ADC-FNN Online First, published on July 3, 2012 as 10.1136/fetalneonatal-2012-301708


# Customised assessment of fetal growth potential: implications for perinatal care

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## ABSTRACT

Assessment of fetal growth is a central requirement for good perinatal care. The concept of the individually customised growth potential has enhanced our understanding of the importance of intrauterine growth restriction and its effects on pregnancy outcome. Prospectively, it provides a promising tool for improving antenatal detection, and highlights the need for appropriate protocols and pathways, training and resources to implement effective strategies for prevention.


## INTRODUCTION

Twenty years since the first publication of the concept of customised fetal growth charts,[1] this may be an opportune time to reflect on its current and potential role in perinatal care.

The customised standard defines the individual fetal growth potential by three underlying principles. It is,

1. adjusted to reflect maternal constitutional variation;
2. optimised, by presenting a standard free from pathological factors such as diabetes and smoking; and
3. based on fetal weight curves derived from normal pregnancies, rather than neonatal weight curves which include pathological preterm deliveries.

Thus the standard strives to predict the weight to be reached in an uncomplicated pregnancy, and to detect if it has deviated from the norm due to pathological influences. In practice, software calculates a 'term optimal weight' (TOW) adjusted for maternal characteristics such as height, weight, ethnic group and parity, as well as the baby's sex if known. TOW is combined with a standard 'proportionality' function[2] using Hadlock's fetal weight distribution[3] to provide a gestation-related optimal weight (GROW) curve[4] (http://www.gestation.net) (figure 1).

Ultrasound biometry studies are confirming that variation of growth due to such maternal characteristics can be demonstrated by fetal measurement *in utero*.[5] It will be interesting to see whether an individual prediction of growth based on intrauterine weight estimation can define variation in normal growth as well or better than when this variation is derived from databases of accurately measured birthweights. Further work is also needed to assess whether the Hadlock growth equation is the best one to use in the proportionality formula for backward projection of the calculated term optimal weight.

## EVIDENCE

The intuitive clinical awareness that 'one size does not fit all'[6] has been tested in different populations, and compared with conventional methods for assessing birthweight and fetal growth.

For the assessment of ***birthweight***, the main criterion is how the new standard compares to a conventional, population-based standard in identifying associations with pathology. Smallness for gestational age (SGA) determined by a customised standard reflects intrauterine growth restriction (IUGR) as it is better associated with perinatal mortality, perinatal morbidity and pregnancy complications including pre-eclampsia, antepartum haemorrhage, abnormal umbilical artery Doppler, caesarean section for fetal distress, low 5 min Apgar score, need for neonatal resuscitation, need for neonatal intensive care, and adverse neurological outcome.[7–12]

Furthermore, customised assessment identifies a group of additional cases which were not small by the conventional population standard, but which also had a significantly increased risk of adverse outcome. Conversely, cases defined as small by the population standard but normal by the customised standard were not at increased risk, suggesting that these were small-normal babies not requiring further investigations and interventions. Figure 2 illustrates this observation for the example of pre-eclampsia and its association with SGA.

It has been suggested that most of the benefits of customised standards are due to their use of a fetal rather than a neonatal curve.[13] This is likely to be the case when assessing birthweight in the preterm period, where pathology tends to be most marked,[14] and where therefore the use of neonatal weight-based curves can hide the fact that a pregnancy was affected by growth restricting pathology. However, even when controlling for this effect by side by side comparisons of fetal weight curves with and without customised assessment, the additional benefits become clearly evident within each of the subgroups adjusted for, such as parity and maternal size.[15] This is illustrated in figure 3 using the example of maternal body mass index and perinatal mortality.

For the assessment of ***fetal growth***, longitudinal studies of ultrasound-estimated fetal weight have found that customised limits (eg, 90th and 10th centile lines) better reflect fetal growth in normal pregnancy, and result in fewer false-positive diagnoses of abnormal growth.[16 17]

Most reports to date have focused on the lower end of the weight-for-gestational age spectrum, that is SGA/IUGR, although studies on macrosomia have started to emerge which similarly support the use of a customised growth potential.[18]

Internationally, many similarities are observed when comparing factors affecting fetal growth and birth weight in different environments.[19 20] The GROW programme is now available in several country-specific editions using the same principles but incorporating coefficients based on local birthweight databases.[4]

Where such data are insufficient to derive coefficients for individual adjustment of growth potential, a population-average birthweight at term can be combined with the standard proportionality growth curve[2] to derive a country-specific antenatal chart.[21 22] Such local standards are still better than imported population-based standards in defining a small for gestational age group with adverse outcome,[22] although they will not have the benefits of customised assessment within the various subgroups of any heterogeneous maternity population.[15]

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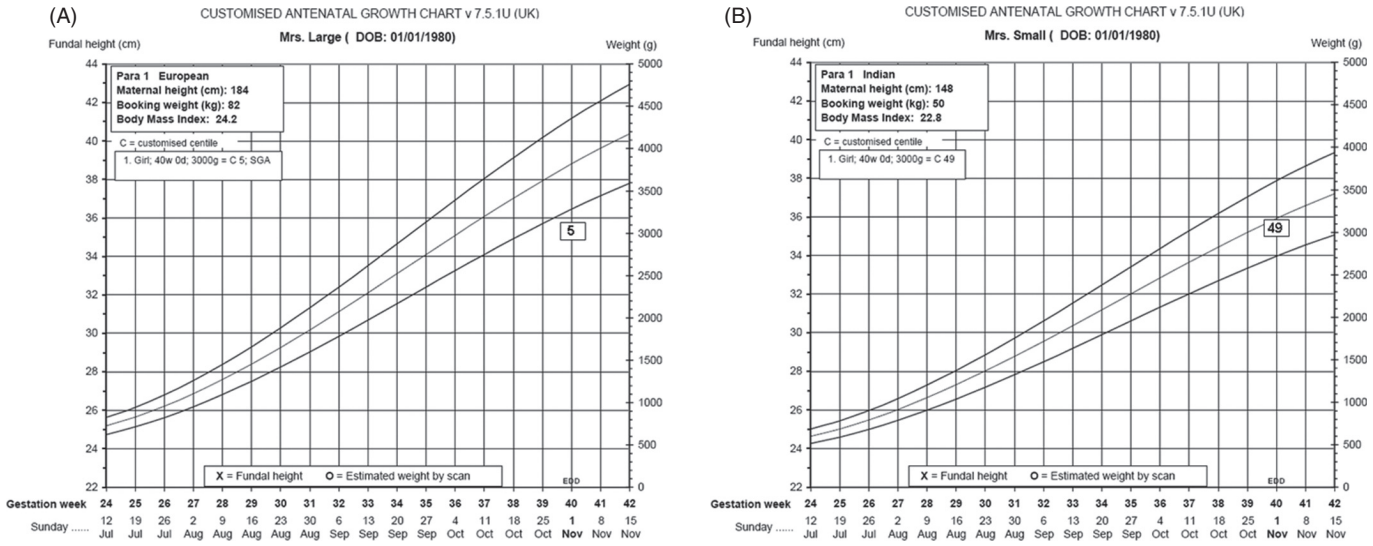


**Figure 1** (A, B) Examples of customised charts using GROW (Gestation-Related Optimal Weight, software v. 7.5.1, http://www.gestation.net). The charts can be used to plot previous baby weights and ultrasound estimated fetal weights in the current pregnancy (right Y axis) as well as fundal height measurements for serial assessment (left Y axis). The horizontal axis shows the day and month of the start of each week of gestation, calculated by the software on the basis of the estimated date of confinement. The three curves on the chart are the 50th centile and the 10th and 90th centile limits, representing the predicted range of optimal growth for each pregnancy, after adjustment for maternal height, weight, parity and ethnic origin. The pregnancy details are shown on the top left of the chart, with maternal height in cm, and maternal weight in kg. The example shows two mothers – (A) 'Mrs Small' and (B) 'Mrs Large', with two different sets of characteristics. A previously born baby girl weighing 3000 g at 40.0 weeks is illustrated as being of average size (49th birthweight centile) for Mrs Small (A), but small for gestational age (SGA, 5th centile) for Mrs Large (B). Copyright Perinatal Institute.

## NEW INSIGHTS

By adjusting for constitutional/physiological variation, the customised standard is better able to define normal growth, and better able to recognise abnormal growth and birthweight as pathological. This concept has led to, or reinforced, several new insights with important clinical implications:

1. Customised centiles can define retrospectively whether there was IUGR, regardless of whether it was suspected or detected antenatally, or whether there was a postmortem. In perinatal mortality databases, as many as 40% of stillbirths had fetal growth restriction as indicated by the customised weight centile at birth, even after adjusting for delay from intrauterine death to time of delivery.[23] Similarly, many neonatal deaths were babies which had failed to reach their intrauterine growth potential.[24]
2. Such observations are relevant for classification systems for stillbirth, which until recently tended to report up to two thirds of cases as unexplained.[25] However, the majority of deaths which remain 'unexplained' even after thorough investigation, have been found to be IUGR according to customised centiles.[26] While IUGR is not a cause of death, it is a relevant condition preceding death. If the classification includes a category for IUGR, the 'unexplained' group can be reduced to around 15%.[23]
3. Customised centiles are also useful in clinical audit and peer review, in particular, as many perinatal deaths in multicultural populations may not have postmortems due to parental choice. They help to establish whether there was antecedent IUGR which was missed during antenatal care.[28] The majority of neonatal deaths show significant upstream factors, including a lack of antenatal recognition of fetal growth restriction.[27]
4. Many spontaneous as well as iatrogenic preterm births are of babies with birthweights which indicate fetal growth restriction,[29 30] raising the possibility of some spontaneous premature deliveries being an adaptive response to an unfavourable intrauterine environment. This in turn could be an underlying reason why tocolysis is often unsuccessful. Threatened or real premature labour should be regarded as an indication to investigate the wellbeing of the fetus, and in particular, to assess its growth status.
5. Customised centiles identify babies that are small but normal, which helps to reassure the mother and can reduce unnecessary investigations and interventions, such as induction of labour for suspected IUGR.[31]
6. There is also improved awareness of the link between IUGR at term birth and subsequent development of cerebral palsy.[32] This in turn points to the need to consider the timing of delivery.[33]
7. The association between obesity and perinatal mortality (figure 3) is in large part due to an increased risk of IUGR.[15] Previous claims that obesity was a protective factor for SGA.[34] have been shown to be an artefact due to the use of population standards which do not adjust for maternal weight.[15]

The ability to retrospectively determine whether there was growth deficit (IUGR) is a significant improvement from the use of arbitrary, population-based weight for gestation cut-offs (SGA) and absolute weight categories which do not even adjust for gestational age (eg, <2500 or <1500 g). Furthermore, they allow a more comprehensive assessment of all pregnancies affected by IUGR, rather than restricting it to the minority which are recognised antenatally as having poor growth. As a result, customised charts have led to a better overall appreciation of the importance of IUGR for management and prevention, and the need to improve antenatal detection.



Gardosi J. *Arch Dis Child Fetal Neonatal Ed* (2012). doi:10.1136/fetalneonatal-2012-301708

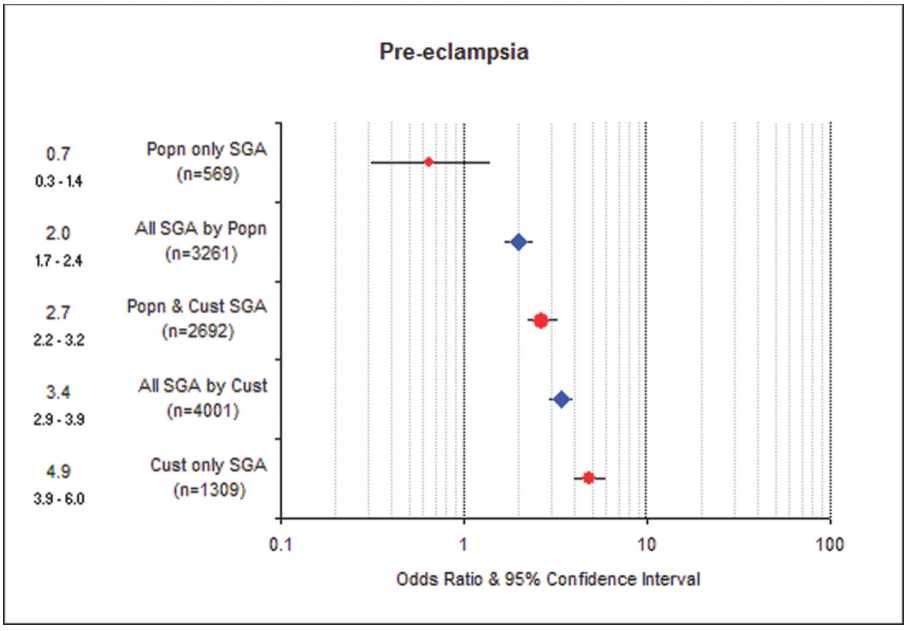


**Figure 2** Risk of pre-eclampsia in pregnancies with a small for gestational age (SGA) fetus, determined according to customised versus population-based centiles. The two subgroups shown top and bottom are those in which, respectively, babies were SGA by the population method only ('SGA pop only'), or by the customised method only ('Cust only SGA'). Cases which were SGA by the population standard but not SGA by customised centiles did not have an increased risk, while those which were not SGA by the population standard but additionally identified by using their customised growth potential, were significantly more likely to be associated with pre-eclampsia. Figures show OR and 95% CI. (Reproduced from[12], with permission).

## IMPLEMENTATION

Detection of 'SGA' or 'IUGR' is a universally agreed key objective of antenatal care. In a controlled study of over 1200 women, fundal height measurements plotted on customised charts was compared with routine practice, and resulted in a significant improvement in antenatal detection of SGA or IUGR, as well as significantly fewer referrals for further investigations, because of enhanced ability to recognise babies which are small-normal.[35] This study was powered to assess differences in detection rate, rather than perinatal outcome. Any power calculation will quickly show that even an optimistic target of reducing perinatal death, by say a third or more, would require recruitment of over a hundred thousand pregnancies in each arm; more realistic targets of 10%–20% reduction in mortality would require substantially more. An additional challenge for any such multicentre trial would be the need to first standardise the current wide heterogeneity of care pathways in use for fetal growth.

Instead, our implementation has progressed along a best practice model, supported by RCOG guidelines[36] and helped by the comprehensive retrospective evidence in favour of measuring babies according to their customised growth potential – unlike conventional population charts, which have become established with little evidence and evaluation. To date, close to half of all pregnancies in England are already managed with customised charts, and they are gradually being introduced in Australia, New Zealand and other parts of the world. As with any change in practice, implementation requires effort, and needs to be part of a 'package' to effect service enhancement, including the following:

- clear clinical protocols and care pathways for antenatal growth surveillance and referral for further investigation;[36 37]
- staff training – including a standardised method of fundal height measurement and plotting, for midwifery as well as medical staff;[37]
- appropriate ultrasound resources to deal with referrals on the basis of fundal height screening in low-risk pregnancy, and for serial assessment in pregnancies at high risk of IUGR;[36]
- ongoing audit: it is essential to have a system in place to establish a benchmark and monitor performance – a simple metric for IUGR detection is the number of cases detected antenatally, divided by the number of babies born with a birth weight below 10th customised centile.

## IMPROVING QUALITY OF CARE

Most maternity units do not know their antenatal detection rates of SGA/IUGR, but occasional audits have shown disappointing baseline rates of only 15%–25%.[38 39]

In the West Midlands, IUGR detection has been established as a key performance indicator for maternity care, together with routine data collection to monitor progress and identify variation. There is a rolling training programme of GROW accreditation workshops, which to date has trained over 1000 midwives and senior and junior medical staff; and regional protocols have been agreed by a professional network of clinicians and ultrasonographers.

As a result, overall antenatal detection rates have increased overall, and in some units to 50%, with a further rise to 80% or more for the cases which get referred on the basis of fundal height surveillance.[40] These improvements have started to translate into actual reductions in perinatal death rates associated with fetal growth restriction.[40] However, detection rates still vary widely, and are proportional to the amount of training staff at a unit has received. They are also dependent on the capacity of obstetric ultrasound services, which within the National Health Service have recently come under additional pressure from the national antenatal screening programme's requirement of routine nuchal scans in the 1st trimester.

Improved awareness of the importance of fetal growth restriction and antenatal detection, and its translation into measurable reductions of perinatal mortality and morbidity, requires adequate resources, implementation of evidence-based protocols and a sustained focus on prevention.

**Competing interests** None.

**Provenance and peer review** Commissioned; externally peer reviewed.

Received 21 January 2012
Accepted 5 March 2012

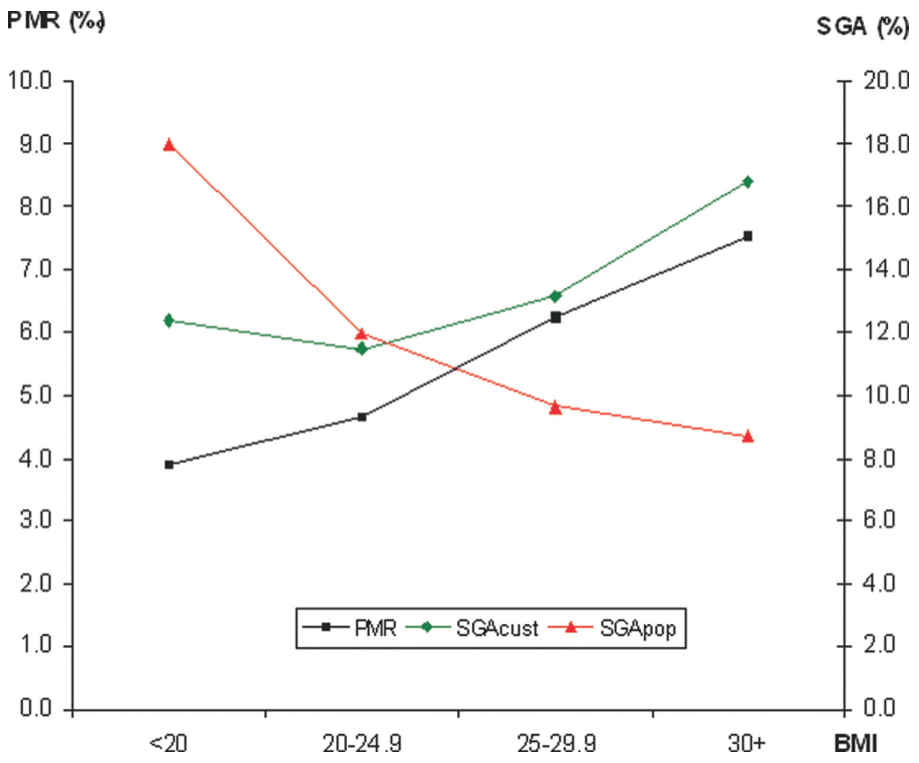


**Figure 3** Maternal body mass index (BMI), perinatal death rate (PMR) and small for gestational age (SGA) by customised (SGAcust) and population-based centiles (SGApop). The figure shows a direct relationship between SGA and perinatal mortality, but only when customised centiles are used to define SGA. Reproduced from,[15] with permission.

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Gardosi J. *Arch Dis Child Fetal Neonatal Ed* (2012). doi:10.1136/fetalneonatal-2012-301708

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*Arch Dis Child Fetal Neonatal Ed* published online June 9, 2012
doi: 10.1136/fetalneonatal-2012-301708