Birth Weight Standards in the Live-Born Population in Israel

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Abstract

Background: Lacking curves of "intrauterine" growth, most birthing centers in Israel use United States or Canadian based curves as standards.

Objective: To establish population-based standards of birth weight of live-born infants in Israel.

Methods: Data on birth weight and gestational age were obtained from the registries of the Israel Ministry of Health and Ministry of the Interior. During the 9 year study period there were 1,074,122 infants delivered in Israel; 787,710 (73%) were included in this analysis.

Results: In this study we provide data of birth weight by gestational age of live infants born in Israel between 1993 and 2001. Ranges of birth weight by gestational age are also depicted for singleton and multiple pregnancies. Fetuses in multiple pregnancies grow in a similar manner to singletons until 30 weeks of gestation, after which their growth slows down.

Conclusions: Use of these data as a standard for "intrauterine" growth better represents the Israeli neonatal population than the North American standards. In addition, curves of multiple pregnancies are significantly different from those of singleton pregnancies and might be more appropriate in these pregnancies.

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Most birthing centers in Israel use United States or Canadian based curves of "intrauterine" growth as standards because of the lack of Israeli curves. The aims of this study were to establish population-based standards of birth weight of singletons in Israel and to determine the gestational age at which the growth of singletons diverges from that of multiple births.

Materials and Methods

For the purpose of this study we used the prospectively established database from the Ministry of Interior and the Ministry of Health. This database is established on the basis of the live-birth certificate, a form completed by physicians in each hospital that has a birthing center. Importantly, over 99.9% of births in Israel occur in these birthing centers. By law, each live birth is reported to the Ministry of Interior and Ministry of Health, using the live-birth certificate. This certificate includes demographic, geographic, ethnic and educational data of the parents. It also contains information about the birth and the infant, including gender, birth date, birth weight, maternal age, first day of last menstrual period, number of infants in the delivery, and the presence of major congenital anomalies. Data from this registry collected between 1993 and 2001 were used for this study and included the entire newly born infant population of Israel. There were 1,074,122 infants delivered in Israel during the study period, and 787,710 (73%) were included in this analysis.

Infants for whom gestational age was unknown, infants whose reported gestational age was below 22 or above 44 weeks (n=915, 0.08%) and infants whose birth weight and gestational age were judged by a neonatologist to be erroneous [1] were excluded (n=286,412, 26.6%). Infants with congenital malformations were included in the analysis (n=21,218, 1.97%).

Statistical analysis

Means and percentiles of birth weight were calculated for each completed week of gestational age from 22 to 44 weeks at 1 week intervals. The Kruskal-Wallis test was used to compare birth weight and gestational age differences between singleton and multiples. A *P* value less than 0.05 was considered significant.

Results

Among the 754,713 singleton infants, the average gestational age was 39.5 weeks, which was significantly longer than the 36 weeks found among the 32,997 multiples ($P < 0.0001$). Mean birth weight in singletons was higher (3,270 g) than in multiples (2,310 g) ($P < 0.0001$). Table 1 shows the sample size and the percentile distribution of birth weight by gestational age in the study population. The data may be found in a graphic form at the website address http://www.health.gov.il under the heading: Statistics, Mother and Child. Figure 1 indicates that the median birth weights of the Israeli infants more closely resemble the birth weights of infants born in Colorado in the 1950s than the birth weights of infants born in the USA in 1991.

There were several differences between singletons and multiples in our population. Table 2 shows the percentiles of birth weights for each gestational age week by gender and parity in singleton versus multiple deliveries. In singleton deliveries, 4.9% of infants were born preterm (less than 37 weeks) and 5.5% were born with low birth weight (<2,500 g). In contrast, the preterm delivery rate among multiples was significantly higher at 49.5% ($P < 0.0001$) and low birth weight was significantly higher at 59.4% ($P < 0.0001$).

Comparison of the 50th percentile of median birth weight by gestational ages in singleton and in multiple deliveries is shown in

Table 1. Birth weight distribution of the 787,710 infants born in Israel between 1993 and 2001 who were included in the study

Gestational age (wk)	No. of observations	Mean ± SD birth weight (g)	Minimum birth weight (g)	Maximum birth weight (g)	50th percentile
22	37	570 ± 87	500	860	530
23	119	588 ± 79	360	800	570
24	247	666 ± 118	500	1,200	650
25	363	758 ± 134	490	1,240	750
26	580	854 ± 151	500	1,410	850
27	664	955 ± 201	480	2,080	960
28	857	1,071 ± 239	340	1,960	1,060
29	1,037	1,232 ± 303	530	2,750	1,210
30	1,454	1,420 ± 361	490	2,950	1,390
31	1,943	1,587 ± 400	560	2,990	1,540
32	3,139	1,857 ± 553	500	3,810	1,740
33	4,009	1,999 ± 497	550	3,800	1,940
34	6,957	2,203 ± 497	670	3,900	2,150
35	11,589	2,430 ± 491	600	4,650	2,380
36	20,665	2,647 ± 481	890	5,000	2,620
37	40,406	2,867 ± 468	1,000	6,290	2,850
38	84,655	3,071 ± 444	900	6,750	3,060
39	146,903	3,228 ± 425	900	6,740	3,210
40	256,036	3,355 ± 425	930	6,870	3,340
41	141,625	3,451 ± 420	910	6,510	3,440
42	52,940	3,512 ± 435	1,020	6,700	3,500
43	8,818	3,465 ± 468	1,280	6,220	3,450
44	2,667	3,407 ± 454	1,610	5,750	3,400

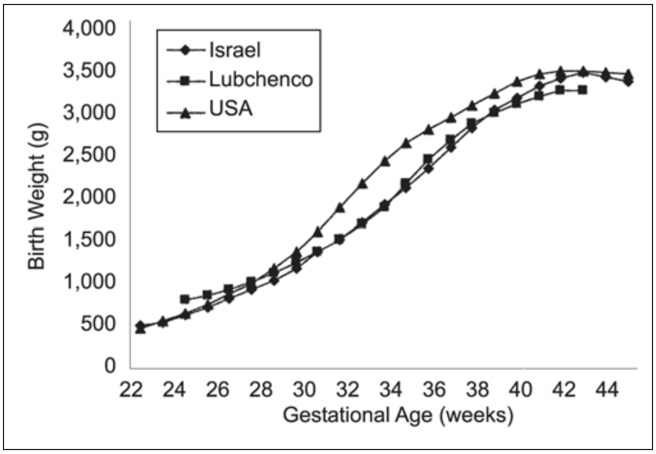

Figure 1. Israeli median birth weights (singleton and multiples) by gestational age data compared with data adapted from Lubchenco et al. [2] on infants born in Colorado between 1948 and 1961 and data adapted from Alexander et al. [4] on all American infants born in 1991.

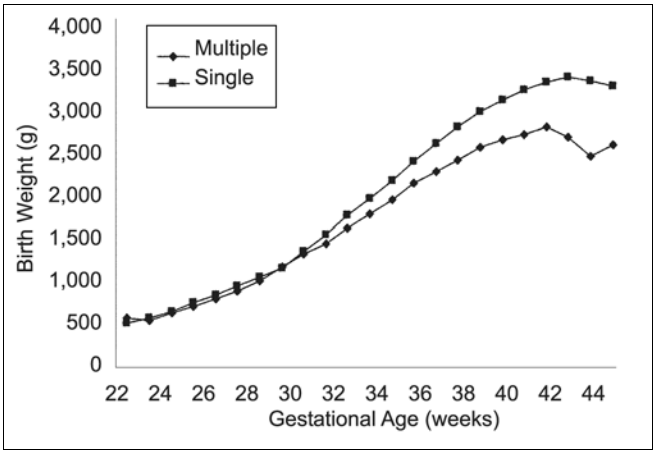

Figure 2. Comparison of the 50th percentile of birth weight by gestational age of singleton- and multiple-delivery infants

Figure 2. There were no significant differences in birth weights in these two groups of infants at gestational ages of 30 weeks or less. From the 31st week, products of multiple gestations had significantly lower birth weight ($P < 0.001$). The difference increased with increasing gestational age. At the 35th week, the difference was 270 g or about 12% of the median birth weights. When using the 10th percentile of singleton infants as the definition for small for gestational age, approximately 50% of male multiple delivery infants and 60% of female multiple delivery infants born at 40 weeks of gestation were small for gestational age.

Discussion

We describe the curves of birth weight by gestational age of live infants born in Israel between 1993 and 2001. We believe these data to be representative of the whole Israeli population since they are based on 73.4% of all infants born in Israel during that period. One-fourth (26.6%) of the infants were not included in the analysis, mainly due to missing gestational age, to some reported gestational ages being below 22 or above 44 weeks, or to a birth weight inappropriate for a given gestational age according to expert opinion [1]. It is important to note that infants with congenital malformations were included in the study, and there is an association between congenital malformations and small for gestational age [3]. However, we do not believe that this inclusion significantly affected our results since the definition of congenital malformations included a very wide range of malformations, most of them minor and unlikely to cause a significant intrauterine growth deviation. Many population-based studies published to date have included such infants [4,5]. With this limitation in mind, we found that the birth weight of Israeli infants born between 1993 and 2001 was distributed by gestational age in a pattern similar to that of infants who were born in the Denver, Colorado area between 1948 and 1961 [2], and smaller than the birth weights reported for infants born in the U.S. in 1991 [4] or in Canada in 1969 [6]. This finding was somewhat surprising; firstly, because most Israeli infants are delivered at or near sea level (a fact that should lead to a relative increase in birth weight, in contrast to infants in the data provided by Lubchenco et al. [1] who were born at a 1 mile-high altitude [2]); secondly, there has been a secular increase in birth weight in the last 50 years [7]. However, many studies conducted worldwide reveal that intrauterine growth curves differ significantly among different populations and in different years [8]. These differences emphasize the need for locally based and temporally updated data on infant birth weight. Comparison of our data with those of Lubchenco et al. [1] and Alexander et al. [4] are in accord with data from the International Collaborative Effort on Birthweight

Table 2. Birth weight for gestational age, percentiles by gender and parity for the study population

	Female							Male						
Gestational age (wk)	1%	5%	10%	50%	90%	95%	99%	1%	5%	10%	50%	90%	95%	99%
Singletons														
22	500	500	500	510	530	610	610	500	500	500	560	670	750	750
23	500	500	500	580	670	700	740	500	500	500	610	750	800	800
24	500	500	500	645	750	860	1110	500	500	530	680	820	870	1000
25	500	520	600	720	900	930	1080	550	590	620	800	940	1000	1070
26	530	640	690	850	1000	1070	1260	520	620	670	890	1060	1160	1200
27	530	570	675	950	1125	1220	1950	510	710	770	1000	1220	1300	1550
28	570	650	730	1030	1310	1400	1720	550	700	780	1120	1400	1500	1800
29	610	720	820	1160	1490	1660	2650	670	780	880	1275	1610	1740	2400
30	670	900	1040	1385	1920	2440	2830	740	850	1020	1440	1830	2100	2920
31	830	1000	1140	1540	2250	2750	2940	800	1030	1150	1620	2290	2640	2950
32	890	1105	1280	1800	3180	3465	3690	940	1190	1340	1845	2950	3290	3690
33	950	1270	1480	1970	3020	3320	3660	1070	1380	1550	2050	2845	3250	3640
34	1200	1480	1650	2200	3070	3370	3680	1300	1610	1760	2300	3110	3410	3710
35	1360	1720	1890	2440	3140	3400	3840	1480	1800	1990	2520	3270	3550	4000
36	1600	1940	2120	2640	3290	3510	3980	1660	2040	2210	2740	3400	3630	4050
37	1850	2160	2330	2840	3410	3620	4070	1920	2260	2440	2960	3550	3770	4210
38	2080	2370	2520	3000	3560	3750	4140	2150	2480	2630	3140	3700	3900	4280
39	2250	2540	2680	3150	3700	3860	4220	2340	2640	2790	3290	3840	4010	4360
40	2370	2650	2790	3270	3810	3980	4320	2450	2770	2910	3410	3970	4140	4480
41	2480	2740	2880	3360	3900	4060	4400	2580	2860	3000	3510	4060	4230	4550
42	2490	2790	2930	3430	3980	4140	4480	2570	2900	3060	3580	4150	4310	4670
43	2400	2700	2850	3390	3950	4150	4510	2410	2810	2980	3520	4150	4330	4660
44	2250	2620	2830	3340	3870	4040	4450	2420	2780	2950	3470	4040	4190	4630
Multiples														
22	500	500	500	530	690	690	690	500	500	500	610	860	860	860
23	500	500	520	550	610	700	700	360	370	500	560	725	750	780
24	500	500	520	630	780	950	1200	500	500	540	650	780	1000	1000
25	500	500	550	700	880	1000	1240	490	510	600	760	1000	1000	1200
26	530	560	640	820	1000	1100	1200	500	500	600	820	1010	1140	1200
27	500	640	710	850	1110	1220	1490	560	700	730	960	1180	1240	1450
28	530	710	800	1050	1320	1480	1750	530	740	800	1030	1310	1470	1880
29	590	820	920	1180	1450	1560	1800	750	890	970	1260	1590	1700	1960
30	710	870	1000	1330	1670	1830	2630	610	930	1070	1400	1680	1820	2360
31	760	1030	1110	1450	1870	2040	2530	750	1040	1190	1530	1920	2100	2400
32	960	1170	1270	1640	2010	2160	2570	980	1230	1350	1700	2090	2200	2500
33	1020	1290	1410	1770	2180	2360	2670	1005	1300	1450	1900	2330	2450	2820
34	1080	1380	1530	1960	2360	2480	2790	1140	1460	1600	2060	2490	2610	2880
35	1300	1600	1730	2150	2600	2730	3000	1380	1690	1830	2260	2700	2830	3140
36	1430	1730	1870	2300	2710	2840	3210	1510	1810	1970	2420	2900	3030	3340
37	1530	1880	2010	2450	2900	3040	3320	1700	1990	2120	2570	3050	3170	3470
38	1680	2010	2150	2600	3050	3190	3440	1800	2070	2220	2700	3200	3310	3600
39	1710	2040	2210	2700	3170	3300	3710	1880	2140	2300	2775	3270	3440	3750
40	1720	2110	2250	2750	3260	3420	3750	1650	2080	2270	2850	3410	3550	3860
41	1880	2090	2280	2800	3400	3600	4000	1980	2230	2390	2980	3530	3700	4030
42	1160	1820	1980	2710	3310	3380	3780	1640	1890	2120	2870	3440	3580	4570
43	1640	1810	1840	2470	3590	3660	3810	1640	1870	1980	2560	3400	3570	4050
44	1730	1730	1850	2610	3310	3350	3350	1750	1750	1750	3050	3500	3500	3500

[8] showing that birth weight of Israeli infants born between 1970 and 1984 is lower than that in most other European and North American countries, and higher than that of black Americans and Japanese born in the same period. These differences may theoretically be due to genetic differences among the different populations considered, but one cannot rule out that environmental differences, such as nutrition, may also play a role.

Interestingly, in spite of the similarity with the birth weight curves of Lubchenco and co-workers [2], our curves differed in a few aspects: between the 34th and 38th week of gestation Israeli infants are smaller, but are heavier at 39 weeks and above. These differences in birth weight in near-term infants may reflect a truly different intrauterine growth pattern, but may also have been due to the active interventions of modern obstetrics, leading to the early delivery of fetuses that sonographically are diagnosed to be small for gestational age and presumed to be at a very high risk of fetal demise [9].

We found, similar to many other studies, a decrease in birth weight after the gestational age of 41 weeks. Although this might indicate a true weight loss, this is unlikely, since other studies that had a similar finding and measured length also found a decrease in length after 41 weeks [10]. While a weight loss is theoretically conceivable, a length loss is not. Thus, one must find another, more tenable explanation for this apparent "weight loss." The most probable explanation is linked to the cross-sectional approach of all so-called intrauterine growth curves. All such curves are in fact based upon a weight measured only once per infant – immediately after delivery. Thus it is likely that these "smaller" infants after 41 weeks have at some point during gestation stopped gaining weight at a "normal" rate, a fact linked to longer gestation. Thus, these infants who exceed 41 weeks may have been smaller all along, or for a significant number of weeks prior to delivery.

As with all population-based studies, this investigation is limited in that data were obtained from different centers (adding an inter-center variance), by different individuals (inter-operator variance), and using different scales (inter-instrument variance). Another limitation is the very small sample size at the lower limits of gestational age. In particular, it is clear that at 22 weeks, the first, fifth and tenth percentiles cannot all be 500 g.

An additional finding of our study was that the weight of the products of multiple gestations diverges from the weight of singletons from the gestational age of 31 weeks. A recent population-based study of twins from England showed that the divergence may occur as early as 24 weeks gestation, a time at which, on average, singletons are 100 g heavier than twins [11]. One register-based study [12], and two large population-based studies – in the USA [13] and Norway [14] – showed that the divergence occurs from the gestational age of 30 weeks, while another smaller study showed it to occur from 33 weeks [15]. At great variance from these results are those published by Min et al. [16], who did not find significant differences between the birth weight of twins and that of singletons until the gestational age of 36 weeks. It appears from our study that in multiple pregnancies there is a significant variation from the normal, singleton intrauterine growth as early as 31 weeks of gestation. This figure might actually be higher if we restrict the population of multiples to twins, which we were not able to do using this database. Thus our "multiple" population included triplets, and more rarely, multiples of four fetuses or more. These may have artificially lowered the threshold of deviation from the singleton growth curves, although the vast majority of multiples was likely to have been twins. There is approximately one set of triplets for every 47 sets of twins [14], and one set of quadruplets for every 900 sets of twins [17].

In summary, we present the population-based curves of birth weight obtained in Israel in recent years. These curves are probably representative of the current population mix of Israel with its high rate of immigration: 30% of the current population was born abroad, with 15% arriving since 1990, mostly from the former Soviet Union [18]. Our data confirm the significant variation from normal singleton birth weight in the products of multiple pregnancies.

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