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

I. DURATION OF GESTATION*

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INTRODUCTION

In investigating the duration of gestation in man, the research worker is confronted with difficulties of two kinds. There is first the problem of establishing the time of conception for any single pregnancy. It is only in exceptional circumstances that the date of fertile coitus is known, and the date of conception if required must usually be estimated from the date of onset of the last menstrual period preceding amenorrhoea. The reliability of this estimate is affected by irregularities of the menstrual cycle and by variations in the interval between the onset of menstruation and ovulation. In practice, and because of this difficulty, it is usual to calculate the duration of gestation from the first day of the last menstrual period, and to ignore the consequent addition of approximately two weeks to the duration calculated from the date of conception. In the second place, even when the duration of gestation is estimated from the last menstrual period, it is difficult to record time of onset and date of birth accurately for a large series which can be regarded as representative of all births. Mothers sometimes do not know the date of menstruation, and may confuse the last cycle with bleeding from the uterus in early pregnancy.

Most data so far available are open to one or both of the criticisms:

- (a) that observations are confined to hospital births (known to be selected, for example, in respect of parity and difficulties of labour),
- (b) that numbers are too small to permit adequate examination of the distribution (Reid, 1850; Schlichting, 1880; Meyer, 1915; Zangemeister, 1917; Siegel, 1921; Hotelling and Hotelling, 1932; Karn, 1947; Hosemann, 1948).

Our present knowledge of the duration of gestation in man may be summarized in the statement that the mean is firmly established as approximately 280 days, but there is insufficient knowledge of the nature of the distribution, and of its association with such variables as maternal age, parity, and birth weight.

We are here concerned with the duration of gestation of single births, and with its relationship to maternal age and parity.

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TABLE I

NUMBERS OF BIRTHS IN THE CITY OF BIRMINGHAM DURING YEAR ENDING DECEMBER 31, 1947

Type of Birth	Stillbirths	Live Births			Total Births
		Died first year	Survived first year	Totals	
Single ..	527	765	21,987	22,752	23,279
Multiple ..	51	92	548	640	691
Total	578	857	22,535	23,392	23,970

Stillbirth rate=24 per 1,000 total births.

Infant mortality rate=37 per 1,000 live births.

TABLE II

NUMBERS OF SINGLE BIRTHS FOR WHICH DURATION OF GESTATION AND BIRTH WEIGHT WERE RECORDED

Data Available	Stillbirths		Live Births		Total Births	
	No.	%	No.	%	No.	%
Duration of gestation and birth weight	412	78.2	16,733	73.5	17,145	73.7
Duration of gestation only	6	1.1	233	1.0	239	1.0
Birth weight only	106	20.1	5,276	23.2	5,382	23.1
Neither	3	0.6	510	2.2	513	2.2
Total	527	100	22,752	100	23,279	100

TABLE III

COMPLETENESS OF DATA RELATED TO SOURCE

Data Available	Hospital Births		Domiciliary Births		Nursing-Home Births		All Births	
	No.	%	No.	%	No.	%	No.	%
Duration of gestation and birth weight	8,334	85.1	7,715	64.5	1,096	72.0	17,145	73.7
Duration of gestation only	39	0.4	163	1.4	37	2.4	239	1.0
Birth weight only	1,407	14.4	3,608	30.1	367	24.1	5,382	23.1
Neither	12	0.1	478	4.0	23	1.5	513	2.2
Total	9,792	100	11,964	100	1,523	100	23,279	100

SOURCES OF DATA

We have attempted to obtain information in respect of all births born to Birmingham mothers in the city of Birmingham between January 1 and December 31, 1947* (Table I), and as this communication is the first of several in which we shall use this material it seems desirable to give the sources of all data at our

* We have excluded (a) births to Birmingham mothers born outside the city, and (b) births born inside the city to mothers not normally resident in Birmingham.

disposal (see Appendix). We need here consider in more detail only those items referred to in relation to duration of gestation, the date of the first day of the last menstrual period, maternal age, and parity. Incidental reference is also made to birth weight, but we shall postpone comment on records of weight until a later communication.

In the absence of knowledge of the date of fertile coitus, duration of gestation has been calculated from the first day of the last menstrual period. We have used only cases in which the date of the first day was recorded in the antenatal period; we have not used records in which an approximate date was given, nor have we accepted the mother's statement as recorded after the birth of the child. Although this procedure does not eliminate all the sources of error referred to above, it does ensure that the data used are as accurate as can be obtained from existing documents.

Table II gives the proportions of single births (23,279) in which were recorded,

- (i) duration of gestation and birth weight*,
- (ii) duration of gestation only,
- (iii) birth weight only,
- (iv) neither duration of gestation nor birth weight.

Losses under (ii) and (iv) are negligible, and we need only consider more carefully the loss under (iii) of about one-quarter of all births. Table II shows that the proportions of births whose weights are known but for which duration of gestation is not available (iii) are approximately the same for stillbirths (20·1 per cent.), live births (23·2 per cent.), and total births (23·1 per cent.). The proportions of total births lost under (iii) are given separately in Table III by place of birth (hospital, 14·4 per cent.; domicile, 30·1 per cent.; nursing home, 24·1 per cent.). In considering duration of gestation we must therefore enquire whether births of known durations are typical of all births, having regard to the fact that proportions unknown are different for the three places of birth. This question is examined below.

DURATION OF GESTATION

(a) *Hospital, Domiciliary, and Nursing-Home Births.*—A comparison of hospital, domiciliary, and nursing-home births, although of no biological interest, is of some importance because in the past data have been derived almost exclusively from hospital sources. Table IV (p. 224) gives separately for live births, stillbirths, and total births, the distributions by duration of gestation of births born after 196 days (28 weeks). The table also gives the means, errors of the means, standard deviations, and the descriptive constants for the distributions, B_1 and B_2 †. We may note:

- (i) Live births and total births. Mean durations of gestation for domiciliary and nursing-home births do not differ significantly and are approximately 281

* Birth weight is included in Tables II and III because we later make use of information about weight in examining the randomness of data available on duration of gestation.

† B_1 is a measure of skewness; B_2 is a measure of kurtosis. In the normal distribution $B_1=0$; $B_2=3\cdot0$.

- days; both are a little longer (by about one day) than the corresponding means for hospital births.
- (ii) Stillbirths. Mean duration of gestation is approximately 267 days for hospital and domiciliary stillbirths.
- (iii) As indicated by the constants, B_1 and B_2 , neither live births nor total births (hospital, domiciliary, or nursing-home) are normally distributed.

TABLE IV
PERCENTAGE DISTRIBUTIONS OF HOSPITAL, DOMICILIARY AND NURSING-HOME BIRTHS BY DURATION OF GESTATION*

Duration of Gestation		Hospital			Domiciliary			Nursing-Home		
Days	Weeks	Live births	Still-births	Total births	Live births	Still-births	Total births	Live births	Still-births	Total births
196-202	28	0.19	0.72	0.21	0.10	1.74	0.13	—	—	—
203-209	29	0.14	1.80	0.19	0.09	1.74	0.12	0.09	—	0.18
210-216	30	0.20	1.44	0.24	0.12	3.48	0.17	—	—	—
217-223	31	0.44	3.96	0.55	0.24	6.08	0.32	—	—	—
224-230	32	0.41	3.96	0.53	0.30	1.74	0.32	0.18	—	0.27
231-237	33	0.87	4.68	1.00	0.38	5.22	0.46	0.56	—	0.55
238-244	34	1.03	3.60	1.12	0.66	0.87	0.66	0.46	—	0.46
245-251	35	1.77	7.19	1.95	1.53	1.74	1.53	1.11	—	1.19
252-258	36	2.73	7.91	2.91	2.26	5.22	2.30	1.57	—	1.55
259-265	37	5.04	7.91	5.14	3.96	3.48	3.96	2.96	—	2.92
266-272	38	8.88	9.35	8.90	8.35	15.65	8.46	8.89	—	8.86
273-279	39	19.39	12.95	19.18	20.66	12.17	20.53	20.83	—	20.64
280-286	40	26.09	11.87	25.62	29.89	16.52	29.69	34.35	—	34.52
287-293	41	18.74	6.47	18.33	16.96	9.56	16.85	18.70	—	18.63
294-300	42	8.85	9.71	8.88	7.91	8.69	7.92	7.22	—	7.12
301-307	43	3.01	2.88	3.00	3.06	2.61	3.06	1.39	—	1.37
308-314	44	0.99	1.44	1.01	1.77	2.61	1.78	1.02	—	1.00
315-321	45	0.55	1.80	0.59	0.88	—	0.87	0.46	—	0.46
322-328	46	0.25	—	0.24	0.47	—	0.47	0.18	—	0.18
329-335	47	0.19	—	0.18	0.18	—	0.18	—	—	—
336-342	48	0.12	0.36	0.13	0.13	0.86	0.14	—	—	—
343-349	49	0.09	—	0.08	0.03	—	0.03	—	—	—
350-356	50	0.01	—	0.01	0.01	—	0.01	—	—	—
357-363	51	—	—	—	0.01	—	0.01	—	—	0.09
Total		100	100	100	100	100	100	100	—	100
No. of births		8,014	278	8,292	7,570	115	7,685	1,080	15	1,095
Mean (days)		280.16	266.54	279.72	281.50	267.85	281.30	281.41	—	281.28
Error of mean		0.18	1.60	0.18	0.17	2.64	0.17	0.37	—	0.38
Standard deviation		16.03	36.51	16.68	14.77	28.28	15.19	12.18	—	12.53
B_1		0.973	—	1.085	0.397	—	0.584	0.343	—	0.636
B_2		6.889	—	6.664	7.14	—	7.346	8.219	—	8.912

* The table is based on 17,145 single births for which duration of gestation and birth weight are known. Of 17,145 births, 73 were excluded because the duration of gestation was less than 28 weeks (196 days).

Let us now enquire whether, in respect of duration of gestation, births upon which these distributions are based are representative of all births. As indicated in Table III, birth weight was known in most cases and, since weight and duration are highly correlated, a comparison of weight distributions of births of known and unknown duration of gestation provides a fairly exacting test of randomness of data. This treatment is exhibited in Table V and indicates that domiciliary and nursing-home births are well represented in Table IV; the hospital births for which duration is known are not random in their weight distribution ($p = < 0.001$).

It is possible, however, that the hospital births in Table IV are representative in respect of duration of gestation, though not in respect of weight. This possibility is examined in Table VI, which shows observed and expected distributions which agree very closely. The numbers of births expected in each week of gestation were estimated thus:

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TABLE V

COMPARISON OF WEIGHT DISTRIBUTIONS OF BIRTHS OF KNOWN (17,145) AND UNKNOWN (5,382) DURATIONS OF GESTATION

Source	Data Available	Birth Weight (lbs)										Totals
		1 and 2	3	4	5	6	7	8	9	10 and over		
Hospital	Duration of gestation and birth weight	94	84	211	748	2,329	2,915	1,535	337	81	8,334	$\chi^2 = 33.8$ $n = 8$ $p = < .001$
	Birth weight only	28	23	57	154	367	476	227	65	10	1,407	
Domicile	Duration of gestation and birth weight	29	32	80	378	1,472	2,739	1,989	732	264	7,715	$\chi^2 = 5.8$ $n = 8$ $0.5 < p < 0.7$
	Birth weight only	11	17	38	192	684	1,300	916	352	98	3,608	
Nursing Home	Duration of gestation and birth weight		15		70	249	418	272	72		1,096	$\chi^2 = 3.7$ $n = 5$ $0.5 < p < 0.7$
	Birth weight only		9		18	89	143	84	24		367	

TABLE VI

EXPECTED AND OBSERVED DISTRIBUTIONS OF HOSPITAL BIRTHS BY DURATION OF GESTATION

Duration of Gestation (weeks)	Expected*		Observed	
	No.	%	No.	%
28	18.4	.22	17	.21
29	17.4	.21	16	.19
30	21.3	.26	20	.24
31	49.0	.59	46	.55
32	46.5	.56	44	.53
33	86.7	1.05	83	1.00
34	95.9	1.16	93	1.12
35	165.5	2.00	162	1.95
36	244.8	2.95	241	2.91
37	429.3	5.18	426	5.14
38	740.1	8.93	738	8.90
39	1586.0	19.13	1,590	19.18
40	2114.6	25.50	2,124	25.62
41	1510.9	18.22	1,520	18.33
42	732.0	8.83	736	8.88
43	247.7	2.99	249	3.00
44	83.4	1.01	84	1.01
45	48.8	.59	49	.59
46	19.9	.24	20	.24
47	14.9	.18	15	.18
48	10.9	.13	11	.13
49	6.9	.08	7	.08
50	1.0	.01	1	.01
Total Births	8291.9	100	8,292	100

* Expected numbers have been estimated: (a) by assuming that distributions within each pound were the same for births of unknown as for births of known durations of gestation; (b) by adjusting the numbers obtained to correspond with the observed number of births (8,292).

- (i) by assuming that distributions by duration of gestation *within each pound* were the same for births of unknown as for births of known durations of gestation,
- (ii) by adjusting the numbers obtained to correspond with the observed number of births (8,292).

In short, we have shown for hospital births that the observed distribution of births of known duration of gestation is very much the same as would be expected if births of unknown duration (but known weight) were distributed in the same way as the observed births of the same weight. Expressed differently, the discrepancies in respect of weight between births of known and unknown duration of gestation are unlikely to be great enough to affect seriously the distribution of all hospital births.

TABLE VII
DISTRIBUTION OF LIVE BIRTHS, STILLBIRTHS, AND TOTAL BIRTHS BY DURATION OF GESTATION*

Duration of Gestation (weeks)	Live Births				Stillbirths				Total Births			
	Spontaneous only		Spontaneous and not spontaneous		Spontaneous only		Spontaneous and not spontaneous		Spontaneous only		Spontaneous and not spontaneous	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
28	20	0.13	23	0.14	4	1.00	4	0.98	24	0.15	27	0.16
29	18	0.11	19	0.11	7	1.75	8	1.96	25	0.15	27	0.16
30	23	0.14	25	0.15	8	2.00	8	1.96	31	0.19	33	0.19
31	46	0.29	53	0.32	18	4.51	18	4.41	64	0.39	71	0.42
32	53	0.33	58	0.35	13	3.26	14	3.43	66	0.40	72	0.42
33	94	0.59	105	0.63	18	4.51	19	4.66	112	0.69	124	0.73
34	131	0.82	138	0.83	10	2.51	11	2.70	141	0.87	149	0.87
35	254	1.60	270	1.62	22	5.51	23	5.64	276	1.70	293	1.72
36	370	2.33	407	2.44	28	7.02	28	6.86	398	2.45	435	2.55
37	671	4.23	736	4.42	25	6.26	26	6.37	696	4.28	762	4.46
38	1,335	8.42	1,440	8.64	44	11.03	45	11.03	1,379	8.48	1,485	8.70
39	3,202	20.19	3,343	20.06	51	12.78	51	12.50	3,253	20.00	3,394	19.88
40	4,582	28.89	4,725	28.35	57	14.28	59	14.46	4,639	28.53	4,784	28.02
41	2,866	18.07	2,988	17.93	31	7.77	31	7.60	2,897	17.82	3,019	17.68
42	1,299	8.19	1,386	8.32	37	9.27	37	9.07	1,336	8.22	1,423	8.34
43	459	2.89	488	2.93	11	2.76	11	2.70	470	2.89	499	2.92
44	216	1.36	225	1.35	7	1.75	7	1.71	223	1.37	232	1.36
45	111	0.70	116	0.70	5	1.25	5	1.22	116	0.71	121	0.71
46	57	0.36	58	0.35	—	—	—	—	57	0.35	58	0.34
47	28	0.18	29	0.17	—	—	—	—	28	0.17	29	0.17
48	17	0.11	20	0.12	2	0.50	2	0.49	19	0.12	22	0.13
49	6	0.04	9	0.05	—	—	—	—	6	0.04	9	0.05
50	2	0.01	2	0.01	—	—	—	—	2	0.01	2	0.01
51	1	0.01	1	0.01	1	0.25	1	0.25	2	0.01	2	0.01
Totals	15,861	100	16,664	100	399	100	408	100	16,260	100	17,072	100
Mean (days)	280.98		280.85		267.47		267.27		280.66		280.52	
Error of mean	0.12		0.12		1.36		1.35		0.12		0.12	
Standard deviation	15.05		15.26		27.23		27.30		15.61		15.75	
B ₁	0.737		0.722		—		—		0.871		0.898	
B ₂	7.236		7.133		—		—		7.219		7.157	

* The table is based on 17,145 single births for which duration of gestation and birth weight are known. Of 17,145 births, 73 were excluded because the duration of gestation was less than 28 weeks.

(b) *Live Births, Stillbirths, and Total Births.*—In Table VII the data for hospital, domiciliary, and nursing-home births have been brought together to give distributions by duration of gestation of live births, stillbirths, and total births. Because artificial termination of some pregnancies influences distributions, spontaneous deliveries are given separately. It has already been shown for the three sources:

- (i) that data are representative of each source (Tables V and VI),
- (ii) that distributions differ slightly (Table IV),

(iii) that proportions for which duration of gestation are known are not the same (Table III).

It is therefore necessary to enquire whether, in assembling data for all births, any error has been introduced which would necessitate standardization to correct for the different proportions of hospital, domiciliary, and nursing-home births.

TABLE VIII

EXPECTED AND OBSERVED DISTRIBUTIONS OF BIRTHS (SPONTANEOUS AND NOT SPONTANEOUS) BY DURATION OF GESTATION. TOTAL BIRTHS

Duration of Gestation (weeks)	Expected*		Observed	
	No.	%	No.	%
28	27·6	·16	27	·16
29	27·6	·16	27	·16
30	33·5	·20	33	·19
31	71·5	·42	71	·42
32	72·3	·42	72	·42
33	122·3	·72	124	·73
34	147·4	·86	149	·87
35	292·3	1·71	293	1·72
36	432·7	2·53	435	2·55
37	753·9	4·42	762	4·46
38	1482·9	8·69	1,485	8·70
39	3402·9	19·93	3,394	19·88
40	4814·0	28·20	4,784	28·02
41	2997·6	17·56	3,019	17·68
42	1410·6	8·26	1,423	8·34
43	498·0	2·92	499	2·92
44	238·5	1·40	232	1·36
45	123·3	·72	121	·71
46	59·9	·35	58	·34
47	28·8	·17	29	·17
48	21·9	·13	22	·13
49	8·4	·05	9	·05
50	2·1	·01	2	·01
51	2·1	·01	2	·01
Totals	17072·1	100	17,072	100

* Expected numbers have been estimated by: (a) assuming that all domiciliary and nursing-home births were distributed by duration of gestation in the same way as births of known distributions; (b) assuming that distributions of hospital births within each pound were the same for births of unknown as for births of known durations of gestation; (c) adjusting the numbers obtained to correspond with the observed number of births (17,072).

Table VIII shows that for total births the observed distribution by duration of gestation is very much the same as the distribution expected when the necessary corrections are made. Expected numbers have been estimated by:

- (i) assuming that all domiciliary and nursing-home births were distributed by duration of gestation in the same way as births of known distributions,
- (ii) assuming that distributions of hospital births *within each pound* were the same for births of unknown as for births of known durations of gestation (as in Table VI),
- (iii) adding the numbers obtained in each week of gestation,

TABLE
WEEKLY PERCENTAGE DISTRIBUTIONS OF SPONTANEOUS DELIV

Week of Delivery	Com							
	27	28	29	30	31	32	33	34
28	0.15							
29	0.15	0.16						
30	0.19	0.19	0.19					
31	0.39	0.40	0.39	0.40				
32	0.41	0.41	0.40	0.41	0.40			
33	0.69	0.69	0.69	0.69	0.69	0.70		
34	0.87	0.87	0.86	0.87	0.87	0.88	0.88	
35	1.70	1.70	1.70	1.71	1.71	1.72	1.73	1.74
36	2.45	2.45	2.46	2.46	2.47	2.48	2.50	2.51
37	4.28	4.29	4.29	4.30	4.32	4.34	4.36	4.40
38	8.48	8.50	8.51	8.52	8.56	8.59	8.65	8.72
39	20.01	20.04	20.07	20.10	20.20	20.27	20.40	20.59
40	28.53	28.58	28.62	28.67	28.80	28.90	29.09	29.36
41	17.82	17.85	17.87	17.90	17.99	18.05	18.16	18.34
42	8.22	8.23	8.24	8.26	8.29	8.32	8.38	8.45
43	2.89	2.90	2.90	2.90	2.91	2.93	2.95	2.97
44	1.37	1.37	1.38	1.38	1.38	1.39	1.40	1.41
45	0.71	0.72	0.72	0.72	0.72	0.72	0.73	0.73
46	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.36
47 and over	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.36
Totals (numbers in brackets)	100 (16,260)	100 (16,236)	100 (16,211)	100 (16,180)	100 (16,116)	100 (16,050)	100 (15,938)	100 (15,797)
Number of births not spontaneous	812	809	807	805	798	792	780	772
Percentage of all births not spontan- eous	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7

* This table is based on 17,145 single births for which duration of gestation and birth weight are known.

(iv) adjusting the numbers obtained to correspond with the observed number of births (17,072).

We have introduced for hospital births the same correction as in Table VI, and have then corrected the totals for the unequal representation of hospital, domiciliary, and nursing-home births.

Mean durations of gestation are as follows:

live births . . . 280.85 days (± 0.12);
stillbirths . . . 267.27 days (± 1.35);
total births . . . 280.52 days (± 0.12).

Of all births 28 per cent. are delivered in the 40th week, and 65 per cent. in the 39th, 40th, and 41st weeks. That is to say, about one-third of all births are delivered earlier than the 39th or later than the 41st week of gestation. Again it may be noted that the births are not normally distributed (for total births, $B_1 = 0.898$, $B_2 = 7.157$).*

* See also the Figure (opposite).

IX
ERIES SUBSEQUENT TO EACH COMPLETED WEEK OF GESTATION*

pleted Weeks of Gestation

35	36	37	38	39	40	41	42	43	44	45
2.56										
4.48	4.60									
8.88	9.11									
20.94	21.50	9.56								
29.87	30.66	22.54	24.92							
18.66	19.15	32.15	35.53	47.32						
8.60	8.83	20.07	22.19	29.55	56.17					
3.03	3.11	9.26	10.23	13.63	25.91	59.14				
1.43	1.47	3.26	3.60	4.79	9.11	20.81	50.92			
0.74	0.77	1.54	1.71	2.27	4.32	9.87	24.16	49.23		
0.36	0.38	0.80	0.89	1.18	2.25	5.14	12.57	25.61	50.43	
0.36	0.38	0.39	0.44	0.58	1.11	2.52	6.18	12.58	24.78	50.00
0.36	0.38	0.39	0.44	0.58	1.11	2.52	6.18	12.58	24.78	50.00
100 (15,521)	100 (15,123)	100 (14,427)	100 (13,048)	100 (9,795)	100 (5,156)	100 (2,259)	100 (923)	100 (453)	100 (230)	100 (114)
755	718	652	546	405	260	138	51	22	13	8
4.6	4.5	4.3	4.0	4.0	4.8	5.7	5.2	4.6	5.1	6.5

Of 17,145 births, 73 were excluded because the duration of gestation was less than 28 weeks.

FIGURE.—Observed percentage distributions of duration of gestation for 17,072 total births compared with curve of a normal distribution having the same mean and variance.

EXPECTED DATE OF DELIVERY

In obstetric practice it is important to be able to give an expected date of delivery. This is usually based on the mean duration of gestation (280 days) and takes no account of variation around the mean, or of changes in the expected date as pregnancy advances. Table IX incorporates in a useful form our knowledge of both these factors. We have no information about pregnancies terminated earlier than the 28th week, but for 17,072 pregnancies

which completed 27 weeks of gestation the date of delivery is known, It has been thought best to exclude 812 births delivered by surgical induction or by Caesarian section, and the information in Table IX relates therefore to 16,620 spontaneous deliveries. The Table is self-explanatory; for example, it gives for 16,260 births the proportion delivered in each week after the 27th, for 16,236 births (which completed 28 weeks) the proportion delivered in each week after the 28th, and so on for all weeks until the 45th. A single example exhibits the use of the Table: of 16,211 births which completed 29 weeks of gestation, 28 per cent. were delivered in the 40th week; of 9,795 births which completed 39 weeks of gestation, 47 per cent. were delivered in the 40th week. As might be expected, the probability of delivery in any given week increases as pregnancy advances.

DURATION OF GESTATION RELATED TO MATERNAL AGE AND PARITY

Data available in respect of maternal age, parity, and duration of gestation are shown below. Estimates of parity are based on all previous pregnancies which resulted in live births, stillbirths, or recognized abortions.

TABLE X
COMPLETENESS OF DATA ON MATERNAL AGE AND PARITY

Data Available										Total Births	
										No.	%
<i>Maternal Age</i>											
Duration of gestation and maternal age	..	..	..	..	..	..	..	..	..	16,931	72.7
Duration of gestation only	..	..	..	..	..	..	..	..	..	453	1.9
Maternal age only	..	..	..	..	..	..	..	..	..	2,967	12.8
Neither	..	..	..	..	..	..	..	..	..	2,928	12.6
TOTAL	..	..	..	..	..	..	..	..	..	23,279	100
<i>Parity</i>											
Duration of gestation and parity	..	..	..	..	..	..	..	..	..	17,316	74.4
Duration of gestation only	..	..	..	..	..	..	..	..	..	68	0.3
Parity only	..	..	..	..	..	..	..	..	..	3,093	13.3
Neither	..	..	..	..	..	..	..	..	..	2,802	12.0
TOTAL	..	..	..	..	..	..	..	..	..	23,279	100

Tables XI (opposite) and XII (overleaf) exhibit the relation of duration of gestation to age and parity. Once again the examination is restricted to about three-quarters of the births for which duration of gestation is known, and we have no means of testing the randomness of data within each age and parity group. On the evidence available there is no consistent relationship between the mean duration of gestation and maternal age and parity; nevertheless, the differences in the distributions are greater in both cases than would be expected by chance (as indicated by the χ^2 test).

TABLE XI
DURATION OF GESTATION RELATED TO MATERNAL AGE*

Duration of Gestation (weeks)	Maternal Age (years)					
	15-24	25-29	30-34	35 and over	Unspeci- fied	All Ages
28	0.27	0.11	0.06	0.23	—	0.16
29	0.21	0.16	0.08	0.15	—	0.15
30	0.29	0.12	0.11	0.30	—	0.20
31	0.45	0.52	0.28	0.34	0.22	0.41
32	0.62	0.29	0.40	0.46	0.44	0.44
33	0.76	0.75	0.62	0.88	0.66	0.74
34	1.23	0.75	0.71	0.84	0.44	0.89
35	1.91	1.75	1.42	1.64	1.76	1.71
36	2.62	2.20	2.49	3.17	2.87	2.55
37	4.25	4.34	4.45	5.27	3.75	4.46
38	8.16	8.26	8.89	10.16	9.27	8.68
39	18.61	19.95	20.74	20.17	24.05	19.87
40	27.51	28.55	28.48	27.28	30.45	28.10
41	18.00	18.45	17.51	16.01	13.68	17.63
42	8.59	8.56	8.02	7.72	7.72	8.31
43	3.28	2.70	3.20	2.37	1.76	2.90
44	1.60	1.14	1.30	1.33	1.54	1.35
45	0.86	0.77	0.45	0.69	0.66	0.72
46	0.45	0.29	0.28	0.38	—	0.34
47	0.16	0.16	0.23	0.19	—	0.17
48	0.10	0.09	0.17	0.19	0.22	0.13
49	0.04	0.03	0.08	0.08	—	0.05
50	—	—	—	0.04	0.22	0.01
51	—	—	—	0.08	0.22	0.02
Total	100	100	100	100	100	100
Number of births	5,121	5,591	3,529	2,617	453	17,311
Mean (days)	280.38	280.75	280.90	279.62	—	280.49
Error of mean	0.23	0.20	0.25	0.32	—	0.12
Standard deviation	16.87	15.26	14.77	16.45	—	15.82
Duration of gestation unspecified ..	903	871	629	564	—	2,967

* The table is based on 17,384 single births for which duration of gestation is known. Of 17,384 births, 73 were excluded because the duration of gestation was less than 28 weeks.

SUMMARY

(1) An attempt has been made to record information in respect of all births (23,970) born to Birmingham mothers in the city of Birmingham between Jan. 1 and Dec. 31, 1947. This paper deals with duration of gestation of single births.

(2) Duration of gestation was estimated from the date of the first day of the last menstrual period as recorded on antenatal documents. The information was available for 17,384 (74.7 per cent.) of the 23,279 single births.

(3) Distributions are given separately by duration of gestation for hospital, domiciliary, and nursing-home births (Table IV). Mean durations of gestation for domiciliary and nursing-home births are approximately 281 days, and do not differ significantly; both are a little longer than the mean for hospital births.

TABLE XII
DURATION OF GESTATION RELATED TO PARITY*

Duration of Gestation (weeks)	Parity							
	1	2	3	4	5 and 6	7 and over	Unspeci- fied	All Parities
28	0.23	0.10	0.04	0.48	—	—	—	0.16
29	0.20	0.10	0.04	0.08	0.20	0.60	1.47	0.15
30	0.23	0.12	0.16	0.08	0.20	1.00	—	0.20
31	0.41	0.49	0.33	0.32	0.40	0.40	—	0.41
32	0.41	0.61	0.16	0.56	0.40	0.20	—	0.44
33	0.84	0.61	0.33	1.04	1.00	1.40	1.47	0.74
34	1.03	0.83	0.65	0.80	0.70	1.19	1.47	0.89
35	1.68	1.70	1.35	2.25	1.80	2.19	5.91	1.71
36	2.42	2.51	2.12	3.45	3.30	3.39	—	2.55
37	4.58	4.06	4.33	4.89	4.80	5.98	2.94	4.46
38	8.54	8.56	8.37	10.99	8.50	7.97	7.34	8.68
39	19.16	21.03	21.39	16.77	20.40	17.53	14.72	19.87
40	27.47	29.38	30.46	26.72	24.70	21.91	30.87	28.10
41	18.64	16.75	17.15	17.82	16.90	15.94	17.64	17.63
42	8.75	7.66	8.08	7.70	9.00	10.16	7.34	8.31
43	2.82	2.68	2.65	3.13	3.50	5.38	4.42	2.90
44	1.25	1.44	0.98	1.60	1.90	2.19	—	1.35
45	0.62	0.81	0.61	0.40	1.10	1.79	—	0.72
46	0.34	0.30	0.28	0.40	0.60	0.20	1.47	0.34
47	0.14	0.12	0.33	0.16	0.10	0.40	1.47	0.17
48	0.13	0.10	0.12	0.08	0.20	0.20	1.47	0.13
49	0.04	0.02	0.04	0.08	0.30	—	—	0.05
50	0.03	—	—	—	—	—	—	0.01
51	0.01	—	—	0.16	—	—	—	0.02
Total	100	100	100	100	100	100	100	100
Number of births ..	6,979	5,067	2,449	1,246	1,000	502	68	17,311
Mean (days) ..	280.42	280.38	281.20	279.66	280.96	280.28	—	280.49
Error of mean ..	0.19	0.21	0.28	0.48	0.53	0.86	—	0.12
Standard deviation ..	16.10	15.26	14.00	16.94	16.73	19.18	—	15.82
Duration of gestation unspecified ..	1,081	894	465	279	216	158	—	3,093

* The table is based on 17,384 single births for which duration of gestation is known. Of 17,384 births, 73 were excluded because the duration of gestation was less than 28 weeks.

(4) When all births (domiciliary, hospital, and nursing-home) are considered together (Table VII), mean durations of gestation are: live births 280.85 days (± 0.12); stillbirths 267.27 days (± 1.35); total births 280.52 days (± 0.12). These figures are only slightly altered by exclusion of deliveries effected by Caesarian section or surgical induction. Neither live births nor total births are normally distributed.

(5) Of all births 28 per cent. are delivered in the 40th week, and 65 per cent. in the 39th, 40th, and 41st weeks. That is to say, about one-third of all births are delivered earlier than the 39th or later than the 41st week of gestation.

(6) The data are used to give expected dates of delivery for pregnancies which have completed a stated number of weeks (Table IX). In this method of anticipating

the date of delivery, account is taken both of variation around the mean duration of gestation, and of changes in the expected date as pregnancy advances.

(7) There is no consistent relationship between the mean duration of gestation and maternal age and parity.

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REFERENCES

- Hosemann, H. A. (1948). *Arch. Gynäk.*, **176**, 109.
 Hotelling, H., and Hotelling, F. (1932). *Amer. J. Obstet. Gynec.*, **23**, 643.
 Karn, M. N. (1947). *Ann. Eugen., Camb.*, **14**, 44.
 Meyer, A. W. (1915). "Fields, graphs and other data on fetal growth." *Contr. Embryol. Carneg. Instn*, **2**, 55.
 Reid, J. (1850). *Lancet*, **2**, 77.
 Schlichting, F. X. (1880). *Arch. Gynäk.*, **16**, 203.
 Siegel, P. W. (1921). *Zbl. Gynäk.*, **45**, 984.
 Zangemeister, W. (1917). *Arch. Gynäk.*, **107**, 405.

APPENDIX

SOURCES OF DATA IN RESPECT OF ALL BIRTHS BORN TO BIRMINGHAM MOTHERS IN THE CITY OF BIRMINGHAM BETWEEN JANUARY 1 AND DECEMBER 31, 1947

Data	Source	
	Live Births	Stillbirths
Name Address Date of birth Place of birth Sex Plurality Birth weight	Notification of birth	Register of stillbirths prepared by the Maternity and Child Welfare Department
Municipal ward (of mother's domicile)	Entered by Maternity and Child Welfare Department	Entered by Maternity and Child Welfare Department
Date of 1st day of last menstrual period Maternal age Parity Birth (spontaneous, induced, or Caesarian section) Previous live births Previous stillbirths Previous abortions	Hospital and nursing-home records Domiciliary midwives records	Register of stillbirths (except for the date of the 1st day of the last menstrual period, obtained as for live births)

Information about the cause of death of stillbirths, or of live births which died in the first year of life, was obtained from central records in the Maternity and Child Welfare Department.