A variety of factors influenced fetal growth, racial, social and economic among others, as well as specific medical conditions that may present or develop during pregnancy. Hence, it is not surprising that mean birth weight shows a degree of variation from country to country and from area to area within the same country. Intrauterine growth retardation (IUGR) implies inhibited intrauterine growth (IUG) and unattained fetal growth potential. Intrauterine growth retardation is a clinical term with the diagnosis usually based on small size for gestational age at birth (SGA). However, IUGR is not equal to SGA. Women seem programmed for having births of a certain size; some SGA babies are not IUGR, and some larger babies are still IUGR. A large number of growth charts, based on populations with different inclusion criteria, and constructed
Methods. This is a cross-sectional study of all births from Abha General Hospital Southwestern of Saudi Arabia over a 6-year period from 1999 to 2004. A total of 6035 Saudi births (2979 males and 3056 females) were included in the present study. The region of Aseer, with a population of 1,200,000, covers more than 80,000 km² in Southwestern Saudi Arabia. Sharing its southern border with Yemen, the area extends from the high Aseer mountains almost 3200 m above sea level down to the Red Sea. Abha, the capital city of the region (population 122,000), is in the Aseer mountains which is 3133 m above sea level; it has the lowest mean annual temperature of any of the southern urban areas and has a high annual rainfall with rain falling mainly in winter and spring. Neonates of Southwestern Saudi Arabia were significantly lighter and shorter than those of the reference population, as well as neonates in other areas of the Kingdom, with prevalent low birth weight (LBW) especially in high altitude area, possibly due to IUGR of secondary type. The aim of the present study was to construct intrauterine percentile growth curves for body weight, length and head circumference for assessing the intrauterine growth of births born in high altitude areas of Saudi Arabia.

Results. Figure 1 represents the smoothed values of weight and length percentiles at each gestational period. That is, these figures represent the clinical curves of these cut-off points. Polynomial regression models from which those curves were constructed are shown in Table 1. Figure 2 represents the smoothed values of the mean and 2 standard deviations below and above the mean weight and length at each gestational period. That is, these figures represent the clinical curves of these cut-off points. Polynomial regression models from which those curves were constructed are shown in Table 1.
Table 1 - Polynomial regression models from which intrauterine growth curves were constructed.

<table>
<thead>
<tr>
<th>Percentiles and mean and mean ± 2SD</th>
<th>Smoothed weight percentiles and mean and mean ± 2SD by the period of gestation</th>
<th>Smoothed length percentiles and mean and mean ± 2SD by the period of gestation</th>
<th>Smoothed head circumference percentiles and mean and mean ± 2SD by the period of gestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>Y = -10964.68 + 628.76X - 7.68X²</td>
<td>Y = -41.66 + 3.97X - 0.0456X²</td>
<td>Y = -33.97 + 2.94X - 0.0317X²</td>
</tr>
<tr>
<td>25th</td>
<td>Y = -10161.62 + 570.73X - 6.57X²</td>
<td>Y = -8.06 + 1.89X - 0.0127X²</td>
<td>Y = -42.20 + 3.43X - 0.0381X²</td>
</tr>
<tr>
<td>50th</td>
<td>Y = -6780.11 + 347.80X - 2.74X²</td>
<td>Y = -0.005 + 1.47X - 0.0067X²</td>
<td>Y = -32.52 + 2.95X - 0.03189X²</td>
</tr>
<tr>
<td>75th</td>
<td>Y = -5340.85 + 241.25X - 0.69X²</td>
<td>Y = 1.07 + 1.41X - 0.0046X²</td>
<td>Y = -49.48 + 4.06X - 0.04876X²</td>
</tr>
<tr>
<td>90th</td>
<td>Y = -4990.94 - 414.41X + 9.68X²</td>
<td>Y = 1.30 + 1.41X - 0.0040X²</td>
<td>Y = 37.95 + 3.44X - 0.04006X²</td>
</tr>
<tr>
<td>Mean - 2SD</td>
<td>Y = -6212.84 + 309.74X - 2.1327X²</td>
<td>Y = -8.60 + 1.99X - 0.01435X²</td>
<td>Y = -40.78 + 3.48X - 0.03995X²</td>
</tr>
<tr>
<td>Mean + 2SD</td>
<td>Y = 881.56 - 165.78X + 6.1490X²</td>
<td>Y = -30.30 + 3.27 - 0.03600X²</td>
<td>Y = -42.50 + 3.40X - 0.0384X²</td>
</tr>
</tbody>
</table>

Y - dependent variable = weight, length or head circumference measurements, X - independent variable = weeks of gestation

Figure 1 - Smoothed weight and length percentiles by the period of gestation.

Figure 2 - Smoothed mean weight and length and there mean ± 2SD by the period of gestation.

Figure 3 - Smoothed head circumference percentiles by the period of gestation.

Figure 4 - Smoothed mean head circumference and mean ± 2SD by the period of gestation.
Figures 3 and 4 represent the smoothed values of both the percentiles and the mean and 2 standard deviations below and above the mean head circumference at each gestational period. That is, these figures represent the clinical curves of these cut-off points. Polynomial regression models from which those curves were constructed are shown in Table 1.

Discussion. We still usually assessed intrauterine growth when the fetus is born or expelled. The size of the newborn relates to the duration of the pregnancy, and we considered relatively small size for gestational age as a reflection of intrauterine growth inhibition. Daily et al.\(^3\) and Manzar et al.\(^4\) considered growth curves as an usual tool for assessing the growth of the fetus in utero. Growth charts (in percentiles) need to be standardized and population-specific.\(^5\)\(^6\) There is no standard definition of IUGR and we clinically diagnosed the condition. Modern technology, however, has made it possible to monitor intrauterine growth, and ultrasonography could provide a basis for operational definitions of variations in intrauterine growth; however, such definitions, have not yet been agreed upon. In the present study, Bernstein et al.\(^7\) carried out ultrasonography for all cases where the exact date of LMP is not known. They labeled LBW for gestation either ‘small-for-date’ or ‘small-for-gestational-age’ (SGA). We most commonly used the 10th weight centile cut-off for defining SGA births. This implies that the 10% of babies with the lowest birth weight for gestation are considered as SGA. Or, where 2SD below the mean weight for gestation is used as the lower cut-off, the 2.5% of births with the lowest weight, are considered SGA. In the present study, Daily et al.\(^1\) and Manzar et al.\(^6\) constructed both percentile as well as standard deviation growth charts. Ideally, an international population standard is considered to exist for each geographic region, and these standards should be well defined and documented allowing for comparisons. Comparison of the values obtained in this study shows that the median (50th percentile) values for weight and length of infants of the present study are lower than those of published charts\(^8\)\(^9\) in all gestational periods. However, for head circumference, the evident appeared only before 32 weeks of gestation. Following that, the median values of head circumference are nearly comparable. This difference may indicate ethnic variations. However, the results of a previous study reported significantly lower birth parameters in the high altitude area than in the low altitude area of the same country, Saudi Arabia. Al-Shehri et al.\(^1\) attributed such findings to the growth-retarding effects of high altitude hypoxia. Previous studies also attributed such effects to the negative energy balance and the interference with protein metabolism, leading to a significant weight loss.\(^11\)\(^-\)\(^15\) However, further studies need to compare fetal growth charts of low and high altitude areas. It was interesting to see that although weight and length of neonates at the high-altitude area of the present study, both were significantly lower than those of published charts, yet this was not the case for head circumference, especially before the 32nd week of gestation. Fetal malnutrition should not affect the neonatal occipitofrontal circumference, since there is relative sparing of the fetal head.\(^16\) This is in agreement with the previous study known as secondary or asymmetrical IUGR.\(^3\) It is a form of growth slowing or cessation occurring in a fetus with normal growth potential. This is the most common type seen in clinical practice and usually occurs in the later part of pregnancy (32 weeks), when the fetus is at the stage of maximal fat accumulation. The baby appears long and scrawling. Weight will be affected more than length and ponderal index is abnormal. This type of IUGR is due to impaired utero placental function or nutritional deficiency. The infants show sparing of head growth whereas weight and organ growth are more severely affected. However, these cases have a better potential for future catch up growth.

In conclusion, this method of determining intrauterine growth profiles is not without criticism. The data are cross-sectional, and assuming the result growth curves are the same as those which the fetus would describe where intrauterine development to have continued normally until term. In fact, delivery before term is an unphysiological occurrence so that these infants could be considered unsuitable material for the construction of growth standards. Keeping in mind the limitations of interpreting intrauterine growth curves, nonetheless, in view of the inaccessibility of the fetus for study, there is no better method at the present time of drawing intrauterine curves of weight, length and head circumference. For this reason, future studies will continuously use the described method to obtained growth curves.

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References

Construction of IUG curves … Al-Shehri et al