EFFECTS OF PARITY ON BIRTH WEIGHT AND OTHER VARIABLES IN A TANGANYIKA BANTU SAMPLE

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In the highlands of the extreme north-west of Tanganyika, in West Lake Province, live the Hangaza, a Bantu-speaking people, some 55,000 in number, divided socially into the Tutsi ruling class, comprising about 5 per cent. of the population, and the Hutu; the Tutsi here are not an endogamous group, and because of intermarriage with the Hutu are not distinguishable in physical appearance. The economy is mixed, cash income being derived from growing Arabica coffee and from wages brought back from Uganda by migrant workers. Serving this people at Murgwanza is a maternity clinic staffed by qualified African nurses, which is part of a larger hospital with resident European senior medical and nursing staff. Records are kept for each maternity case, from which may be obtained the number of previous pregnancies, the number of previous unsuccessful pregnancies (abortions and stillbirths), the number of children now living and who have died, the outcome of the present pregnancy, and the sex of the infant. These records covering the period January, 1952, to November, 1957, were analysed. A proportion of entries was incomplete and these were excluded. For about two-thirds of the remaining entries, birth weight was also recorded.

RESULTS

TWINNING RATE

Details of 1,624 confinements remained after exclusion of entries in which the mother's reproductive history was lacking; there seems no reason for bias to have been thereby introduced. Of these confinements, 1,585 produced single children, 848 males and 737 females. There were no triplets, but 39 pairs of twins, eight male/male, 16 male/female, and fifteen female/female. By Weinberg's formula uncorrected for the sex ratio, the monozygotic twinning rate is 4.3 per thousand confinements, the

dizygotic 19.7, and the total 24.0 per thousand, *i.e.* one in 41.7 confinements. The monozygotic rate is slightly but not significantly above, and the dizygotic and total rates considerably above, those listed by Bulmer (1960) for European populations, but are generally similar to those he quotes for central African peoples. Jeffreys (1953) collated data from a number of African samples, though including some of doubtful reliability, to give a total rate of 19.6 per thousand births, *i.e.* one in 50.9 births. The only other available figures for peoples of the East African territories, one in 36.4 Kikuyu births (Preston, 1942) and one in 43 Kavirondo births (Preston, 1936), are similar to the rate in the present sample.

Despite the relative smallness of the sample there is a clear increase in frequency of twinning with parity defined as the number of previous pregnancies (Table I); in primiparae the rate is 17.6 per thousand; in those with one previous pregnancy 16.6; with two, 22.4; with three, 26.0; with four

TABLE I
INCIDENCE OF TWINNING, BY PARITY

Number of Previous Pregnancies	Number of Singletons Born		Number of Twins Born		Total Born	
	Male	Female	Male	Female	Male	Female
0	201	194	9	5	210	199
1	152	144	5	5	157	149
2	111	107	4	6	115	113
3	100	87	4	6	104	93
4	81	53	4	6	85	59
5	64	54	—	8	64	62
6	64	37	1	7	65	44
7	37	27	—	—	37	27
8	16	12	2	2	18	14
9	9	15	—	—	9	15
10	7	2	—	—	7	2
11	4	4	—	—	4	4
12	2	—	1	1	3	1
13	—	—	—	—	2	—
14	—	1	—	—	—	1
Total Births . .	848	737	32	46	880	783

and five, 34.5; with six to eight, 30.1; and with nine or more previous pregnancies, 43.5 per thousand; the data are insufficient for these figures to be divided according to zygosity. While the overall trend is in the same direction as in the English data of Waterhouse (1950) and in the Italian data of Bulmer (1959), in the African sample the rate is consistently higher in all these parity groupings than in the European, significantly so (pooling adjacent parities for χ^2 testing). There is some suggestion, moreover, though the numbers are inadequate to test it, that the rate increases with parity more rapidly in the African sample. If, as Bulmer suggests, there is a direct effect of parity on the dizygotic twinning rate perhaps by increasing ovarian activity, then perhaps this effect is greater in the present Bantu women than in Europeans.

SEX RATIO

The overall sex ratio is 112.39 males per 100 females. Inspection suggests that there is an upward trend from first births to seventh and eighth births, in the opposite direction to that noted by a number of authors (Lewis and Lewis, 1905; Knibbs, 1917; Russell, 1936; Ciocco, 1938; MacMahon and Pugh, 1953) for white populations, but in the same direction as that shown by Novitski and Sandler (1956). Barraï, Fraccaro, Lindsten, and Zei (1961) suggested that in an older Swedish sample there was a parabolic regression of sex ratio on parity, with a maximum male frequency between the fifth and sixth birth orders. A parabolic curve fitted to the present data pooling parities of 8 and above ($y = .006118 + .02516x - .00164x^2$, where y is $\log \frac{\text{males}}{\text{females}}$ and x is the number of previous pregnancies) is similar to theirs in shape though not in position, with a maximum at a rather later parity, as perhaps would be expected from the inclusion of unsuccessful pregnancies, but the regression is not statistically significant, and neither is a linear regression.

NON-SURVIVORS

Of the singleton births, 106 were either born dead or died before leaving the maternity clinic; 64 of these were male, 42 female, but this is not a significant difference between the sexes. Of the 78 twin individuals, eighteen were either stillborn or died before leaving the clinic, a highly significant excess

over the proportion observed in singletons, indicating the heavy disadvantage with which a twin is endowed in this population; this proportion is similar to that of fifteen out of sixty individuals observed by Preston (1942) among the Kikuyu. In the singletons, though heavier losses appear to affect the primiparous and highly multiparous (>5 previous pregnancies) women, there is no significant association of survival and parity. The frequency of unsuccessful births, *i.e.* stillbirths and those dying before leaving hospital, of 7.5 per cent. appears rather more favourable than those quoted by Goosen (1960) of 11.7 per cent. for stillbirths and deaths during the first week in the African maternity hospital Nairobi, by Preston (1942) of 13.7 per cent. and 12.5 per cent. for stillbirths at Fort Hall, and by Grounds (1959) of 9.5 per cent. for stillbirths from a survey in rural southern Nyanza. The apparent advantage may however be partly due to a shorter stay by some of the mothers in the clinic.

BIRTH WEIGHT

For 1,046 of the successful singleton births, *i.e.* those born alive who survived until leaving the maternity clinic, weight was recorded, giving for 547 males a mean birth weight of 6.37 lb. (standard deviation 0.93 lb.) and for 499 females a mean of 6.16 lb. (standard deviation 0.88 lb.). While the distribution shown in Fig. 1 (opposite) appears to show a slight skewness, the curve is sufficiently regular to suggest that it is highly unsatisfactory to regard all single births under 5½ lb. as premature. Existing data relating to birth weight in East Africa are of limited value for comparative purposes, since they do not record variabilities and take little account of variations with sex and parity, and indeed it is only for very few of the many populations in the area, with its great ethnic economic, and environmental contrasts, that any data on birth weight are available. Shaw (1933) gave means of 7.03 and 6.84 lb. for 387 male and 363 female infants born in Nairobi African maternity hospitals, excluding multiple and non-induced premature births, the mean weights of first born being less than subsequent births, and of Kikuyu (6.93) less than Luo (7.02) infants. Preston (1942) observed a mean of 6.59 lb. and a range from 3.5 to 9.8 lb. in 700 Kikuyu infants (366 male, 334 female) at Fort Hall. In 654 nearly consecutive Ganda births, excluding infants of 5 lb. and under, the mean weights were 7 lb. for males and 6.7 lb. for females, with standard deviations of 0.9 lb. and 0.8 lb. respectively (Allbrook and Sibthorpe, 1961).

FIG. 1.—Birth weight of successful singleton births compared with that of twins and non-surviving singletons.

Welbourn (1955a) calculated the average birth weight for all single Ganda births at C.M.S. Mengo hospital 1948–51 as 6.5 lb., the sample comprising 1,002 subjects, and referred to a mean figure of 6.83 lb. for 1,000 births over 5½ lb. collected by Shaw at Mulago hospital. She suggested (1955b) that the Luo infants were perhaps slightly heavier than the Ganda, since a small sample of 47 Luo infants in Kampala had an average birth weight of 7.1 lb. Cachia (1960) listed mean birth weights at Narok hospital of 6.38 lb. for 46 Masai babies where the custom of maternal starvation was practised, and of 7.06 lb. for 86 infants of mixed Masai parentage and 7.38 lb. for 144 infants of non-Masai parentage in which two groups there was no deliberate antenatal starvation of the mother. In one sample, of Sukuma at Mwanza (McLaren, 1959) with means of 6.6 lb. male and 6.3 lb. female, weights are set out according to parity. The present Hangaza sample appears to be rather lighter than the few other samples studied, even when allowance is made for the artificial elevation of the means of some of them by truncation of the sample at 5½ lb.; it is also lighter for a given parity than the Sukuma data, except for first born.

Table II gives for each sex the birth weight in the Hangaza sample by the number of previous pregnancies of the mother. Mean birth weights of first-born are as expected below those in later pregnancies and there appears to be a general increase in parity in both sexes. As Millis and Seng (1954) in Chinese, Fraccaro (1956) in Italians, Banerjee and Roy (1962)

TABLE II
BIRTH WEIGHT (LB.), BY PARITY AND SEX

No. of Previous Preg- nancies	Sex						Total		
	Male			Female					
	m	n	S.D.	m	n	S.D.	m	n	S.D.
0	6.07	116	.77	5.98	129	.94	6.03	245	.86
1	6.33	98	.93	6.09	99	.79	6.21	197	.87
2	6.49	71	1.03	6.21	67	.71	6.35	138	.90
3	6.32	68	.84	6.28	64	.82	6.30	132	.83
4	6.42	57	.86	6.34	33	.94	6.39	90	.88
5	6.66	47	.96	6.05	38	.88	6.39	85	.97
6	6.52	42	1.08	6.45	25	1.10	6.49	67	1.08
> 6	6.64	48	1.04	6.35	44	.91	6.50	92	.98
Total	6.37	547	.93	6.16	499	.88	6.27	1,046	.91

in Indians, and other authors have shown, the relationship between birth weight and parity tends to be curvilinear. Second-degree polynomials were fitted to the present data, the equations being in males $y = 6.136 + .125x - .00799x^2$, and in females $y = 6.043 + .053x - .00156x^2$, where y is the birth weight in pounds, and x the number of previous pregnancies of the mother (Fig. 2).

FIG.—2. Birth weight related to parity.

Both regressions are statistically significant ($R = .181$ male, $.120$ female), and in both the greater part of the regression sum of squares is due to the linear

rather than the curvilinear component. The linear correlation coefficients (male $+ .164$, female $.118$) are similar to those in other studies, *e.g.* Balakrishnan and Namboodiri (1960) male $.140$, female $.141$; Fraccaro (1956) male $.122$, female $.111$; Karn and Penrose (1951) male $.166$, female $.180$. The slightness of the curvilinear component in females is predominantly due to the values observed in the sixth pregnancy, where the inclusion of a few infants of very low weight is by some chance not counter-balanced, as it is in other pregnancies, by some of high weight.

Weights of singletons were analysed by month of birth, as preliminary plotting of means suggested that males born in May to September were slightly heavier than in the remainder of the year. However, in neither sex are there significant variations in birth weight between months, and there are none when monthly weight means are adjusted to allow for parity differences.

For many of the stillbirths, birth weight was not recorded, and it may well be that those that were recorded represent a biased sample. However, by comparison with the weights of successful single births, the weights in a small sample (29) of singletons who were stillborn or died before leaving the clinic tend to cluster at the lower part of the distribution (Fig. 1). Although there is a suggestion that mortality is greatest at the lowest birth weights (100 per cent. at under 2 lb.) and diminishes as weight increases, as noted by Gibson and McKeown (1951), meaningful mortality rates cannot be calculated from the present data; the data are inadequate to show any such increased mortality at higher weights as was noted by Karn and Penrose (1951).

Birth weights were recorded for 31 of the twin pairs, and again their distribution curve is displaced to the left by comparison with that of the successful singletons (Fig. 1).

Means and standard deviations of twin weights are tabulated below:

Twins		Birth Weight (lb.)		
		mean	s.d.	n
In like sex pairs ..	Male	5.31	.62	14
	Female	4.66	.80	24
In unlike sex pairs ..	Male	4.98	.89	12
	Female	4.83	1.07	12
All twins	Male	5.15	.76	26
	Female	4.72	.89	26

UNSUCCESSFUL PREGNANCY

In Table III are summarized data from the reproductive histories of the Hangaza women with three to eight previous pregnancies. Stillbirths, miscarriages, and abortions are grouped together on account of the difficulty of defining them in the vernacular. The mean number of unsuccessful pregnancies per woman per pregnancy increases with parity. For comparison, similar data from the English sample of Whitehouse (1929) are also presented. While the trends in both samples are similar, the Bantu sample appears to have a rather lower incidence of failures. This may be due partly to the fact that the English sample may have included some cases of induced abortion, and partly to the fact that there may have been under-reporting of unsuccessful pregnancies in the present Hangaza data.

TABLE III
INCIDENCE OF ABORTIONS IN HANGAZA AND ENGLISH WOMEN, BY PARITY

Number of Previous Pregnancies	Hangaza			English	
	Number of Subjects	Mean number of Unsuccessful Pregnancies		Mean number of Abortions	
		Per woman	Per woman per pregnancy	Per woman	Per woman per pregnancy
3	193	.228	.076	.454	.151
4	141	.277	.069	.618	.154
5	121	.281	.056	.905	.181
6	104	.577	.096	1.070	.178
7	64	.875	.125	1.394	.199
8	30	1.033	.129	1.514	.189

James (1961) recently demonstrated that, statistically by curve fitting, there could be detected in this English sample two components, a small group of women each with a relatively high probability of aborting each pregnancy and a larger group with a relatively low probability of aborting; this distinction corresponds in some measure with the long accepted clinical recognition of habitual aborters and abortion-resistant women. It seemed of interest to inquire whether the same occurred in the present Hangaza data, which were therefore analysed in the same manner. The numbers of females in each pregnancy group from 3 to 8 who had experienced 0, 1, 2, . . . n unsuccessful pregnancies were compared with those expected from the expansion of the double binomial $v_1 (p_1 + q_1)^n + v_2 (p_2 + q_2)^n$, where v_1 is the number of abortion-prone women each with a probability of aborting q_1 , v_2 is the number of abortion-resistant women each with the probability of abortion q_2 , $p_1 = 1 - q_1$, $p_2 = 1 - q_2$, and n is the parity group (Table IV). The parameters were reasonably consistent among the different parities except in the 5th; in this group it seemed that the abortion-prone component was lacking, so that the parameters from this group were not pooled with the remainder.

Though the fit is not at all good, there is, as in James's study, no significant difference between the numbers observed in each group and those expected from the pooled parameters; for testing, cells in which expected numbers were fewer than 8 were pooled until this number was obtained. It is reasonable to assume that no worse fit would be obtained were it possible to test each pregnancy group separately—for which in the present case there are

TABLE IV
DISTRIBUTION OF NUMBERS OF WOMEN BY THE NUMBER OF UNSUCCESSFUL PREGNANCIES EXPERIENCED AND BY PARITY

Number of Previous Pregnancies	3		4		5		6		7		8	
	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected
0	158	158.00	113	113.25	94	*	67	64.28	39	36.50	17	15.73
1	28	28.00	20	19.01	20	*	20	28.56	8	16.18	5	8.28
2	5	5.00	5	6.49	7	*	14	6.14	12	3.77	4	2.07
3	2	2.00	3	2.01	0	*	2	2.21	1	2.09	1	.78
4	—	—	0	0.25	0	*	0	1.72	1	2.42	2	.96
5	—	—	—	—	0	*	0	.90	1	1.95	0	1.06
6	—	—	—	—	—	—	1	.20	2	0.88	0	.75
7	—	—	—	—	—	—	—	—	0	0.17	1	.30
8	—	—	—	—	—	—	—	—	—	—	0	.01
9	—	—	—	—	—	—	—	—	—	—	—	—
Number of Women . .	193	—	141	—	121	—	104	—	64	—	30	—

* The expected numbers are those calculated from expansions of double binomials for each pregnancy group separately; such a distribution could not be fitted for those with five previous pregnancies.

insufficient degrees of freedom. Also as in James's study, there is a highly significant difference of the observed numbers from those expected from the expansion of a single binomial for each pregnancy group, indicating that in this sample too the probability of unsuccessful pregnancy is not constant for all women. The fit of negative binomials could not be tested on account of insufficient degrees of freedom.

The pooled parameters in the Hangaza show a percentage of habitual "aborters" of 8.8 per cent., in whom the probability of an unsuccessful pregnancy is .527, and the percentage of "abortion" resistant 91.2 per cent., in whom the probability of an unsuccessful pregnancy is .049. In the English sample the values were 13.6 per cent., .593 and 86.4 per cent., .111 respectively. It appears that there may be a lower frequency of habitual "aborters" in the present Bantu sample than there is in the English sample that James analysed; in the "abortion-resistant" the probability of an unsuccessful birth is also lower while in the "abortion-prone" the figure is not far from the English probability.

In the absence of comparable reliable data from other East African samples, little weight should perhaps be placed on the arithmetical values for these parameters. What is surprising, however, is that in data so open to error there is *any* measure of agreement with James's findings, from presumably more reliable material, that such data may be described by the double binomial—and this moreover where relatively slight departures in the upper categories (e.g. the absence of a total of three or four individuals from Cells 3, 4, and 5 in the 5th pregnancy group) can have a severe effect on the calculated parameters. It is unfortunate that the sample is of inadequate size to allow the examination of other distributions. This agreement may of course merely reflect the inadequacies of curve fitting as a method of analysis when applied to small samples, though in the absence of better data it should surely be recorded. Or it may indicate that most of the present data are not of such low reliability after all, and that such error as there is hardly affects the form but merely displaces the distributions.

DISCUSSION

The object of this study was twofold: to put on record some data in a field almost totally neglected in East Africa, and to draw attention to how much useful information may be hidden in the records maintained at clinics and hospitals there. Difficulties in obtaining such information were probably partly

responsible for this neglect until recently, and there still exists as a secondary cause uncertainty as to the reliability of the data even though taken from clinic records; this uncertainty can be largely removed by examination for evidence of internal inconsistencies at the outset of any analysis (e.g. fluctuations in the number of entries per month, trends in the data recorded, numbers of incomplete entries, etc.). In the present study (a) the estimates of sex ratio are subject only to error in recording, since there seems little cause for the observer to be prejudiced either way; (b) in the weights there may be unreliability in the weighing as well as in recording; (c) the twinning rates may be over-estimated, depending on the extent to which the antenatal service succeeds in persuading an undue proportion of twin pregnancies, as potentially difficult cases, to attend the clinic; over-estimation on this score seems unlikely to be great; (d) there may be a further source of unreliability in the number of non-survivors which may be an under-estimate conscious or unconscious arising from an unwillingness to report the loss of a live born infant. In these direct observations, while the possibility of unreliability from these sources should be recognized, it should not be over-emphasized. Trained African personnel carrying out limited and routine tasks of responsibility, such as the nurses maintaining the clinic, are usually careful in detail; the data themselves show no sign of internal inconsistency; the results are similar to the other limited evidence on these topics. There seems little reason to regard the present data on birth weight, twinning, and sex ratio as other than reliable.

Less reliance perhaps should be put on the reproductive histories leading to the estimates of probability of unsuccessful pregnancy. The differences from the European sample are in the direction expected were there under-reporting of abortions. Apart from the difficulty of definition, reproductive histories are notoriously difficult to collect, in European as well as in African women. Yet it may be argued that the African nurses using the vernacular and known personally to the patients are more likely to secure answers nearer to the truth (if indeed the truth is remembered by the patient) than a European investigator in an African population. In some of the histories at least, reference was made to the record card of the individual kept from previous confinements. The similarity in parity effects on the other data to the effects observed elsewhere suggests that there is no great error in the number of pregnancies reported. While error cannot be eliminated as the course of the differences between the African and European samples, yet the suggestions that there may be fewer habitual aborters and a

lower abortion probability should not be rejected out of hand on that account. They could well represent a real biological difference between the populations, worthy of further investigation.

SUMMARY

Records of twinning, sex ratio, survival, and birth weight in Hangaza births in the Murgwanza maternity clinic are analysed. It appears that the twinning rate at each parity is greater than in Europeans. The overall sex ratio is high. Birth weight is low and increases with parity, though the curvilinear form of the increase is not as clear as in some other studies. Unsuccessful pregnancies may be fewer than in Europeans.

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REFERENCES

Allbrook, D., and Sibthorpe, E. M. (1961). *S. Afri. J. med. Sci.*, **26**, 73.

- Balakrishnan, V., and Namboodiri, N. K. (1960). *Ann. hum. Genet.*, **24**, 5.
- Banerjee, A. R., and Roy, S. K. (1962). *J. Indian pediat. Soc.*, **1**, 89.
- Barral, I., Fraccaro, M., Lindsten, J., and Zei, G. (1961). *Ann. hum. Genet.*, **25**, 189.
- Bulmer, M. G. (1959). *Ibid.*, **23**, 454.
- (1960). *Ibid.*, **24**, 121.
- Cachia, C. (1960). *E. Afr. med. J.*, **37**, 224.
- Ciocco, A. (1938). *Hum. Bilo.*, **10**, 36.
- Fraccaro, M. (1956). *Ann. hum. Genet.*, **20**, 282.
- Gibson, J. R., and McKeown, T., (1951). *Brit. j. soc. Med.*, **5**, 177.
- Goosen, C. J. (1960). *E. Afr. med. J.*, **37**, 140.
- Grounds, J. G. (1959). *Ibid.*, **36**, 644.
- James, W. H. (1961). *Ann. hum. Genet.*, **25**, 207.
- Jeffreys, M. D. W. (1953). *S. Afr. J. med. Sci.*, **50**, 89.
- Karn, M. N., and Penrose, L. S. (1951). *Ann. Eugen. (Lond.)*, **16**, 147.
- Knibbs, G. H. (1917). "Census of the Commonwealth of Australia 1911" I.
- Lewis, C. J., and Lewis, J. N. (1905). "Natality and Fecundity" Oliver and Boyd, Edinburgh.
- MacMahon, B., and Pugh, T. F. (1953). *Brit. J. soc. Med.*, **7**, 83.
- McLaren, D. S. (1959). *Trans. roy. Soc. trop. Med. Hyg.*, **53**, 173.
- Millis, J., and Seng, Y. P. (1954). *Ann. hum. Genet.*, **19**, 58.
- Novitski, E., and Sandler, L. (1956). *Ibid.*, **21**, 123.
- Preston, P. G. (1936). *E. Afr. med. J.*, **13**, 215.
- (1942). *Ibid.*, **19**, 223.
- Russell, W. T. (1936). *J. Hyg.*, **36**, 381.
- Shaw, M. M. (1933). *E. Afr. med. J.*, **10**, 32.
- Waterhouse, J. A. H. (1950). *Brit. J. soc. Med.*, **4**, 197.
- Welbourn, H. F. (1955a). *J. trop. Pediat.*, **1**, 34.
- (1955b). *E. Afr. med. J.*, **32**, 291.
- Whitehouse, B. (1929). *Proc. roy. Soc. Med.*, **23**, 248.