Trends of Abnormal Birthweight among Full-term Infants in Newfoundland and Labrador

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ABSTRACT

Objectives: The objective of this study was to investigate whether any observed trends in birthweight are accompanied by changes in maternal socio-demographic characteristics, including age, marital status, and education.

Methods: We conducted a population-based study of term singletons born in Newfoundland and Labrador, Canada, between 1992 and 2005 (N=66,638). Large-sample significance tests for two population proportions were used to test whether differences in mean birthweight, the proportion of low and high birthweight infants, and differences in maternal socio-demographic characteristics between 1992-95 and 2002-05 were statistically significant. Chi-square tests were used to test for associations between birthweight group and maternal age, education and marital status. Multivariate logistic regression was used to examine the interaction of these effects across time periods.

Results: Of the 66,638 infants included in the study, 54,256 (81.4%) were born in the normal birthweight range (2500-4000 grams) while 11,305 (17.0%) were high birthweight (>4000 grams) and 1,077 (1.6%) were low birthweight (<2500 grams). The rate of low birthweight significantly decreased from 1992 to 1995 compared to the period 2002 to 2005 (1.9% to 1.3%; $p<0.01$). The rate of high birthweight significantly increased over the same two time periods (16.2% to 17.5%; $p<0.01$). Mean birthweight increased from 3529 grams to 3566 grams ($p<0.01$). Compared to women who had babies from 1992 to 1995, women who gave birth from 2002 to 2005 were more likely to be older, have higher levels of education, and never have been married. Birthweight outcomes were significantly associated with mother's age, education and marital status.

Conclusion: Changes in maternal demographics are associated with the upward shift in birthweight in Newfoundland and Labrador.

Key words: Birth weight; trends; full-term infants; Newfoundland and Labrador

La traduction du résumé se trouve à la fin de l'article.

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Birthweight is an important indicator of population health and plays a large role in healthy child development. Studies that have analyzed birthweight trends over the past several decades have concluded that birthweight is increasing in many parts of the developed world,¹⁻⁷ and that these changes are linked to shifts in maternal factors, such as increasing maternal age,^{3,4,8} higher levels of education,³ and decreased smoking status.^{3,7,8} Both low and high birthweight have been linked with adverse health conditions throughout the life span.⁹⁻²⁵ Since the distribution of infant birthweight and the relative contribution of the factors influencing it vary from one population to the next, it is important to examine birthweight and its determinants in individual populations.

Information on birthweight trends in Newfoundland and Labrador, Canada is limited due to the unavailability of electronic birthweight data prior to 1992. As such, a population-based study of this kind has not been conducted in Newfoundland and Labrador. The objectives of this study are to explore trends in birthweight rates in Newfoundland and Labrador for infants born between 1992 and 2005 and to investigate whether any observed trends in birthweight are associated with changes in maternal socio-demographic characteristics, including age, marital status, and education.

METHODS

The study included all full-term singletons born between 1992 and 2005 to women who were residents of Newfoundland and Labrador. The *Live Birth System*, maintained by the Newfoundland

and Labrador Centre for Health Information, was the primary data source. Data are captured from Live Birth Notification forms completed at the time of birth. The database contains both clinical and demographic data for all births that occur in the province. From 1992 to 2005, there were 74,863 live births in Newfoundland and Labrador. Infants were excluded if they were part of a multiple birth (N=1,801), were born preterm (before 37 weeks completed gestation) or post-term (greater than 41 weeks of completed gestation) (N=6,567), were born to women who were not residents of Newfoundland and Labrador (N=609), or if there were no data available for birthweight (N=70) or gestational age (N=250). The total number of live births included in the study was 66,638.

Low birthweight was defined using the World Health Organization definition of infant weight less than 2500 grams.²⁶ Infants were categorized as normal birthweight if they weighed between 2500

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and 4000 grams and high birthweight if they weighed more than 4000 grams.

The birthweight distribution of the study population was described according to infant sex, maternal age, maternal education, and legal marital status of mother. Maternal age was computed based on mother's date of birth and infant's date of birth to determine mother's age as of her last birthday and was grouped into three categories: less than 20 years, 20 to 34 years, and 35 years or older. Maternal education was categorized as high school incomplete, high school complete, and beyond high school. Mother's legal marital status was categorized into three groups: single; married; and separated, widowed or divorced.

Large-sample significance tests for two population proportions were used to test whether differences in mean birthweight and the proportion of low and high birthweight infants over time were statistically significant. Birthweight groupings for the period from 1992 to 1995 were compared with the same groupings for the period of time from 2002 to 2005, thereby smoothing out any random fluctuations within one-year periods.

Four-year time periods were chosen for comparison due to the variation in individual years and allowed for a separation of a decade for analyzing trends in birthweight patterns. Large-sample tests for two population proportions were used to detect differences in maternal socio-demographic characteristics over the same two time periods. Chi-square tests were used to test for associations between birthweight group and maternal age, education and marital status. To confirm the descriptive results, two multivariate logistic models were estimated predicting the likelihood of being low or high birthweight, respectively, as compared to being normal birthweight. Interaction terms between the time variable and the demographic variables were included to determine if these effects diminished or became stronger over time.* Some mothers contribute multiple births to the dataset, thus making these observations non-independent from each other. To address this, the standard errors are adjusted by clustering on the mother's unique identifier.† The study was approved by the Human Investigation Committee of Memorial University of Newfoundland.

RESULTS

The dataset consisted of 42,838 mothers contributing 66,638 observations. Of these, 29,919 mothers (69.4%) contributed one birth; 11,262 (26.3%) contributed two births; 1,434 (3.3%) contributed three births and 223 (0.5%) contributed four or more births to the dataset.‡

The majority (81.4%) of infants were born in the normal birthweight range (Table 1). Just over half (51.0%) of the infants were male; most mothers (82.5%) were between the ages of 20 and 34 years and the majority (70.7%) were legally married. About one in five (19.1%) mothers had not completed high school while more than half (58.4%) had been educated beyond high school.

* Analyses were conducted using SPSS 14.0²⁷ and Stata 10.0²⁸

† A unique identifier could not be generated for the 1992 births and as such these observations are not included in the regression analysis. To examine the impact of losing these observations, unclustered models were estimated that included the 1992 observations, with there being little tangible difference in the results.

‡ For the sample included in the regression analysis (i.e., live full-term births between 1993 and 1995 and 2002 and 2005), there were 27,692 unique mother identifiers. Over 90% of mothers contributed a single birth to the data set.

Table 1. Characteristics of Study Population, Newfoundland and Labrador, 1992-2005

Characteristic	n	%
Infant Sex (N=66,638)		
Male	33,958	51.0
Female	32,680	49.0
Birthweight Group (N=66,638)		
Low (<2500 grams)	1077	1.6
Normal (2500-4000 grams)	54,256	81.4
High (>4000 grams)	11,305	17.0
Maternal Age (N=66,638)		
<20 years	5669	8.5
20-34 years	54,978	82.5
>34 years	5991	9.0
Legal Marital Status of Mother (N=66,608)		
Married	47,079	70.7
Never Married	18,516	27.8
Separated/Divorced/Widowed	1013	1.5
Mother's Education (N=64,286)		
Less than high school	12,274	19.1
Completed high school	14,455	22.5
Beyond high school	37,557	58.4

Table 2. Birthweight Distribution of Study Population by Infant Sex and Maternal Characteristics, Newfoundland and Labrador, 1992-2005

Characteristic	Total N	Normal Birth- weight %	Low Birth- weight %	High Birth- weight %
Infant Sex				
Male	33,958	77.8	1.4	20.8
Female	32,680	85.5	1.9	13.0
Maternal Age (years)				
<20	5,669	85.3	2.0	12.7
20-34	54,978	81.1	1.5	17.3
>34	5,991	80.3	2.0	17.7
Mother's Marital Status				
Married	47,079	80.4	1.5	18.2
Never Married	18,516	84.0	2.0	14.0
Separated/Widowed/Divorced	1,013	82.5	2.8	14.7
Mother's Education				
High school incomplete	12,274	83.8	2.5	13.7
Completed high school	14,455	82.2	1.7	16.1
Beyond high school	37,557	80.3	1.3	18.4

χ^2 tests for the association between birthweight and infant sex, maternal age, mother's marital status and mother's education were all significant at $p < 0.01$

Table 3. Changes in Birthweight and Maternal Socio-demographic Characteristics, Newfoundland and Labrador, 1992-1995 vs. 2002-2005

Characteristic	1992-1995 %	2002-2005 %	p-value
Birthweight Group			
Low (<2500 grams)	1.9	1.3	$p < 0.0001$
Normal (2500-4000 grams)	82.0	81.1	$p < 0.05$
High (>4000 grams)	16.2	17.5	$p < 0.0001$
Maternal Age (years)			
<20	10.1	6.4	$p < 0.0001$
20-34	83.7	81.0	$p < 0.0001$
>34	6.2	12.6	$p < 0.0001$
Mother's Marital Status			
Married	73.7	56.6	$p < 0.0001$
Never Married	25.0	40.8	$p < 0.0001$
Separated/Widowed/Divorced	1.3	2.6	$p < 0.0001$
Mother's Education			
High school incomplete	25.3	13.6	$p < 0.0001$
Completed high school	25.9	17.5	$p < 0.0001$
Beyond high school	48.8	69.0	$p < 0.0001$
Gestational Age at Birth (weeks)			
37	4.8	5.5	$p < 0.05$
38	12.7	15.4	$p < 0.0001$
39	20.6	27.9	$p < 0.0001$
40	41.8	33.0	$p < 0.0001$
41	20.1	18.2	$p < 0.0001$

The percentage of low birthweight infants was slightly higher among females compared to males (1.9% vs. 1.4%); infants born to mothers less than 20 or more than 34 years of age compared to

Table 4. Multiple Logistic Regressions Predicting Low and High Birthweight among Full-term Infants in Newfoundland and Labrador, 1993-2005

	Low Birthweight		High Birthweight	
	OR	95% CI	OR	95% CI
Year = 2002-05	0.558	(0.34-0.91)	1.216	(1.04-1.42)
Gestational age (in weeks)	0.435	(0.40-0.46)	1.620	(1.57-1.67)
Age less than 20 years	0.976	(0.64-1.49)	0.950	(0.78-1.15)
Age greater than 34 years	1.829	(1.22-2.73)	1.165	(0.97-1.40)
High school incomplete	1.362	(0.99-1.88)	0.854	(0.74-0.98)
Beyond high school	0.818	(0.60-1.12)	1.095	(0.98-1.23)
Marital status = single	1.237	(0.92-1.67)	0.736	(0.65-0.84)
Marital status = separated, widowed or divorced	2.064	(1.01-4.22)	0.568	(0.35-0.94)
Number of observations	23959		28353	
Pseudo R-square	.106		.041	

mothers aged 20 to 34 years (2.0% vs. 1.5%); and mothers who were separated, widowed or divorced as opposed to married (2.8% vs. 1.5%) (Table 2). High birthweight was more common among male infants (20.8% vs. 13.0%); mothers greater than 34 years (17.7%) compared to those less than 20 years of age (12.7%); mothers who were married (18.2%) compared to those who were never married (14.0%); mothers with post-secondary education (18.4%) compared to those who had not completed high school (13.7%).

The rate of low birthweight significantly decreased from 1992 to 1995 compared to the period 2002 to 2005 (1.9% to 1.3%; $p<0.0001$) (Table 3). The rate of high birthweight significantly increased from 1992 to 1995 compared to the period 2002 to 2005 (16.2% to 17.5%; $p<0.001$). Overall, mean birthweight increased from 3529 grams for the period 1992-1995 to 3566 grams for the period 2002-2005 ($p<0.0001$).

Between 1992-95 and 2002-05, the percentage of mothers greater than 34 years of age more than doubled from 6.2% to 12.6% ($p<0.0001$); the percentage of mothers who were never married significantly increased from 25.0% to 40.8% ($p<0.0001$); the percentage of mothers who had not completed high school dropped from 25.3% to 13.6% ($p<0.0001$); and the percentage of mothers who had enrolled in educational training beyond high school significantly increased from 48.8% to 69.0% ($p<0.0001$). Chi-square tests revealed significant associations between birthweight and each of the maternal socio-demographic characteristics.

Table 4 shows the results of two multiple logistic regressions.* The first examines factors influencing the probability of being low birthweight and the second examines factors associated with high birthweight. The low birthweight results suggest that the risk of being low birthweight is significantly smaller in the later period (2002-05). Mothers older than 34 are at a higher risk of having a low birthweight baby, however the odds ratio for the interaction term being less than one and marginally significant suggests that this effect is more pronounced in the earlier period (1993-95). Mothers with less than high school education are more likely to have a low birthweight baby throughout the observation period; however, this is only a marginally significant result. Mothers who are separated, widowed or divorced are significantly more likely to have a low birthweight baby in both the 1993-95 and 2002-05 time periods.

The high birthweight results in Table 4 suggest that being high birthweight significantly increases in the 2002-05 period. Mothers who are older than 34 tend to be more likely to have a high birth-

weight baby, however this effect is largely offset when age greater than 34 is interacted with the time period variable, suggesting that this is not a significant risk factor any longer. Mothers who are not married (single or separated, widowed or divorced) are less likely to have a high birthweight baby.

The age variables suggest that younger mothers are less likely to have a low or high birthweight baby. In contrast, older mothers are more likely to have babies who fall in both categories, although it should be noted that the only significant age effect is with older mothers being more likely to have a low birthweight baby. This effect appears to weaken over time. The pseudo r-squares for the regressions are relatively low, suggesting that other factors (such as genetics, onset of difficulties during pregnancy and random factors) play an important role in determining birthweight.

DISCUSSION

The majority of infants born full-term in Newfoundland and Labrador from 1992 to 2005 were within the normal birthweight range. High birthweight accounted for a vast majority of infants with a birthweight outside the normal range. In general, the distribution of low and high birthweight according to maternal characteristics was consistent with previous research. Low birthweight was more prevalent among younger and older mothers, mothers who were single, separated, widowed or divorced, and mothers with low levels of education. The proportions of high birthweight infants were higher among mothers who were older, married, and had higher levels of education.

Mean birthweight and rates of high birthweight have significantly increased in Newfoundland and Labrador from 1992 to 2005, while rates of low birthweight have significantly decreased. The finding of increasing birthweight is consistent with that found in previous studies investigating birthweight trends in developed countries.^{2-7,29} Since the investigation included only those infants born full-term, it can be inferred that increases in birthweight reflect increases in fetal growth.

Increasing birthweight in Newfoundland and Labrador can be explained, at least in part, by changes in maternal socio-demographic characteristics (i.e., a significant increase in the proportions of older and more educated mothers). The increase in the proportion of mothers aged 35 years or older from 6.2% to 12.6% from 1992 to 2005 mirrors the increases documented in Alberta³⁰ and Nova Scotia.⁸ Although the proportion of unmarried mothers increased significantly from 25.0% to 40.8%, it is believed that this is not an indication of increases in the proportion of unpartnered mothers, but instead a reflection of more women cohabitating or living common-law. This notion is supported by a study conducted in Finland which found that 74.6% of women who were unmar-

* None of the interaction terms were statistically significant at a 5% level and as such they are not included in Table 4. The interactions with age greater than 34 are significant in both regressions at a 10% level and are described in the results and discussion.

ried during pregnancy were cohabitating with their partners.³¹ Data on the Live Birth Notification forms for 2002 to 2005 indicate that 63.9% of mothers who were never married were living together with their baby's father as a couple.

Weight for gestational age may be a better outcome measure given that it would have taken into account infant weight as well as gestational age and allowed for the inclusion of all infants born in the province. However, the use of weight-for-age charts for assessing fetal growth has limitations. Data used to create the size-for-gestational-age charts are based on the weight distributions of infants who are born at a given gestational age, but do not include weights of fetuses that remain *in utero* at each gestational age.³² This is especially problematic for infants born preterm. Preterm births are not normal pregnancies and should not be used to characterize the growth patterns of the full conception cohort.³² The charts are therefore based on the weights of an extremely small fraction of the total birth population and introduce a bias into studies of fetal growth. The limitations of prenatal growth standards have deterred some neonatologists from using them to replace birthweight standards.³³ The lack of a standard definition for high birthweight meant that direct comparisons could not be made with some other studies.

Increasing high birthweight rates and mean birthweight have been accompanied by significant declines in the proportion of infants born in the low birthweight range. Increases in infant birthweight are at least partly tied to changes in maternal socio-demographic characteristics including increasing maternal age and education. As conditions such as overweight, obesity and diabetes continue to rise, it is expected that the proportion of bigger babies will grow. However, this paper provides some evidence that the risk of abnormal birthweight has a lower association with maternal age than in previous decades. The monitoring of birthweight rates and the relative contribution of the determinants of fetal growth will be a vital part of informing policy and programs related to the provision of prenatal care to pregnant women. Intervention efforts, which often target mothers at risk for delivering low birthweight infants – such as those having low socio-economic status and those who smoke during pregnancy – should be modified to accommodate the growing group of mothers at risk for delivering high birthweight infants.

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RÉSUMÉ

Objectif : Déterminer si les tendances observées dans le poids de naissance s'accompagnent de changements dans le profil sociodémographique des mères (âge, état matrimonial et scolarité).

Méthode : Nous avons mené une étude représentative des bébés uniques nés à terme à Terre-Neuve-et-Labrador, au Canada, entre 1992 et 2005 (N=66 638). À l'aide de tests d'hypothèses pour grand échantillon menés sur deux sous-populations, nous avons déterminé si les écarts dans le poids de naissance moyen, les proportions de nourrissons présentant une insuffisance ou un excédent de poids à la naissance, et le profil sociodémographique des mères entre 1992-1995 et 2002-2005 étaient significatifs. À l'aide de tests du khi-carré, nous avons testé les

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associations entre les deux groupes de poids de naissance et l'âge, la scolarité et l'état matrimonial des mères. Par analyse de régression logistique multivariée, nous avons examiné l'interaction de ces effets dans le temps.

Résultats : Sur les 66 638 nourrissons inclus dans l'étude, 54 256 (81,4 %) avaient un poids normal à la naissance (2 500 à 4 000 g); 11 305 (17 %) avaient un excédent de poids à la naissance (>4 000 g), et 1 077 (1,6 %) avaient un poids insuffisant à la naissance (<2 500 g). Le taux d'insuffisance de poids à la naissance a significativement diminué entre 1992 et 1995 comparé à la période de 2002 à 2005 (de 1,9 % à 1,3 % : $p<0,01$). Le taux d'excédent de poids à la naissance a significativement augmenté sur les deux mêmes périodes (de 16,2 % à 17,5 % : $p<0,01$). Le poids de naissance moyen a augmenté, passant de 3 529 g à 3 566 g ($p<0,01$). Comparées aux femmes ayant accouché entre 1992 et 1995, celles qui ont accouché entre 2002 et 2005 étaient plus susceptibles d'être plus âgées, plus scolarisées et de n'avoir jamais été mariées. Le poids de naissance présentait une corrélation significative avec l'âge, la scolarité et l'état matrimonial de la mère.

Conclusion : Les changements dans le profil démographique des mères sont associés à la tendance haussière du poids de naissance des bébés à Terre-Neuve-et-Labrador.

Mots clés : poids de naissance; tendances; naissance à terme; Terre-Neuve-et-Labrador

BOOK REVIEW

Well Beings: A Guide to Health in Child Care (Third Edition)

Danielle Grenier, Denis Leduc (Eds.), Ottawa, ON: Canadian Paediatric Society, 2008; 448 pp., CDN \$69.95

The third edition of *Well Beings* is an up-to-date resource guide on health and safety in child care. The book is primarily written for child care and public health professionals, however it would be an invaluable resource for early childhood education instructors and their students. As well, any professional working with young children and families in Canada (e.g., public health nurses, child and educational psychologists, physicians, mental health practitioners) would benefit from adding this publication to their resource library. Most importantly, public health professionals who license and set policy on child care in their respective regions would be well served by having a national resource to supplement their specialized and local knowledge base. Finally, although parents are not the target audience, many of the topics reviewed for best practice in caring for young infants and children would be highly beneficial for parents, first as a personal resource, and second as a guide to facilitate child care discussions between parents, early childhood educators, and health practitioners.

The text is written in an informative, straightforward and practical way allowing a wide variety of audiences to access the information presented. *Well Beings* is divided into 16 chapters, beginning with an introductory description to the early learning and child care field and covering topics focused on health and safety issues such as: nutrition, dental health, safety standards, prevention, response and treatment of injuries, infections, emergencies, and medical conditions. Reflective of current issues in both research and practice in child care is the inclusion of chapters dealing with: children's emotional well-being; how to be

knowledgeable and supportive of including children with special needs in child care settings; protecting children from maltreatment; and two chapters addressing caregivers' physical and emotional health needs (a necessary addition for a field with excessively high staff turnover). Surprisingly, very little attention was given to the promotion of early social development and care. In addition, more detailed information could have been placed on early childhood mental health and early intervention with the provision of current references pertaining to social and emotional development and well-being. One other specific area that could have been further enhanced is parent-practitioner communication. The message to communicate and build partnerships with families is strongly endorsed throughout the guide, however a full chapter could have been dedicated to this vital relationship. *Well Beings* provides a solid overview of the topics as they relate to early child care and lists additional resources encouraging further and ongoing independent learning (www.caringforkids.cps.ca).

In sum, this book makes a valuable contribution to the child care field by combining evidence-based and practical information for its broad audience. The editors have managed to use an extensive team of contributors and reviewers from across multiple disciplines related to child care development, health, and safety and the guide keenly embodies this expert knowledge. The most important "take-home" message is that children do not grow and develop in isolation, and this book is a testament to those who work in the early child care profession, and who help shape the lives of young infants and children in their care every day.

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