Are babies getting bigger? An analysis of birthweight trends in New South Wales, 1990–2005

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ABSTRACT

Objective: To determine whether the proportion of babies born large for gestational age (LGA) in New South Wales has increased, and to identify possible reasons for any increase.

Design and setting: Population-based study using data obtained from the NSW Midwives Data Collection, a legislated surveillance system of all births in NSW.

Participants: All 1 273 924 live-born singletons delivered at term (⩾ 37 complete weeks' gestation) in NSW from 1990 to 2005.

Main outcome measures: LGA, defined as > 90th centile for sex and gestational age using 1991–1994 Australian centile charts; maternal factors associated with LGA were assessed using logistic regression.

Results: The proportion of babies born LGA increased from 9.2% to 10.8% (18% increase) for male infants and from 9.1% to 11.0% (21% increase) for female infants. The mean birthweight increased by 23 g for boys and 25 g for girls over the study period. Increasing maternal age, higher rates of gestational diabetes and a decline in smoking contributed significantly to these increases, but did not fully explain them.

Conclusions: There is an increasing trend in the proportion of babies born LGA, which is only partly attributable to decreasing maternal smoking, increasing maternal age and increasing gestational diabetes.

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Although there is a widespread belief that there has been an increase in babies' birthweight in the past decade, there is a lack of Australian research to confirm this. The postulated increase in birthweight has been reported emotively in the media, with comments such as "... the weight of new mothers and babies rockets to record levels ...",[1] "Fatter babies mean more c-sections" and "Babies are being born bigger than ever ...".[2]

Increases in birthweight have been reported overseas. In Canada, the proportion of babies born large for gestational age (LGA) increased from 8% in 1978 to 11.5% in 1995.[3] This increase was principally attributed to increases in maternal body mass index (BMI), gestational weight gain, and height and a decrease in smoking during pregnancy.[3] Similar findings from Sweden demonstrated an increase from 3.7% to 4.6% in the proportion of newborns weighing over 4500 g between 1992 and 2001, with the increase attributed to increased maternal BMI and reduced prevalence of smoking.[4]

We aimed to determine whether the proportion of babies born LGA in New South Wales has increased since 1990, and to identify some of the factors that influence any observed increase.

METHODS

Data source and study population

Data from all births in NSW are collected in the NSW Midwives Data Collection (MDC), a legislated population-based surveillance system. The MDC includes information on all babies born at ⩾ 20 weeks' gestation or weighing at least 400 g.

All live-born singletons delivered at term (defined as ⩾ 37 complete weeks of gestation) in NSW between 1990 and 2005 were included in this study. Only term deliveries were included to avoid any effect of the increasing number of pre-term births on mean birthweight.

Outcome and explanatory variables

The outcome of size at birth was assessed in three ways: i) mean birthweight, ii) proportion of babies weighing over 4000 g and/or over 4500 g and iii) proportion of babies born LGA. LGA was defined as > 90th centile for sex and gestational age, based on published Australian birthweight centiles for 1991–1994.[5] The explanatory variables available for analysis included infant sex, maternal age, parity, smoking during pregnancy, pre-existing diabetes, gestational diabetes, hypertensive disorders during pregnancy, and maternal region of birth and year of birth. Babies were excluded from the analysis if their sex was indeterminate or unknown, their birthweight was missing or a probable outlier as defined by the Tukey method,[6] and/or their gestational age was ⩾ 43 weeks.

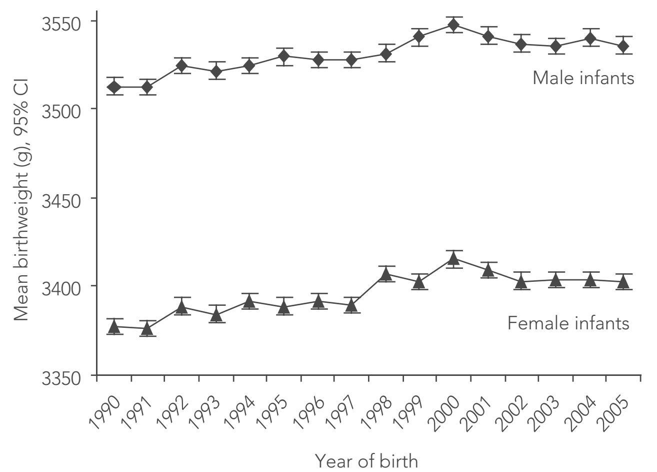
Data analysis

To investigate whether any shift in birthweight was a complete upward shift in the normal distribution, we compared the change in birthweight at each quartile over time. We hypothesised that a complete shift in the distribution would demonstrate a natural evolutionary increase, such as for height; conversely, an increase mainly at the high birthweight end could be expected if the increase was due to another factor, such as increasing rates of gestational diabetes.

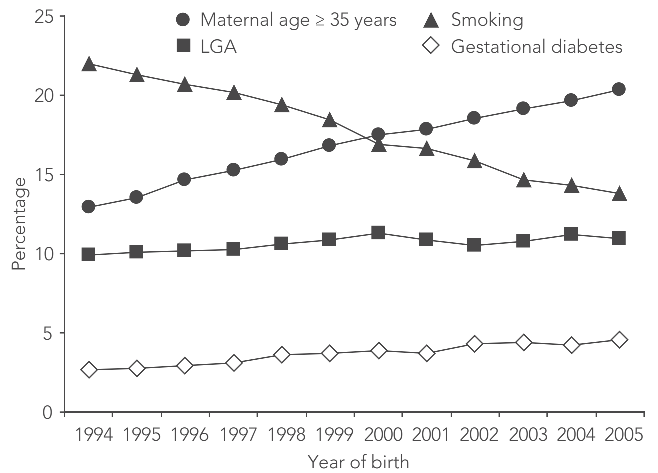
To investigate the association between LGA and the proposed explanatory variables over time, we used logistic regression analysis on the 1994–2005 data because smoking status was only collected in the MDC from mid 1993. Crude odds ratios (ORs) with 95% confidence intervals were estimated for all explanatory variables. Adjusted ORs were calculated by entering all significant explanatory variables, including year of birth, into the logistic regression model. Each variable entered the model if the likelihood-ratio test for its coefficient was significant ($P < 0.01$), apart from infant sex, which was included a priori.

A predictive logistic regression model was similarly established using all significant explanatory variables from the 1994 data alone ($n = 79\,125$). The coefficients from the equation for this fitted model were then applied to data from subsequent years to calculate the predicted number of LGA babies, thus allowing for the changing frequency of the explanatory variables.[7] The expected proportion of LGA babies was plotted against time and compared with the

1 Mean birthweight and 95% confidence intervals for male and female live-born, term singletons in New South Wales, 1990–2005



2 Trends over time for babies born large for gestational age (LGA) and the variables of maternal age, smoking and gestational diabetes



observed trend. If the observed and predicted values over time were not significantly different, this would suggest that the available explanatory variables account for all of the increase in LGA. Conversely, any difference between the observed and predicted proportions would be due to factors not included in the model.

Analyses were carried out using SAS, version 8.02 (SAS Institute, Cary, NC, USA). The study had the approval of the NSW Department of Health Ethics Committee.

RESULTS

From 1990 to 2005, 1 273 924 singleton babies were born alive at term in NSW, after excluding 3858 due to missing, indeterminate or unknown sex, birthweight or gestational age. Over the 16-year study period, the mean birthweight increased significantly — by 23 g for boys and 25 g for girls (P for trend < 0.001, Box 1). The percentage of male infants with birthweight > 4000 g increased from 14.3% to 15.8% (10.5% increase), and the percentage with birthweight > 4500 g increased from 2.2% to 2.4% (9.0% increase); male infants born LGA increased from 9.2% to 10.8% (17.9% increase). The percentage of female infants with birthweight > 4000 g increased from 8.3% to 9.5% (15.2% increase), and the percentage with birthweight > 4500 g increased from 1.0% to 1.2% (20.0% increase); female infants born LGA increased from 9.1% to 11.0% (21.0% increase).

A number of maternal characteristics also changed significantly over time (Box 2). The proportion of women who reported smoking during pregnancy decreased over the study period, from 22.0% in 1994 to 13.8% in 2005. The proportion of women with reported gestational diabetes increased from 1.1% in 1990 to 4.6% in 2005, and the mean maternal age at delivery increased from 28.4 years to 30.4 years. There were no significant changes in maternal region of birth over time. The trend in mean birthweight for babies of women who underwent elective caesarean section and induction of labour was similar to the trend for those without these interventions.

A total of 952 671 babies born between 1994 and 2005 met the entry criteria for the logistic regression analysis. Crude and adjusted ORs are shown in Box 3. The factors most strongly associated with LGA were pre-existing and gestational diabetes, multiparity, maternal age ⩾ 35 years and Polynesia as the maternal region of birth (Box 3). All proposed explanatory variables were statistically significant and were retained in the model, including year of birth.

The shift in the normal distribution of birthweight was not a complete upward shift. The distribution shifted disproportionately, with a greater increase at the high birthweight end. Between 1990 and 2005 for both sexes, the 25th quartile increased by 15 g, compared with 25 g for the 50th quartile, 35 g for the 75th quartile and 40 g for the 90th quartile.

The increasing trend in the observed proportion of babies born LGA compared with the predicted proportion, adjusted for covariates, is shown in Box 4, and demonstrates that only some of the increase can be accounted for by the changing trends in maternal age, parity, smoking, diabetes, pregnancy hypertension and maternal region of birth. The increase from 1994 to 2005 in the percentage of babies born LGA was from 9.9% to 10.9%, but the percentage increase predicted by the model for the same time period was only 10.4%.

DISCUSSION

We have shown that the birthweight of live-born, term singletons in NSW has increased since 1990. We have demonstrated that factors that influence the probability of being LGA at term include maternal age, parity, smoking, pre-existing diabetes, gestational diabetes, pregnancy hypertension and maternal region of birth. Clearly, the decrease in the rate of smoking among pregnant women, and its subsequent effect on birthweight, is a positive outcome. However, other factors have also affected the increase in birthweight, such as the increasing rate of gestational diabetes.

High birthweight may have important health implications for the infant, and has been shown to be associated with a high BMI in later life.[8] There is evidence for a relationship between high birthweight and increased future risk of cancer,[9,10] including Wilms' tumour,[11] infant and childhood leukaemia,[12] osteosarcoma,[13] astrocytoma,[14] and breast,[15,16] prostate[17] and colon[18] cancer. In addition, the future risk of asthma[19] and type 1 diabetes[20] is increased in high birthweight babies. The fetal origins hypoth-

3 Crude and adjusted odds ratios (ORs) of being born large for gestational age (LGA) for 952 671 live-born, term singleton births in New South Wales, 1994–2005

Characteristic	No. of births	No. LGA*	LGA (%)	Crude OR (95% CI)	Adjusted OR† (95% CI)
Baby's sex					
Male	488 656	51 158	10.5%	Referent	Referent
Female	464 015	49 760	10.7%	1.03 (1.01–1.04)	1.03 (1.02–1.04)
Maternal age (years)					
⩽ 24	158 079	12 144	7.7%	Referent	Referent
25–29	267 622	26 332	9.8%	1.28 (1.26–1.31)	1.08 (1.06–1.11)
30–34	366 506	42 205	11.5%	1.56 (1.53–1.59)	1.15 (1.13–1.18)
⩾ 35	160 464	20 237	12.6%	1.75 (1.72–1.79)	1.19 (1.16–1.22)
No. previous pregnancies‡					
0	387 969	29 366	7.6%	Referent	Referent
1	324 933	38 629	11.9%	1.65 (1.64–1.68)	1.63 (1.60–1.66)
2	151 156	20 214	13.4%	1.92 (1.88–1.95)	1.86 (1.82–1.90)
3	55 066	7 758	14.1%	2.08 (2.03–2.13)	2.03 (1.97–2.08)
⩾ 4	32 168	4 756	14.8%	2.20 (2.14–2.26)	2.20 (2.13–2.28)
Smoking during pregnancy§					
Yes	169 813	9 712	5.7%	0.46 (0.45–0.47)	0.41 (0.40–0.42)
No	781 120	91 017	11.7%	Referent	Referent
Pre-existing diabetes					
Yes	3 828	1 049	27.4%	3.31 (3.08–3.55)	2.93 (2.72–3.16)
No	948 843	99 869	10.5%	Referent	Referent
Gestational diabetes					
Yes	34 671	5 480	15.8%	1.63 (1.58–1.68)	1.64 (1.59–1.69)
No	918 000	95 438	10.4%	Referent	Referent
Any pregnancy hypertension					
Yes	59 817	7 142	11.9%	1.16 (1.13–1.19)	1.15 (1.12–1.18)
No	892 854	93 776	10.5%	Referent	Referent
Maternal region of birth					
Australia	693 082	78 064	11.3%	Referent	Referent
Europe	57 944	6 444	11.1%	0.99 (0.96–1.01)	0.91 (0.88–0.93)
Asia	103 526	5 832	5.6%	0.47 (0.46–0.48)	0.40 (0.39–0.41)
Polynesia	14 317	2 349	16.4%	1.56 (1.49–1.63)	1.24 (1.18–1.29)
Other	83 802	8 229	9.8%	0.86 (0.84–0.88)	0.76 (0.74–0.78)

Data are from the NSW Midwives Data Collection (1994–2005, n = 952 671). * LGA was defined as > 90th percentile based on published percentiles for sex and gestational age.[5] † Adjusted for all characteristics shown and year of birth. ‡ Data for this characteristic were missing for 1379 records. § Data for this characteristic were missing for 1738 records. ◆

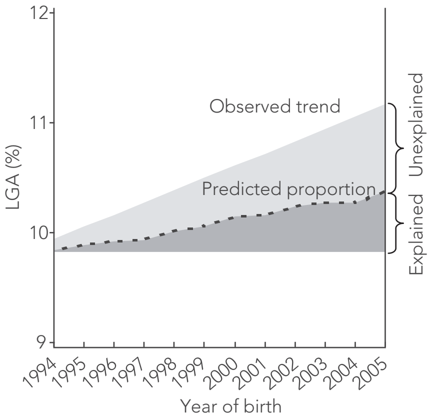
esis may provide an explanation for the fact that high birthweight may have lifelong health consequences.[21]

At the time of delivery, high birthweight may result in injury to the infant, with increased risk of shoulder dystocia and brachial plexus injury,[22] or to the mother, with higher rates of caesarean section, fourth-degree perineal lacerations, prolonged hospital stay[23] and postpartum haemorrhage.[7,24] For these reasons, the increasing proportion of large babies is of concern. Further studies to ascertain all factors contributing to the increase in birthweight over time, including maternal pre-pregnancy BMI and weight gain during pregnancy, are warranted. In addition, estimation of the increase in high-birthweight babies is important to enable appropriate maternity health services planning. By means of illustration, 1429 more babies weighing > 4000 g were born in NSW in 2005 than in 1990.

Although a portion of the increase in babies born LGA over the 16-year study period can be attributed to variables we have studied, a larger portion is unexplained (Box 4). In other studies, increasing maternal pre-pregnancy weight and gestational weight gain have been implicated.[3,4] Indeed, the prevalence of overweight or obesity among pregnant women in Australia is high.[25] Data on maternal BMI or weight gain were not available. It may be important to limit gestational weight gain, although evidence for the effect of dietary intervention and physical activity to reduce gestational weight gain is conflicting.[26] Randomised controlled trials investigating the limitation of weight gain during pregnancy are currently in the early stages of recruitment.[27,28]

Our findings are similar to the trends observed in other countries. In Sweden, the mean birthweight increased by 35 g (or an average of 3.5 g/year) between 1992 and 2001,[4] and in Canada, the mean birthweight increased by 46 g (equivalent to 2.4 g/year) between 1978 and 1996.[3] In comparison, an increase of 24 g between 1990 and 2005

4 Observed trend and the predicted proportion of infants born large for gestational age (LGA), by year



(1.5 g/year) was observed in the NSW population studied. This lower rate of increase may in part be due to the fact that smoking among pregnant women is relatively more common in Australia (16.7% in NSW compared with 10.9% in Sweden, based on 2001 data[4]).

A strength of our study is the availability of a population health dataset that has been validated against the medical record. Birthweight is recorded in the MDC with high accuracy, and a 96.5% concordance with the medical record has been reported.[29] Most variables have a good level of agreement with the medical record, with high κ values. For example, pregnancy hypertension as recorded in the MDC has a specificity of 99.5% and a sensitivity of 63.3%[30] when compared with the medical record. The main shortcoming of our study is that we were unable to investigate several important factors, such as maternal pre-pregnancy weight and weight gain during pregnancy. In addition, there may have been changes over time, such as increased screening for gestational diabetes. Improved screening and resulting treatment for gestational diabetes over the study period could have reduced the number of infants born LGA.

In conclusion, we have demonstrated that the birthweight of babies born at term is increasing in NSW. Although decreasing smoking, increasing maternal age and increasing gestational diabetes account for a portion of this increase, a portion of the increase remains unexplained by our data and warrants further investigation.

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COMPETING INTERESTS

None identified.

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