

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

### III. SURVIVAL

BY

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Observations previously published on the duration of gestation (Gibson and McKeown, 1950) and birth weight (McKeown and Gibson, 1951) lend themselves to an examination of the association between these variables and foetal mortality. Data available for single births in Birmingham during 1947 are exhibited in Table I, separately for stillbirths, first-year deaths, and births which survived to the end of the first year of life. We have previously discussed the representativeness of these records, and need here note only that there are no conspicuous differences between the proportions complete in each of the three classes.

TABLE I

DATA AVAILABLE FOR ALL SINGLE BIRTHS (23,279) BORN IN BIRMINGHAM, 1947

Data Available	Stillbirths		First-Year Deaths		Births surviving the First Year		Total Births	
	Number	Per cent.	Number	Per cent.	Number	Per cent.	Number	Per cent.
Birth Weight .. ..	518	98·3	754	98·6	21,255	96·7	22,527	96·8
Birth Weight and Duration of Gestation .. ..	412	78·2	570	74·5	16,163	73·5	17,145	73·7
All Single Births .. ..	527	100	765	100	21,987	100	23,279	100

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TABLE II  
INCIDENCE OF STILLBIRTH AND DEATH IN THE FIRST YEAR OF LIFE RELATED TO DURATION OF GESTATION

Duration of Gestation (completed weeks)	Total Births (a)	Stillbirths (b)		First-Year Deaths (c)		(b)+(c)	
		Number	Percentage of (a)	Number	Percentage of (a)	Number	Percentage of (a)
28	16	3	18.7	12	75.0	15	93.7
29	16	8	50.0	7	43.7	15	93.7
30	23	8	34.8	9	39.1	17	73.9
31	50	17	34.0	20	40.0	37	74.0
32	44	13	29.5	11	25.0	24	54.5
33	76	18	23.7	15	19.7	33	43.4
34	111	9	8.1	19	17.1	28	25.2
35	266	23	8.6	26	9.8	49	18.4
36	435	28	6.4	25	5.7	53	12.2
37	762	26	3.4	29	3.8	55	7.2
38	1,485	45	3.0	47	3.2	92	6.2
39	3,394	51	1.5	80	2.4	131	3.9
40	4,784	59	1.2	117	2.4	176	3.7
41	3,019	31	1.0	60	2.0	91	3.0
42	1,423	37	2.6	31	2.2	68	4.8
43	497	11	2.2	9	1.8	20	4.0
44	231	6	2.6	4	1.7	10	4.3
45	112	4	3.6	2	1.8	6	5.4
46	5	—	—	—	—	—	—
All Births of known Duration of Gestation and Weight	16,749*	397	2.4	523	3.1	920	5.5
All Births of known Weight	22,454	514	2.3	720	3.2	1,234	5.5

\* Of 17,145 births for which duration of gestation and birth weight were known, 73 were excluded because the duration of gestation was less than 28 weeks, and 323 as indicated in Part II of this study.

Tables II and III relate the incidence of stillbirth and death in the first year of life to duration of gestation and birth weight respectively, and give the percentage of total births which died before the first birthday. We may note the following facts:

- (a) Mortality rates are highly correlated with birth weight and with duration of gestation.
- (b) Few infants survive if born before the completion of 30 weeks' gestation, and none at less than 2 lb. in weight.
- (c) Mortality rates diminish rapidly with each completed week of gestation

TABLE III  
INCIDENCE OF STILLBIRTH AND DEATH IN THE FIRST YEAR OF LIFE  
RELATED TO BIRTH WEIGHT

Birth Weight (lb.)	Total Births (a)	Stillbirths (b)		First-Year Deaths (c)		(b)+(c)	
		Number	Percentage of (a)	Number	Percentage of (a)	Number	Percentage of (a)
1 -	4	2	50.0	2	50.0	4	100.0
1½ -	19	11	57.9	8	42.1	19	100.0
2 -	49	23	46.9	23	46.9	46	93.9
2½ -	60	30	50.0	21	35.0	51	85.0
3 -	68	25	36.8	20	29.4	45	66.2
3½ -	89	29	32.6	22	24.7	51	57.3
4 -	170	31	18.2	32	18.8	63	37.0
4½ -	223	28	12.6	28	12.6	56	25.1
5 -	580	42	7.2	54	9.3	96	16.5
5½ -	977	31	3.2	58	5.9	89	9.1
6 -	2,107	45	2.1	86	4.1	131	6.2
6½ -	3,080	38	1.2	72	2.3	110	3.6
7 -	4,358	64	1.5	97	2.2	161	3.7
7½ -	3,617	37	1.0	65	1.8	102	2.8
8 -	3,350	34	1.0	60	1.8	94	2.8
8½ -	1,668	14	0.8	34	2.0	48	2.9
9 -	1,127	15	1.3	21	1.9	36	3.2
9½ -	438	3	0.7	10	2.3	13	3.0
10 -	331	7	2.1	3	0.9	10	3.0
10½ -	82	2	2.4	2	2.4	4	4.9
11 -	39	2	5.1	2	5.1	4	10.3
11½ -	11	—	—	—	—	—	—
12 -	4	1	—	—	—	1	—
12½ and over	3	—	—	—	—	—	—
All Births of known Weight	22,454	514	2.3	720	3.2	1,234	5.5

up to 34 weeks, and with each half-pound increase in weight up to 4 lb. Rates are fairly constant after 39 completed weeks and above 6½ lb. The evidence for a slight increase after 45 weeks and above 11 lb. is, in the absence of adequate numbers, only suggestive.

(d) Trends in mortality rates by weight and by gestation are not strictly comparable, since indices of weight and duration of gestation cannot be equated.

In short, contrary to the general impression, there is little to choose between duration of gestation and birth weight as indices of the probability of survival. We shall discuss the significance of this observation in a later communication.

TABLE IV  
PERIOD OF SURVIVAL RELATED TO DURATION OF GESTATION

Duration of Gestation (completed weeks)	Total Births	Percentage of Total Births Alive at:						
		Birth	One Day	One Week	One Month	Six Months	Nine Months	One Year
28	16	81.2	31.2	12.5	6.2	6.2	6.2	6.2
29	16	50.0	37.5	18.7	18.7	6.2	6.2	6.2
30	23	65.2	47.8	26.1	26.1	26.1	26.1	26.1
31	50	66.0	56.0	34.0	32.0	28.0	26.0	26.0
32	44	70.5	54.5	47.7	47.7	45.5	45.5	45.5
33	76	76.3	68.4	57.9	57.9	56.6	56.6	56.6
34	111	91.9	85.6	83.8	81.1	74.8	74.8	74.8
35	266	91.4	88.7	87.2	85.0	83.1	82.0	81.6
36	435	93.6	93.1	92.2	90.6	88.7	87.8	87.8
37	762	96.6	96.2	95.3	94.6	93.3	92.8	92.8
38	1,485	97.0	96.2	95.5	95.1	94.0	93.9	93.8
39	3,394	98.5	98.3	97.8	97.5	96.6	96.2	96.1
40	4,784	98.8	98.6	98.2	98.0	96.8	96.4	96.3
41	3,019	99.0	98.7	98.4	98.0	97.3	97.1	97.0
42	1,423	97.4	97.3	96.8	96.8	95.4	95.4	95.2
43	497	97.8	97.6	97.2	96.8	96.0	96.0	96.0
44	231	97.4	97.0	96.1	96.1	95.7	95.7	95.7
45	112	96.4	96.4	94.6	94.6	94.6	94.6	94.6
46	5	—	—	—	—	—	—	—
All Births of known Duration of Gestation and Weight	16,749	97.6	97.1	96.4	96.0	94.9	94.6	94.5
All Births of known Weight	22,454	97.7	97.1	96.5	96.1	95.0	94.6	94.5

Tables IV and V relate the period of survival to duration of gestation and birth weight respectively, and Tables VI and VII exhibit the corresponding stillbirth and neonatal death rates, deaths at between 1 and 12 months being expressed per thousand infants alive at one month. Two points should be noted: first, that the changes in association with the duration of gestation and with birth weight are more marked for the neonatal death rate than for the stillbirth rate; and second, that although the risk of death is much reduced after the end of the first month of life, it is still very definitely associated with the duration of gestation and with the weight at birth. No doubt this effect is diminished as the year progresses, but our data do not permit us to separate deaths at between 1 and 12 months.

Since weight at birth and the duration of gestation are correlated, it is of course of considerable interest to separate their effects on survival rates, and Table VIII enables us to inspect the regression of mortality rates on duration of gestation with birth weight fixed (reading down the columns) and on birth weight with length of gestation fixed (reading along the rows). We have here expressed the number of stillbirths and neonatal deaths (added together) as a percentage of total births. Unfortunately, the data do not entirely separate the effects of the two variables;

TABLE V

PERIOD OF SURVIVAL RELATED TO BIRTH WEIGHT

Birth Weight (lb.)	Total Births	Percentage of Total Births Alive at:						
		Birth	One Day	One Week	One Month	Six Months	Nine Months	One Year
1 -	4	50.0	0.0	—	—	—	—	—
1½ -	19	42.1	5.3	0.0	—	—	—	—
2 -	49	53.1	36.7	10.2	8.2	6.1	6.1	6.1
2½ -	60	50.0	25.0	20.0	16.7	15.0	15.0	15.0
3 -	68	63.2	50.0	39.7	36.8	35.3	33.8	33.8
3½ -	89	67.4	58.4	47.2	46.1	43.8	42.7	42.7
4 -	170	81.8	75.9	71.2	68.8	64.7	63.5	62.9
4½ -	223	87.4	83.9	82.1	81.2	75.8	75.3	74.9
5 -	580	92.8	90.9	88.4	86.4	84.3	83.4	83.4
5½ -	977	96.8	96.0	94.3	93.3	91.4	91.0	90.9
6 -	2,107	97.9	97.3	96.7	96.0	94.3	93.8	93.8
6½ -	3,080	98.8	98.5	98.0	97.6	96.8	96.6	96.5
7 -	4,358	98.5	98.2	97.9	97.6	96.6	96.4	96.3
7½ -	3,617	99.0	98.8	98.7	98.3	97.5	97.3	97.2
8 -	3,350	99.0	98.9	98.6	98.5	97.6	97.2	97.2
8½ -	1,668	99.2	99.0	98.9	98.6	97.8	97.4	97.1
9 -	1,127	98.7	98.5	98.2	98.0	97.2	97.0	96.8
9½ -	438	99.3	99.3	99.1	98.8	98.2	97.7	97.0
10 -	331	97.9	97.9	97.6	97.3	97.0	97.0	97.0
10½ -	82	97.6	97.6	97.6	97.6	96.3	96.3	95.1
11 -	39	94.9	94.9	94.9	92.3	92.3	92.3	89.7
11½ -	11	100.0	100.0	100.0	100.0	100.0	100.0	100.0
12 -	4	75.0	75.0	75.0	75.0	75.0	75.0	75.0
12½ and over	3	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All Births of known Weight	22,454	97.7	97.1	96.5	96.1	95.0	94.6	94.5

for example, the weight-composition of births within any single lb. interval is undoubtedly influenced by the duration of gestation. Yet we are not able to narrow the weight interval without reducing further the number of births in each cell. In spite of these limitations the data do suggest that:

- (a) the association between mortality and weight when gestation is constant is stronger than that between mortality and length of gestation when weight is constant,
- (b) for births of the same weight, mortality is slightly increased when the duration of gestation is unduly prolonged,
- (c) for births delivered after the same period of gestation, the proportion of deaths is slightly increased in the highest weight group (9 lb. and over).

SUMMARY

Data are presented which relate the mortality experienced by single births as stillbirths or deaths in the first year of life to duration of gestation (Tables II, IV, and VI) and birth weight (Tables III, V, and VII). The regression of mortality on

TABLE VI  
MORTALITY RELATED TO DURATION OF GESTATION

Duration of Gestation (completed weeks)	Stillbirths (per thousand total births)	Neonatal Deaths (per thousand live births)	Deaths 1-12 months (per thousand infants alive at one month)
28-	344	810	500
30-	342	542	136
32-	258	270	31
34-	85	84	51
36-	45	24	23
38-	20	13	14
40-	12	9	14
42-	25	7	15
44-	29	15	3
All Births of known Duration of Gestation and Birth Weight .. .. .	24	17	16
All Births of known Weight	23	17	16

TABLE VII  
MORTALITY RELATED TO BIRTH WEIGHT

Birth Weight (lb.)	Stillbirths (per thousand total births)	Neonatal Deaths (per thousand live births)	Deaths 1-12 months (per thousand infants alive at one month)
1-	565	1,000	—
2-	486	750	143
3-	344	359	76
4-	150	108	81
5-	47	48	29
6-	16	14	17
7-	13	8	13
8-	10	5	14
9-	12	6	14
10 and over	26	7	9
All Births of known Weight	23	17	16

length of gestation when weight is fixed, and on birth weight when duration of gestation is fixed, is exhibited in Table VIII. The data require no detailed comment, but we may note the following points:

- (1) There is little to choose between duration of gestation and birth weight as indices of the probability of survival.
- (2) The changes in association with duration of gestation and with birth weight are more marked for the neonatal death rate than for the stillbirth rate.

TABLE VIII

PERCENTAGE OF BIRTHS STILLBORN OR DEAD IN THE FIRST MONTH OF LIFE RELATED TO DURATION OF GESTATION AT DIFFERENT BIRTH WEIGHTS

Duration of Gestation (completed weeks)	Birth Weight (lb.)									Total
	1-	2-	3-	4-	5-	6-	7-	8-	9 and over	
28-30	100.0 (3)	93.3 (30)	72.2 (18)	25.0 (4)	— —	— —	— —	— —	— —	81.8 (55)
31-34	100.0 (9)	100.0 (33)	47.6 (42)	27.5 (80)	27.7 (83)	8.8 (34)	— —	— —	— —	39.1 (281)
35-37	100.0 (2)	80.0 (5)	64.5 (31)	25.0 (100)	8.9 (303)	6.1 (479)	2.6 (380)	2.6 (114)	4.1 (49)	8.3 (1,463)
38-39	—	75.0 (4)	57.1 (14)	23.5 (68)	8.5 (412)	2.8 (1,381)	2.2 (1,810)	1.1 (900)	2.4 (290)	3.2 (4,879)
40-41	—	60.0 (5)	71.4 (7)	13.3 (30)	7.1 (294)	2.4 (1,633)	1.6 (2,978)	1.3 (2,074)	1.8 (782)	2.1 (7,803)
41-46	—	—	50.0 (2)	33.3 (6)	6.5 (77)	5.3 (436)	3.0 (787)	1.8 (622)	3.0 (338)	3.4 (2,268)
All Births of known Duration of Gestation and Birth Weight .. ..	100.0 (14)	92.2 (77)	58.8 (114)	24.3 (288)	9.5 (1,169)	3.4 (3,963)	2.0 (5,955)	1.3 (3,710)	2.3 (1,459)	4.0 (16,749)
All Births of known Weight .. ..	100.0 (23)	87.2 (109)	58.0 (157)	24.2 (393)	9.2 (1,557)	3.0 (5,187)	2.0 (7,975)	1.5 (5,018)	2.1 (2,035)	3.9 (22,454)

Numbers in brackets are the numbers of total births.

- (3) Though much reduced after the end of the first month, the risk of death is still associated with the duration of gestation and with the weight at birth.
- (4) The association between mortality and weight when gestation is constant is stronger than that between mortality and length of gestation when weight is constant.
- (5) For births of the same weight, mortality is slightly increased when the duration of gestation is unduly prolonged; and, for births delivered after the same period of gestation, the proportion of deaths is slightly increased in the highest weight group examined (9 lb. and over).

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## REFERENCES

- Gibson, J. R., and McKeown, T. (1950). *British Journal of Social Medicine*, 4, 221.  
 McKeown, T., and Gibson, J. R. (1951). *Ibid.*, 5, 98.