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New birth body length and head circumference charts for the British Columbia population

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

ABSTRACT

Background: **A study of newborn growth data based on male and female births in British Columbia has permitted the preparation of new gender-specific body length and head circumference charts. These are now available to supplement the recently approved BC standards and provide physicians with additional, clinically applicable references.**

Methods: **Data on birth body length and head circumference were collected at BC hospitals from 1995 to 2000. The summary statistics were then compared with those from four other studies.**

Results: **When anthropometric measures from BC and elsewhere were compared, body length in BC tended to be slightly greater, while head circumference closely approximated the values found in the other studies at each week of gestation. Males exhibited progressively greater median length and circumference compared to females from early gestation, with differences of approximately 1 cm at term.**

Conclusions: **Data recording and analysis practices used in the study assured accuracy of the charts prescribed here, which can be considered replacements for previous versions. The charts are especially useful because they reflect the particular population mix in BC, the availability of medical care and other health-related services for infants, and the context in which health services are delivered.**

Background

In a previous study we presented birth weight by gestational age charts[1] based on live birth registrations and notices of birth to residents of British Columbia from 1981 to 2000. In this study we considered birth body length and head circumference, which are important prognostic and etiologic indicators that can be used to assess the quality of intrauterine growth and to determine the need for additional surveillance.[2] Although these two measures are not as predictive of mortality and morbidity as birth weight by gestational age, they can be used to diagnose potential pathological conditions at birth.[3] They can also be used to diagnose abnormalities in body pro-

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portions, such as achondroplasia, hydrocephalus, and microcephalus.[4]

Charts showing the distributions of body length and head circumference at each gestational age have been available to BC physicians for several decades,[3-6] but have been based on small-sample ad hoc studies in hospitals. The body length and head circumference standards that previously appeared on the Newborn Record in BC hospitals were modifications of charts based on births in a hospital in Melbourne, Australia.[5]

In 1993, the British Columbia Vital Statistics Agency (BCVSA) produced a report that included only birth weight by gestational age charts.[7] In recognition of the importance of body length and head circumference as well, BCVSA began collecting and recording data for both measures in 1995. The number of recorded observations has increased each year and reliable population statistics are now feasible. Charts based on both measures were presented in a BCVSA birth chart report[8] in 2004 to provide population statistics and enable research on these two important outcome indicators. The British Columbia Reproductive Care Program has recently approved[9] the 2004 overall charts (i.e., charts combining male and female statistics) as the standards for births in BC, and these standards now appear on the Newborn Record in provincial hospitals.[10]

Gender-specific charts for birth body length and head circumference are presented here to supplement the overall charts that appear in provincial hospitals. Like the work presented earlier for birth weight by gestational age,[1] these charts provide physicians and other health care professionals with additional, clinically applicable references based solely on births to BC residents.

Methods

Birth body length and head circumference were added to the Notice of Birth in 1994 and BCVSA has been recording both since 1995. The charts presented here are based on records of live births from 1 January 1995 to 31 December 2000. Records with missing values for length, head circumference, gestational age, or gender were excluded from further analysis. In addition, cases were excluded where either the body length or head circumference were grossly improbable (>5 standard deviations from gestational age mean) and not correctable by reference to original documents. In response to concerns regarding the accuracy of gestational age estimates,[2] which have usually been based on the mother's report of the onset of the last normal menstrual period and can result in inaccurate estimates when compared to ultrasound dating,[11] BCVSA obtained gestation data from the notice of birth completed by the attending physician rather than the birth registration completed by the mother. These data were considered more reliable, given that the physician had access to ultrasound assessment usually performed in the second trimester.

In 1995, 64% of birth records in the data file included measurements for length and head circumference. The percentage consistently increased each year until 2000, when it reached 94%. Measuring body length and, to a lesser extent, head circumference of newborns can present difficulties[2] and requires a combination of skill, speed, and patience. Although body length and head circumference are routinely measured after delivery, BCVSA is the first vital event registry in Canada, and as far as we know in the world, to collect and record population-based measurements of both. As this involved a new transcription and recording protocol, we also investigated the statistical quality of the data. The summary statistics from this study were compared with those from four other studies at each week of gestation.[3,6] The standards reported in the other studies were previously used in BC.

These charts provide physicians and other health care professionals with additional, clinically applicable references based solely on births to BC residents.

As in the previous study, data were analyzed using SAS Release 8.2, leased and maintained by the British Columbia Ministry of Labour and Citizens' Services and operated on the Microsoft Windows XP platform. Specialized graphic output was produced using Microsoft Excel software Version 2002.

Charts for body length and head circumference were produced for singleton males and females separately. There were sufficient births to report

Table. Descriptive statistics for singleton males and females in four gestational periods, 1995–2000.

Gestational period	Male					Female				
	N	Max	Min	Mean	Standard deviation	N	Max	Min	Mean	Standard deviation
	Body length (cm)									
25 to 30 weeks	205	57	27	39.43	5.08	149	53	25	38.81	4.80
31 to 36 weeks	4495	59	28	48.09	3.03	3573	65	18	47.52	3.10
37 to 41 weeks	95 254	67	34	52.15	2.62	91 600	69	33	51.37	2.54
42 to 44 weeks	2092	62	36	53.43	2.62	1946	64	42	52.57	2.54
Live births	102 046	67	27	51.98	2.84	97 268	69	18	51.23	2.72
	Head circumference (cm)									
25 to 30 weeks	205	36	20	27.39	3.15	149	35	21	26.68	2.78
31 to 36 weeks	4495	43	18	32.66	1.79	3573	40	23	32.24	1.73
37 to 41 weeks	95 254	54	20	34.79	1.53	91 600	54	20	34.20	1.43
42 to 44 weeks	2092	40	29	35.58	1.43	1946	45	25	34.89	1.42
Live births	102 046	54	18	34.70	1.64	97 268	54	20	34.13	1.52

Source: British Columbia Vital Statistics Agency

the 5th, 10th, 50th (median), 90th, and 95th percentiles at 25 to 44 weeks of gestation. Smoothing of the curves 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.

The confidentiality of BCVSA records was protected to ensure observance of the agency's privacy requirements, which have been fully described elsewhere.[8]

Results

After the exclusions noted previously, there were 102 046 singleton male and 97 268 singleton female birth records. Less than 1% of these records (995 male and 970 female cases) were excluded because the values for body length or head circumference were grossly inconsistent with gestational age means. Separate analysis indicated that the exclusion of these cases did not alter the percentile values used to produce the curves reported here or those previously published.[8,10] Neonatal mortality was 3.0 for every 1000 live births in the full analysis file, postneonatal mortality was 1.4 for every 1000 live births, the preterm rate was 65.7 for every 1000 live births, and the low birth weight rate was 51.2 for every 1000 live births. These rates are comparable to the rates among all BC babies born during the study period.[12]

The **Table** shows summary descriptive statistics in four gestational periods for birth body length and head circumference in both genders. Males had greater average length and circumference compared to females in all four gestational periods.

The comparison of the BC medians with those from four other studies at each week of gestation indicated very similar values on each anthropometric measure.[3-6] The ratio of the BC values to those from the other studies ranged from 0.98 to 1.06, indicating close similarities, with the BC values tending to be slightly greater than those in other studies. The BC body length values were greater at virtually all gestational ages, while the BC head circumference values fluctuated close to those from other studies. Also, the differences tended to increase depending on the elapsed time since the data were collected for earlier studies.

Figure 1 and **Figure 2** show the smoothed percentiles for body length for males and females, respectively. At 25 and 26 weeks of gestational age, both genders showed virtually identical median body length. However, from 27 weeks, males had increasingly greater length than females, culminating in a difference of approximately 1 cm at term (37 to 41 weeks). The 5th, 10th, and 90th percentiles exhibited slightly greater comparative differences but none exceeded 2 cm. The 95th percentile showed larger female values compared to males prior to 30 weeks gestational age, with a crossover at 30 weeks, after which males had progressively greater values that approached but did not exceed 2 cm at term.

Figure 3 and **Figure 4** show the smoothed percentiles for head circumference for males and females, respectively. Males exhibited slightly greater

median circumferences from 25 to 44 weeks gestational age, but the differences did not exceed 1 cm. The 5th, 10th, and 90th percentiles exhibited similar comparative patterns but none of the differences exceeded 2 cm. The 95th percentiles again showed greater female values prior to 30 weeks, with a crossover at 30 weeks, and thereafter males had greater values than females. Close inspection of the data indicated that a few females recorded relatively high values on both dimensions prior to 30 weeks. The high values were few in number and did not meet the exclusion criteria, but they inflated the smoothed 95th percentile values for females compared to males. It is likely that the high values were due to measurement, recording, or transcription errors and not due to underestimation of gestational age because the birth weight values for the identified cases were well within the expected range.

In a recent BCVSA report, descriptive statistics for the raw values at each week of gestation are shown for singleton male and female birth length (see Tables 6.1.33 and 6.1.34).[8] The same source shows the raw values for male and female head circumference (see Tables 6.1.31 and 6.1.32). The report indicates there were relatively few cases at the extremes of gestational age and on the edges of the distributions. While this resulted in fluctuations in the raw values, the smoothed percentile curves reliably represented the trends.

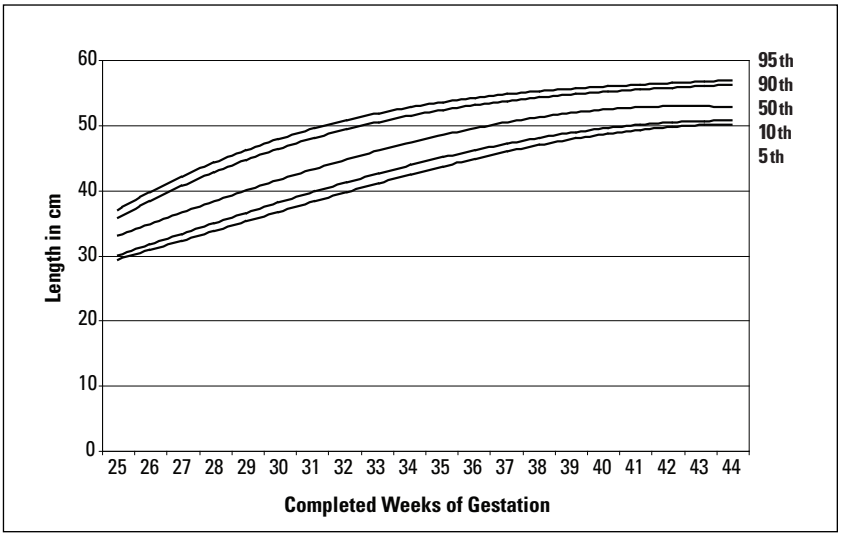

Figure 1. Smoothed* percentiles for male body length, 1995–2000.

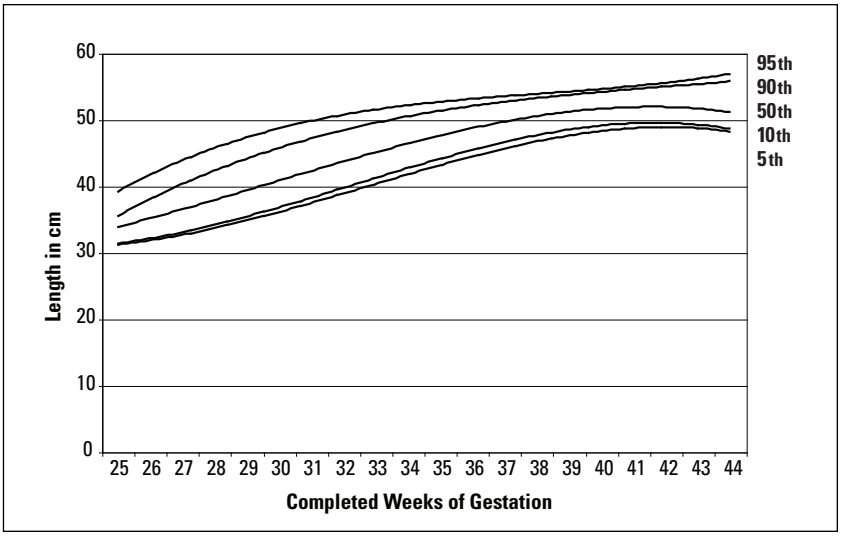

Figure 2. Smoothed* percentiles for female body length, 1995–2000.

* 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.

Conclusions

The charts presented here are based solely on births to residents of BC. As such, they can be considered representative of births with our particular risk demographics, access to medical care, and other factors known to affect intrauterine growth and duration. The fact that the charts are BC-based addresses the concern that previously available charts were based on selective, out-of-date, small samples, usually collected in hospitals with narrow catchment areas. In addition, the charts here meet the current recommendation for periodically updated, population-specific charts.[2,13,14]

As far as we know, these are the first population-based charts for body length and head circumference measurements. Despite the difficulties inherent in obtaining, transcribing, recording, and editing these data, comparisons with charts previously used in BC indicate that the BCVSA

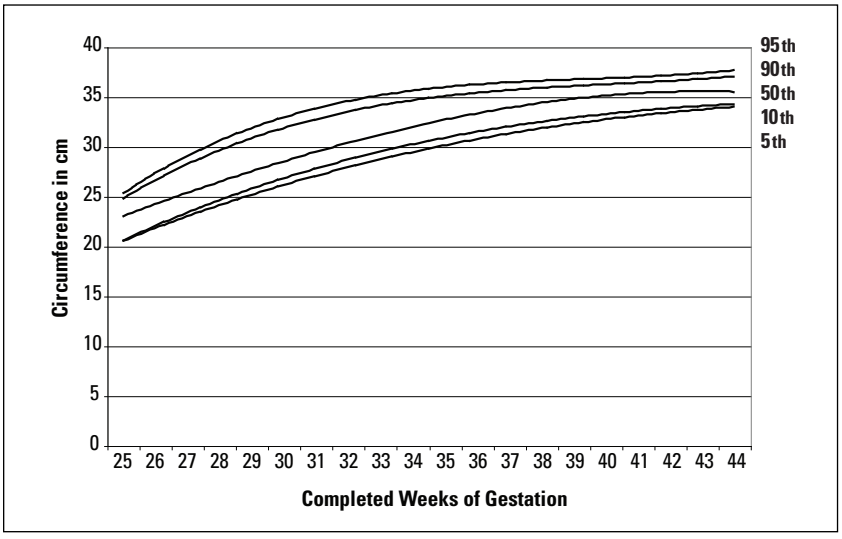

Figure 3. Smoothed* percentiles for male head circumference, 1995–2000.

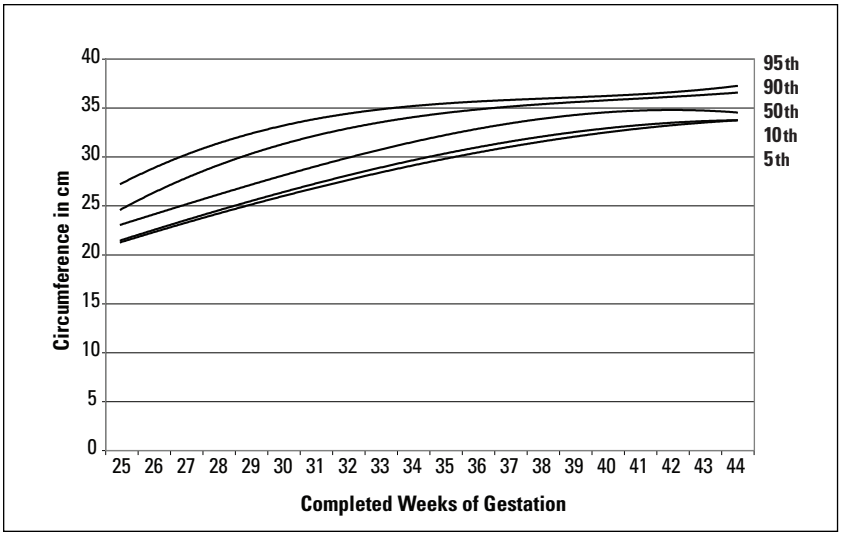

Figure 4. Smoothed* percentiles for female head circumference, 1995–2000.

* 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.

data are commensurate with data collected for "in-hospital" studies.[3-6] There were differences between our charts and those previously available to BC physicians, but the differences were minor and partially due to the time elapsed since data were collected for the earlier studies. Comparing the curves in three of the studies[3,4,6] with recently collected data[14,15] indicates increased birth size in the interim so the differences are not surprising.

According to the BCVSA data, BC male neonates had greater average body length and head circumference than females, which is in accord with their relatively higher average birth weight.[1] This in itself is not new, but the fact that males showed progressively greater length and head dimensions from early gestational ages is noteworthy. Some other studies have reported greater male body length and head circumference averages at 40 weeks[6] or overall,[13] while others[3-5] have reported no reliable gender differences. Our data included sufficient numbers to report reliable gender differences from early gestational ages.

The curves for both dimensions prior to 35 weeks had wide positively skewed distributions that narrowed at term. There were a few high female head circumference values before 30 weeks, but both dimensions exhibited wide distributions prior to 35 weeks. While other studies[5,6] have shown slightly wider distributions at early compared to later gestations, the other studies used highly selective samples and the curves were smoothed visually. Further experience with full population data will be required to confirm the reliability of the wide distributions at early gestations.

As with all population-based studies, recording and transcribing errors and underestimates of gestational age may have been included in the analysis. However, we believe our comprehensive review of the data and the availability of original documents have reduced these errors to a minimum. Nonetheless, a few errors at very preterm gestations can have relatively large impacts on size for gestational age. In addition, the number of available cases from 1995 to 2000 was insufficient to produce charts for specific ethnic groups, geographic regions, and secular trends—charts that we were able to present in the recent birth weight by gestational age report because we had sufficient birth weight data.[8] Despite these limitations, we believe the body length and head cir-

cumference charts can still make a functional contribution to neonatal care in BC.

Used in combination with the previously published birth weight information,[1] the charts presented here can provide useful standards to evaluate the gender-specific body proportions of newborns. They will also provide BC physicians and other health care professionals with a useful supplement to the overall charts that appear on the Newborn Record in hospitals.[10]

The fact that the charts are BC-based addresses the concern that previously available charts were based on selective, out-of-date, small samples, usually collected in hospitals with narrow catchment areas.

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Competing interests

None declared.

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