OBSERVATIONS ON ALL BIRTHS (23,970) IN BIRMINGHAM, 1947*

VI. BIRTH WEIGHT, DURATION OF GESTATION, AND SURVIVAL RELATED TO SEX

BY

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In this report we use data for births delivered in Birmingham during 1947 (Gibson and McKeown, 1950) to examine sex differences

- (a) in birth weight and duration of gestation
- (b) in survival rates.

BIRTH WEIGHT AND DURATION OF GESTATION

That mean birth weight is higher for males than for females has been consistently recorded (for example by Pearson, 1900; Murray, 1924; Martin, 1931; Bakwin and Bakwin, 1934; Anderson, Brown, and Lyon, 1943), and more recently by Karn and Penrose (1951), Norval, Kennedy, and Berkson (1951), and Salber and Bradshaw (1951). There have been fewer investigations of duration of gestation; but in general reported differences between the two sexes have been trivial (Schlichting, 1880; Siegel, 1921; Anderson, Brown and Lyon, 1943; Karn, 1947; Karn and Penrose, 1951).

Table I gives mean birth weights of the Birmingham births as 7.57 and 7.31 lb.

TABLE I
PERCENTAGE DISTRIBUTIONS BY BIRTH WEIGHT

Birth Weight (lb.)	Male	Female
Under 4	1.32	1.24
4—	1.59	1.92
5—	5.88	8.07
6—	20.52	25.91
7—	34.92	36.18
8—	24.51	20.01
9—	8.58	5.22
10 and over	2.68	1.45
Total	100	100
Number of Births	11,602	10,811
Mean (lb.)	7.57	7.31
Error of Mean	0.012	0.012
Standard Deviation	1.31	1.24

Sex was unspecified in 41 of 22,454 births of known weight.

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for males and females respectively. In comparing these figures with others reported in the literature it should be remembered that about half the births were delivered in hospitals and nursing homes and about half at home, and that mean birth weight is approximately half a pound heavier for domiciliary (7·65) than for hospital births (7·15) (McKeown and Gibson, 1951). If the comparison were confined to institutional births the means would no doubt be very close to those recorded recently by Karn and Penrose (1951) for University College Hospital, London (7·27 for males; 7·06 for females).

Table II gives the mean duration of gestation (in days) as 280·29 for males and 280·78 for females; the difference between the means is just significant by the conventional tests, although it is of course quite trivial. In particular, and what is of most biological interest, it in no way accounts for the sex difference in weight at birth, which must be wholly attributed to a difference in the rate of foetal growth (unlike the difference in weights of twin and single births, which is partly attributable to a difference in rate of foetal growth, and partly to a substantial difference in the duration of gestation).

TABLE II
PERCENTAGE DISTRIBUTIONS BY DURATION OF GESTATION

Duration of Gestation (weeks)	Male	Female
Under 34	2·09	2·04
34—	2·62	2·55
36—	7·38	6·62
38—	29·01	28·13
40—	44·74	46·73
42—	11·53	10·98
44 and over	2·63	2·95
Total	100	100
Number of Births	8,765	8,306
Mean (days)	280·29	280·78
Error of Mean	0·17	0·17
Standard Deviation	15·75	15·75

Table III and the Figure (overleaf) show the mean birth weights of males and females according to the duration of gestation. At all intervals examined, males are heavier than females, although in many cases the differences are not significant. It is of course to be expected that the sex difference in foetal weight would become more conspicuous during the period of rapid growth, but on this evidence the difference is present as early as the 29th week.

TABLE III
BIRTH WEIGHT RELATED TO DURATION OF GESTATION

Duration of Gestation (weeks)	Male				Female			
	Number of Births	Mean Weight (lb.)	Error of Mean	Standard Deviation	Number of Births	Mean Weight (lb.)	Error of Mean	Standard Deviation
28—	18	2.78	0.15	0.64	14	2.71	0.11	0.43
30—	34	3.56	0.20	1.16	39	3.37	0.18	1.14
32—	64	4.33	0.12	0.97	56	4.09	0.17	1.25
34—	193	5.90	0.09	1.29	184	5.86	0.10	1.39
36—	647	6.80	0.05	1.23	550	6.60	0.05	1.27
38—	2,543	7.43	0.02	1.13	2,336	7.17	0.02	1.11
40—	3,921	7.84	0.02	1.04	3,882	7.55	0.02	1.08
42—	1,010	7.98	0.04	1.18	910	7.68	0.04	1.31
44—46	182	7.99	0.09	1.17	166	7.80	0.08	1.00
All births of known duration of gestation	8,612	7.56	0.014	1.28	8,137	7.30	0.014	1.29
All births of known birth weight	11,602	7.57	0.012	1.31	10,811	7.31	0.012	1.24

Fig. 1.—Birth weight related to duration of gestation.

SURVIVAL

Tables IV and V (overleaf) show the association of sex specific stillbirth and neonatal mortality rates with birth weight and duration of gestation respectively; because the numbers are small for this purpose the data have been grouped. Both rates are higher for males than for females, the slight differences between the corresponding figures in the two tables being explained by the different number of births for which weight and duration of gestation were known. We now enquire to what extent the sex differences are accounted for by differences in birth weight, duration of gestation, and cause of death.

SEX SPECIFIC STILLBIRTH RATES

(a) For the relatively small number of births delivered at weights less than 3 lb., female stillbirth rates are higher than male rates (Table IV). The difference is attributable almost entirely to the higher incidence in this weight group of female stillbirths due to anencephalus. Similarly when considered in relation to duration of gestation, the sex specific stillbirth rate for births delivered before completion of 38 weeks' gestation is higher for females than for males (Table V), again because of the different sex incidence of anencephalus. The higher female stillbirth rate is exhibited by births delivered in each fortnight from 28 to 38 weeks (examined by subdividing the group shown in Table V).

The association of anencephalus with early onset of labour is of course well recognized, and since the proportion of males affected is considerably lower than the proportion of females, this will naturally influence the sex specific stillbirth rates. Moreover it has recently been shown that the sex ratio (expressed as percentage of males) of stillbirths due to anencephalus increases with duration of gestation (McKeown and Lowe, 1951a). The marked effect of this malformation upon sex specific stillbirth rates of births delivered early or at low weights is therefore explained partly by its high incidence relative to other causes of stillbirth, and partly by its low sex ratio relative to anencephalics delivered later in gestation.

(b) For births weighing from 3 to 5 lb., male stillbirth rates are higher than female rates, mainly because of the much higher incidence of male stillbirths grouped under "all other causes". These causes include maternal disease, toxæmia, and constriction of the cord, but the group consists largely of stillbirths due to ill-defined and unknown causes, many of which on grounds of low weight would commonly be attributed to "prematurity".

(c) For births of 6 lb. and over, male stillbirth rates are again higher than female rates; the difference is comparatively small, and is due to higher numbers of male stillbirths attributed to "mechanical causes" and to "all other causes" about equally. Indeed, in another context, McKeown and Lowe (1951b) concluded that above 3500 g. (approximately 7½ lb.) there was no significant difference in sex specific stillbirth rates of males and females delivered at the same weight. In arriving at this conclusion they considered the 1947 Birmingham stillbirth rates, but were influenced

mainly by data for New York (published by Baumgartner, Pessin, Wegman, and Parker, 1950) based on much larger numbers.

In two respects the data here considered are not entirely satisfactory. In the first place, the number of births makes it necessary to use coarse weight groups, with the result that we are not strictly comparing births of the same weight, males in any weight group being somewhat heavier than females. Secondly, except in the case

TABLE 8
STILLBIRTH AND NEO-NATAL MORTALITY

Birth Weight (lb.)	Sex	Total Births	Stillbirth Rates* attributed to			
			Anencephalus	Other Malformations	Mechanical Causes	All Other Causes
Under 3	(a) Male	70	6	3	3	31
	(b) Female	62	23	3	—	32
	(a) — (b)	—	—17	—	3	—1
3—	(a) Male	951	0·6	1·0	1·6	7·3
	(b) Female	1,154	0·8	1·0	0·9	4·8
	(a) — (b)	—	—0·2	—	0·7	2·5
6 and over	(a) Male	10,581	0·02	0·10	0·51	0·83
	(b) Female	9,595	0·01	0·10	0·34	0·67
	(a) — (b)	—	0·01	—	0·17	0·16
Total	(a) Male	11,602	0·10	0·19	0·61	1·56
	(b) Female	10,811	0·22	0·21	0·40	1·29
	(a) — (b)	—	—0·12	—0·02	0·21	0·27

* Stillbirths per hundred total births.

TABLE 9
STILLBIRTH AND NEO-NATAL MORTALITY

Duration of Gestation (Weeks)	Sex	Total Births	Stillbirth Rates* attributed to			
			Anencephalus	Other Malformations	Mechanical Causes	All Other Causes
Under 38	(a) Male	956	0·6	0·6	0·8	5·2
	(b) Female	843	2·4	0·9	0·8	5·6
	(a) — (b)	—	—1·8	—0·3	—	—0·4
38 and over	(a) Male	7,656	0·04	0·16	0·53	1·16
	(b) Female	7,294	0·01	0·11	0·34	0·90
	(a) — (b)	—	0·03	0·05	0·19	0·26
Total	(a) Male	8,612	0·10	0·21	0·57	1·62
	(b) Female	8,137	0·26	0·20	0·39	1·37
	(a) — (b)	—	—0·16	0·01	0·18	0·25

* Stillbirths per hundred total births.

of the congenital malformations, and possibly of "mechanical causes" of stillbirth, the certification of cause of stillbirth is unreliable, and consequently no attempt has been made to subdivide the group entitled "all other causes". This means that where small differences in sex specific stillbirth rates are observed we cannot be certain that they are not influenced by grouping, and that where substantial differences exist we are unable adequately to explore the cause of death. In spite of these limitations

IV RATES RELATED TO BIRTH WEIGHT

All Causes	Total Live Births	Neo-Natal Mortality Rates† attributed to				
		Malformations	Mechanical Causes	Infection	All Other Causes	All Causes
43 58	40 26	3 —	17 11	5 4	60 54	85 69
-15 ± 9	—	3	6	1	6	16 ± 10
10.5 7.5	851 1,068	0.6 0.3	2.9 1.6	0.9 0.9	3.4 3.2	7.8 6.0
3.0 ± 1.2	—	0.3	1.3	—	0.2	1.8 ± 1.2
1.46 1.12	10,426 9,488	0.13 0.09	0.27 0.19	0.24 0.17	0.48 0.31	1.12 0.76
0.34 ± 0.16	—	0.04	0.08	0.07	0.17	0.36 ± 0.14
2.46 2.12	11,317 10,582	0.18 0.11	0.53 0.36	0.31 0.26	0.91 0.72	1.93 1.45
0.34 ± 0.20	—	0.07	0.17	0.05	0.19	0.48 ± 0.17

† Deaths in the first month per hundred live-births.

V RATES RELATED TO DURATION OF GESTATION

All Causes	Total Live Births	Neo-Natal Mortality Rates† attributed to				
		Malformations	Mechanical Causes	Infection	All Other Causes	All Causes
7.2 9.7	886 761	0.9 0.3	2.1 1.8	1.1 0.9	4.4 3.4	8.5 6.4
-2.5 ± 1.3	—	0.6	0.3	0.2	1.0	2.1 ± 1.3
1.89 1.36	7,511 7,195	0.21 0.21	0.33 0.15	0.24 0.24	0.28 0.36	1.06 0.96
0.53 ± 0.21	—	—	0.18	—	0.08	0.10 ± 0.16
2.50 2.22	8,397 7,956	0.28 0.27	0.52 0.31	0.33 0.30	0.73 0.66	1.86 1.48
0.28 ± 0.23	—	0.07	0.21	0.03	0.07	0.38 ± 0.20

† Deaths in the first month per hundred live-births.

it seems justified to conclude that the difference in sex specific stillbirth rates (all weights) reflects:

- (i) higher female stillbirth rates at the lowest weights (under 3 lb.), attributable to the prominence of anencephalus as a cause of female stillbirths;
- (ii) higher male stillbirth rates between 3 and 5 lb.; no reliable explanation can be given;
- (iii) slight or possibly no difference (in view of the New York data referred to above) between sex specific stillbirth rates at 6 lb. and over;
- (iv) sex differences in weight distributions of related total births, attributable to the different growth rates of male and female foetuses (see Figure).

SEX SPECIFIC NEO-NATAL MORTALITY RATES

There is little to be said about the sex specific neo-natal mortality rates shown in Tables IV and V, except that in every group (by weight and duration of gestation) male rates are higher than female rates. The same result is obtained when the data are further subdivided into 1 lb.-groups for weight, and into fortnightly groups for duration of gestation. We are of course again confronted with the difficulties referred to above (small numbers and unreliable certification) and can draw no firm conclusions about the cause of the higher male death rates.

SUMMARY

(1) For births delivered in Birmingham during 1947, mean birth weights (in pounds) were: male, 7.57; female, 7.31. Mean durations of gestation (in days) were: male, 280.29; female, 280.78. The sex difference in birth weight is exhibited by births delivered as early as the 29th and 30th weeks.

(2) The male stillbirth rate is higher than the female rate, and the sex difference is shown to be associated with:

- (i) higher female stillbirth rates under 3 lb., explained by the prominence of anencephalus as a cause of early female stillbirth;
- (ii) higher male stillbirth rates between 3 and 5 lb.; no adequate explanation is given;
- (iii) slight or possibly no difference between sex specific stillbirth rates of males and females of 6 lb. and over of the same weight.
- (iv) sex differences in weight distributions of related total births, attributable to the different growth rates of male and female foetuses.

(3) The male neo-natal mortality rate is higher than the female rate. The sex difference is still present when births in the same weight group are compared.

REFERENCES

- Anderson, N. A., Brown, E. W., and Lyon, R. A. (1943). *Amer. J. Dis. Child.*, **65**, 523.
 Bakwin, H., and Bakwin, R. M. (1934). *Hum. Biol.*, **6**, 612.
 Baumgartner, L., Pessin, V., Wegman, M. E., and Harker, S. L. (1950). *Pediatrics*, **6**, 329.
 Gibson, J. R., and McKeown, T. (1950). *British Journal of Social Medicine*, **4**, 221.
 Karn, M. N. (1947). *Ann. Eugen., Camb.*, **14**, 44.
 — and Penrose, L. S. (1951). *Ibid.*, **16**, 147.
 McKeown, T., and Gibson, J. R. (1951). *British Journal of Social Medicine*, **5**, 98.
 — and Lowe, C. R. (1951a). *Ibid.*, **5**, 229.
 — — (1951b). *Hum. Biol.*, **23**, 41.
 Martin, W. J. (1931). *Ann. Eugen., Camb.*, **4**, 327.
 Murray, M. Bruce (1924). *Spec. Rep. Ser. Med. Res. Coun., Lond.*, No. 81.
 Norval, M., Kennedy, R. L. J., and Berkson, J. (1951). *Hum. Biol.*, **23**, 273.
 Pearson, K. (1900). *Proc. roy. Soc.*, **66**, 23.
 Salber, E. J., and Bradshaw, E. S. (1951). *British Journal of Social Medicine*, **5**, 113.
 Schlichting, F. X. (1880). *Arch. Gynäk.*, **16**, 203.
 Siegel, P. W. (1921). *Zbl. Gynäk.*, **45**, 984.