

## CLINICAL ARTICLE

## Obstetrics

# FIGO position paper on reference charts for fetal growth and size at birth: Which one to use?

Gerard H. A. Visser<sup>1\*</sup> | Wanda K. Nicholson<sup>2</sup> | Eytan R. Barnea<sup>3</sup> | Diana Ramasauskaite<sup>4</sup> | Anwar H. Nassar<sup>5</sup> | For the FIGO Safe Motherhood & Newborn Health Committee<sup>6†</sup>

<sup>1</sup>Department of Obstetrics, University Medical Center, Utrecht, The Netherlands

<sup>2</sup>Department of Obstetrics and Gynecology, University of North Carolina, Chapel Hill, USA

<sup>3</sup>SIEP, The Society for the Investigation of Early Pregnancy, New York, NY, USA

<sup>4</sup>Center of Obstetrics and Gynaecology, Vilnius University Medical Faculty, Vilnius, Lithuania

<sup>5</sup>Department of Obstetrics and Gynecology, American University of Beirut Medical Center, Beirut, Lebanon

<sup>6</sup>International Federation of Gynecology and Obstetrics, London, UK

## \*Correspondence

Gerard H. A. Visser, Department of Obstetrics, University Medical Center, Lundlaan 6, Utrecht, The Netherlands. Email: g.h.a.visser@umcutrecht.nl

## Abstract

Publication of the Intergrowth-21st and WHO growth charts raises the question of which growth data prenatal providers should use in clinical practice. Is it better to use a universal chart applied globally, or metrics based on local or regional growth patterns? And what about customized charts versus local charts? FIGO has reviewed the different growth charts and studies assessing their reproducibility and predictive values for small- and large-for-gestational age newborns and, where available, adverse fetal outcomes. It concludes that local or regional charts are likely to be best for identifying the 10th percentile of newborns at highest risk. However, international standards for growth may also be used when coupled with locally appropriate thresholds for risk interpretation.

## KEYWORDS

Fetal growth charts, Intergrowth, Neonatal birthweight charts

## 1 | INTRODUCTION

Reference charts for fetal size and growth are intended to define normality and identify abnormal size and growth. In general, fetal or newborn weight below the 10th percentile (small-for-gestational age, SGA) is used to identify neonates who are likely to have sub-optimal growth and are at increased risk for perinatal mortality and short- and long-term physical and behavioral impairment. Similarly, a weight or size above the 90th percentile (large-for-gestational age) is used to identify neonates who may have excess growth. Within this context, it is important to establish whether a local chart based on all pregnancies, a local chart based on only low-risk cases, or a universal chart should be used.

The recent publication of the Intergrowth-21st<sup>1</sup> and WHO<sup>2</sup> charts for fetal growth and size necessitates careful discussion and consideration. The aim of the present FIGO position paper is to review these two charts, alongside studies that have assessed their

reproducibility and predictive value, in order to provide guidance on reference charts for fetal growth and size and birth.

### 1.1 | Advantages and limitations of the Intergrowth-21<sup>st</sup> and WHO charts

The Intergrowth-21st charts, published in 2014,<sup>1</sup> were based on large, prospectively collected data sets from healthy well-nourished populations in Brazil, China, India, Italy, Kenya, Oman, the United Kingdom, and the United States. Size at birth and ultrasound measures according to gestational age were designed to be an estimate of physiologic or normal growth under ideal conditions. The data suggest that growth curves are similar across different populations under optimal conditions and that the Intergrowth-21st charts may be used universally, abolishing the need for local charts.

<sup>†</sup>FIGO Safe Motherhood and Newborn Health Committee Members are listed at the end of the paper.

Universal charts are likely to identify more fetuses with a weight below the 10th percentile in populations where many unfavorable factors, such as malnutrition or hypertension, may adversely affect fetal growth; this may be one of the reasons why in India 50% of newborns have a birthweight below the global 10th percentile of the Intergrowth-21st charts.<sup>3</sup> Among lower risk populations and groups with higher rates of fetal overgrowth (e.g., cases of maternal obesity and/or gestational diabetes mellitus), the incidence of a weight below the 10th percentile may be lower than the universal 10th percentile. Prior studies have shown that, based on the 10th percentile for weight in the Intergrowth-21st charts, only 2%–3% of populations in high-income countries will be found to be SGA in contrast to up to 50% in countries such as India.<sup>3,4</sup>

The controversy regarding the Intergrowth-21st charts stems from the fact that, even under optimal conditions, fetal growth may not be the same in different countries. The Intergrowth-21st data show that skeletal fetal growth (head circumference), and length and head circumference at birth may differ by 2.5%–4.0% among populations, and the difference in birthweight may be as high as 20%.<sup>3</sup> When comparing Intergrowth-21st data from India with those from the United Kingdom, for example, mean  $\pm$  SD fetal weights at term were  $2.9 \pm 0.4$  kg and  $3.5 \pm 0.5$  kg in India and the United Kingdom, respectively.<sup>1</sup> Newborn height after a term delivery was 48.6 cm and 49.9 cm, respectively, and head circumference was 33.1 cm and 34.5 cm, respectively.<sup>1</sup> Similarly, in Norway it was found that there are differences in birthweight, abdominal circumference, and ponderal index between ethnic western Europeans and second-generation immigrants with different ancestral backgrounds. This after correction for parity, maternal height, body mass index (BMI), age, education, and adjusted for paternal height and BMI.<sup>5</sup>

In other words, when corrected for confounding variables, fetal growth and size, and/or weight at birth do not seem to be the same in different populations. This conclusion was also reached in the 2017 WHO fetal growth study using data that were also derived from low-risk populations across multiple countries and regions.<sup>5</sup> Data from Argentina, Brazil, Democratic Republic of the Congo, Denmark, Egypt, France, Germany, India, Norway, and Thailand were compared, and considerable differences in fetal size among populations were noted. Between India and Norway, for example, there was a 500-g difference in the 50th percentile for weight at term, and a difference of more than 600 g in the 10th percentile. These differences were almost the same as those found by the Intergrowth-21st study and shed doubt on a universal similarity in growth potential.

## 2 | UNIVERSAL OR LOCAL (CUSTOMISED?) CHARTS

Because the Intergrowth-21st and WHO charts were published relatively recently, there have not been many validation studies. However, studies from New Zealand<sup>4</sup> and the United Kingdom<sup>6</sup> have shown that local charts identify more fetuses with a poor outcome as compared

with the Intergrowth-21st charts. The UK study showed that 37% of stillbirths had a weight below the 5th percentile based on local charts, as compared with only 23% based on the Intergrowth-21st charts.<sup>6</sup> Similarly, the New Zealand data showed that, when comparing perinatal death and morbidity, customized charts identified significantly more neonates with a poor outcome than the Intergrowth-21st charts.<sup>4</sup> The latter study concluded that the Intergrowth-21st charts failed to detect many at-risk SGA neonates, particularly among ethnic groups with larger maternal BMI, while disproportionately identifying higher rates of SGA among those with smaller maternal BMI.

In a third study, maternity data from 10 countries (ranging from Bhutan, China, and India to the United Kingdom and United States) with a total of 1.25 million term pregnancies were analyzed.<sup>7</sup> Birthweight percentiles in relation to stillbirth were assessed by using the Intergrowth-21st charts and a customized gestation-related optimal weight chart, in which term optimal weight was adjusted for maternal height, weight, parity, and ethnic origin. Customized assessment resulted in increased identification of SGA and stillbirth risk. Thus, these data do not support use of the universal Intergrowth-21st charts.

## 3 | DISCUSSION

Large data sets from Norway, Australia, the United Kingdom (two studies), and the Netherlands have shown that perinatal mortality (especially stillbirth) is highest in fetuses with a weight below the 2.3rd percentile.<sup>8–12</sup> With increasing weight, mortality gradually decreases and is lowest at approximately 1 SD above the mean (~90th percentile). The same holds for the incidence of cerebral palsy.<sup>13</sup> The 10th percentile identifies neonates at highest risk but remains an arbitrary cut-off because poor outcome will continue to fall with increasing weight percentiles.

Population data on perinatal mortality in relation to birthweight percentiles are lacking for low- and middle-income countries; however, assuming that optimal fetal weight for survival is also approximately +1 SD above the mean in those countries, for a progressive increase in perinatal mortality at lower birthweight percentiles and highest mortality for a weight below the 10th percentile, then local population charts should be used to identify small newborns at highest risk in the different populations. We would not promote a universal growth chart that identifies only the highest risk fetuses (<2.3rd percentile) in high-income countries and excludes those that have a weight between the 3rd and 10th percentile according to local charts. Nor would we promote use of a chart that identifies 50% of fetuses as being at increased risk, which is the case in India when the Intergrowth-21st charts are applied. It would be difficult to design management protocols if 50% of the population were identified to be at increased risk. In countries such as India, it is essential to identify the 10% of the population at highest risk, acknowledging that risks gradually decrease with increasing weight percentiles.

The above discussion is based on recognition that the obstetric community has widely internalized the 10th percentile as a threshold for risk.

An alternative approach (which is widely used in child health anthropometry) is to use international standards for growth and to select a locally appropriate threshold for risk interpretation in percentiles or z scores. In a high-income country setting, it is likely that a higher percentile (e.g., 15th or 20th percentile) might be more useful as a marker of risk; in a low-income setting, by contrast, a lower percentile threshold for special surveillance (e.g., 3rd or 5th percentile) would be appropriate. The authors of the WHO charts also point out the possibility of adjusting the charts “by changing cut-offs to fit clinical needs better”.<sup>2</sup> Whichever the setting, it should be realized that prenatal fetal weight estimation is not very precise.

The Intergrowth-21st and WHO charts have shown that birthweights do not differ much between neighboring countries; in other words, for countries without their own local growth charts, regional charts for populations with the same ethnicity may be used and there is no great need to develop charts for each individual country. For instance, term birthweight in low-risk pregnancies is approximately 3.3 kg in southern Europe and 3.5 kg in northern Europe. Similarly, term birthweight in Brazil and Argentina are also more or less the same. For immigrant populations, it may be wise to use customized charts that take ethnicity into account.

Local charts may be based on data from all pregnancies or from only low-risk pregnancies. The latter seems preferable because more SGA fetuses may be identified. To our knowledge, however, no studies have compared outcomes in relation to the two approaches.

Customized charts, based on parity, maternal weight, fetal sex and ethnicity, may improve the detection of SGA fetuses with highest risk of perinatal mortality and morbidity, which is an argument for using these charts (e.g., 14,15). However, their utility was not demonstrated either in a prospective study<sup>16</sup> or a population study.<sup>17</sup> Among other reasons, this may be due “to the fact that their apparent benefit in improving the prediction of adverse outcomes is derived from their incorporation of intrauterine based reference values at preterm ages rather than adjustment for maternal characteristics”.<sup>18,19</sup> When assessing fetal size prenatally by ultrasound, fetal size charts of ongoing pregnancies for gestation should be used and not the birthweight charts. This is especially important before 34–36 gestational weeks, when ultrasound estimated fetal weight is approximately 200 g higher than the corresponding weight of a neonate born preterm,<sup>20</sup> or when the proportion of neonates with a birthweight below the 10th percentile is considerably higher as compared with fetuses still in utero.<sup>21</sup> Comparing ultrasound estimated fetal weight with birthweight charts will underestimate the proportion of fetuses that are SGA in ongoing pregnancies. The lower weight of neonates born preterm is likely to reflect the high incidence of growth restriction that is associated with pre-eclampsia and/or with spontaneous preterm birth. At term, there are no large differences between fetal size charts and newborn size charts. Assessment of fetal growth with a one-time measurement remains standard clinical practice, despite recognition that a single measurement can indicate only size. At least two measurements separated in time are needed to estimate a trajectory.

Timing of delivery of the SGA fetus depends on more variables than size alone, such as maternal disease, gestational age, Doppler measurements of fetoplacental circulation, and local facilities

to cope with very preterm neonates. The TRUFFLE study provides a management protocol for delivery of an SGA or intrauterine growth-restricted fetus before 32 gestational weeks.<sup>22</sup> After 37 weeks, an SGA fetus may be delivered on the basis of size alone, especially if the estimated weight is below the 2.3rd percentile.<sup>23,24</sup> More studies are necessary to determine the timing of delivery of SGA fetuses between 32 and 37 weeks.

Lastly, in term pregnancies there is a poor correlation between size at birth and stillbirth; therefore, development of markers for deterioration of the fetal condition in utero would seem to have greater importance than discussions regarding the most appropriate growth chart.<sup>25</sup>

## 4 | CONCLUSIONS

- In low-risk, healthy, well-nourished optimal populations, such as those included in the Intergrowth-21st study, skeletal fetal growth (head circumference) and length and head circumference differ at birth by 2.5%–4.0% among populations, and birthweight by up to 20%. Similar differences in birthweight are also observed in the WHO growth study.
- Based on the 10th percentile for weight in the Intergrowth-21st charts, only 2%–3% of populations in high-income countries will be found to be SGA and at high risk, in contrast to up to 50% in countries such as India.
- Knowing that perinatal mortality and severe morbidity decrease with increasing weight percentiles (up to +1 SD above the mean; only studied in high-income populations), it seems unrealistic to identify only 2.3% or alternatively up to 50% of the population as being at increased risk. For practical reasons, therefore, local reference charts identifying the lowest 10th percentile of that particular population seem to be most appropriate, but it must be realized that mortality and morbidity continue to fall with increasing weight percentiles and that fetal weight measurements or estimations are not very precise.
- Alternatively, international standards for growth may be used with locally appropriate thresholds for risk interpretation.
- There is no great need to have charts for individual countries, because birthweights do not differ largely in neighboring countries with similar ethnicity.
- When assessing fetal weight percentiles, ultrasound size and growth charts should be used rather than birthweight charts. This is especially important during the preterm period.

## MEMBERS OF THE FIGO SAFE MOTHERHOOD AND NEWBORN HEALTH COMMITTEE, 2018–2021

Anwar Nassar (chair), Gerard H.A. Visser (past chair), Eytan R Barnea, Maria Fernanda Escobar, Yoon Ha Kim, Wanda Kay Nicholson, Rodolfo Pacagnella, Diana Rmasaukaite, Gerhard Theron, Alison Wright.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest.

## AUTHOR CONTRIBUTIONS

This paper has been written by GHAV and has been revised by WKN, ERB, DR and AHW. It has been approved by all members to FIGO's Committee Safe Motherhood and Newborn Health. All authors approved the final manuscript.

## REFERENCES

- Villar J, Cheikh Ismail C, Ohuma EO, et al. International standards for newborn weight, length, and head circumference by gestational age and sex: the Newborn Cross-Sectional Study of the INTERGROWTH-21st Project. *Lancet*. 2014;384(9946):857-868.
- Kiserud T, Piaggio G, Carroli G, et al. The World Health Organization fetal growth charts: a multinational longitudinal study of ultrasound biometric measurements and estimated fetal weight. *PLoS Medicine*. 2017;14(1):e1002220.
- Papageorghiou AT, Kennedy SH, Salomon LJ, et al. The INTERGROWTH-21st fetal growth standards: toward the global integration of pregnancy and pediatric care. *Am J Obstet Gynecol*. 2018;218(2, Supplement):S630-S640.
- Anderson NH, Sadler LC, McKinlay CJD, McCowan LME. INTERGROWTH-21st vs customized birthweight standards for identification of perinatal mortality and morbidity. *Am J Obstet Gynecol*. 2016;214(4):509.e1-509.e7.
- Sletner L, Nakstad B, Yajnik CS, et al. Ethnic differences in neonatal body composition in a multi-ethnic population and the impact of parental factors: a population-based cohort study. *PLoS One*. 2013;8(8):e73058.
- Poon L, Tan MY, Yerlikaya G, Syngelaki A, Nicolaides KH. Birth weight in live births and stillbirths. *Ultrasound Obstet Gynecol*. 2016;48(5):602-606.
- Francis A, Hugh O, Gardosi J. Customized vs INTERGROWTH-21<sup>st</sup> standards for the assessment of birthweight and stillbirth risk at term. *Am J Obstet Gynecol*. 2018;218(2):S692-S699.
- Glinianaia SV, Rankin J, Pearce MS, Parker L, Pless-Mulloli T. Stillbirth and infant mortality in singletons by cause of death, birthweight, gestational age and birthweight-for-gestation, Newcastle upon Tyne 1961-2000. *Paediatr Perinat Epidemiol*. 2010;24(4):331-342.
- Vangen S, Stoltenberg C, Skjaerven R, Magnus P, Harris JR, Stray-Pedersen B. The heavier the better? Birthweight and perinatal mortality in different ethnic groups. *Int J Epidemiol*. 2002;31(3):654-660.
- Moraitis AA, Wood AM, Fleming M, Smith GC. Birth weight percentile and the risk of term perinatal death. *Obstet Gynecol*. 2014;124(2 PART 1):274-283.
- Francis JH, Permezel M, Davey MA. Perinatal mortality by birthweight centile. *Aust N Z J Obstet Gynaecol*. 2014;54(4):354-359.
- Vasak B, Koenen SV, Koster MPH, et al. Human fetal growth is constrained below optimal for perinatal survival. *Ultrasound Obstet Gynecol*. 2015;45(2):162-167.
- Jarvis S, Glinianaia SV, Torrioli M-G, et al. Cerebral palsy and intra-uterine growth in single births: European collaborative study. *The Lancet*. 2003;362(9390):1106-1111.
- Clausson B, Gardosi J, Francis A, Cnattingius S. Perinatal outcome in SGA births defined by customized versus population-based birthweight standards. *BJOG*. 2001;108(8):830-834.
- De Jong CL, Gardosi J, Dekker GA, Colenbrander GJ, Van Geijn HP. Application of a customized birthweight standard in the assessment of perinatal outcome in a high risk population. *Br J Obstet Gynaecol*. 1998;105:531-535.
- Sovio U, White IR, Dacey A, et al. Screening for fetal growth restriction with universal third trimester ultrasonography in nulliparous women in the Pregnancy Outcome Prediction (POP) study: a prospective cohort study. *The Lancet*. 2015;386(10008):2089-2097.
- Iliodromiti S, Smith GCS, Lawlor DA, Pell JP, Nelson SM. UK still-birth trends in over 11 million births provide no evidence to support effectiveness of Growth Assessment Protocol program. *Ultrasound Obstet Gynecol*. 2020;55:599-604.
- Poon LC, Volpe N, Muto B, Syngelaki A, Nicolaides KH. Birthweight with gestation and maternal characteristics in live births and stillbirths. *Fetal Diagn Ther*. 2012;32(3):156-165.
- Hutcheon JA, Zhang X, Platt RW, Cnattingius S, Kramer MS. The case against customized birthweight standards. *Paediatr Perinat Epidemiol*. 2011;25:11-16.
- Visser GHA, Bilardo CM, Lees C. Fetal growth restriction at the limits of viability. *Fetal Diagn Ther*. 2014;36(2):162-165.
- Nicolaides KH, Wright D, Syngelaki A, Wright A, Akolekar R. Fetal Medicine Foundation fetal and neonatal population weight charts. *Ultrasound Obstet Gynecol*. 2018;52(1):44-51.
- Bilardo CM, Hecher K, Visser GHA, et al. Severe fetal growth restriction at 26-32 weeks: key messages from the TRUFFLE study. *Ultrasound Obstet Gynecol*. 2017;50(3):285-290.
- Boers K, Vijgen SM, Bijlenga D, et al. Induction versus expectant monitoring for intrauterine growth restriction at term: randomized equivalence trial (DIGITAT). *BMJ*. 2010;341:c7087.
- Figueras F, Gratacos E. Update on the diagnosis and classification of fetal growth restriction and proposal of a stage-based management protocol. *Fetal Diagn Ther*. 2014;36(2):86-98.
- Thilaganathan B. Ultrasound fetal weight estimation at term may do more harm than good. *Ultrasound Obstet Gynecol*. 2018;52(1):5-8.

**How to cite this article:** Visser GH, Nicholson WK, Barnea ER, et al. FIGO position paper on reference charts for fetal growth and size at birth: Which one to use?. *Int J Gynecol Obstet*. 2021;152:148-151. <https://doi.org/10.1002/ijgo.13500>