ORIGINAL ARTICLES

Growth Curves for Normal Jamaican Neonates

M Samms-Vaughan[1], M Thame[1], C Osmond[2], IR Hambleton[3], A McCaw-Binns[1], DE Ashley[4], GR Serjeant[5]

ABSTRACT

The aim of this study was to provide standards for the assessment of birthweight, head circumference and crown-heel length for normal, singleton newborns of predominantly West African descent. Data were collected for 10 482 or 94% of all recorded births in Jamaica during the two-month period September 1 to October 31, 1986. After editing procedures, data were available for 6178 (birthweight), 5975 (head circumference), and 5990 (crown-heel length). The data presented in tables and growth curves include birthweight, head circumference and crown-heel length for males and females separately, for gestational ages 30–43 weeks. Data sets from the University Hospital of the West Indies in 1990 and 1999 were used to explore the possibility of secular change over the period 1986–1999. In conclusion, these ethnic and gender-specific growth curves are based on the most extensive dataset currently available in Jamaica for babies of West African descent.

Curvas de Crecimiento en los Neonatos Jamaicanos Normales

M Samms-Vaughan[1], M Thame[1], C Osmond[2], IR Hambleton[3], A McCaw-Binns[1], DE Ashley[4], GR Serjeant[5]

RESUMEN

El objetivo de este trabajo fue brindar normas para la evaluación del peso al nacer, la circunferencia cefálica, y la longitud coronilla-talón en neonatos de descendencia afroccidental, nacidos en partos simples. Se compilaron datos de una cifra de 10482, equivalente al 94% de todos los nacimientos registrados en Jamaica durante el período de dos meses que va desde septiembre 1 a octubre 31 de 1986. Tras los procedimientos de edición, se pudo disponer de datos en relación con 6178 (peso al nacer), 5975 (circunferencia cefálica), y 5990 (longitud coronilla-talón). Los datos presentados en las tablas y en las curvas de crecimiento incluyeron el peso al nacer, la circunferencia cefálica, y la longitud coronilla-talón en varones y hembras por separado, en edades de gestación de 30–43 semanas. Se usaron conjuntos de datos del Hospital Universitario de West Indies de 1990 y 1999, con el fin de explorar la posibilidad de un cambio secular en el período de 1986–1999. En conclusión: estas curvas de crecimiento étnicas y de género, tienen por base el conjunto de datos más amplio disponible en Jamaica en relación con bebés de descendencia afroccidental.

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From: Department of Obstetrics, Gynaecology and Child Health[1], Medical Research Council Epidemiology Resource Centre, Southampton, England[2], Tropical Medicine Research Institute[3], The University of the West Indies, Kingston, Jamaica, Ministry of Health, Jamaica[4], and the Sickle Cell Trust (Jamaica[5]), Kingston 7, Jamaica, West Indies.

Correspondence: Dr M Thame, Department of Obstetrics, Gynaecology and Child Health, The University of the West Indies, Kingston 7, Jamaica, West Indies. Fax: (876) 927-1446 e-mail: piperhcp@cwjamaica.com.

INTRODUCTION

Growth curves are useful for assessing the size of an individual against that expected in the general population and are of particular use in the neonatal period for assessment of fetal growth and maturity. Ethnic origin influences fetal growth rates (1, 2) and the available standards suggest that infants born to parents of African descent have birthweights approximately 150–200g below those of Caucasian comparison groups (3, 4). Furthermore, there are no data on ethnic differences in head circumference and crown-heel length. Standards currently used in Jamaica (5) have serious limitations since these were derived from a biased population of neonates admitted to the special care nursery and the small numbers did not allow analysis of the known gender differences. Presented in this study are data and growth curves, analysed by gender, for birthweight, head circumference and crown-heel length on a larger group of newborns of predominantly West African descent.

SUBJECTS AND METHODS

The data are derived from the Jamaican Perinatal Morbidity and Mortality Study (6) which aimed to include all births throughout the island between September 1 to October 31, 1986. The cohort included 10 482 births or 94% of the recorded total births during that two-month period. The ethnic origin of parents was not routinely recorded but was unlikely to differ from population censuses which indicate that 91% of the Jamaican population is of West African descent and a further 7% of mixed West African descent (7). The proportion of pure Caucasian births is likely to be less than 0.5%.

Deliveries took place at 24 public hospitals (72.7%), six private hospitals (4.1%), in other situations (6.0%), or at home (17.1%). This study was confined to singleton births (excluding 98 twin pairs) and live births (excluding 255 stillbirths), and was further restricted to institutional deliveries, known last menstrual period, calculated gestational age between 30 to 43 weeks (210–307 days), known infant gender and no recognized congenital abnormality.

Weight was measured by lever balance, head circumference with a tape measure and crown-heel length with the infant placed on a flat surface with a tape from the crown of the head to the heel with the knees held in extension. Validation of birthweight procedures was checked in 23 public hospitals with a standard 7 lb weight. This revealed a mean deviation of < 0.7%. For numeric data, head circumference values were restricted to the range 25–42 cm and for crown-heel length to the range 36–60 cm. Values for birthweight were available in 6178 (3203 males), head circumference in 5975 (3098 males) and crown-heel length in 5990 (3104 males).

This is the most complete dataset available, but its collection nearly 20 years ago raises concerns on secular change over this period. Cross-sectional studies on the distribution of birthweights in deliveries at the University Hospital of the West Indies for 1990 and for 1999 were used to assess this possibility.

For birthweight, crown-heel length and head circumference and for separate genders, the median value was modelled as a cubic spline in gestational age, with knots, at 33, 36, 39 and 41 weeks of gestation. Between these knots, this median curve is a cubic polynomial, and at the knots it is continuous in level, slope and curvature. At each gestational age, the distribution of the observations was close to normal for each of the measurements. The standard deviation of the measurements changed with gestational age and this was modelled as a linear function, using the procedures of Royston (8). The estimates of median and spread were then combined to generate the standards.

RESULTS

The mean and distribution of data over gestational ages from 30–43 weeks are summarized in Tables 1–3, the centiles of the distributions in Tables 4–6 and the growth curves depicting 3rd, 5th, 10th, 50th, 90th, 95th, and 97th centiles in Figs. 1–6. Mean birthweights for 1990 were significantly higher for both genders than those for 1986 (Table 7) but

Table 1: Distribution of mean birthweights (g) by gestational age in males and females

Gestational age (weeks)	Males n	Males mean	Males SD	Females n	Females mean	Females SD
30	6	1569	266	6	1600	358
31	7	1858	90	8	1619	342
32	12	1824	213	10	1778	208
33	15	2059	407	14	1959	349
34	54	2518	490	59	2493	496
35	86	2715	482	79	2743	499
36	144	2972	518	132	2830	435
37	291	2995	478	239	2945	395
38	566	3116	434	490	3040	385
39	755	3253	444	709	3127	411
40	671	3345	443	639	3205	445
41	368	3357	469	382	3269	446
42	165	3355	504	153	3266	531
43	63	3233	542	55	3211	384
Total	**3203**	**3185**	**511**	**2975**	**3089**	**479**

Table 2: Distribution of mean head circumference (cm) by gestational age in males and females

Gestational age (weeks)	Males n	Males mean	Males SD	Females n	Females mean	Females SD
30	4	29.25	0.96	5	29.20	2.28
31	7	29.57	1.81	7	29.29	2.36
32	9	30.67	1.66	10	30.70	1.16
33	14	30.07	1.94	12	30.17	2.41
34	50	32.38	2.17	55	31.64	1.91
35	84	32.36	2.03	74	32.28	1.79
36	142	32.84	1.89	129	32.54	1.84
37	275	32.90	1.70	231	32.75	1.73
38	545	33.30	1.76	479	33.07	1.70
39	737	33.57	1.76	681	33.03	1.68
40	657	33.69	1.79	624	33.37	1.75
41	353	33.87	1.68	368	33.51	1.58
42	161	33.97	1.69	148	33.53	1.78
43	60	33.57	1.90	54	33.50	1.66
Total	**3098**	**33.42**	**1.85**	**2877**	**33.08**	**1.78**

Table 3: Distribution of mean crown-heel length (cm) by gestational age in males and females

Gestational age (weeks)	Males n	Males mean	Males SD	Females n	Females mean	Females SD
30	3	38.67	0.58	4	43.25	3.86
31	7	42.86	1.57	7	41.71	3.09
32	9	42.75	2.82	10	43.10	3.18
33	13	45.69	2.56	13	43.08	3.01
34	49	47.06	3.09	57	46.51	3.05
35	83	47.59	3.29	75	46.77	3.22
36	140	48.56	3.67	127	47.14	3.46
37	278	48.62	3.07	234	48.06	3.17
38	548	49.14	3.18	479	48.84	3.38
39	735	49.51	3.30	683	48.98	3.06
40	661	49.96	3.23	625	49.20	3.24
41	358	50.08	3.54	370	49.45	3.18
42	161	50.27	3.29	148	49.18	3.40
43	59	49.20	3.18	54	49.16	2.87
Total	**3104**	**49.37**	**3.40**	**2886**	**48.74**	**3.35**

there was no difference between the 1999 and 1986 datasets. Since the 1990 data were the only group excluding gestational ages below 200 days, it seems likely that exclusion of less mature infants rather than a true secular change accounted for this difference.

DISCUSSION

Commonly used indices of fetal growth include the relationship between gestational age and birthweight, head circumference and crown-heel length. Despite widespread recognition that babies born to parents of African descent have lower birthweights (3, 4, 9, 10), only limited ethno-specific data are available. Most standard birthweight curves from American data are presented for populations where the African American component was 10% (11, 12) and the growth curves, while relevant for North American populations, would not be appropriate for assessment of growth in populations of predominantly African descent.

Table 4: Centiles derived from the distribution of birthweight (kg) among 6178 singleton births at 30–43 weeks gestation in males and females

	Males							Females						
Weeks	3rd	10th	25th	50th	75th	90th	97th	3rd	10th	25th	50th	75th	90th	97th
30	0.831	1.069	1.311	1.580	1.849	2.090	2.329	0.849	1.064	1.283	1.525	1.768	1.986	2.201
31	0.903	1.145	1.389	1.661	1.933	2.178	2.419	0.892	1.111	1.333	1.580	1.826	2.048	2.267
32	1.067	1.311	1.559	1.834	2.109	2.356	2.601	1.047	1.270	1.496	1.746	1.997	2.223	2.445
33	1.295	1.542	1.792	2.071	2.349	2.599	2.846	1.283	1.509	1.739	1.993	2.248	2.478	2.704
34	1.558	1.808	2.061	2.342	2.623	2.877	3.126	1.563	1.793	2.027	2.285	2.544	2.777	3.008
35	1.817	2.069	2.325	2.610	2.894	3.150	3.403	1.838	2.072	2.309	2.572	2.835	3.072	3.305
36	2.030	2.285	2.544	2.832	3.119	3.378	3.634	2.053	2.291	2.531	2.798	3.066	3.306	3.543
37	2.170	2.428	2.690	2.981	3.271	3.533	3.791	2.173	2.414	2.658	2.929	3.200	3.445	3.686
38	2.265	2.526	2.790	3.084	3.378	3.642	3.903	2.234	2.478	2.726	3.002	3.277	3.525	3.770
39	2.355	2.619	2.886	3.183	3.480	3.747	4.011	2.293	2.542	2.793	3.073	3.352	3.604	3.852
40	2.463	2.730	3.000	3.300	3.600	3.871	4.137	2.386	2.638	2.893	3.176	3.460	3.715	3.967
41	2.537	2.806	3.079	3.382	3.686	3.959	4.228	2.458	2.714	2.973	3.260	3.548	3.807	4.063
42	2.519	2.791	3.067	3.374	3.680	3.956	4.228	2.458	2.717	2.980	3.272	3.563	3.826	4.085
43	2.421	2.696	2.975	3.284	3.594	3.873	4.148	2.417	2.680	2.947	3.243	3.539	3.805	4.068

Table 5: Centiles derived from the distribution of head circumference (cm) among 5975 singleton births at 30–43 weeks gestation in males and females

	Males							Females						
Weeks	3rd	10th	25th	50th	75th	90th	97th	3rd	10th	25th	50th	75th	90th	97th
30	24.79	25.85	26.92	26.11	29.30	30.37	31.43	24.65	25.76	26.89	28.14	29.39	30.51	31.62
31	26.10	27.15	28.22	29.41	30.60	31.67	32.72	25.80	26.90	28.01	29.25	30.48	31.59	32.69
32	27.10	28.15	29.22	30.41	31.59	32.66	33.71	26.75	27.83	28.93	30.15	31.37	32.47	33.56
33	27.85	28.90	29.97	31.15	32.33	33.40	34.45	27.52	28.59	29.68	30.88	32.09	33.18	34.25
34	28.41	29.46	30.53	31.71	32.89	33.95	35.00	28.14	29.20	30.27	31.47	32.66	33.73	34.79
35	28.85	29.90	30.96	32.14	33.32	34.38	35.43	28.65	29.69	30.75	31.93	33.11	34.17	35.22
36	29.22	30.26	31.32	32.50	33.68	34.74	35.79	29.06	30.10	31.14	32.31	33.47	34.52	35.55
37	29.57	30.61	31.67	32.85	34.02	35.08	36.13	29.42	30.44	31.47	32.62	33.77	34.80	35.83
38	29.90	30.94	32.00	33.17	34.34	35.40	36.44	29.72	30.72	31.75	32.88	34.02	35.04	36.05
39	30.18	31.23	32.28	33.45	34.62	35.68	36.72	29.9	30.96	31.97	33.09	34.21	35.22	36.22
40	30.41	31.45	32.50	33.67	34.84	35.90	36.93	30.18	31.16	32.16	33.26	34.37	35.37	36.35
41	30.56	31.60	32.65	33.82	34.98	36.03	37.07	30.36	31.33	32.31	33.40	34.49	35.48	36.45
42	30.61	31.65	32.70	33.86	35.03	36.08	37.11	30.50	31.46	32.43	33.51	34.59	35.56	36.52
43	30.55	31.59	32.63	33.80	34.96	36.01	37.04	30.63	31.58	32.53	33.60	34.66	35.62	36.56

Table 6: Centiles derived from the distribution of crown-heel length (cm) among 5990 singleton births between 30–43 weeks gestation

	Males							Females						
Weeks	**3rd**	**10th**	**25th**	**50th**	**75th**	**90th**	**97th**	**3rd**	**10th**	**25th**	**50th**	**75th**	**90th**	**97th**
30	31.13	32.96	34.81	36.87	38.93	40.79	42.62	34.95	37.03	39.15	41.49	43.84	45.95	48.04
31	35.03	36.87	38.73	40.80	42.87	44.73	46.57	35.76	37.82	39.92	42.24	44.56	46.66	48.72
32	37.78	39.63	41.50	43.58	45.65	47.52	49.37	36.74	38.79	40.86	43.16	45.46	47.53	49.58
33	39.62	41.47	43.34	45.43	47.51	49.39	51.24	37.83	39.85	41.90	44.18	46.46	48.51	50.54
34	40.77	42.63	44.51	46.60	48.70	50.58	52.44	38.94	40.95	42.98	45.24	47.49	49.52	51.53
35	41.48	43.35	45.24	47.34	49.44	51.33	53.20	40.02	42.01	44.02	46.25	48.49	50.50	52.48
36	42.00	43.87	45.77	47.88	49.99	51.89	53.76	40.99	42.96	44.95	47.16	49.37	51.36	53.32
37	42.52	44.40	46.30	48.42	50.53	52.44	54.32	41.79	43.74	45.71	47.90	50.09	52.06	54.00
38	43.03	44.91	46.82	48.95	51.07	52.98	54.87	42.43	44.35	46.30	48.47	50.63	52.58	54.51
39	43.48	45.38	47.30	49.43	51.56	53.48	55.37	42.91	44.81	46.74	48.88	51.03	52.96	54.86
40	43.84	45.74	47.66	49.80	51.94	53.87	55.77	43.24	45.13	47.04	49.16	51.28	53.19	55.07
41	44.04	45.95	47.88	50.03	52.18	54.11	56.02	43.45	45.32	47.21	49.30	51.40	53.29	55.16
42	44.05	45.96	47.90	50.06	52.22	54.16	56.07	43.54	45.39	47.26	49.33	51.41	53.28	55.12
43	43.81	45.73	47.68	49.84	52.01	53.95	55.88	43.53	45.36	47.20	49.26	51.31	53.16	54.98

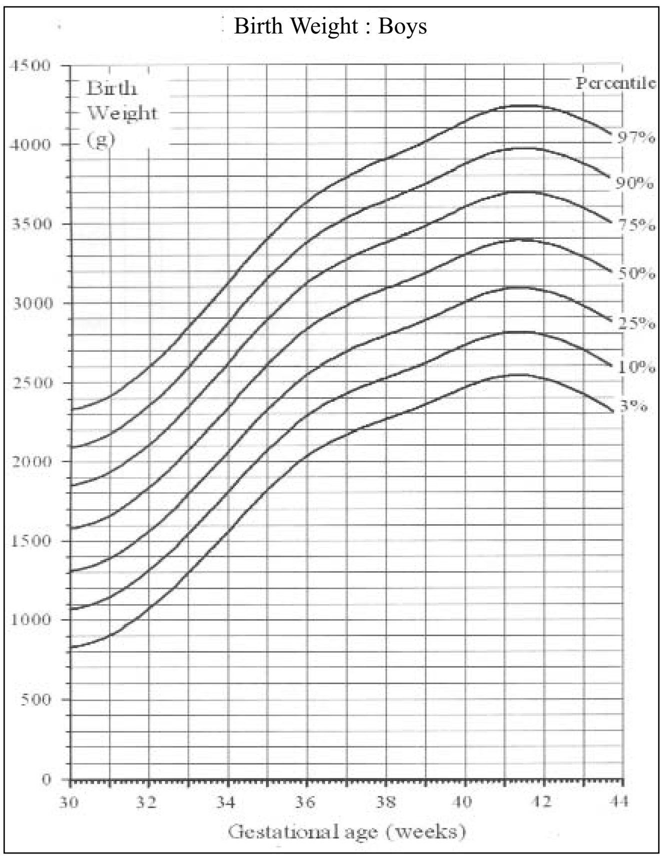

Fig.1: Centiles derived from the distribution of birthweight for gestational age among boys.

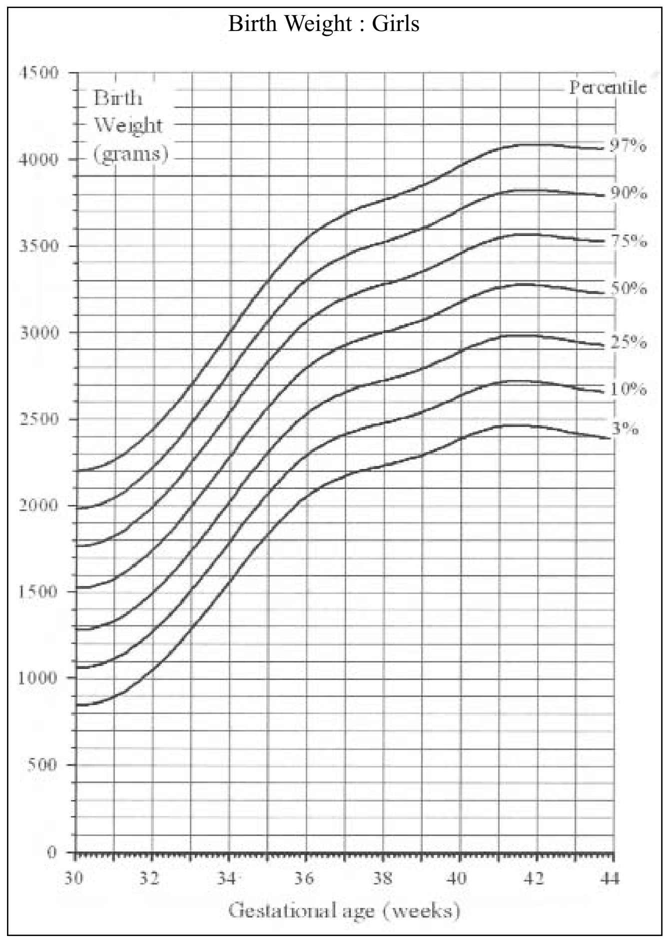

Fig. 2: Centiles derived from the distribution of birthweight for gestational age among girls.

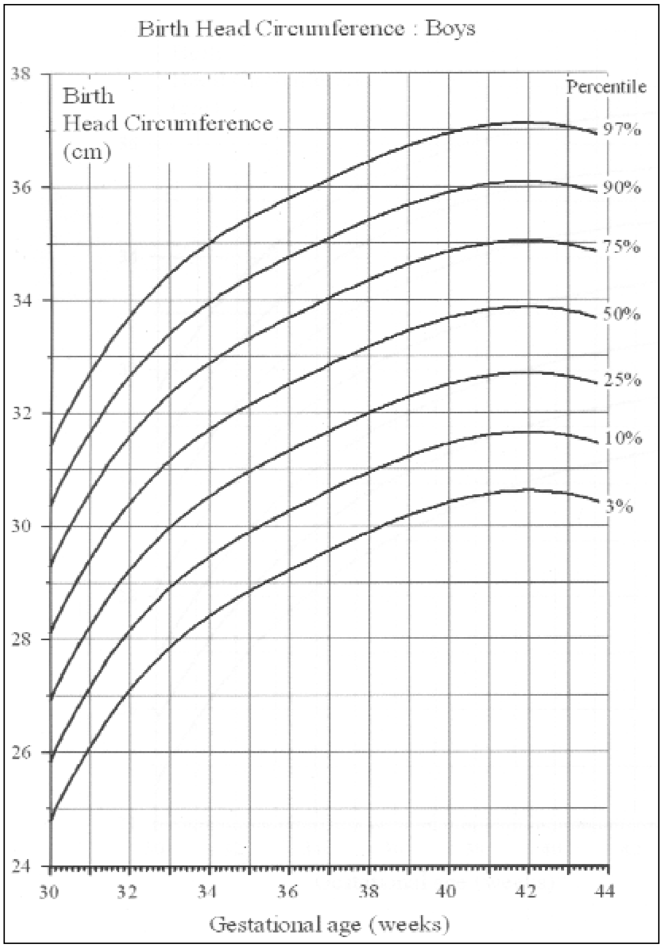

Fig. 3: Centiles derived from the distribution of head circumference for gestational age among boys.

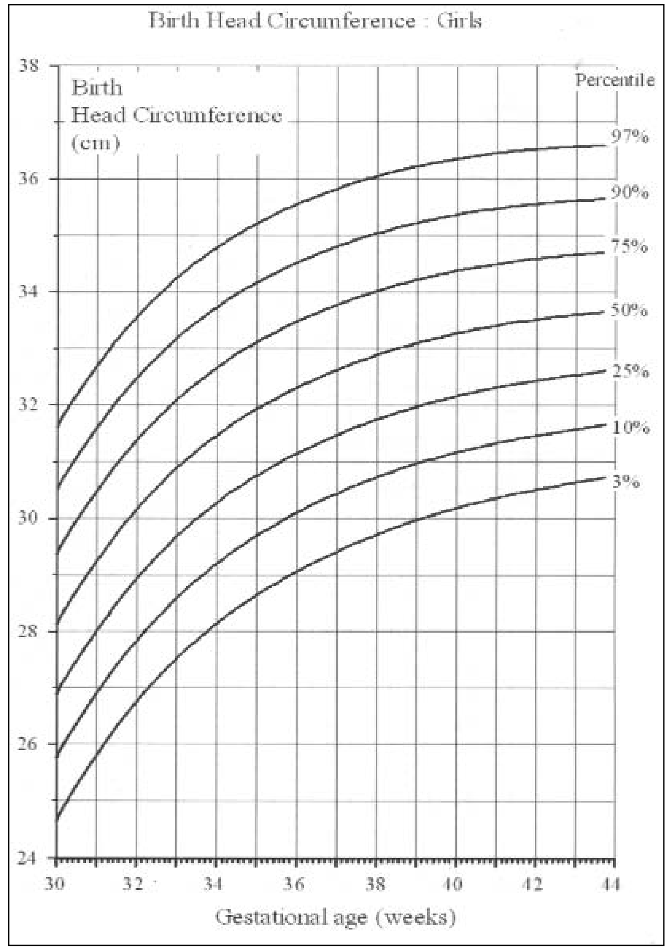

Fig. 4: Centiles derived from the distribution of head circumference for gestational age among girls.

Furthermore, specific ethnic data have often been presented only as the 10th centile of the birthweight distribution used for defining intrauterine growth retardation (13). The average African descent newborn weighs approximately 200g less than Caucasian newborns (3, 4) but the limited growth curve data suggest that in the United States of America (USA), this ethnic difference is confined to gestational ages beyond 37 weeks (14). Birthweight distributions from African populations in Africa (15–17) are likely to reflect adverse environmental conditions such as malaria, suboptimal nutrition and infections and those from the Caribbean have been limited by small numbers and sometimes racial heterogeneity. The most comprehensive data previously available from Jamaica (5) were based on 1230 babies delivered at the University Hospital of the West Indies in Kingston but were confined to babies admitted to the special care nursery and the birthweight curves pooled data from both genders, which are known to be different. Data on head circumference and crown-heel length are even more limited for populations of African descent and are confined to the report of Lowry and Bailey (5). Against this background, the current presentation of birthweight, head circumference and crown-heel length will provide ethnic and gender specific standards for a Jamaican population which is likely to be representative of Caribbean populations in the United Kingdom and USA and more relevant to the African American population than existing data.

A concern in the present dataset is the reliance of determining gestational age from the history of the last menstrual period which is known from Nigerian studies to be unreliable (18,19) leading to greater dependence on objective assessments of maturity or to the presentation of birthweight data without attempts to relate this to gestational age (20). This problem has been addressed with 'corrections' for obvious discrepancies (21), independent assessment by selected clinical features (5) or by formal physical examination (22); good agreement having been shown between the latter two measures (5). The current larger dataset, representing an extensive island wide survey, did not allow such independent assessment. It is also recognized that having many different observers and the inability to precisely standardize measurement methods will also introduce inaccuracies, but, because

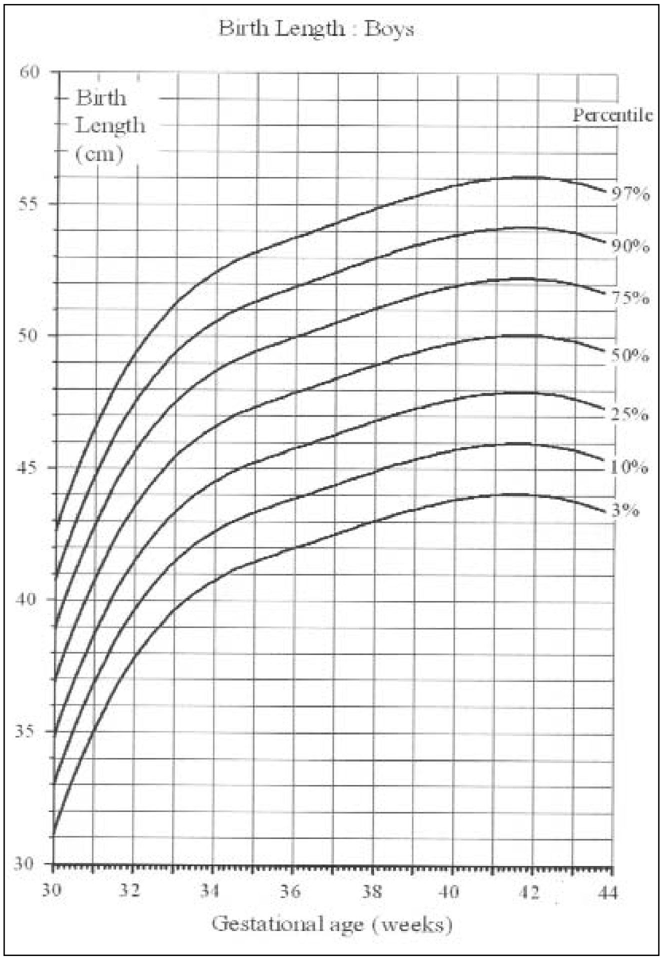

Fig. 5: Centiles derived from the distribution of crown-heel length for gestational age among boys.

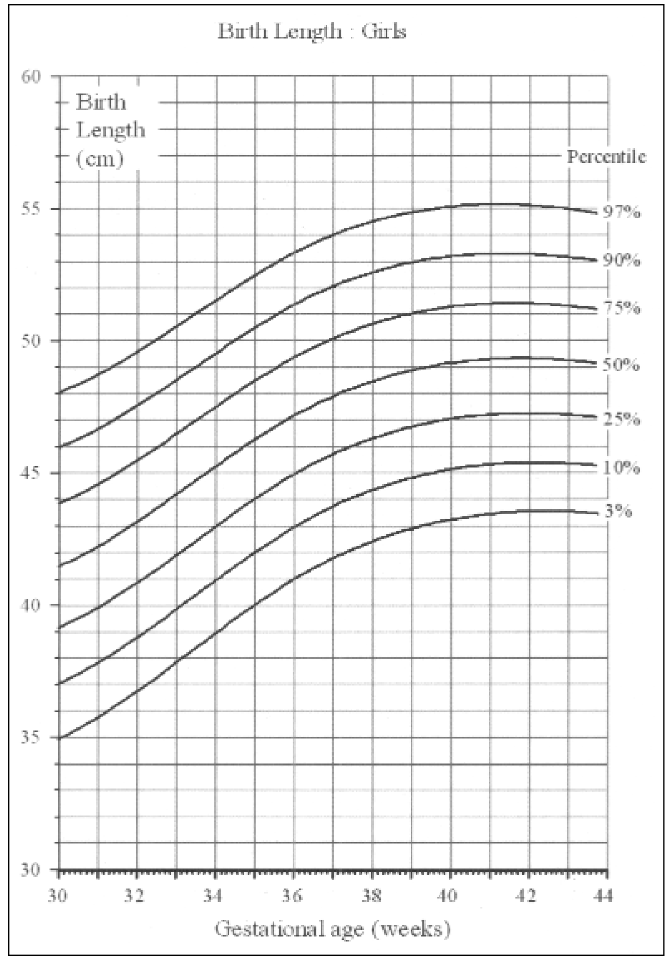

Fig. 6: Centiles derived from the distribution of crown-heel length for gestational age among girls.

Table 7: Comparison of mean singleton birthweights in the perinatal study and in two more recent samples

Sample	Male infants n	Mean	SD	Comparison with 1986 (*t* test)	Female infants n	Mean	SD	Comparison with 1986 (*t* test)
Perinatal Study Sept/Oct 1986	3023	3185	511	–	2975	3089	479	–
University Hospital 1990*	1201	3235	527	$p = 0.005$	1174	3145	524	$p = 0.0015$
University Hospital 1999**	1426	3210	651	NS	1288	3072	641	NS

*confined to gestational ages of 200d or greater.
**unedited for gestational age

of the size of the dataset, these errors will represent only a small proportion. Comparison of the current growth curves with previous Jamaican standards indicates a greater median weight, especially at lower gestational ages; at 30 weeks, weight increased from 1.25 kg to 1.58 kg (males) and to 1.53 kg (females); at 38 weeks, from 2.98 kg to 3.08 kg (males) and to 3.00 kg (females) and there was good agreement at 40 weeks. The lack of significant secular change in birthweight over the period 1986 to 1999 renders it unlikely that the magnitude of these differences resulted from secular change over an eight-year period, 1978 to 1986, and the most plausible explanation is the bias introduced by small babies admitted to the special care nursery. In this context, it is hoped that the new standards will give a truer picture of growth among Jamaican children of West African descent.

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