William J. Kierans, MA, P.R.W. Kendall, MBBS, FRCPC, Leslie T. Foster, BSc, MA, PhD, Robert M. Liston, MB, ChB, FRCSC, FRCOG, Terry Tuk, BSc

New birth weight and gestational age charts for the British Columbia population

Gender-specific data are now available to help evaluate the health of infants born in BC.

ABSTRACT: The birth weight charts presented here are part of a series of British Columbia–specific charts that include body length, head circumference, ethnic group, geographic region, and neighborhood income quintile. Because birth weight charts can be used to identify infants who exhibit accelerated or retarded intrauterine growth compared with other infants in the same population, they are useful for evaluating nutritional status and postnatal growth. The gender-specific charts presented here provide physicians with additional clinically applicable references to supplement the newly approved overall British Columbia birth weight chart that will soon appear in hospitals. Data recording and analyses practices have assured the accuracy of these charts and allowed them to reflect the particular population mix in BC, the availability of medical care and other health-related services for infants, and the context in which those services are delivered.

Birth weight and gestational age are two very important determinants not only of disability and death among newborn infants but also of their subsequent health and well-being. Charts showing the distribution of birth weights at each gestational age gained wide acceptance after Lubchenco and colleagues[1] presented intrauterine growth charts in the now classic 1963 article that recommended the use of such charts in evaluating the nutritional status of newborns and the postnatal growth of premature infants.

Since then, numerous charts have been published depicting various populations in locations throughout the world, including British Columbia[2-4] and Canada.[5-7] The British Columbia Vital Statistics Agency (BCVSA) published the first BC-specific chart in 1990,[2] followed by comprehensive reports in 1993[3] and 2004.[4] The British Columbia Reproductive Care Program (BCRCP) has recently approved the 2004 overall chart as the standard for births in BC and it will soon appear on the Newborn Record in provincial hospitals.[8]

There is a growing preference for gender-specific charts because females are at lower risk for mortality and morbidity than males despite their smaller size at the same gestational age.[9,10] Gender-specific charts are presented here to supplement the overall chart that will appear on the Newborn Record in hospitals. It is hoped that these charts will provide physicians and other health care professionals with additional clinically applicable references based solely on births to BC residents.

Methods

The charts presented here are based on data available from birth registrations and notices of birth received at BCVSA detailing events that occurred from 1 January 1981 to 31 December 2000. Twenty years of data are considered sufficient to provide highly accurate and reliable summary statistics for both genders, particularly at early gestations. Births in Alberta that involved BC residents were also included because previous work has indicated

Mr Kierans is an epidemiology biostatistician at the British Columbia Vital Statistics Agency. Dr Kendall is British Columbia's Provincial Health Officer. Dr Foster is an adjunct professor in the School of Child and Youth Care at the University of Victoria. Dr Liston is head of the Department of Obstetrics and Gynaecology at the University of British Columbia. Mr Tuk is director of Knowledge Integration and Development, BC Ministry of Health.

the potential for skewed results if those births were not included.[11]

The full data file contained 882 390 records of live births to residents of BC. Analyses were restricted to singleton live births between 20 and 44 completed weeks of gestation and weights less than 7000 g. Records where the weight, gestational age, or gender were missing and four cases where the weight was grossly at variance with the gestational age and not correctable by reference to original documents were excluded.

Data were analysed using SAS Release 8.2, leased and maintained by the British Columbia Ministry of Labour and Citizens' Services. Specialized graphic output was produced using Microsoft Excel Version 2002. Smoothing of the charts was accomplished using a third-order polynomial calculated as the least squares fit through data points according to the following equation: $y = b + c_1x + c_2x^2 + c_3x^3$ where b and c are constants.

These data span 20 years and it is possible that median birth weight standards at each gestational age may have changed during that period. To address this possibility, the medians were plotted in five 4-year periods from 1981 to 2000.

The confidentiality of BCVSA records was protected. No unique identifiers were used in any analysis. Birth registration numbers were included in the computer file as links to original documents in cases where verification was required. Access to the data was restricted to one investigator (W.K.), who prepared and ran all analysis programs and obtained the output. All programs and output were saved for review by BCVSA and all output was examined for unique identifiers, "small N cells," and personal, confidential, or sensitive information to ensure observance of the privacy requirements of BCVSA.

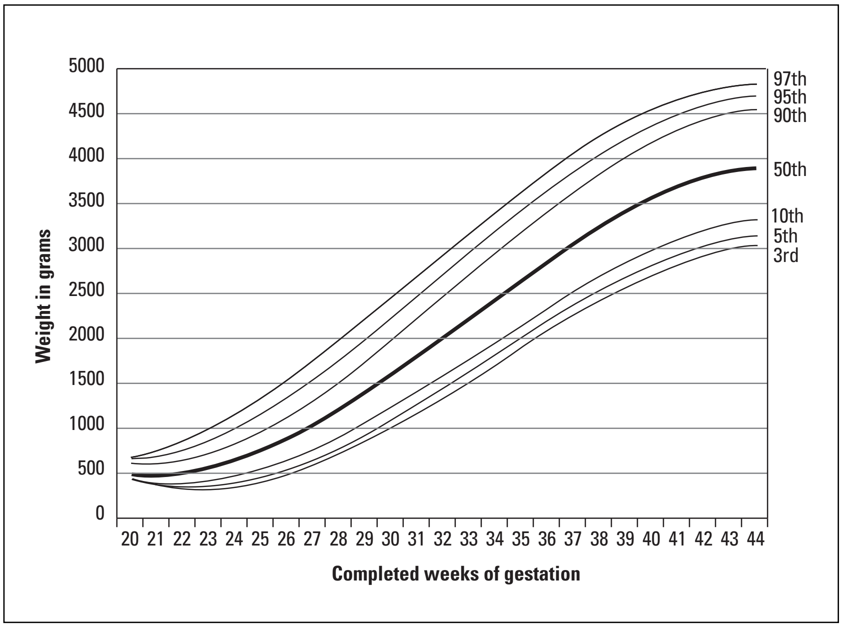

Figure 1. Smoothed* percentiles for singleton males.

*Third-order polynomial calculated as the least squares fit through points using the equation $y = b+c_1x +c_2x^2+c_3x^3$ where b and c are constants.

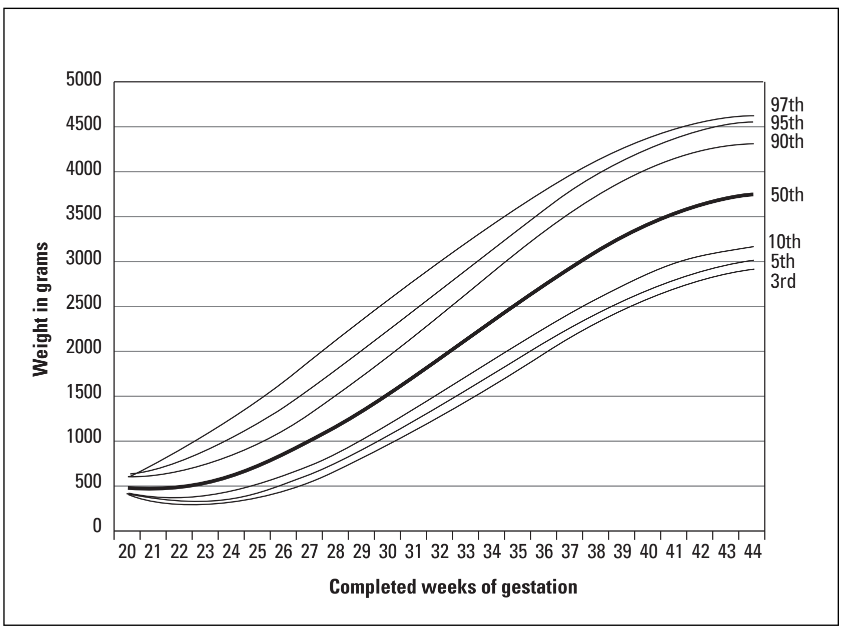

Figure 2. Smoothed* percentiles for singleton females.

*Third-order polynomial calculated as the least squares fit through points using the equation $y = b+c_1x +c_2x^2+c_3x^3$ where b and c are constants.

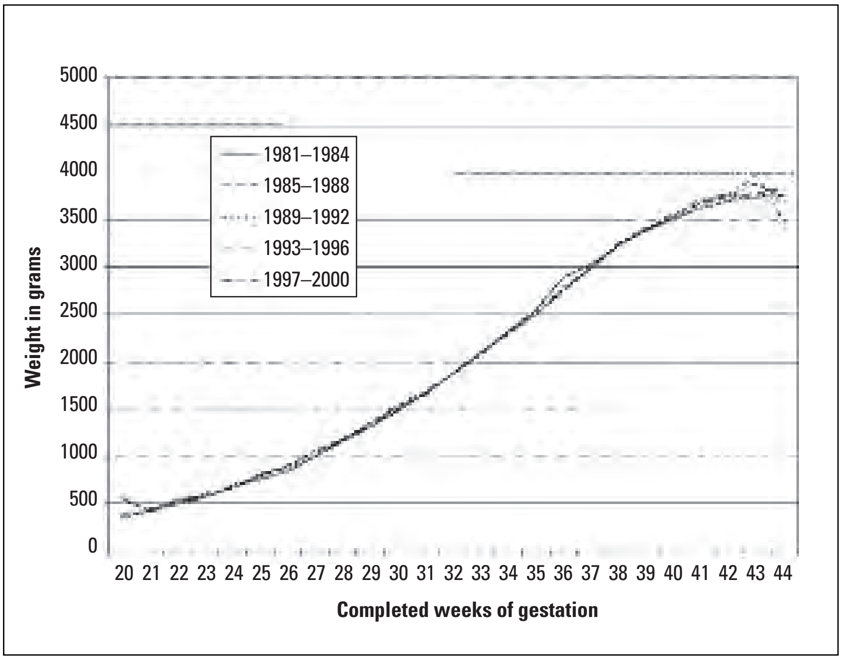

Figure 3. Medians (50th percentile raw values) in four-year periods, 1981-2000.

Results

After the exclusions noted previously, there were 442 848 singleton male and 418 945 singleton female birth records. There were 26 150 preterm male births (5.90% prior to 37 weeks) and 21 072 female preterm births (5.03%); 25 218 postterm male births (5.69% after 41 weeks) and 23 312 postterm female births (5.56%). Average birth weight was 3552 g for full-term male infants and 3417 g for females. For preterm males and females it was 2448 g and 2376 g, respectively, and for postterm males and females it was 3828 g and 3663 g, respectively.

Figure 1 shows the smoothed percentile curves for males and Figure 2 shows the smoothed percentile curves for females. At 20 and 21 weeks the median birth weights for boys were similar to those for girls, but thereafter boys were heavier and the median difference steadily increased to 150 g at term. Figure 3 shows the medians during five 4-year periods. While there were some fluctuations, the curves were almost indistinguishable.

Descriptive statistics for the raw values at each week of gestation are shown for singleton males and females on the BCVSA web site (as Tables 6.1.4 and 6.1.5, respectively).[12] There were sufficient numbers of cases even at early gestational ages to provide reliable raw-value estimates of the 3rd, 5th, 50th (median), 90th, 95th, and 97th percentiles. The tables show positive "blips" in the 95th and 97th percentiles for males at 30 weeks gestation and in the 90th, 95th, and 97th percentiles for females at 28 and 30 weeks. Excursions at those particular gestational ages have been reported by other Canadian population-based studies[5,6] and have been attributed to underestimates of gestational ages.

Discussion

Birth weight charts are intended to be used to identify infants who exhibit accelerated or retarded intrauterine growth compared with other infants in the same population. Accordingly, an individual infant should be compared with other infants in a population with comparable risk demographics, access to medical care, and other factors known to affect intrauterine growth and duration. Although national and provincial charts have been available for some years, the current recommendation is to update them periodically to reflect ongoing changes in local conditions. The standards that previously appeared on the Newborn Record in BC hospitals were modifications of charts based on Australian[13] births and were shown[3] to underestimate BC birth weights at each gestational age. The charts recently approved by BCRCP to replace previous versions reflect the particular population mix in BC, the availability of medical care and other health-related services for newborns, and the context in which those services are delivered.

According to data collected for the new charts, boys weighed more than girls at virtually all gestational ages. This finding is consistent with Canadian studies using large databases, which have consistently reported differences across the full spectrum of gestational ages.[3-7] As noted previously, current preference suggests separate charts for male and female assessment. Despite their smaller size, females are at lower risk for mortality and morbidity than males at the same gestational age.[9,10]

The validity of gestational age estimates has been a question that has plagued birth weight by gestational age studies. It has been shown in one study that the use of the mother's report of the onset of the last normal menstrual period can result in a less accurate estimate than would be obtained with ultrasound dating.[14] To address the problem, a recent Canadian study by Kramer and colleagues[6] used a complex procedure where infants were excluded from further analysis based on the probability, derived from a maximum likelihood algorithm, that an alleged preterm or postterm infant's true gestational age was 40 weeks. Data for singleton boys and girls were presented, so it is appropriate to compare Kramer's results with those reported here. Supplementary analyses of our results and Kramer's indicated that in both studies the 90th percentiles, where errors would be most apparent, were remarkably similar before 27 and after 36 weeks. However, in the interim period, the Kramer study showed weights for both genders along the 90th percentile that were about 60 to 70 g less than in our study. The same pattern was apparent for the 50th and 10th percentiles, but the differences were reduced. Although the possibility of an accelerated growth pattern during weeks 27 to 36 in BC cannot be ruled out, the differences were commensurate with the exclusion strategy used in the Kramer study. Considering the size of the differences between 27 and 36 weeks, those results do not detract from the reference value of the BC charts.

A further assurance of the accuracy of the charts reported here is the fact that we had access to original documents and could correct inconsistent birth weight and gestational age values. Also, the main source of BCVSA gestation data prior to 1993 was the notice of birth completed by the attending physician, supplemented by the birth registration completed by the mother, but since 1993 the notice of birth has been the sole source. In most cases, the physician had access to ultrasound assessment performed in the second trimester. There is the added assurance that our results are based on births to residents of BC with the inclusion of births to residents occurring in Alberta.

Births with weights below the 10th percentile are widely accepted as the operational definition of intrauterine growth retardation, "light for date," or small for gestational age, and previous charts usually included a line showing the 10th percentile. However, there has been a recent disposition to report the 3rd and 5th percentiles as additional cut-off points for risk assessment and there is some evidence[15] that, for term infants at least, the 3rd percentile is the important threshold for increased mortality and morbidity risk. In recognition of the need for improved discrimination, we have included the 3rd, 5th, 95th, and 97th percentiles, which were not available on previous charts.

While birth outcomes vary by regional health districts,[16] there is no reason to believe that individual health authority birth weight charts differ from the provincial picture.[4]

Here we have presented charts for singleton males and females. However, there is growing evidence that other demographic segments show discordant morbidity and/or mortality when standard charts are used for risk assessment.[4] In recognition of the potential relevance of segment-specific charts, BCVSA has developed BC charts[4] based on births to First Nations, Chinese, and South Asian parents; neighborhood income levels; and other sectors within our province. Those charts are available at the BCVSA[12] and BCRCP[17] web sites.

The birth weight charts described above and those presented here can be supplemented by other British Columbia–specific charts of body length and head circumference for all births, males, females, singleton males, and singleton females. As far as we know, the British Columbia Vital Statistics Agency is the first vital event registry to collect population-based body length and head circumference data. The additional charts are available from BCVSA and BCRCP[4,12,17] and updates are planned for a future article in the *BC Medical Journal*. It is hoped that the data and charts presented here and on the BCVSA and BCRCP web sites will satisfy the need for information based on ever-changing populations and the advancing needs of attending physicians and other health care professionals.

In recognition of the potential relevance of segment-specific charts, BCVSA has developed BC charts based on births to First Nations, Chinese, and South Asian parents; neighborhood income levels; and other sectors within our province.

Acknowledgments

The authors wish to thank individuals formerly at BCVSA: R.J. Danderfer, under whose auspices this study was conducted, and J. Mohamed, who reviewed the analysis programs and output. The authors also wish to recognize other authors of the original report from which these data were obtained.

Competing interests

None declared.

References

1. Lubchenco LO, Hansman C, Dressler M, et al. Intrauterine growth as estimated from liveborn birth-weight data at 24 to 42 weeks of gestation. Pediatrics 1963; 32:793-800.
2. Foster LT, Danderfer RJ (eds). Vital Statistics of the Province of British Columbia, Division of Vital Statistics, Annual Report, 1989. Victoria, BC: British Columbia Vital Statistics Agency; 1990.
3. Kierans WJ, Collison MA, Foster LT, et al. Charting Birth Outcome in British Columbia: Determinants of Optimal Health and Ultimate Risk. Victoria, BC: British Columbia Vital Statistics Agency; 1993.
4. Kierans WJ, Kramer MS, Wilkins R, et al. Charting Birth Outcome in British Columbia: Determinants of Optimal Health and Ultimate Risk—An Expansion and Update. Victoria, BC: British Columbia Vital Statistics Agency; 2004. www.vs.gov.bc.ca/stats/pdf/ChartingBirthOutcomeReport.pdf (accessed 15 October 2005).
5. Arbuckle T, Wilkins R, Sherman G. Birth weight percentiles by gestational age in Canada. J Obstet Gynecol 1993;81:39-48.
6. Kramer M, Platt R, Wen S, et al. A new and improved population-based reference for birth weight for gestational age. Pediatrics 2002;108:E35.
7. Robertson CM, Svenson LW, Kyle JM. Birth weight by gestational age for Albertan liveborn infants, 1985 through 1998. J Obstet Gynaecol Can 2002;24:138-148.
8. British Columbia Reproductive Care Program. Minutes of the Provincial Perinatal Steering Committee. 25 June 2004.
9. World Health Organization. Physical Status: The Use And Interpretation of Anthropometry. Geneva: WHO;1995:854.
10. Joseph KS, Wilkins R, Dodds L, et al. Customized birth weight for gestational age standards: Perinatal mortality patterns are consistent with separate standards for males and females but not for blacks and whites. BMC Pregnancy Childbirth 2005;5:3.
11. Burr KF, McKee B, Foster LT, et al. Interprovincial data requirements for local health indicators: The British Columbia experience. Health Rep 1995;7:17-24.
12. British Columbia Vital Statistics Agency. Charting Birth Outcome in British Columbia. 6.1.Appendix 1 Descriptive Statistics and Charts. www.vs.gov.bc.ca/stats/pdf/Appendix1.pdf (accessed 15 October 2005).
13. Kitchen WH, Robinson HP, Dickinson AJ. Revised intrauterine growth curves for an Australian population. Aust Paediatr J 1983;19:157-161.
14. Kramer M, McLean F, Boyd M, et al. The validity of gestational age estimation by menstrual dating in term, preterm, postterm gestations. JAMA 1988;260:3306-3308.
15. McIntire DD, Bloom SL, Casey BM, et al. Birth weight in relation to morbidity and mortality among newborn infants. N Engl J Med 2003;340:1234-1238.
16. Danderfer RJ. Selected Vital Statistics and Health Status Indicators: One Hundred Twenty-ninth Annual Report 2000. Victoria: British Columbia Vital Statistics Agency; 2001A.
17. British Columbia Reproductive Care Program. www.rcp.gov.bc.ca/periforms.htm (accessed 2 December 2005). BCMJ