Intrauterine Growth Curves of Weight, Length, and Head Circumference for a Predominantly Hispanic Infant Population

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Synopsis

The purpose of this study was to develop intrauterine growth curves in a predominantly Hispanic population of low socioeconomic status near sea level and to compare them with published intrauterine growth curves.

Infants born at Los Angeles County-University of Southern California Medical Center provided the study population. Gestational age was determined by maternal history and confirmed by Ballard clinical assessment in 6,100 infants. Growth curves were developed for weight, length, and head circumference from 24 through 44 weeks gestation.

The intrauterine curves were similar to those developed from white non-Hispanic births in California and from white middle class infants born in Portland, OR. The Los Angeles curves differed from other curves developed in Denver, CO, where the infants were significantly smaller from the 34th week of gestation.

The authors found no adverse effects on intrauterine growth by race or socioeconomic status. The curves presented in this paper are more appropriate than the Denver curves for white populations born near sea level regardless of socioeconomic status.

ACCURATE, STANDARDIZED intrauterine growth curves are an important adjunct to obstetrical management for monitoring of fetal growth. Such growth curves are essential to neonatal care where classification of newborns by gestational age (GA) as well as birth weight (BW) is required for assessment of neonatal status, risks, and management. Factors known to affect fetal growth include high altitude, race, malnutrition, low social economic status (SES), and drugs (*1–4*).

The first intrauterine growth curves based on GA using measurements of BW, length, and head circumference (HC) were developed by Lubchenco and coworkers (*5,6*) in 1963 from a population born in the Denver, CO, area. Despite the known depressing effect of high altitude on the Denver curves, they are still extensively used in newborn nurseries.

In 1970, Babson published curves developed from predominantly white middle class infants born at sea level in Portland, OR (*7*). Although curves for HC and length are included as well as for weight, the Portland curves are not extensively used.

Birth weight curves also have been developed in California using data from a statewide computerized birth certificate program (*8*). The California weight curves were developed for the State population as a whole, for the white non-Spanish surname, for the black, and for the white Hispanic surname populations (*3*). The majority of infants in California are born at or near sea level. The California intrauterine growth curve for BW is now often used in California for assessment of fetal growth. Lack of corresponding California growth curves for HC and for length has limited the usefulness of the weight curve and resulted in many clinicians continuing to use the Denver curves. To date there are no uniformly acceptable intrauterine growth curves for weight, height, and HC that are in general use.

The purpose of this study was twofold—(*a*) to develop intrauterine growth curves for weight, length,

Table 1. Intrauterine growth in weight of 6,100 infants born at Los Angeles County-University of Southern California Medical Center, 1985–87

Gestational age (weeks)	Unweighted number of infants	Smoothed percentiles (grams) both sexes				
		10th	25th	50th	75th	90th
24	45	580	659	705	776	901
25	30	596	694	764	857	1,039
26	34	647	767	864	978	1,209
27	39	729	873	998	1,134	1,405
28	35	840	1,007	1,162	1,319	1,623
29	56	974	1,165	1,350	1,528	1,857
30	41	1,128	1,343	1,557	1,755	2,104
31	52	1,299	1,535	1,778	1,995	2,357
32	38	1,481	1,738	2,008	2,244	2,614
33	35	1,672	1,947	2,241	2,494	2,867
34	84	1,867	2,157	2,473	2,742	3,114
35	130	2,063	2,364	2,699	2,981	3,348
36	224	2,255	2,564	2,912	3,207	3,566
37	478	2,440	2,752	3,108	3,414	3,763
38	792	2,613	2,924	3,282	3,596	3,933
39	1,226	2,772	3,074	3,428	3,749	4,071
40	1,179	2,911	3,199	3,541	3,867	4,174
41	914	3,027	3,295	3,617	3,944	4,236
42	453	3,117	3,356	3,650	3,975	4,253
43	178	3,186	3,378	3,634	3,956	4,219
44	31	3,200	3,357	3,565	3,880	4,131

Table 2. Intrauterine growth in length of 6,100 infants born at Los Angeles County-University of Southern California Medical Center, 1985–87

Gestational age (weeks)	Unweighted number of infants	Smoothed percentiles (centimeters) both sexes				
		10th	25th	50th	75th	90th
24	30	29.7	31.7	32.8	34.1	36.1
25	23	30.3	32.4	33.9	35.2	37.2
26	30	31.1	33.4	35.1	36.5	38.4
27	37	32.2	34.5	36.4	37.8	39.6
28	31	33.4	35.7	37.8	39.2	41.0
29	51	34.7	37.0	39.2	40.6	42.4
30	37	36.1	38.4	40.6	42.1	43.8
31	43	37.6	39.8	42.1	43.6	45.1
32	32	39.2	41.2	45.0	45.0	46.5
33	30	40.7	42.7	44.9	46.4	47.9
34	80	42.2	44.1	46.2	47.8	49.1
35	116	43.6	45.4	47.4	49.0	50.3
36	191	45.0	46.6	48.5	50.1	51.4
37	448	46.2	47.8	49.5	51.2	52.4
38	748	47.2	48.7	50.4	52.0	53.2
39	1,158	48.1	49.5	51.0	52.7	53.8
40	1,122	48.8	50.1	51.5	53.2	54.3
41	868	49.2	50.5	51.7	53.4	54.6
42	436	49.3	50.6	51.7	53.4	54.6
43	158	49.0	50.5	51.5	53.2	54.4
44	26	48.5	50.0	50.9	52.6	53.9

and HC in a predominantly Hispanic, low SES population and (*b*) to compare these curves with those from Denver, Portland, and California.

Materials and Methods

Study population. The sample consists of all infants born alive at the Women's Hospital of Los Angeles County-University of Southern California (LAC-USC) Medical Center during the 6-month period from January through June 1987 and all infants born live at the hospital weighing less than 1,501 grams (g) during the 3-year period from 1985 through 1987. The intent was to increase the sample size of the very low birth weight (VLBW) group. In the analysis, a weighting procedure, to be described in the analysis section, was used to correct for the oversampling of VLBW infants.

The patient population at Women's Hospital is of uniformly low SES, predominantly (91 percent) Hispanic, mostly of Mexican origin. More than half of the mothers are Mexican-born.

The GA to the nearest completed week was calculated from the day of the last menstrual period as stated in the history obtained from the mother and recorded prior to delivery. Infants whose gestational age as assessed by the Ballard clinical score (*9*) fell within 2 weeks of the mother's dates were included. Excluded from the sample were infants with major congenital anomalies, multiple gestation, and infants of diabetic or chronic hypertensive mothers.

Birth weights were obtained in the delivery room before infants' transfer to the nurseries. Measurements of length and HC were made either by critical care nurses on admission of the infant to the Neonatal Intensive Care Unit or by pediatric nurse practitioners within the first 24 hours in the normal nurseries.

Data collection and analysis. Data were collected from the hospital records on GA by maternal history and clinical examination, maternal illnesses, multiple gestation, sex, race, BW, HC, length, and congenital anomalies.

Statistical analysis. Since there were 6-month data for infants with birth weight of more than 1,500 g and 3-year data for infants weighing less than 1,501 g, the data set was made equal by expanding the 6-month data set six times and adding it to the 3-year data set for the under-1,501 g group. All analyses are based on this weighted data set.

The procedure for generating the intrauterine growth curves was as follows. First, the percentile values (10th, 25th, 50th, 75th, and 90th) of BW,

Figure 1. Intrauterine growth curves of weight for 10th, 50th, and 90th percentiles of 6,100 infants born at Los Angeles County–University of Southern California Medical Center, 1985–87

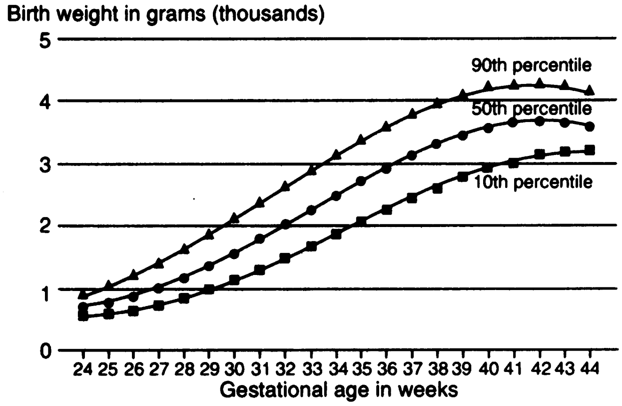


Figure 2. Intrauterine growth curves of length for 10th, 50th, and 90th percentiles of 6,100 infants born at the Los Angeles County–University of Southern California Medical Center, 1985–87

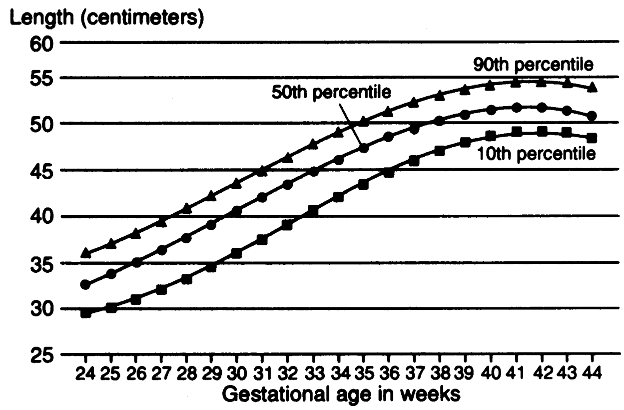


Figure 3. Intrauterine growth curves of head circumference for the 10th, 50th and 90th percentiles of 6,100 infants born at Los Angeles County–University of Southern California Medical Center, 1985–87

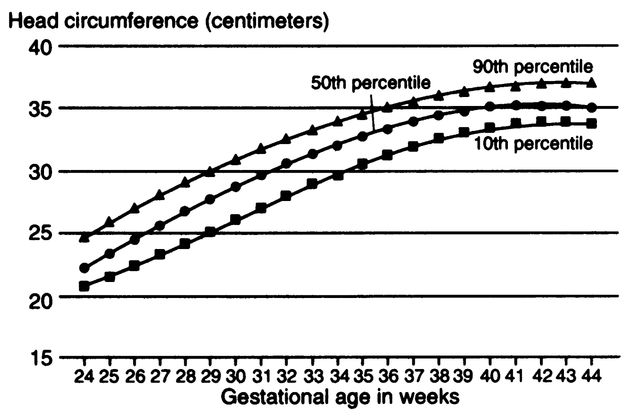


Table 3. Intrauterine growth in head circumference of 6,100 infants born at the Los Angeles County-University of Southern California Medical Center, 1985–87

Gestational age (weeks)	*Unweighted number of infants*	*Smoothed percentiles (centimeters) both sexes*				
		10th	*25th*	*50th*	*75th*	*90th*
24	35	20.8	21.5	22.3	23.2	24.6
25	26	21.5	22.4	23.4	24.3	25.8
26	33	22.4	23.4	24.5	25.4	26.9
27	37	23.3	24.3	24.5	26.5	28.0
28	32	24.2	25.3	26.7	27.5	29.0
29	54	25.1	26.2	27.7	28.5	29.9
30	38	26.1	27.2	28.7	29.5	30.8
31	46	27.0	28.2	29.6	30.4	31.7
32	34	27.9	29.1	30.5	31.3	32.5
33	30	28.8	30.0	31.3	32.1	33.2
34	79	29.7	30.8	32.0	32.8	33.9
35	116	30.5	31.6	32.7	33.5	34.5
36	193	31.3	32.3	33.4	34.1	35.0
37	450	32.0	33.9	33.9	34.7	35.5
38	748	32.6	33.4	34.4	35.1	35.9
39	1,159	33.1	33.9	34.7	35.5	36.3
40	1,119	33.5	34.2	35.0	35.8	36.5
41	870	33.8	34.4	35.2	36.0	36.8
42	434	33.9	34.5	35.2	36.1	36.9
43	160	33.9	34.4	35.2	36.2	37.0
44	26	33.8	34.2	35.0	36.1	37.0

length, and HC for each GA from the 24th week through the 44th week were derived from the actual data. Then the curves of the observed percentiles were smoothed using the cubic polynomial that has been found to have a better fit than the quartic polynomial (*10*). Then each pair of the observed and smoothed curves were plotted and examined for goodness of fit. The fit was good for the entire range of GA for all three measurements.

Published intrauterine curves on BW from Denver, Portland, and California white, non-Hispanic infants were compared with that for the LAC-USC population, using the goodness-of-fit chi-square test procedure at each gestational age. The LAC-USC and Denver curves for HC and for length were similarly compared.

All statistical analysis was conducted by the Research and Biostatistics Division at LAC-USC Medical Center using the Statistical Analysis System (SAS) software programs on the mainframe IBM computer (*11*). Specifically, the nonlinear regression procedure was used to derive the smoothed percentile values.

Results

Study population. During the 6-month period in 1987, 7,268 live-born infants weighed more than 1,500 g. During the 3-year period from 1985 through 1987, 867 infants weighed less than 1,501 g (VLBW group).

Excluded from this cohort were those cases where the gestational age as assessed by the Ballard clinical score fell beyond 2 weeks of the mother's reported date of last menstrual period; this included 1,111 cases in the heavier than 1,500 g group and 218 cases in the VLBW group. Also excluded were 236 infants in the VLBW group with major congenital anomalies, multiple gestation, and diabetic or chronic hypertensive mothers. The infants in the heavier than 1,500 g groups had been excluded in the master file. The third exclusion were 470 infants whose gestational age fell out of the range of this study—less than 24 or more than 45 weeks—419 in the heavier than 1,500 g group and 51 in the VLBW group.

The net number of live births in the study population consisted of 5,738 heavier than 1,500 g and 362 VLBW infants. This data set was then weighted, as described previously, to form the base data set from which the intrauterine growth curves were derived.

Smoothed curve values of the 10th, 50th, and 90th percentiles for BW, length, and HC are plotted against GA in figures 1–3. The values used in the construction of the smoothed curves as well as those for the 25th and 75th percentiles are shown in tables 1–3. Growth curve charts that include the 25th and 75th percentiles are available from the authors on request.

Comparison of BW curves between LAC-USC, California non-Hispanic whites, and Denver are shown in figure 4. Denver curves differed from LAC-

USC curves in weight, HC, and length. Growth in weight through 29 weeks gestation was similar, but at 30 weeks the two sets of curves began to diverge. The LAC-USC infants were significantly heavier ($P < .05$) from the 30th week at the 50th percentile and from the 32nd week at the 10th and 90th percentiles. Denver infants had significantly smaller HC and shorter length beginning at 33 weeks of gestational age for all percentiles ($P < .05$).

Comparison of the California birth weight curves with LAC-USC curves showed close agreement (fig. 4). There were no significant differences in the 90th percentile. For the 10th and 50th percentiles, no significant differences were found until the 40th week of gestation after which LAC-USC birth weights were higher ($P < .05$) than those for California white non-Hispanic infants.

Because the weight curves for Portland were similar to those from LAC-USC they are not presented in the figures. The only differences were from 35–40 weeks GA at the 50th percentile where LAC-USC infants were heavier ($P < .05$).

When LAC-USC curves were plotted by sex (fig. 5), boys were larger than girls, as expected, except for the 10th percentile before 36 weeks GA when the two were equal.

Discussion

We undertook this study to develop intrauterine growth curves for BW, length, and HC for a predominantly Hispanic population born near sea level. Although the recently developed California intrauterine growth curves for BW are widely used, they do not include curves for length or for HC. Information on head size is important for both obstetricians in the assessment of fetal growth and pediatricians in the ongoing management of the infant (*12,13*). It is well recognized that head size is correlated with brain size and that infants with evidence of abnormal head size at birth are at risk for neurologic abnormality originating prior to birth (*14*).

When the LAC-USC curves are compared with the Denver curves, the effect of altitude on growth is apparent and, although all growth parameters are affected, the effect on weight is both earlier and greater than that on head size, as would be expected. Altitude has been shown to have a dampening effect on growth, more pronounced in later gestation when growth becomes proportionately more rapid. To evaluate infants born at sea level by means of the Denver curves results in too few infants classified as small for gestational age and too many infants classified as large for gestational age.

Figure 4. Comparison of intrauterine weight curves between infants from Los Angeles County–University of Southern California Medical Center (LAC & USC) and Denver, CO, (top) and infants from LAC & USC and California white, non-Hispanic infants (bottom)

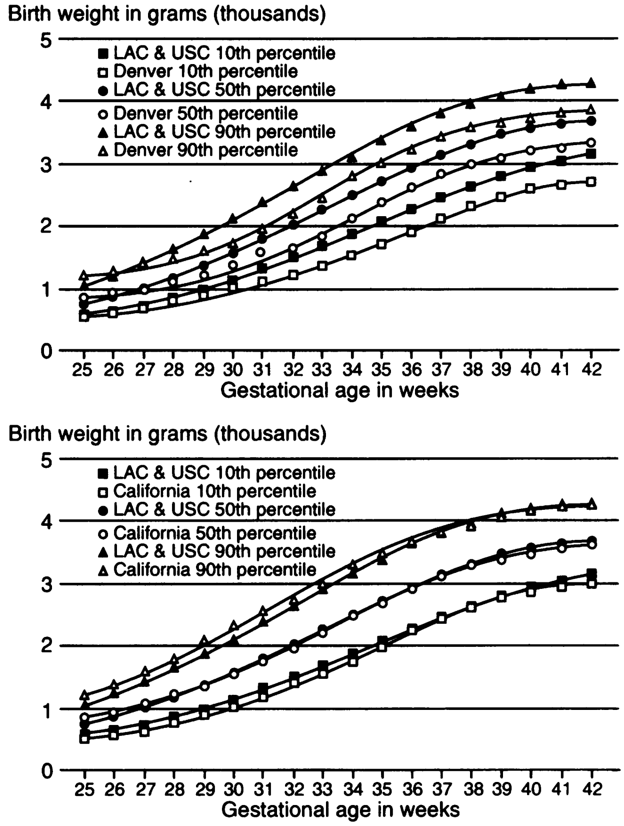
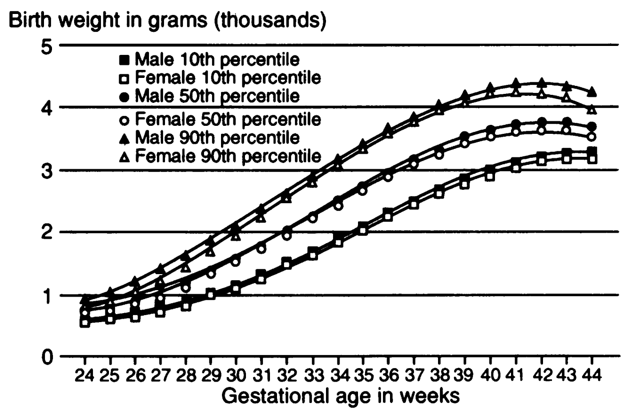


Figure 5. Intrauterine weight curves for 6,100 male and female infants born at Los Angeles County–University of Southern California Medical Center, 1985–87



There are no data supporting an effect of socioeconomic status on BW of Hispanic infants of Mexican origin. Notzon and coworkers (*15*) report that once altitude has been taken into account, there is no difference in BW distribution between Mexico City and Mexican Americans born in the United States. Previous research has indicated that the lifestyle of Mexican American women including low smoking and drug abuse rates and presence of family support provides protection against the effects of adverse SES on BW (*16*). Differences in BW distribution have been reported when infants born of Spanish surname women themselves born in the United States were compared with those mothers born in Mexico (*17*). In this study, risk factors for U.S.-born Hispanic mothers more closely resembled those for black mothers, and their infants were smaller than those of Mexican-born mothers.

Although racial differences in BW have long been recognized (*18*), little is known about intrauterine growth of Hispanic infants of North and Central American origin despite the growing size of this population within the southwest and west coastal areas of the United States.

The LBW rate of 5.7 for Mexican Americans reported by the National Center for Health Statistics is similar to that of 5.5 for non-Hispanic whites (*19*). Again, in the study from California, the LBW rate for Mexican-born mothers mirrored that of U.S.-born whites (*17*). In a recent report that compared birth weights of Mexican American and non-Hispanic white infants born in Arizona during 1986 and 1987, Mexican American infants were larger until 36 weeks of gestation. Both groups of Arizona infants were larger than infants born in California until 40 weeks of gestation (*20*). There were few differences between the LAC-USC BW curves and those from Portland that were developed on a white middle class population. Finally, the LAC-USC BW curve was essentially the same as that of the California non-Hispanic white population. Interestingly, in both cases, the Hispanic infants were larger at or close to term. Thus, we found no adverse effect of poverty within a group of poor Hispanic infants born at sea level in any growth parameter measured.

We conclude that the growth curves developed and presented in this study are more appropriate than the Denver curves to determine intrauterine growth of the poor Hispanic infant born at LAC-USC Medical Center. Additionally, since only minor differences were found between the weight curves for white non-Hispanic California infants and LAC-USC Hispanic infants, we feel that the LAC-USC curves provide appropriate measurement tools for assessment of intrauterine growth in weight, HC, and length for white populations born near sea level.

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