±1·13	
16 and over	2,104	815	2,919	9·6	6·7	±1·08

OTHER FINDINGS

The same features in the natives' feet as reported by Engel and Morton (1931) were found in the present sample, i.e. pachydermatous skin of the sole, reduction of the usual size of the toenails (especially that of the great toe), imperfect development of the fourth toe. False flat feet were very common. No corns, warts, athlete's foot or onychogryphosis were seen.

DISCUSSION

The hallux position in the present sample of Malagasy people is near the straight line of the inner border of the foot. The MHA increases with age from −0·64° at the age of six to +2·52° at the age of 15 but does not change significantly after that. The main increase is at the age of 10–11 and there is a suggestion that this increase is earlier for girls. The explanation for this slight though significant lateral deviation of the hallux may be that during the first 10–15 years of life the hallux adapts itself from the varus position as found at birth. This new position, which is nearer the long axis of the foot, may permit a better use of the hallux and its muscles in walking.

While there is no significant difference between the MHAs for the two sexes in the younger (6–15) age group, the MHA of +2·45° for males aged 16 and over is significantly different from the MHA of +2·08° for females of the same age group. The same feature was found in the sample of West Africans examined by Barnicot and Hardy. This is consistent with the fact that there are significantly more hallux valgus cases in older men than women, the highest incidence for an arbitrarily accepted valgus deflection being 17·0 per cent. The hypothesis suggested by Keith (1923) and developed by Lake (1952) that during the 'step off' the metatarso-phalangeal joint is exposed to more strain and thus more likely to cause a breakdown of

the neuromuscular machinery which guards the condylar joint of the great toe would explain the prevalence of hallux valgus in the older people in our survey. Its prevalence in the male may be explained by the fact that the man leads a much more active life and when hunting has to walk miles. That some local factors may also be responsible for the formation of hallux valgus as suggested by Basler (1937) is confirmed by the fact that there were some people in our sample showing a deflection of their hallux on the one foot opposite in direction to that of the other.

Surveys of hallux position in shod people have been done in Austria (Kalmus, 1931), Germany (Basler, 1937) and in Great Britain (Emslie, 1939; Wilkins, 1941; Winner, 1945; Booth, 1949; B.B.S.A.T.R.A., 1949; Craigmile, 1950, 1953; Hardy and Clapham, 1952; Pratt, 1957). Although different methods have been used by the different examiners the results are that hallux valgus is found in about 50 per cent of the population at the age 16–19 and is more common in girls than in boys. Several aetiological factors have been suggested: hereditary, congenital, postural, degenerative (osteo-arthritic), inflammatory (rheumatic fever, rheumatoid arthritis) and footwear. This last factor has been recognized for years particularly by orthopaedic surgeons (Creer, 1938; Lorenz, 1949; Pratt, 1957). Not only badly fitting shoes but also tight socks may cause the condition (Hennicke, 1935; Basler, 1938; O'Loghlen, 1953). Basler was able to produce experimentally a valgus deflection of the hallux by asking volunteers to wear very tight shoes (1937).

Haines and McDougall (1953) found that in Egypt the incidence of hallux valgus is related to social classes: it does not exist among poor people who usually walk barefoot. Schlegel (1960) reports that in Japan hallux valgus is becoming more common since modern (i.e., European) footwear has become more widespread.

The results of the present survey confirm the view that footwear is not the only factor causing hallux valgus. But since more than 80 per cent of the people examined showed a hallux position corresponding to the idea of Sir Arthur Keith of a healthy and unblemished great toe, the cause for the high incidence of hallux valgus among shod people can only be sought in their footwear.

ACKNOWLEDGMENTS

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