New References for Neonatal Weight by Gestational Age and Sex, Holguín, Cuba

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ABSTRACT

INTRODUCTION Birth weight is considered to be the best predictor of an infant's health status in the neonatal phase. In the Americas, several studies have set the foundation for determining references birth weights. In Cuba there is a report on anthropometric patterns in neonates in 1990 from a maternity ward in Havana, but there are no updated neonatal weight distribution curves by gestational age and sex, as suggested by WHO.

OBJECTIVE Create birth weight percentile distribution tables and curves for neonates by gestational age and sex in Holguín Municipality, capital of the eastern Cuban province of the same name.

METHODS A retrospective longitudinal study was designed in a universe of 16,018 neonates born alive, delivered within a gestational range of 30 to 42 weeks in the maternity unit of the V.I. Lenin University General Hospital in Holguín Municipality between January 2008 and December 2012. Included were neonates born in the study hospital living in Holguín Municipality; neonates from multiple births were excluded. Variables included gestational age, sex, and birth weight. Gestational age- and sex-specific weight percentile distribution tables and curves were constructed based on observed values. A third-degree polynomial was applied via weighted least squares regression to smooth distribution curves. Analysis of variance was conducted to compare four years (2008, 2009, 2010 and 2011) and the coefficient of variation was calculated for each week of gestation.

RESULTS The average weight of neonates of both sexes rose from week 30 to week 42. The coefficient of variation between weeks 34 and 42 was 11.6%–19% in girls and 12.1%–21.3% in boys. The 10th percentile value at 36 weeks of gestation was 2140 g for girls and 2200 g for boys. For girls, cutoff points for the 10th percentile (small for gestational age infant) were higher at 34–42 weeks and for boys at 36–42 weeks. Applying our cutoff points to this population identified 47% more low birth weight infants than did previously applied standards.

CONCLUSIONS Marked differences were found when comparing our tables with tables from other countries. The higher references values for the 10th percentile (compared to previous ones in Cuba) in mean more neonates fall in the low birth weight category, providing greater opportunities to reduce morbidity and mortality in this high-risk group.

KEYWORDS Birth weight, gestational age, chronologic fetal maturity, low birth weight infant, small for gestational age infant, reference growth curves, growth tables, Cuba

INTRODUCTION

There is general consensus that anthropometric measures (mainly birth weight, crown-rump length and head circumference) are useful parameters for monitoring fetal growth and a neonate's nutritional status.[1–4] Intrauterine growth parameters are important when establishing short- and medium-term postnatal prognosis.

Population studies as well as studies of selected neonatal groups are needed to assess whether an infant has attained satisfactory growth and nutritional status and to identify at-risk groups. This necessity is corroborated by multiple investigations (including those by Lausman in Canada,[5] Polloto[6] and Lagos[7]) that examine potential neonatal complications from intrauterine growth restriction, such as respiratory distress, hypothermia, hypoglycemia and necrotizing enteritis. Other disorders can also occur in early childhood (cardiovascular diseases, arterial hypertension, diabetes mellitus and kidney problems, etc.). Studies by Mañalich,[8] Susuki,[9] Fattal[10] and Pérez[11] elucidate some of the evidence related to these.

Assessment of birth weight alone, however, started to lose ground after studies by Lubchenco[12] and Battaglia and Lubchenco[13] began to examine weight in relation to gestational age (in weeks) and growth percentile curves, making it possible to identify the following categories: small for gestational age (SGA) if the infant's birth weight is below the 10th percentile (P10); appropriate for gestational age (AGA) if the infant's weight is in the 10th–90th percentile range; and large for gestational age (LGA) for infants whose birth weight exceeds the 90th percentile. In light of the lack of any previously established standards, these new standards were rapidly accepted and applied, especially here in the Americas.

As time passed, however, new weight standards related to gestational age (in weeks) were proposed by Latin American authors such as Alarcón,[14] González,[15] Pazcusso,[16] Parra,[17] and Urquía,[18] who presented evidence that P10 figures were higher than those found by Battaglia and Lubchenco.[13] After 1995, when WHO established criteria to set these standards,[1] numerous studies were conducted in Latin America with country-specific populations; Parra,[17] Ticona,[19,20] and more recently, Villamonte[21] in Peru; Montoya in Colombia;[22]; San Pedro in Argentina;[23] and Lagos and Juez in Chile.[24–26]

Intercountry differences observed in their results may be due, among other factors, to variations in features of the population studied, varying demographic and environmental factors, sample size and varying inclusion/exclusion criteria applied by the researchers.[27–30]

In Cuba, the situation of standards relating weight and gestational age has not progressively developed since the curves proposed by Dueñas in 1990.[31] Dueñas is important historically and scientifically, not only because he was the first Cuban to design weight percentile curves by week of gestational age, but also because he realized the importance of these curves for identifying newborn infants whose weight for gestational age was less than P10, given this group's greater risk of morbidity and mortality.[32–35] No other weight-for-gestational-age curves have been designed in Cuba since.

We consider Dueñas' curves[31] no longer unsuitable for several reasons. First, they were designed more than two decades ago; second, Dueñas' small study sample was not representative of the universe at that time (as he acknowledges); and third, more recent criteria for constructing such curves have been established. Esquivel, in a comprehensive review of all growth monitoring studies in the country from the 1970s on, concluded that Cuban newborns have been getting bigger.[36]

No national or regional studies have been conducted in our country that would allow comparison with the reference values determined in our work. Cuba's 2010 Consensus on Diagnostic and Therapeutic Procedures in Gynecology and Obstetrics[37] contains no mention of reference weights by gestational age for Cuban infants, but refers only to reports by foreign authors, such as Hadlock[2,3] and Usher,[4] among others. Cuba's 2010 Pediatric Consensus refers only to Dueñas' curves.[38]

For all these reasons and in light of WHO's recommendation that each perinatology service or area construct its own references,[1] we decided to formulate weight-for-gestational-age tables and curves for our hospital's area of service.

METHODS

A retrospective longitudinal study was designed whose universe consisted of the 16,018 infants born alive in the maternity unit of the V.I. Lenin University General Hospital in Holguín Municipality, January 2008–December 2012. In 2012, only infants born at 36 weeks or less were included, due to the need to increase the number of cases in this age group.

Included were neonates born in the study hospital living in Holguín Municipality. Neonates from multiple births were excluded. Also excluded were any cases with omissions or errors in gestational age or weight in the infant's records. Infants with histories of conditions that could affect intrauterine growth were not excluded.

The study database was set up with information from the Municipal Statistics Department's registry of live births. Study variables included gestational age, birth weight and sex. Gestational age was determined from date of last menstrual period and corrected, if necessary, by early sonogram (between 13–16 and 20–22 weeks of pregnancy), in accordance with nationally established criteria for antenatal control and followup of all pregnant women.[37]

Weight was determined in grams. Neonates in the study hospital are weighed immediately after birth in the delivery room by experienced nurses, under direct supervision by obstetricians. The dial scales used are routinely calibrated by the Provincial Metrology Department.

To determine weight curves for gestational age and sex, values were determined for the 3rd, 5th, 10th, 25th, 50th, 75th and 90th percentiles. To smooth the curves, a third-degree polynomial was obtained via weighted least squares regression. Mean weights, standard deviations and weight distribution by gestational age and sex were determined for each of these percentiles.

For data validation, analysis of variance was conducted to compare the years 2008, 2009, 2010 and 2011; no unexpected effects were found to influence results, and the coefficient of variation (CV) for each table was calculated, which was considered to be stable when there was no more than 10% variation in each week of gestation. The normality test was also conducted to determine if weight was normally distributed. Calculations were performed with SYSLAT MY-STAT v.12 (2009) and Excel (Microsoft Office).

Ethics The study was approved by the scientific council and medical ethics committee of the Holguín Municipal Health Department.

RESULTS

Weight distribution curves by gestational age and sex for the 3th, 5th, 10th, 25th, 50th, 75th and 90th percentiles are displayed in Figures 1 and 2. Mean birth weight for both sexes increased from week 30 to week 42. Table 1 shows a predominance of births in weeks 39 and 40 for newborn girls (29.4% and 27% respectively). Mean weights were 3222 g (SD 381) in week 39 and 3331 g (SD 398) in week 40.

Figure 1: Weight distribution in newborn girls by gestational age (n = 8025)

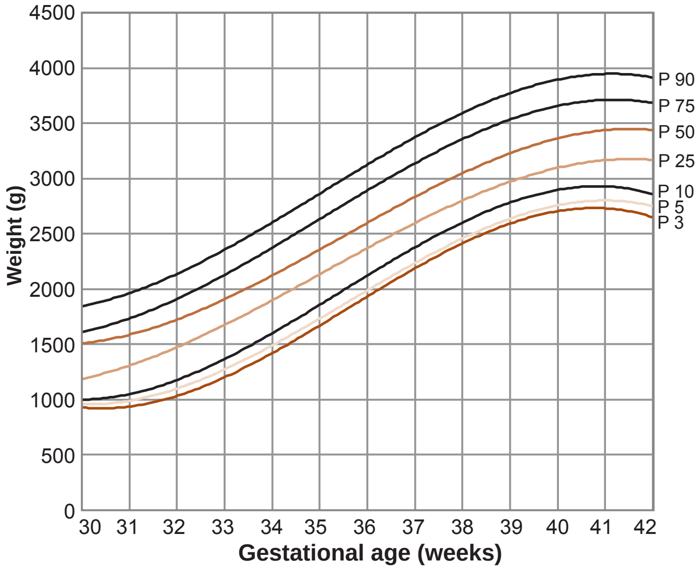

Figure 2: Weight distribution in newborn boys by gestational age (n = 7993)

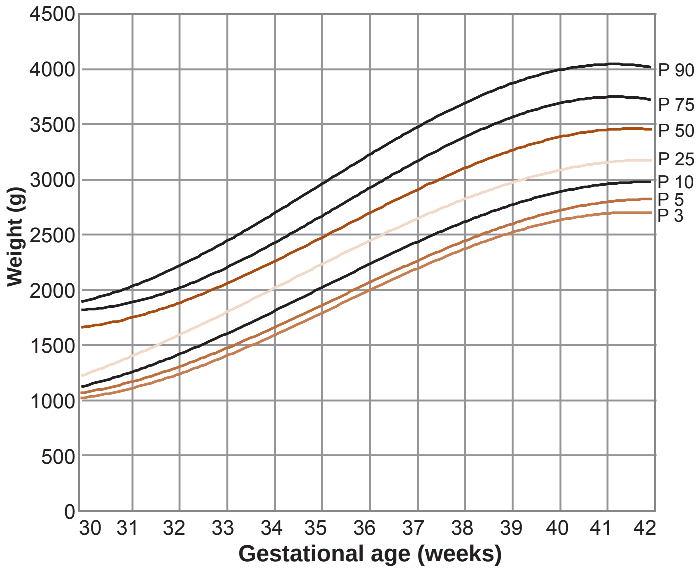

Table 1: Weight distribution in newborn girls by gestational age (n = 8025)

Gestational age (weeks)	n	Weight (g)			Percentile						
		Mean	SD	CV	3	5	10	25	50	75	90
30	14	1496	410	27.4	850	900	958	1175	1550	1660	1920
31	14	1595	196	12.3	1070	1090	1158	1375	1590	1690	1840
32	25	1664	382	23.0	1088	1108	1164	1400	1620	1900	2200
33	38	1853	380	20.5	1122	1270	1300	1643	1900	2080	2312
34	47	2131	399	18.7	1370	1444	1560	1990	2160	2400	2544
35	111	2396	456	19.0	1565	1625	1840	2100	2400	2630	2900
36	202	2631	435	16.5	1981	2001	2140	2305	2560	2900	3200
37	440	2915	413	14.2	2300	2360	2500	2658	2900	3200	3400
38	1217	3102	421	13.6	2464	2500	2600	2820	3080	3400	3640
39	2358	3222	381	11.8	2547	2600	2757	3000	3200	3500	3700
40	2198	3331	398	11.9	2660	2700	2845	3050	3300	3600	3840
41	1119	3406	399	11.7	2700	2800	2900	3130	3400	3650	3920
42	242	3452	401	11.6	2685	2770	2900	3200	3495	3750	3968

As of week 35, weight variation began to decline in both sexes, as demonstrated by diminishing CVs (Table 2).

Figure 1 shows weight distribution for newborn girls by gestational age (in weeks). At 36 weeks, P10 for this group was 2140 g, and showed a steady rise until week 42. Applying those values, 9.4% of newborn girls fall under P10 and 9.8% above the 90th percentile. Weight distribution for newborn boys by gestational age (Figure 2) shows that P10 was 2200 g at 36 weeks, with increasing values up to week 42. Based on these values, 9.8% of infant boys are below P10 and 8.3% are above the 90th percentile. Applying our cutoffs to the universe of newborns, 47.3% more low birth weight infants were identified than would have been by Dueñas' curves (1538 vs. 811).

Mean birth weight in most weeks was less for infant girls than for boys, although the mean difference between the two sexes was only 84 g from week 35 to week 42. In the SGA group, a slight predominance of 0.5% was observed for infant boys.

Table 2: Weight distribution in newborn boys by gestational age (n = 7993)

Gestational age (weeks)	n	Weight (g)			Percentile						
		Mean	SD	CV	3	5	10	25	50	75	90
30	7	1477	419	28.4	950	1000	1115	1193	1560	1820	1932
31	12	1692	340	20.1	1200	1214	1229	1340	1850	1905	1974
32	20	1898	316	16.6	1256	1398	1454	1720	1945	2100	2270
33	33	2034	355	17.5	1371	1424	1636	1900	2100	2180	2300
34	44	2141	456	21.3	1700	1715	1844	1945	2196	2355	2623
35	127	2490	500	20.1	1696	1812	1960	2200	2400	2705	3192
36	205	2669	428	16.0	1954	2008	2200	2400	2640	2980	3227
37	436	2965	407	13.7	2200	2300	2450	2660	2995	3203	3500
38	1184	3184	412	12.9	2500	2500	2653	2900	3200	3460	3700
39	2399	3348	412	12.3	2600	2700	2820	3100	3320	3600	3900
40	2154	3452	418	12.1	2700	2800	2942	3150	3450	3700	4000
41	1116	3511	435	12.4	2729	2848	3000	3200	3500	3800	4100
42	256	3510	431	12.3	2756	2865	3000	3220	3500	3800	4100

However, in the LGA group, there was a 1.5% predominance for infant girls over boys. The overall results (for both sexes) were 9.6% for SGA, 81.4 % for AGA and 9% for LGA. A comparison of the curves in Figures 1 and 2 indicates that in the 30–36 week group, both curves show the same percentage of SGA.

DISCUSSION

Timely detection of abnormal weight values for gestational age during intrauterine and neonatal development enables better risk assessment for possible early or subsequent disorders.[10,11]

Our study showed an average weight increase of 26.6% in infant girls and 29.3% in infant boys between weeks 36 and 41, surpassing the results reported by Dueñas (22.2% for both sexes).[31] A similar trend was also observed in studies by San Pedro in Argentina[23] and González in Chile[15] (38.4% and 32.8% respectively; again, for both sexes). The greater increases in mean weights over this period of intrauterine development are important in explaining these studies' higher 10th-percentile values as compared with ours.

The cutoff point for P10 can vary, according to different authors (Ayerza,[27] Alarcón[14]), due to various factors, including study design, specific population characteristics, ethnicity and maternal characteristics (such as weight and height). These authors noted that boys' birth weights tended to be higher than girls', which is consistent with our findings. P10 values found by Lubchenco[12] were below those reported in studies by Ayerza,[27] González,[15] and Ticona;[19] Lubchenco detected only 2.2% of SGA for both sexes at week 40. The portion of SGA (9.1%) found in our study falls within the range of 7%–11% reported by Latin American authors such as Urquía,[18] Lagos[24] and Juez.[25]

Other studies presented higher cutoff points than ours for P10 at 36 weeks, but these were for both sexes combined. San Pedro of Argentina presented a cutoff point of 2190 g,[23] which was 10 g less than our equivalent cutoff for boys, but higher than ours calculated for both sexes combined. Hadlock in the USA found 2335 g,[2] the Latin American Center for Perinatology in Uruguay indicated 2324 g[39] and Alexander in the USA determined a cutoff point of 2354 g,[40] all values higher than either of our sex-specific cutoffs.

Variability in weeks 36 and 40 in both sexes in our study is consistent with that described by González, who found CVs of 16.6% and 12.1%, respectively, in those weeks,[15] and by Juez, who reported CVs of 13.9% at

36 weeks and 11.2% at 40 weeks.[25] CVs in our study approached stability as gestational age progressed.

It is important to note that the low number of neonates born in weeks 30–34 (5.6% of total neonates) is a possible source of bias in our study, and caution should be exercised in interpreting the values calculated for this gestational age. WHO's technical report recommends a minimum of 200 cases for each week of gestation,[1] which is extremely difficult to attain in studies in perinatology services and areas with few births. In his work, Alarcón.[14] noted that the Chilean Pediatric Society, in establishing criteria for preparing such growth curves, recommended a minimum of 100 neonates for each gestational age. Our work meets this standard from week 35 on. In an attempt to solve this problem, some authors (such as Pittaluga) have designed curves based solely on neonates born at 36 weeks of gestation or earlier, for greater statistical efficiency.[32]

Our inclusion criteria were also very broad; neonates whose mothers had risk factors that could affect fetal weight (such as pre-eclampsia, hypertension and diabetes mellitus) were not excluded, which could introduce a negative bias in reporting SGA.[41,42] However, other researchers have also used this design, including González, who studied more than 2 million neonates in Chile without excluding fetal weight risk factors,[15] and Juez, also in Chile, who likewise included them.[25]

This study has enabled construction of weight percentile distribution curves and tables by gestation age (in weeks) and sex, specific to the population of Holguín Municipality, Cuba. It also fills an information gap since such curves were not previously available here.

CONCLUSIONS

Values were established for new reference weights by gestational age and sex, enabling formulation of percentile distribution curves and tables. Differences were found when our tables were compared with tables from other countries. The increased detection of newborns under P10 (SGA infants) enables clinical and epidemiological actions that can help reduce morbidity and mortality in this high-risk neonatal group.

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