Choosing a growth standard

Clare Whitehead
Optimising detection of FGR not SGA

Which chart you choose will determine what % of babies in your population are SGA and FGR.
Which growth chart: birthweight vs fetal weight

Babies in the NICU are not the same.......... 

As babies that remain in-utero until term!

Live birth charts will systematically underdiagnose FGR prior to term
Which growth chart: birthweight vs fetal weight

Birthweight

Ultrasound

Bwt = Kramer 2001
Which growth chart: *Standard vs Reference charts*

Growth *standards* charts describe how a baby *should* grow.....based on data from *only healthy pregnancies*

Whereas growth *reference* charts describe how *all babies in a population* grow including those that subsequently develop complications
Hadlock Charts

- USA 1991
- 392 women
- All caucasian
- Single center in Texas
- Only 1 USS per fetus
Intergrowth 21

International standards for fetal growth based on serial ultrasound measurements: the Fetal Growth Longitudinal Study of the INTERGROWTH-21st Project

Lancet 2014

Aris T Papageorghiou, Eric O Ohuma, Douglas G Altman, Tullia Todros, Leila Cheikh Ismail, Ann Lambert, Yasmin A Jaffer, Enrico Bertino

Ultrasound based growth standard: “Optimal fetal size”

4321 low risk women from 8 countries included in final chart (Brazil, UK, Italy, Oman, USA, China, India & Kenya)

Linked with WHO infant and childhood growth charts up to age 2 yrs

Dating scan < 14 weeks then scanned every 5 weeks to 42 weeks
International Estimated Fetal Weight Standards of the INTERGROWTH-21st Project

J. Stirnemann \(^a\), J. Villar\(^b\^*,\) L.J. Salomon\(^a\), E. Ohuma\(^b,c\), P. Ruyan\(^d\), D.G. Altman\(^c\), F. Nosten\(^e\), R. Craik\(^b\), S. Munim\(^f\), L. Cheikh Ismail\(^b\), F.C. Barros\(^g,h\), A. Lambert\(^b\), S. Norris\(^l\), M. Carvalho\(^j\), Y.A. Jaffer\(^k\), J.A. Noble\(^l\), E. Bertino\(^m\), M.G. Gravett\(^n\), M. Purwar\(^o\), C. Victora\(^h\), R. Uauy\(^p,q^*\), Z. Bhutta\(^r^*\), S. Kennedy\(^b^*\), A.T. Papageorghiou\(^b^*\), for the International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st).

\[ \log(\text{EFW}) = 5.1 - 54.1 \times \left( \frac{\text{AC}}{100} \right)^3 - 95.8 \times \left( \frac{\text{AC}}{100} \right)^3 \times \log\left( \frac{\text{AC}}{100} \right) + 3.1 \times \left( \frac{\text{HC}}{100} \right) \]

ONLY HC and AC included!
Intergrowth 21

**INTERGROWTH**

**LOCATION**
8 Countries
Brazil, China, India, Italy, Kenya, Oman, U.K. and U.S.

**RACE & ETHNIC**
One overall growth chart
No statistical testing for differences among countries

- One size fits all
- Skeletal growth not affected
- AC, EFW, Bwt – differ due to environment
- Not fetal sex specific – inc in calculator

**INCLUSION/EXCLUSION**
Exclusion of pregnancy complications and fetal factors such as congenital anomalies and stillbirth

Supernormal
2 yrs – normal ND

**ANALYTIC APPROACHES**
Data transformation: none
Model assumptions: linear mixed models with location and scale assumptions, assuming a normal distribution of the fetal growth trajectories

- Mean Bwt ~600g < in India
- In Canada high rates of LGA, low rates of SGA

**ESTIMATED FETAL WEIGHT**
Created a new formula based on only HC and AC, making the comparison of EFW less meaningful

- All measurements blinded, standardised equipment, trained sonographers
Growth charts

- 10th%
- Kramer (BW)
- Hadlock (EFW)
- Intergrowth-21 (EFW)
WHO

- **Ultrasound based growth standard:**
  “Optimal fetal size”

- 1387 low risk women from 10 ultrasound centres included in final chart (Argentina, Brazil, DRC, Denmark, Egypt, France, Germany, India, Norway & Thailand)

- Dating scan < 14 weeks then scanned x 7

- EFW calculated using Hadlock eqn

- Presented pooled data – 1 chart

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RESEARCH ARTICLE

The World Health Organization Fetal Growth Charts: A Multinational Longitudinal Study of Ultrasound Biometric Measurements and Estimated Fetal Weight

Torvid Kiserud¹,²*, Gilda Piaggio³,⁴*, Guillermo Carroli⁵, Mariana Widmer⁶*,

PLOS Med 2017
- **Country variation**
- Country not self reported race
- Sample size for each country ~150
- ~300 patients contribute to each geographical region (Asia, Africa)
- High rates of early term CS in S. America – limited term growth data
- Birthweight ~ 500g less in India compared to Norway
Sex specific
- Males 4.5% bigger
**WHO FETAL**

**LOCATION**
10 Countries
Argentina, Brazil, Democratic Republic of the Congo, Denmark, Egypt, France, Germany, India, Norway, and Thailand

**RACE & ETHNIC**
One overall growth chart
Fetal growth showed natural variation, differing significantly between countries which largely followed ethnic distribution

**INCLUSION/EXCLUSION**
Only optimal health inclusions
No complication excluded (no impact on percentiles)

**ANALYTIC APPROACHES**
Data transformation: log
Model assumptions: Quantile regression without distributional assumptions
Smoothing technique over gestational age: polynomial functions

**ESTIMATED FETAL WEIGHT**
Calculated EFW from HC, AC and FL using the Hadlock 1985 formula

**WHO**

1 postnatal chart WHO MGRS

Reflects clinical practice better

Measurements not blinded – clinically revealed
Growth charts

- Hadlock (EFW)
- WHO (EFW)
• **Ultrasound based growth standard**: “Optimal fetal growth”

• Hypothesis: are racial/ethnic growth standards better

• 12 USA sites, 1733 women

• Dating scan 10-14 weeks then scanned x 5

• EFW calculated using Hadlock eqn
• **Race based differences in EFW**

• **Differences in maternal height, weight, leg length, body composition (fat) based on race**
Risk of misclassification on FGR dependent on race – up to 15%

But higher rate of adverse outcome (stillbirth, PTB) in Black and Hispanic groups
Different chart for:
White
Non Hispanic black
Hispanic
Asian/Pacific Islander
Growth charts

Weight (gr) vs. Gestational age (weeks)

- Hadlock (EFW)
- Kramer (BW)
- Intergrowth-21 (EFW)
- NICHD (EFW, white)
Customised GROW charts

- Country specific – not Canada
- International charts available
- Fetal weight charts
- Term optimal weight and multiple regression analyses

Customise for:
- Maternal height
- Maternal weight
- Ethnicity
- Parity
- Fetal sex
- Country of residence
Customised GROW charts

3 kg baby at 40 weeks

- BMI
- Better at identifying large mothers with FGR babies more at risk of FDIU
- Reduces interventions for low risk small mothers
Customisation and adverse outcomes

Proportion (%) of the composite adverse outcome in relation to birthweight percentile category.

Differences accounted for by use of fetal weight standard, prematurity and increased adverse outcomes in women with high BMI
Self reporting ethnicity?

235 women – 16 categories
50% used multiple descriptors
13% couldn’t identify their ethnicity
Partners interpretation varied

Lockie, BJOG 2018