Birth size of Australian Aboriginal babies

Susan M Sayers and Jennifer R Powers

Objectives: **(i) To describe birth size of Aboriginal babies by sex, gestational age, and Aboriginality; (ii) to analyse the results with reference to standards of ponderal index and birthweight for gestational age.**

Subjects: **570 liveborn singletons routinely delivered at Royal Darwin Hospital between January 1987 and March 1991, and recorded in the Delivery Suite Register as being born to an Aboriginal mother.**

Main outcome measures: **Weight, length and head circumference at birth.**

Results: **The mean birthweight was 3098 g (standard deviation, 601 g), peak gestational age was 39 weeks, 13% were low birthweight and 7% were preterm. Preterm rates did not differ significantly for sex and Aboriginality. Babies without a non-Aboriginal ancestor had a lower mean birthweight and at term, were significantly smaller than babies with a non-Aboriginal ancestor as assessed by mean birthweight, length, head circumference and ponderal index. More than a quarter of babies (27%) without a non-Aboriginal ancestor were below the 10th percentile of birthweight for gestational age, compared with 14.2% of babies with a non-Aboriginal ancestor.**

Conclusions: **On the basis of postnatal clinical estimates of gestational age, Aboriginal babies have a preterm rate of 7% and Aboriginal babies without a non-Aboriginal ancestor are smaller in size at birth than babies with a non-Aboriginal ancestor.**

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Birth size and birthweight analyses are of clinical and epidemiological value. The clinician can identify babies at a higher risk of medical problems and organise appropriate intervention and follow-up strategies.[1] Epidemiologically, birth size analysis provides comparative indicators for the evaluation of health care.

Birth size has been studied by various methods, such as birthweight groupings,[2] percentiles of birthweight, length and head circumference for gestational age,[3,4] and the relationship of weight to length for gestational age.[5] There are few detailed studies of Aboriginal babies.

Accurate estimation of gestational age in Aboriginal babies is difficult.[6] Past studies have analysed birthweight without gestational age, concentrating on the low birthweight group;[7,8] other studies use imprecise gestational age estimates to define term and preterm babies.[9,10]

More recent studies have analysed gestational age and birthweight jointly but rely on mothers remembering the date of their last menstruation for gestational age estimation,[11] or sample only a community[12] or low birthweight group.[13]

Significant differences in mean birthweight between babies with and without a non-Aboriginal ancestor have been described,[14,15] but most studies report the Aboriginal population as a homogeneous group.[7-12]

We sought to describe the birth size of Aboriginal babies in terms of sex and Aboriginality using postnatal gestational age estimates and to analyse the results using reference standards of ponderal index[16] and birthweight for gestational age.[17]

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Methods

Subjects

The Darwin Health Region covers an area of approximately 120 000 km². The Aboriginal population is heterogeneous, including urban dwellers whose main language is English and traditional Aboriginal people living in remote communities.

The Royal Darwin Hospital serves a population of approximately 110 000 people, representing 65% of the population of the Northern Territory. The percentage of Aboriginal women having babies outside the hospital in the Darwin Health Region is low; in 1987, 89.2%, and in 1988, 90.7% of Northern Territory Aboriginal mothers delivered in hospital.[18]

Babies were eligible if they were liveborn singletons delivered at the Royal Darwin Hospital between January 1987 and March 1990 to a mother living in the Darwin Health Region and recorded as Aboriginal in the Delivery Suite Register. There were no exclusions. Of the 1053 eligible babies, 445 were not studied in detail because the paediatric investigator (S M S) was absent for these deliveries; 94% of the remaining 608 babies were enrolled in the prospective study. Those studied in detail were not randomly selected, but a binomial model and unpaired *t* tests showed no significant differences between the sex ratios or mean birthweights of subsets and the total population fitting the selection criteria (Table 1).

Procedures

Birthweights and crown–heel lengths were measured by midwives within two hours of delivery. Birthweights were recorded to the nearest gram with a balance scale. The crown-heel lengths were measured with a length-board by the standard anthropometric technique[19] and recorded to the nearest millimetre.

The paediatric investigator examined maternal case notes and, within four days of delivery, interviewed Aboriginal mothers and examined their babies. Information was

obtained about home location and mothers' knowledge of a non-Aboriginal ancestor).

Gestational age was estimated according to neurological and physical criteria described by the Dubowitz scoring system.[20] Because this method of estimation of gestational age was central to the study, it was evaluated in detail on 344 Aboriginal babies born at the Royal Darwin Hospital.[6] Gestational age was estimated by the paediatric investigator using the Dubowitz scoring system and compared retrospectively with gestational age estimates from the first fetal ultrasound performed by one of seven District Medical Officers.

Two statistical methods for assessing agreement between methods of clinical measurement were used. The intraclass correlation coefficient (ICC), a measure of agreement between methods after adjusting for subject differences,[21] showed that there was good agreement between the Dubowitz and ultrasound estimates for all babies (Table 2), as ICC values of 0.40 to 0.75 represent fair to good agreement and values above 0.75 show excellent agreement.[22] However, the method of Bland and Altman[23] for calculating the mean difference between the two gestational age estimates (Dubowitz estimate minus ultrasound estimate, divided by the number of babies) showed no difference in babies with a non-Aboriginal ancestor, a difference of three days in babies without a non-Aboriginal ancestor and nine days for babies less than 2500 g.

The head circumference was measured by the paediatrician and recorded to the nearest millimetre.

Definitions

Gestational age: according to the WHO convention,[17] where 36 weeks' gestation means the period from exactly 36 weeks up to 36 weeks and six days.
Low birthweight: below 2500 g.
Preterm: below 37 weeks' gestation.
Term: From 37 to 42 weeks' gestation.
Ponderal index (pi): a measure of weight in grams (bw) for length in centimetres (length), $pi = (bw/length^3) \times 100$.
Group A: babies without a known non-Aboriginal ancestor.
Group B: babies with a known non-Aboriginal ancestor.

Reference standards

Kitchen's Melbourne-based study provided the reference standard for birthweight for gestational age;[17] the 10th percentile was selected to identify the babies within the cohort who were small for gestational age.

Miller's 10th percentile for ponderal index for gestational age was used to identify babies with reduced soft tissue mass within the cohort.[16]

Analysis

The analysis was performed by means of the statistical packages, GLIM[24] and SPIDA.[25]

Results

Birthweights were available for 570 babies; data on Aboriginality and gestational age were complete for 553 and 506 babies respectively; data on both were available for 502 babies (Table 1). The birthweights of all liveborn babies ranged from 850 to 5340 g. The mean birthweight was 3098 g (standard deviation, 601 g); the median was 3115 g; 13% were low birthweight.

Group B were significantly heavier than Group A (Table 3, Figure 1). Group B boys were significantly heavier than Group A boys, but Group B girls were not significantly heavier than those in Group A (Table 3). For babies for whom there were complete data, analysis of variance was used to examine the effects of Aboriginality and sex on birthweight after taking gestational age into account; Group B boys were still significantly heavier than the other babies.

Table 1: Number, sex and birthweight of babies fitting selection criteria

				Birthweight in grams	
Babies	Boys	Girls	Total	Mean	(SD)
Total eligible	552	501	1053	3106	(580)
Paediatrician absent	243	202	445	3112	(562)
Paediatrician present	309	299	608	3102	(593)
Babies missed	16	22	38	3159	(460)
Babies in study	293	277	570	3098	(601)
Babies with Aboriginality and gestational age data	252	250	502	3090	(595)

SD = standard deviation.

Table 2: Agreement of Dubowitz score with ultrasound estimates of gestational age

		Mean difference (days)			
Category	Number of babies	Point estimate	(95% CI)	Limits of agreement (weeks)	Intraclass correlation coefficient
All babies	344	2	1 to 4	−3.3 to 4.0	0.69
Group A	251	3	2 to 5	−3.2 to 4.2	0.66
Group B	93	0	−2 to 3	−3.4 to 3.5	0.77
Birthweight <2500g	54	9	5 to 13	−2.9 to 5.4	0.81

CI = confidence interval.
Group A = babies without a known non-Aboriginal ancestor.
Group B = babies with a known non-Aboriginal ancestor.

Table 3: Mean birthweight (g) by Aboriginality and sex

	Group A			Group B			
	n	mean	(SD)	*n*	mean	(SD)	Unpaired *t* test
Boys	181	3080	(587)	105	3405	(597)	4.412*
Girls	181	2969	(527)	86	3093	(617)	1.683
Total	362	3025	(560)	191	3265	(624)	4.604*

Group A = babies without a known non-Aboriginal ancestor.
Group B = babies with a known non-Aboriginal ancestor.
SD = standard deviation.
*$P < 0.001$.

Group A had a higher rate of low birthweight than Group B (Table 4), but this difference was not significant.

Gestational age for the 506 babies ranged from 26 to 41 weeks with a mean of 38.5 weeks and median of 39 weeks; 7% were preterm. The gestational age distribution was similar for Groups A and B, each showing a peak gestational age of 39 weeks (Figure 2). There were no significant differences in the preterm rate for Group A boys (6.6%) and girls (6.6%) or Group B boys (4.8%) and girls (7.0%).

Mean birthweights for Group B were greater than those for Group A at most gestational ages (Figure 3). Likewise, the mean birthweights for boys were greater than for girls at all gestational ages with sufficient numbers for comparison (data not shown). Mean birthweights could not be calculated for gestational ages below 33 weeks, as only seven babies were born before this gestational age. Only one Group B neonate was born after 40 weeks' gestation.

More than a quarter of Group A (90/333) were below the 10th percentile of birthweight for gestational age compared with 14.2% of Group B (24/169). Binominal models showed significantly more babies in Group A than in Group B were below the 10th percentile of birthweight for gestational age.

There were 467 babies born at term. Babies in Group A were significantly smaller than those in Group B as assessed by mean weight, length and head circumference at birth and mean ponderal index (Table 5).

Table 4: Number and percentage of low birthweight babies by Aboriginality and sex

	Low birthweight	Total	Percentage
Group A			
Boys	22	181	12.2%
Girls	31	181	17.1%
Total	53	362	14.6%
Group B			
Boys	7	105	6.7%
Girls	11	86	12.8%
Total	18	191	9.4%

Group A = babies without a known non-Aboriginal ancestor.
Group B = babies with a known non-Aboriginal ancestor.

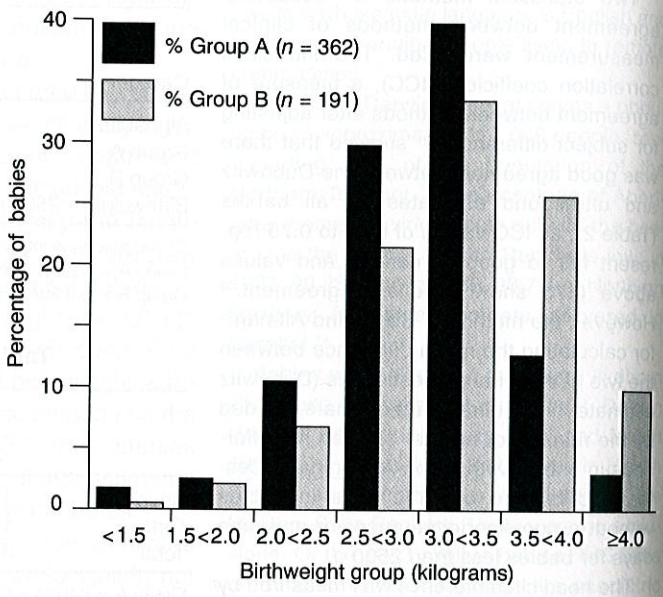

Figure 1: Birthweight distribution by Aboriginality.

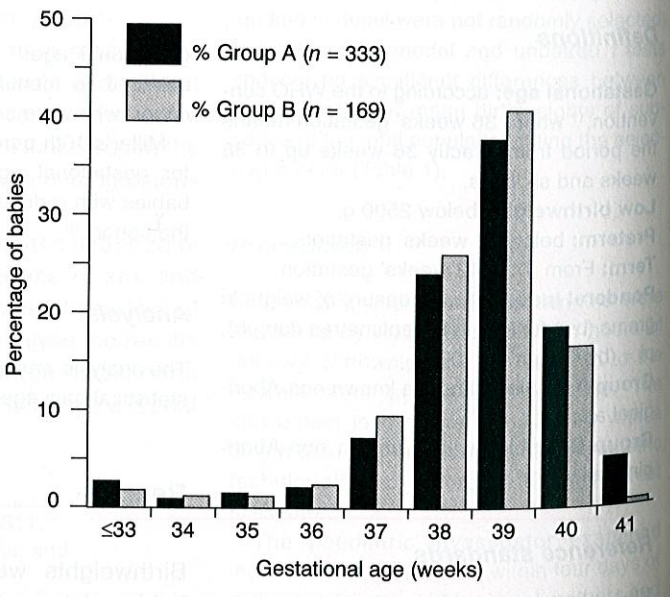

Figure 2: Gestational age distribution by Aboriginality.

Discussion

Previous reports of Aboriginal birth size have not identified babies with non-Aboriginal ancestors, nor adequately addressed the accuracy of gestational age estimations. By exploring these areas, we have made a more informative analysis of Aboriginal birth size.

Gestational age is usually estimated from the mother's recall of her last menstrual period, and verified with an early ultrasound measurement.[26] Nevertheless, a number of factors can invalidate the gestational age calculated by these methods.[27] Of the measurements used to classify babies at birth, the estimated gestational age is often the most unreliable. Aboriginal women rarely record the date of their last menstrual period,[28] and early ultrasound is impossible because they frequently present late for antenatal care.[6,9,29] Therefore other methods of estimating gestational age are needed.

At Royal Darwin Hospital, fetal ultrasound measurements are used to estimate fetal maturity for the obstetric management of Aboriginal pregnancies and the Dubowitz scoring system is used to estimate the gestational age of Aboriginal babies.

Although fetal ultrasound measures size rather than maturity, gestational age estimates based on fetal ultrasound measurements are reliable, particularly if done in the first trimester.[30] Ethnic differences are reported,[31] and Aboriginal fetal measurements have been shown to be less than those

Table 5: Size at term by Aboriginality

	Group A			Group B			Unpaired
	n	mean	(SD)	*n*	mean	(SD)	*t* test
Birthweight	309	3099	(462)	158	3320	(549)	4.57*
Birth length	306	49.1	(2.2)	157	49.8	(2.4)	3.21*
Head circumference	307	33.9	(1.4)	158	34.3	(1.6)	2.47†
Ponderal index	306	2.60	(0.25)	157	2.67	(0.26)	2.62*

Group A = babies without a known non-Aboriginal ancestor.
Group B = babies with a known non-Aboriginal ancestor.
SD = standard deviation.
*$P < 0.01$.
†$P = 0.05$.

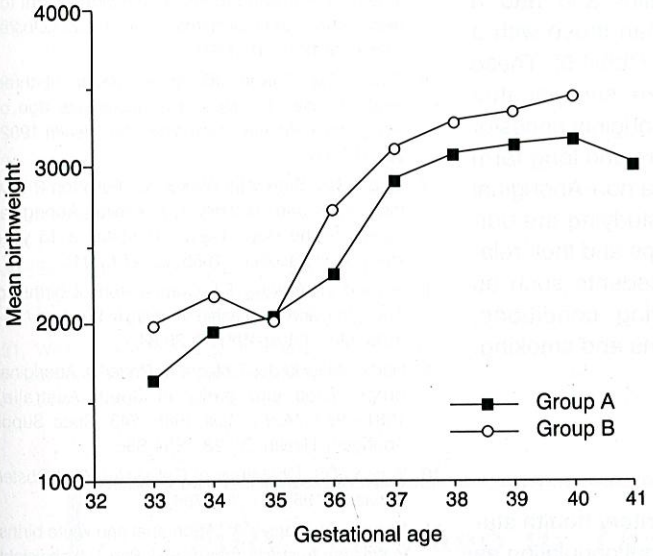

Figure 3: Mean birthweight by gestational age and Aboriginality.

of a United States population.[28] Gestational age estimates of Aboriginal babies based on fetal measurements with reference to Caucasian standards may underestimate maturity.

The postnatal Dubowitz method is widely used in clinical practice and scores criteria of physical and neurological maturation as an indirect measure of the duration of gestation.[20] Previous studies have established the accuracy of the Dubowitz scoring system in non-Aboriginal populations for which there are reliable last menstrual period data, for a mixture of Bantu, Indian and Malay infants in Capetown, Nigerian born infants, and Rhodesian born Africans.[20,32,33] There are suggestions that maternal and fetal factors influence maturation criteria[34,35] so that clinical assessment is unreliable over the entire gestational age range,[36] and conflicting reports, specifically about the Dubowitz score overestimating gestational age in low birthweight babies.[37-39]

There was good agreement between gestational age estimates based on the Dubowitz scoring system and estimates based on fetal ultrasound measurements taken throughout pregnancy. There was no difference between Dubowitz and ultrasound estimates for Group B babies, but Dubowitz estimates were greater than ultrasound estimates by two to five days for Group A babies (Table 2). While this represents a bias of three days, this is unlikely to be clinically significant. An intraclass correlation coefficient of 0.81 indicated excellent agreement between the Dubowitz and ultrasound estimates for low birthweight babies, but there was a mean difference of nine days between them with a 95% confidence interval of 5–13 days and a limit of agreement of –2.9 to 5.4 weeks. This represents a bias of clinical significance.

The Dubowitz method, which is based on the maturity of the baby, may overestimate the gestational age, or ultrasound, which uses the fetal size, may underestimate the gestational age, or both gestational age estimates may have some inaccuracy, as their true values are unknown. While there are inherent difficulties in both methods, it is likely that Dubowitz estimation by one paediatrician is more consistent than the fetal measurements performed by multiple medical officers.

In this study the preterm rate of 7% is lower than rates reported in other studies of Aboriginal births (11% in South Australia,[9] 11%–22% for seven communities in Queensland,[40] 16% in Western Australia[11] and 21.5% in the Northern Territory).[10] The methods of estimating gestational age are not reported in two studies.[9,40] The methods in the other retrospective studies were case note review of fundal heights[10] and mothers' recall of last menstrual date,[11] and are more likely to misclassify small babies as preterm.[41] None the less, because many pregnancies in this study could be considered stressed (because of the high proportion of babies below the 10th percentile of birthweight for gestational age), the lower preterm rate may be due to adverse maternal factors accelerating the maturation characteristics of the Dubowitz score. However, the 13% low birthweight rate resembles rates reported in developing countries,[42] where (according to a study of 11 developing nations which did address the issue of accuracy of gestational age) low birthweight rates above 10% have been attributed to increased numbers of small babies rather than increased numbers of preterm deliveries.[42]

Babies with and without a non-Aboriginal ancestor both had a peak gestational age of 39 weeks. Surprisingly, despite different methods of estimating gestational age, this peak of 39 weeks has been described previously for Aboriginal babies.[11,12] Most births are recorded world-wide at 40 weeks' gestation but as meticulous estimation of gestational age is not routine it is likely that some data are based on unreliable estimations of gestational age and that 40 weeks is arbitrarily chosen to record a term neonate. Nevertheless, there is little evidence that Afro-American women have a shorter gestational period than white American women.[43]

The similarity of the gestational age distributions for babies with and without a non-Aboriginal ancestor (Figure 2) suggests that the shorter gestational length is due to environmental rather than genetic factors. It is possible that the Dubowitz score underestimates gestational age over 40 weeks as this has been reported of a method of gestational

age estimation similar to the Dubowitz method;[44] this bias would be in the opposite direction to that postulated for the low birthweight group at the opposite end of the gestational age range.

Most studies report the Aboriginal population as homogeneous. Like other health institutions, the Royal Darwin Hospital records a child as Aboriginal if the mother identifies herself as an Aborigine (defined as a person of Aboriginal or Torres Strait Islander descent who identifies herself as an Aborigine or Torres Strait Islander and is accepted as such by the community in which she lives).[45] Unknown numbers of babies with an Aboriginal ancestor, born to white mothers and Aboriginal fathers, are classified as white. The proportion of babies classified as Aboriginal with a non-Aboriginal ancestor is also unknown, although there is evidence that this proportion is increasing. A preliminary figure from the 1991 census suggests an increase of 61% in the Aboriginal population in the previous 10 years.[46] This increase is significantly greater than the growth of the overall Australian population.[46] Part of this increase may be due to improved census taking in remote areas, but most is an increased willingness of people with an Aboriginal ancestor to identify themselves as Aboriginal.[46]

In our study direct questioning of the mother about knowledge of a non-Aboriginal ancestor showed that a third of Aboriginal babies had an identified non-Aboriginal ancestor.

Babies without a non-Aboriginal ancestor are lighter in weight than those with a non-Aboriginal ancestor (Figure 1) and these birthweight differences are not due to gestational age differences (Figures 2 and 3).

Internal cut-offs by means of percentiles are used to identify high risk babies in a known population, but percentiles of birthweight for gestational age could not be generated from this cohort as there were insufficient numbers in the lower gestational ages. Prolonged collection of more data would be inconsistent as there has been a change in low birthweight rates over time at the Royal Darwin Hospital.[7] Commonwealth Department of Health intrauterine growth charts[47] were considered, but parity and maternal height data were only recorded in the obstetric case notes of 361 babies. Consequently the Melbourne based reference was used to identify the babies who were small for gestational age. As it is likely that Aboriginal babies have a growth potential similar to other non-Aboriginal Australian babies,[48] it is disturbing to note that, against this reference, 27% of babies without a non-Aboriginal ancestor were below the 10th percentile.

The detailed analysis of the term babies was possible because of the larger number of babies (467). The term babies without a non-Aboriginal ancestor were significantly smaller and had a lower ponderal index than those with a non-Aboriginal ancestor (Table 5). These differences in birth size suggest that babies without a non-Aboriginal ancestor have different risk factors and long-term outcomes to those with a non-Aboriginal ancestor. We are now studying the outcomes of these subgroups and their relationships to birth antecedents such as maternal nutrition, living conditions, familial birth size patterns and smoking.

Conclusion

Currently, State and Territory health statistics regard the Aboriginal population as a homogeneous group, but babies with a non-Aboriginal ancestor are different in birth size to those without a non-Aboriginal ancestor. Failure to define these different Aboriginal neonatal populations may produce inaccurate information about their health status.

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