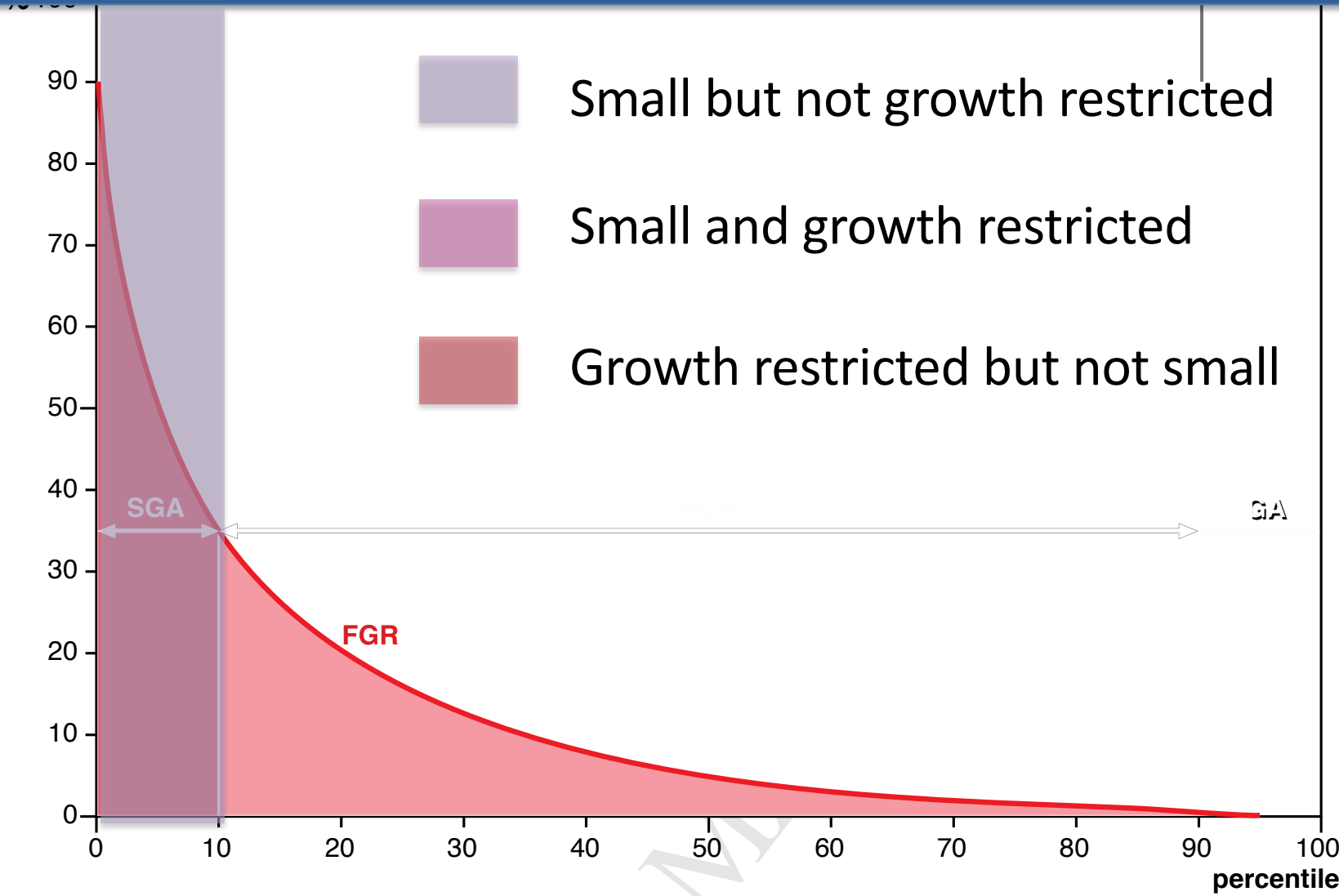
Choosing a growth standard

Clare Whitehead

Optimising detection of FGR not SGA



Which chart you choose will determine what % of babies in your population are SGA and FGR Ganzevoort, AJOG 2018

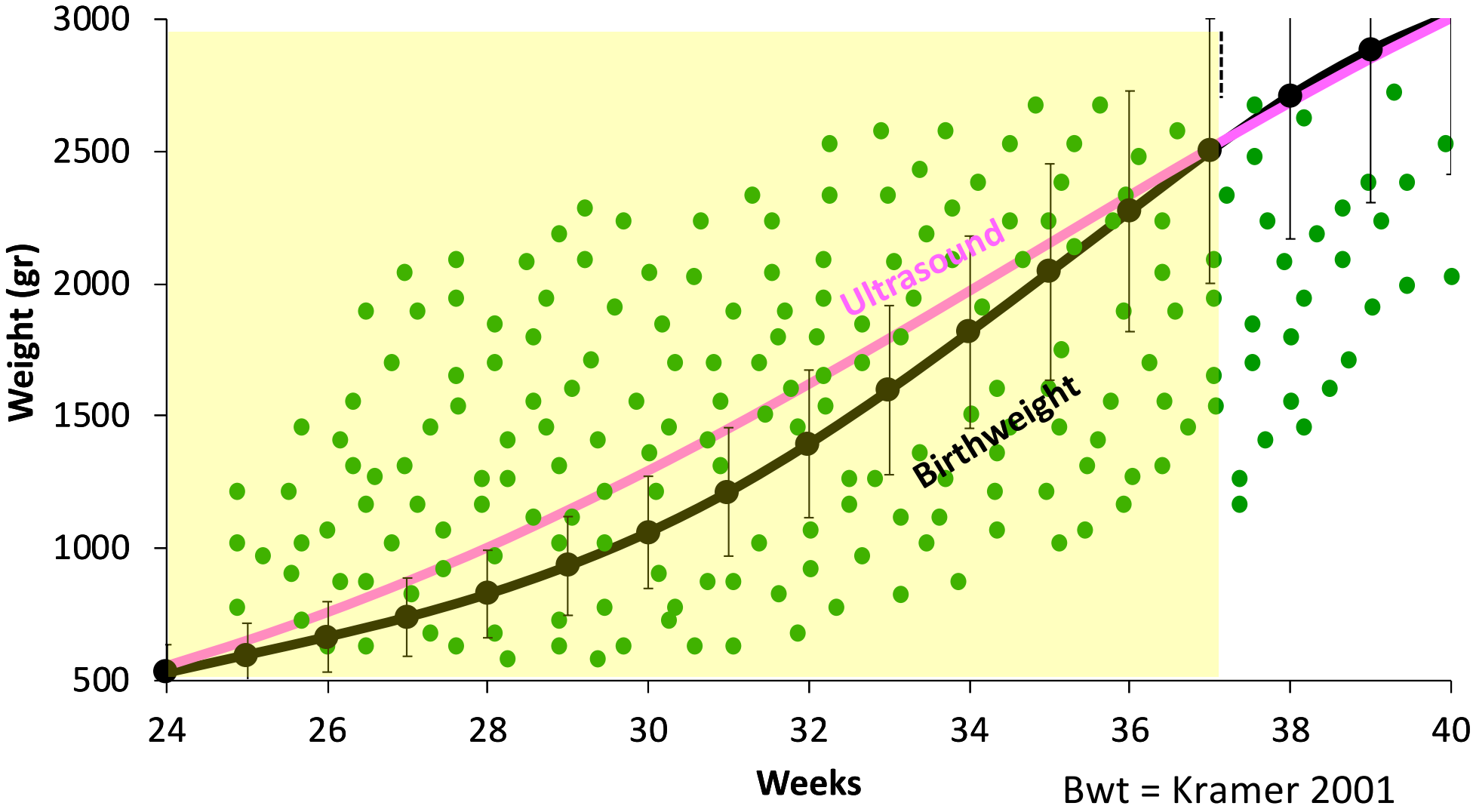
Which growth chart: birthweight vs fetal weight

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



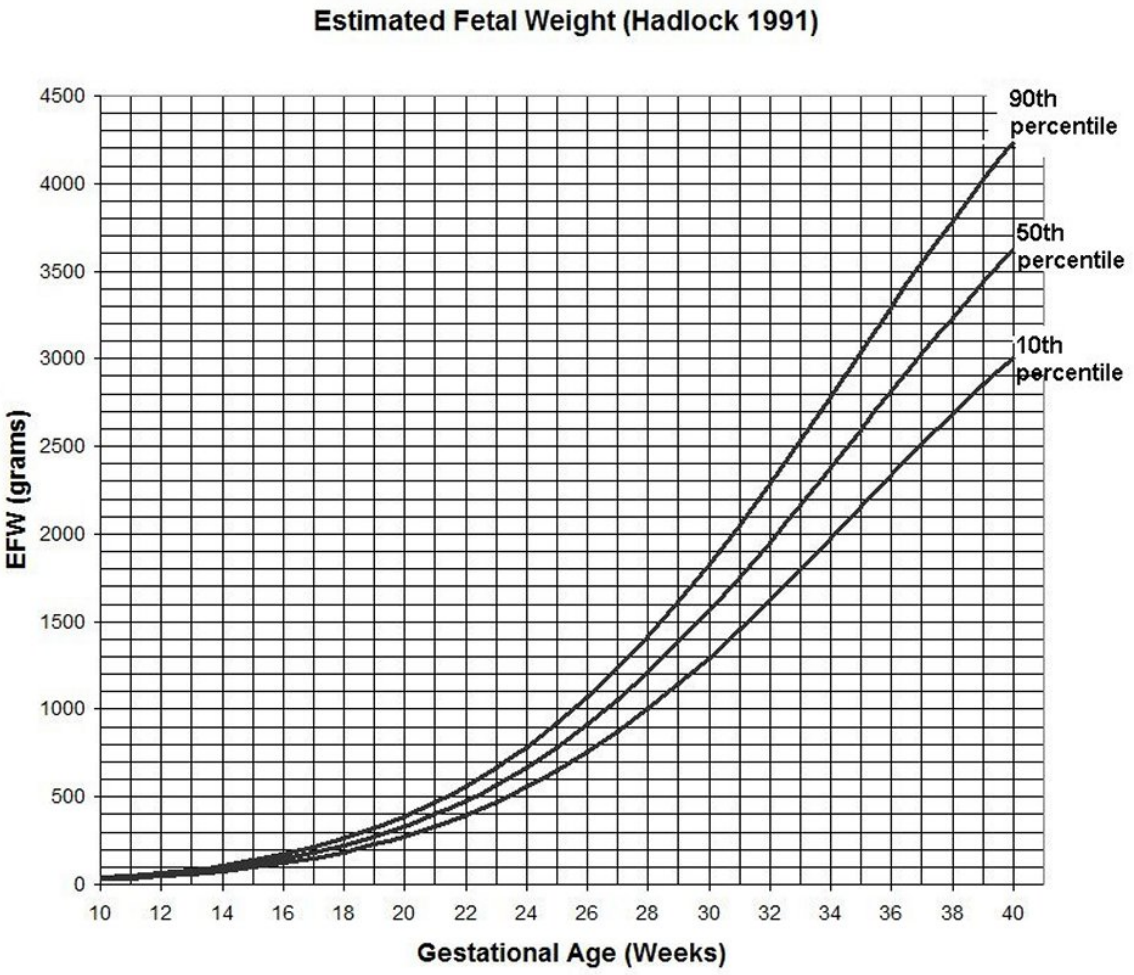
Which growth chart: *Standard vs Reference charts*

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

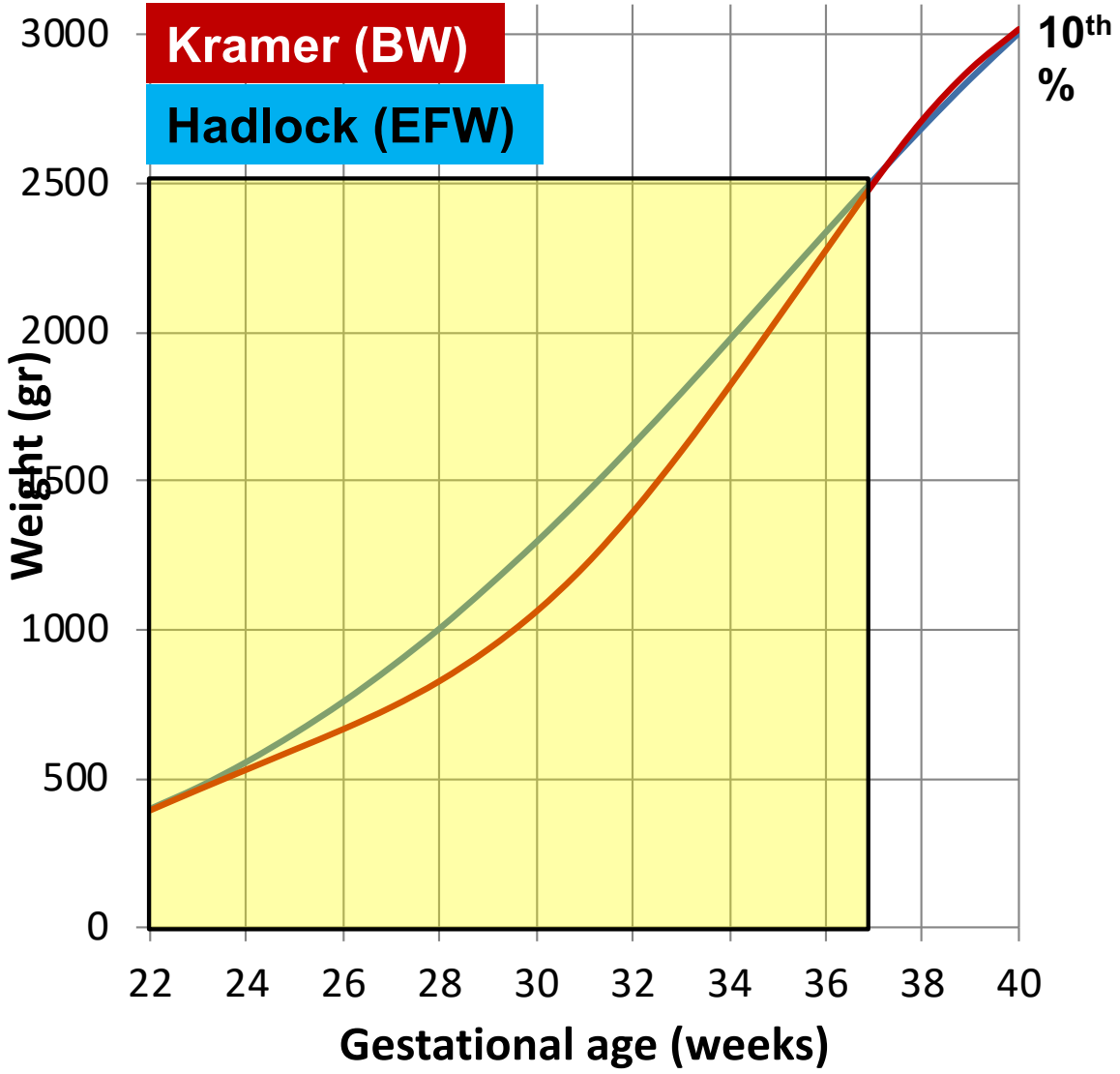
Whereas growth *reference* charts describe how *all babies in a population* grow including those that subsequently develop complications

Hadlock Charts

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



Growth charts



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,

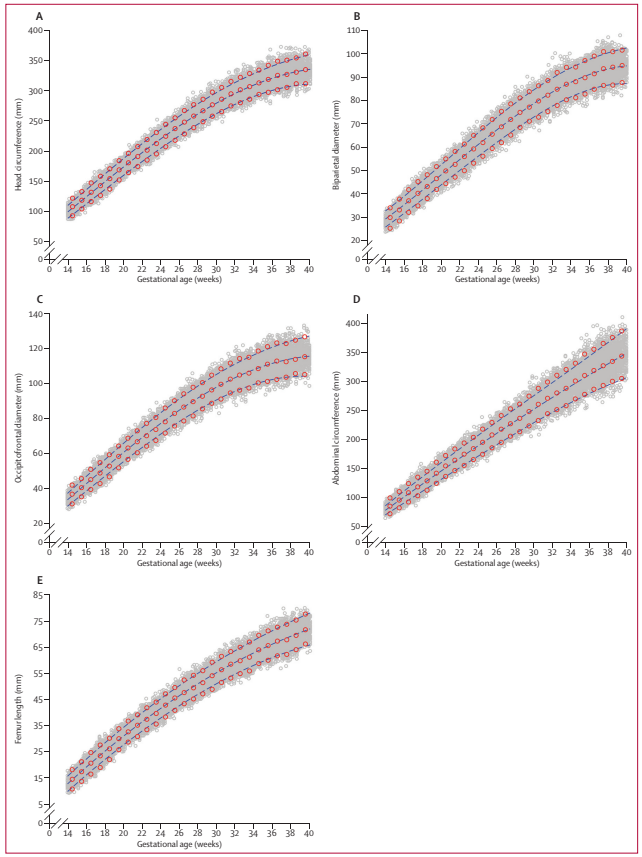


Figure 2: **Fitted 3rd, 50th, and 97th smoothed centile curves of fetal measurements**
Fitted 3rd (bottom dashed line), 50th (middle dashed line), and 97th (top dashed line) smoothed centile curves for fetal head circumference (A), fetal biparietal diameter (B), fetal occipitofrontal diameter (C), fetal abdominal circumference (D), and fetal femur length (E) measured by ultrasound according to gestational age. Open red circles show empirical values for each week of gestation and open grey circles show actual observations.

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

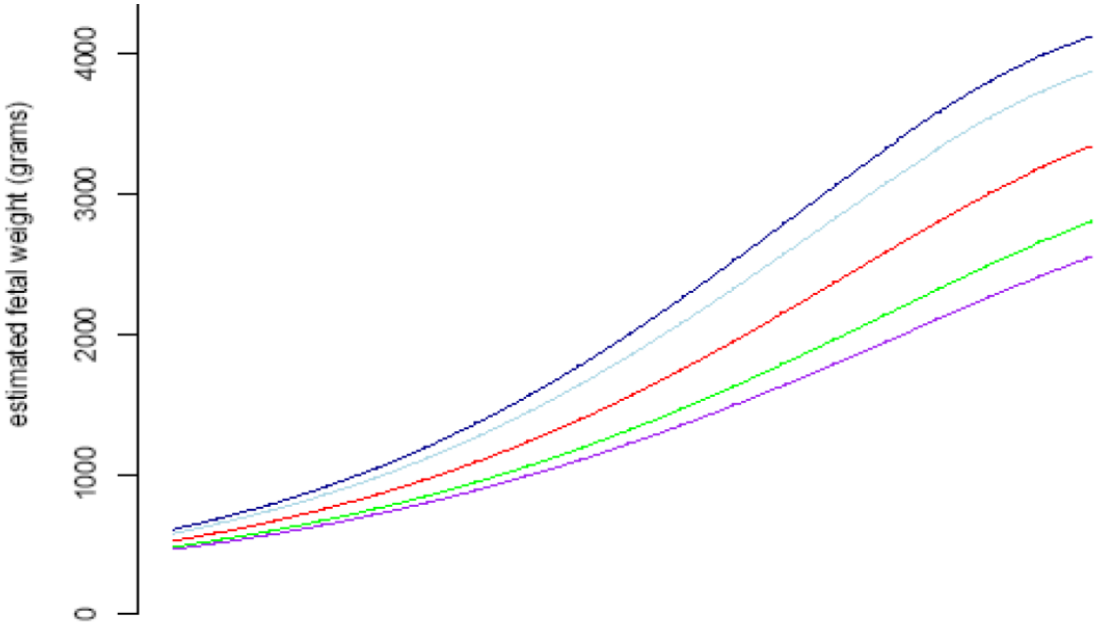
Dating scan < 14 weeks then scanned every 5 weeks to 42 weeks

Intergrowth 21

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[i], 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).

UOG 2017



log(**EFW**) =
5.1 – 54.1×(**AC**/100)^3 –
95.8×(**AC**/100)^3×log(**AC**/100) + 3.1
×(**HC**/100)

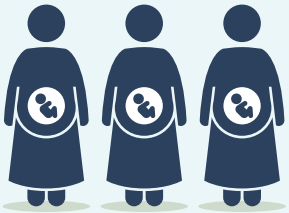
ONLY HC and AC included !

Intergrowth 21

INTERGROWTH

LOCATION

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

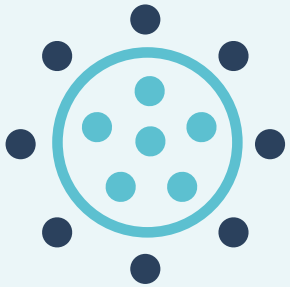


RACE & ETHNIC

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

Smoothing technique over gestational age: second-degree fractional polynomials

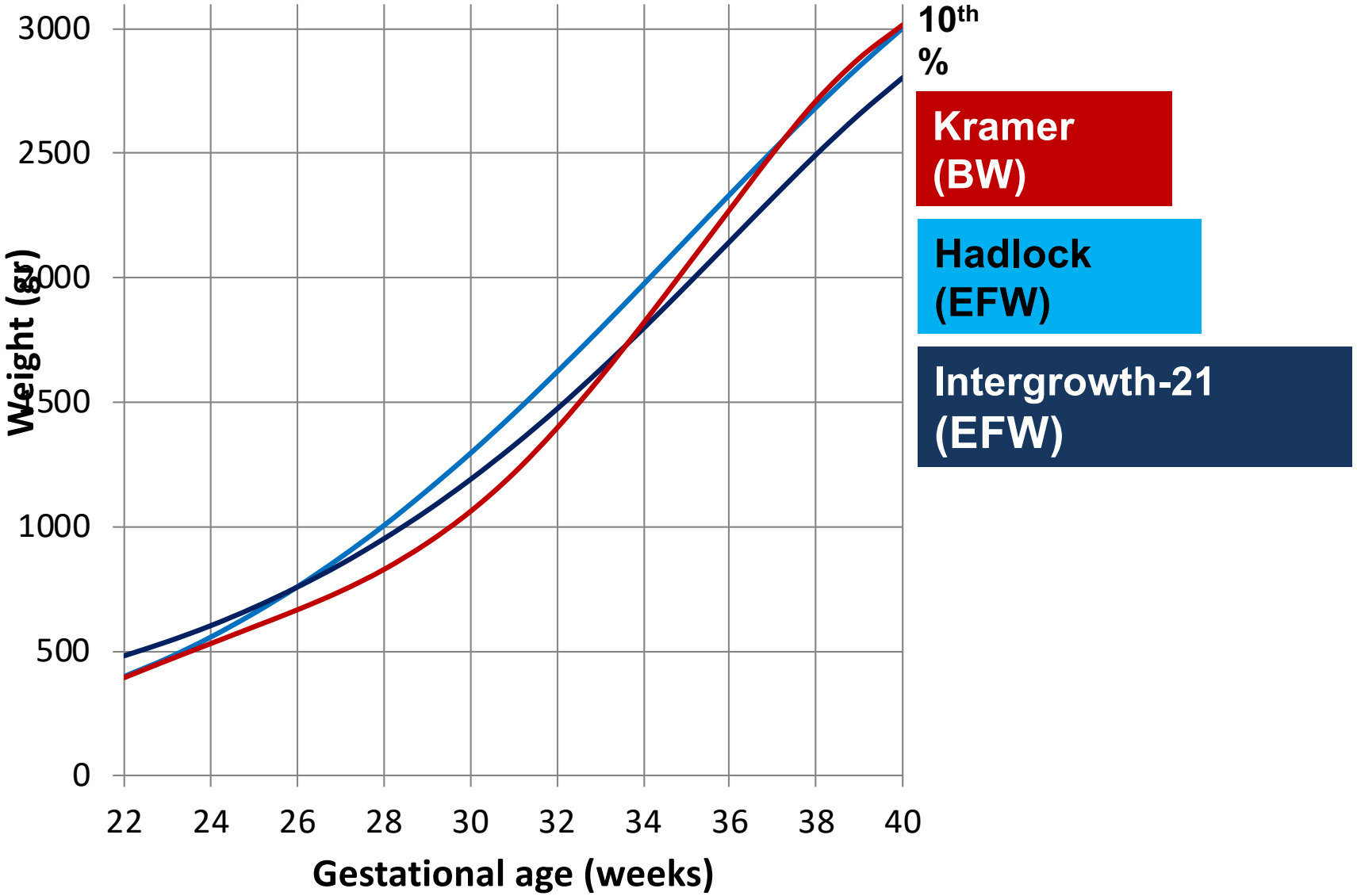
- All measurements blinded, standardised equipment, trained sonographers

ESTIMATED FETAL WEIGHT

Created a new formula[12] based on only HC and AC, making the comparison of EFW less meaningful

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

Growth charts



WHO

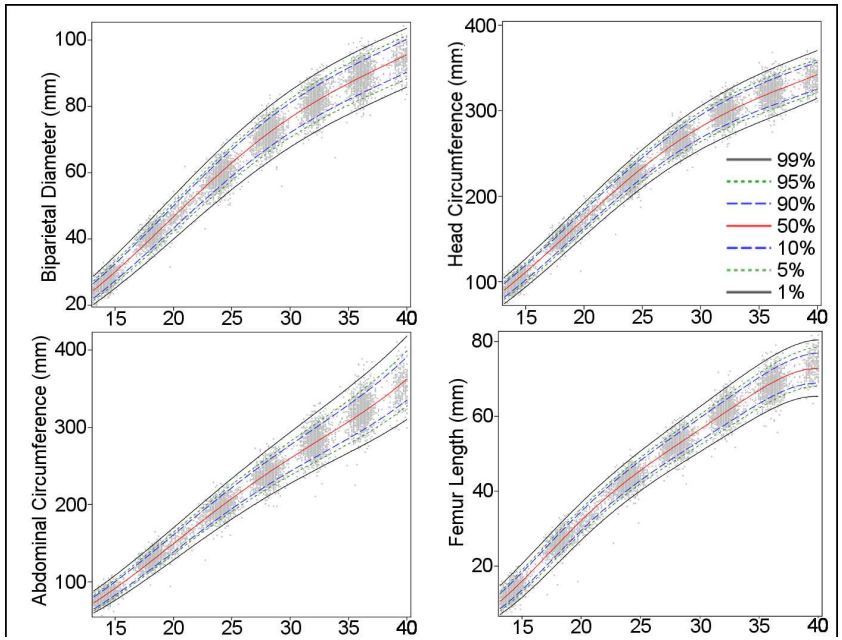
- ***Ultrasound based growth standard:*** "Optimal fetal size"
- 1387 low risk women from 10 ultrasound centres included in final chart (Argentina, Brazil, DRC, Denmark, Egypt, France , Germany, India, Norway & Thailand)
- Dating scan < 14 weeks then scanned x 7
- EFW calculated using Hadlock eqn
- Presented pooled data – 1 chart

RESEARCH ARTICLE

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

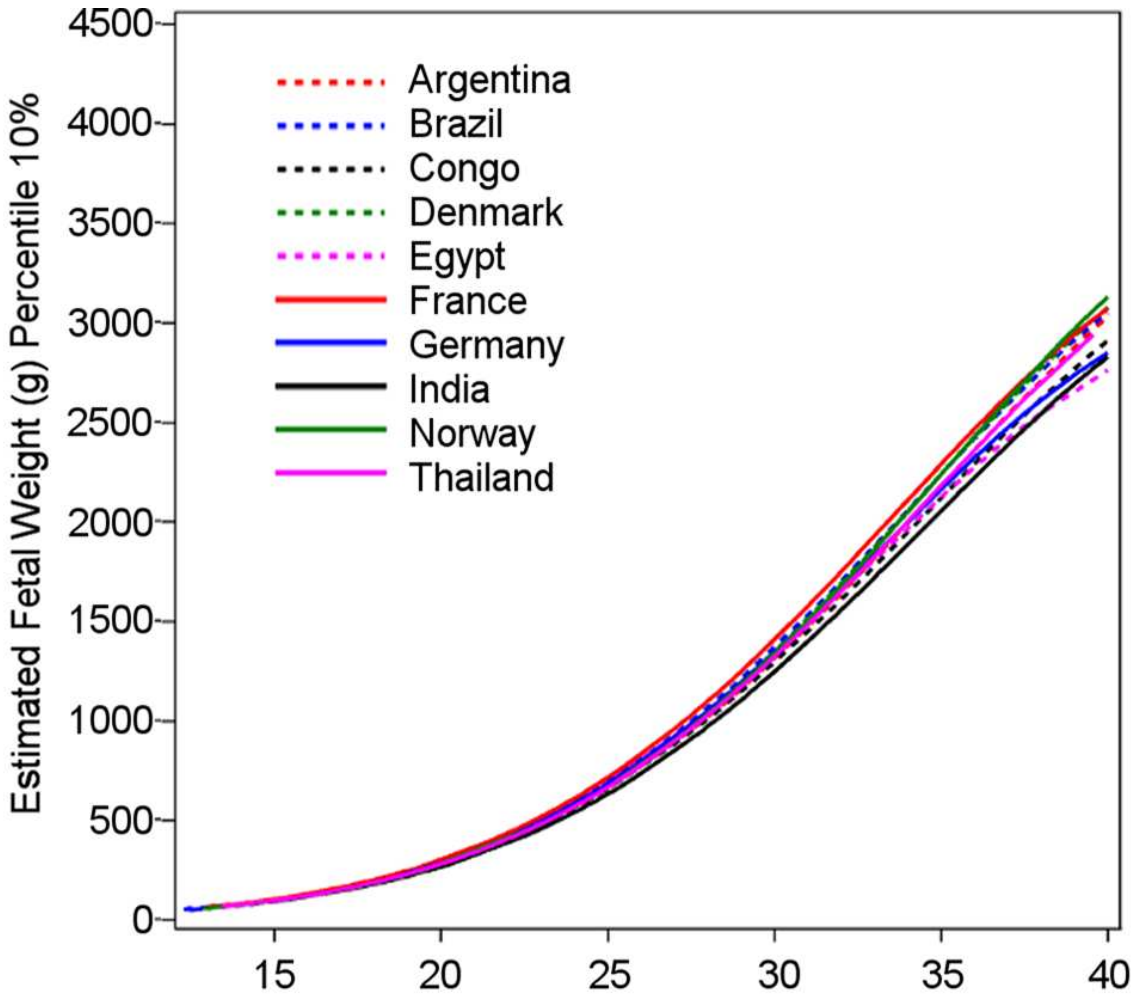
Torvid Kiserud[1,2]*, Gilda Piaggio[3,4]*, Guillermo Carroli[5], Mariana Widmer[6]*,

PLOS Med 2017



WHO

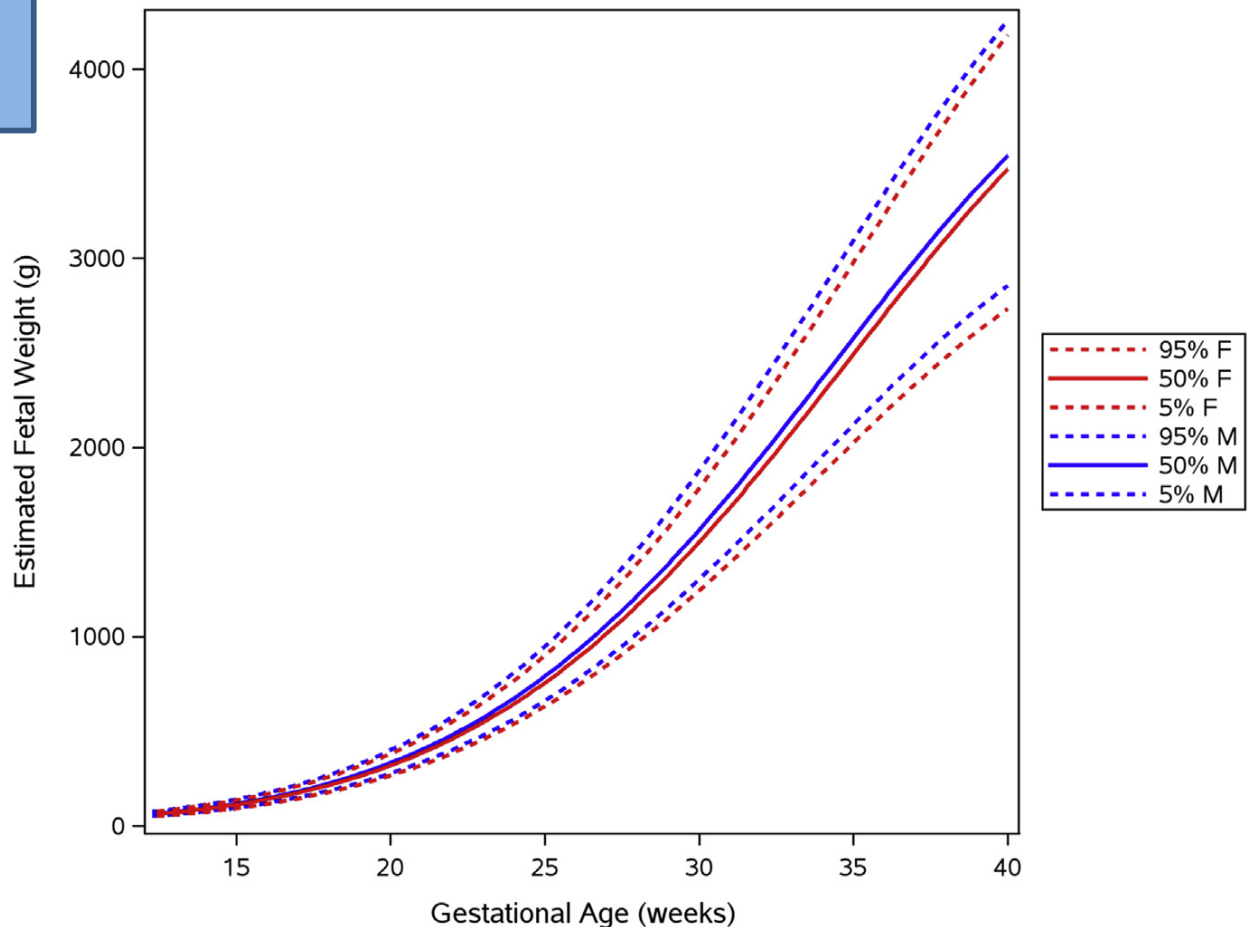
- **Country variation**
- Country not self reported race
- Sample size for each country ~150
- ~300 patients contribute to each geographical region (Asia, Africa)
- High rates of early term CS in S. America – limited term growth data
- Birthweight ~ 500g less in India compared to Norway



WHO

Sex specific

- Males 4.5% bigger

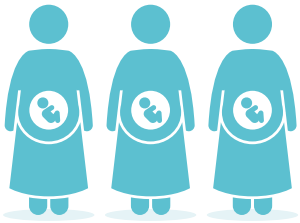


WHO

WHO FETAL

LOCATION

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

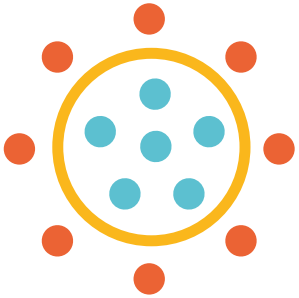


RACE & ETHNIC

One overall growth chart

Fetal growth showed natural variation, differing significantly between countries which largely followed ethnic distribution

1 postnatal chart WHO MGRS



INCLUSION/ EXCLUSION

Only optimal health inclusions

No complication excluded (no impact on percentiles)

Reflects clinical practice better

ANALYTIC APPROACHES

Data transformation: log

Model assumptions: Quantile regression without distributional assumptions

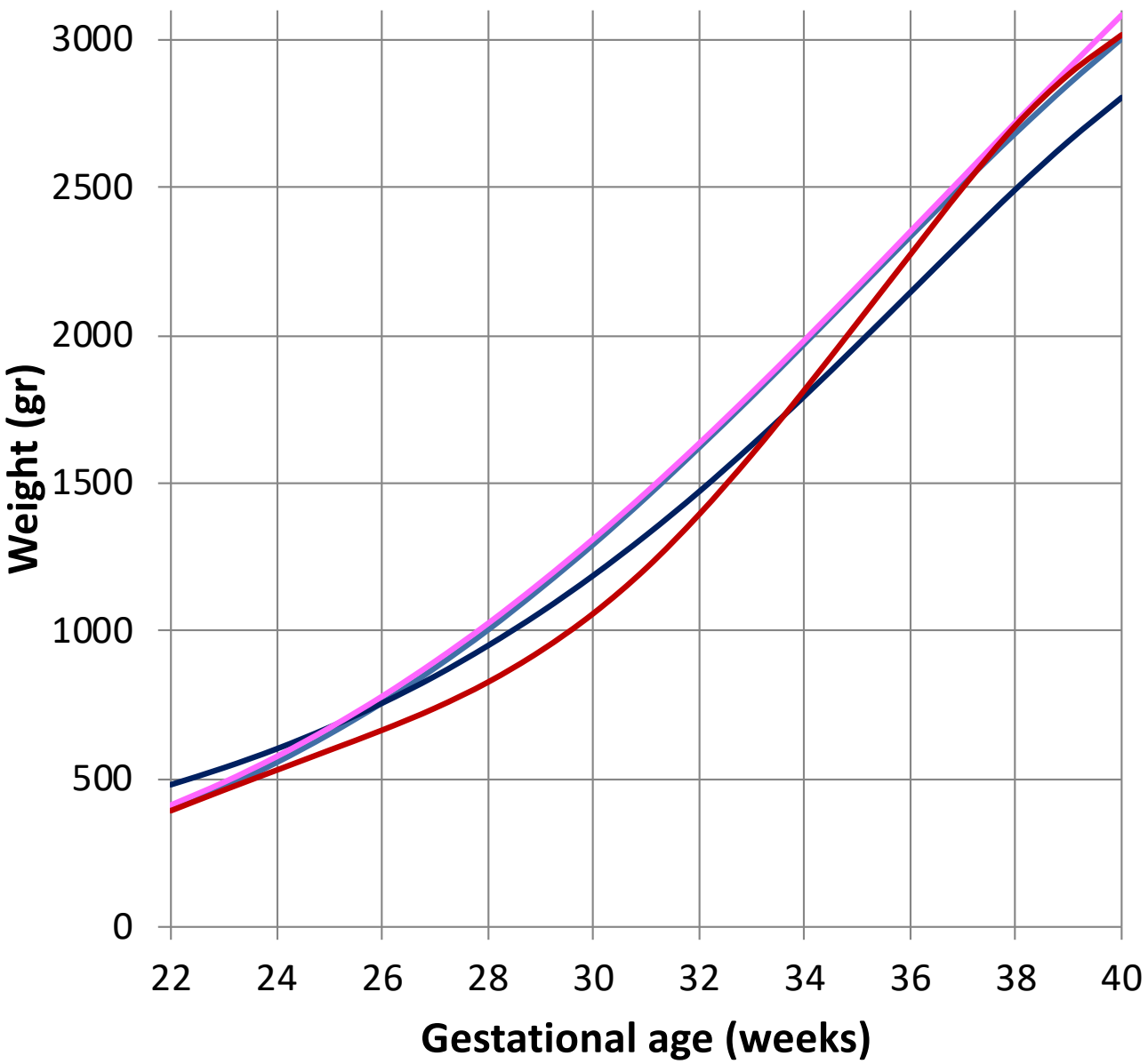
Smoothing technique over gestational age: polynomial functions

Measurements not blinded – clinically revealed

ESTIMATED FETAL WEIGHT

Calculated EFW from HC, AC and FL using the Hadlock 1985 formula[26]

Growth charts



10th%

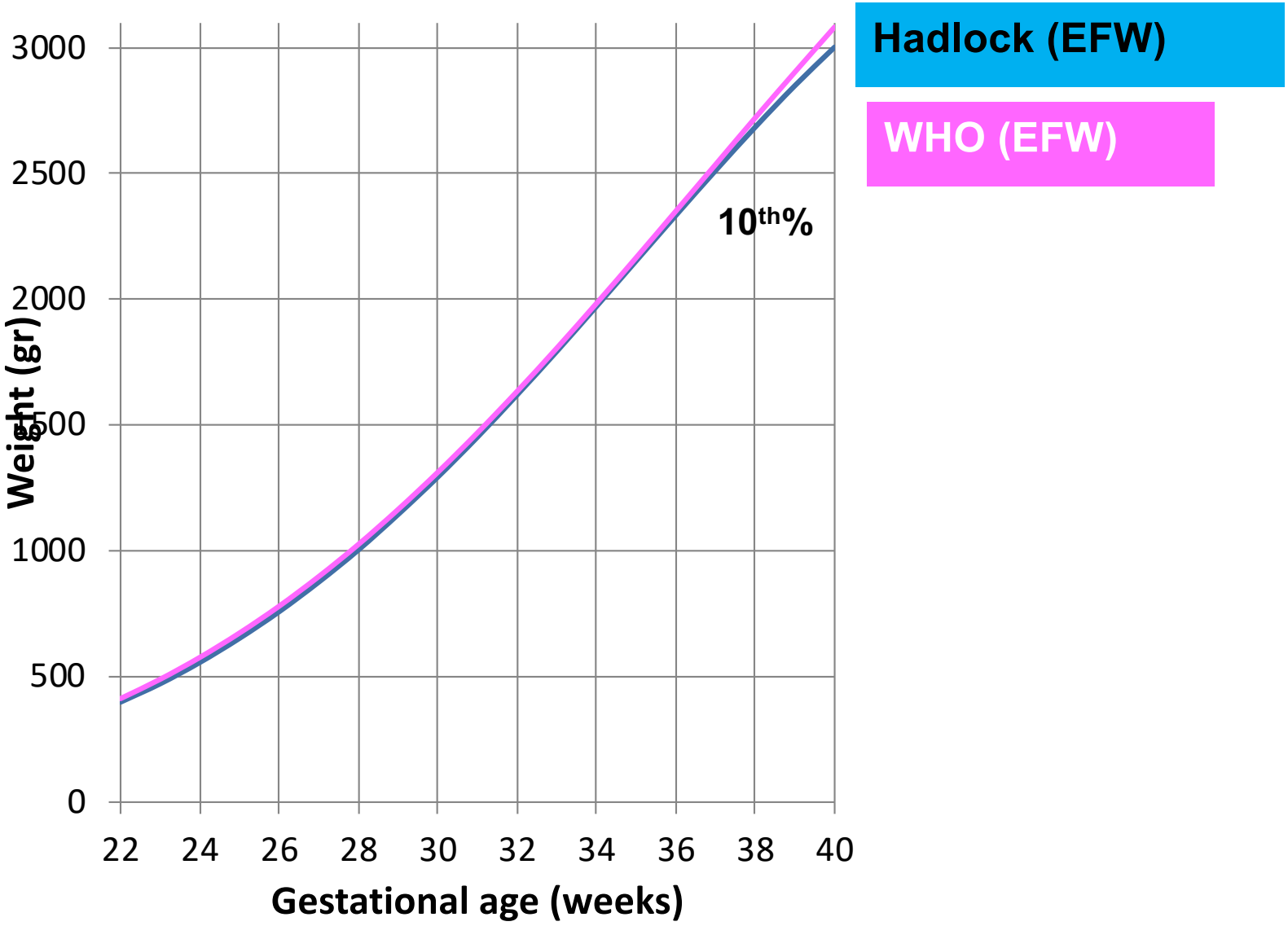
Kramer (BW)

Hadlock (EFW)

Intergrowth-21 (EFW)

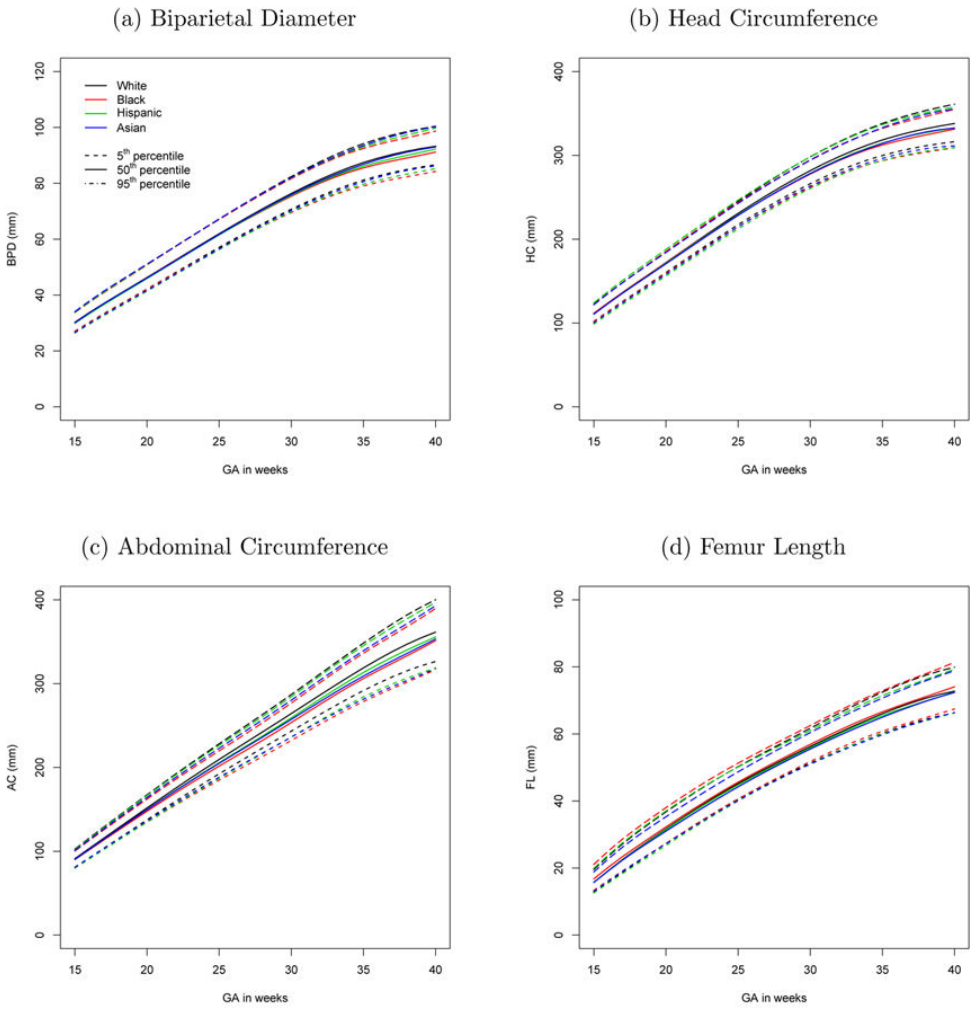
WHO (EFW)

Growth charts



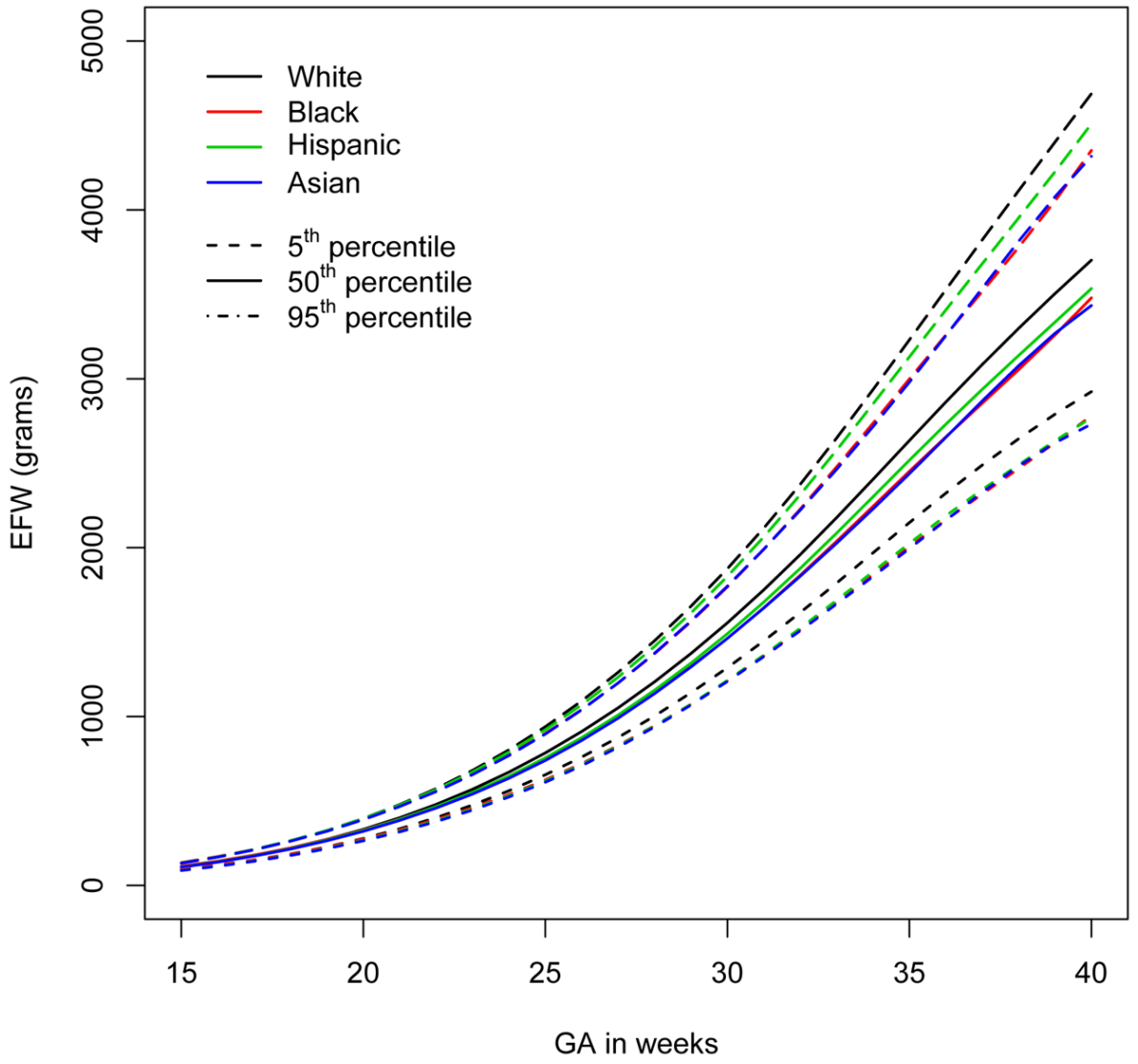
NICHD

- ***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



NICHD

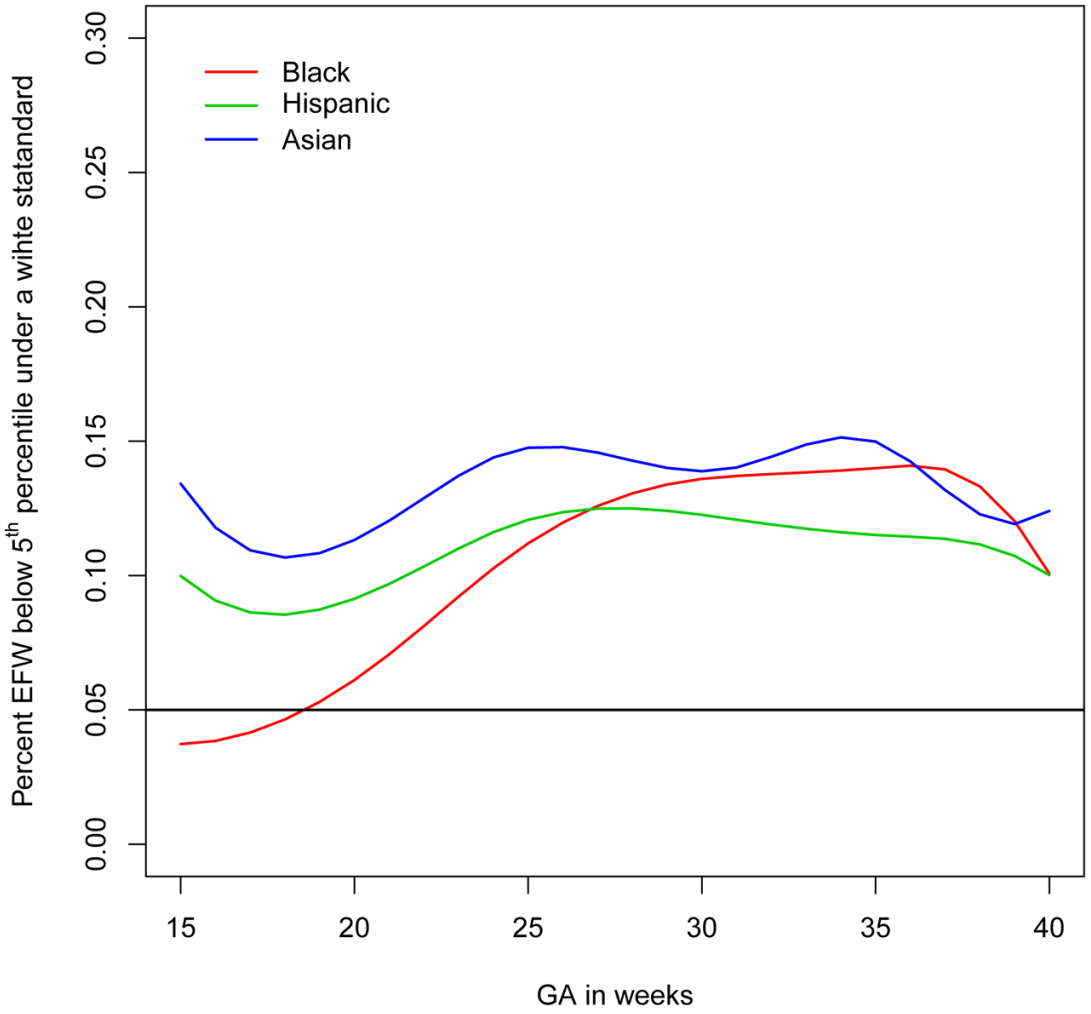
- ***Race based differences in EFW***
- *Differences in maternal height, weight, leg length, body composition (fat) based on race*



NICHD

Risk of misclassification on FGR dependent on race – up to 15%

But higher rate of adverse outcome (stillbirth, PTB) in Black and Hispanic groups

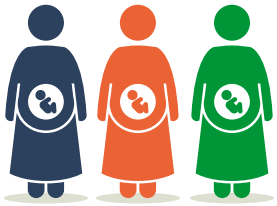


NICHD

NICHD

LOCATION

12 U.S. Sites
New York [2], New Jersey, Delaware, Rhode Island, Massachusetts, South Carolina, Alabama, Illinois, and California [3]



RACE & ETHNIC

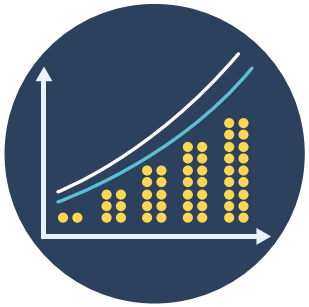
Highly statistically significant differences in fetal growth by race/ethnicity

Racial/ethnic-specific derived standards

Different chart for:
White
Non Hispanic black
Hispanic
Asian/Pacific Islander

INCLUSION/ EXCLUSION

A priori exclusion of pregnancy complications, preterm delivery < 37 weeks' gestation, stillbirth and fetal factors including all structural anomalies and karyotype abnormalities



ANALYTIC APPROACHES

Data transformation: log

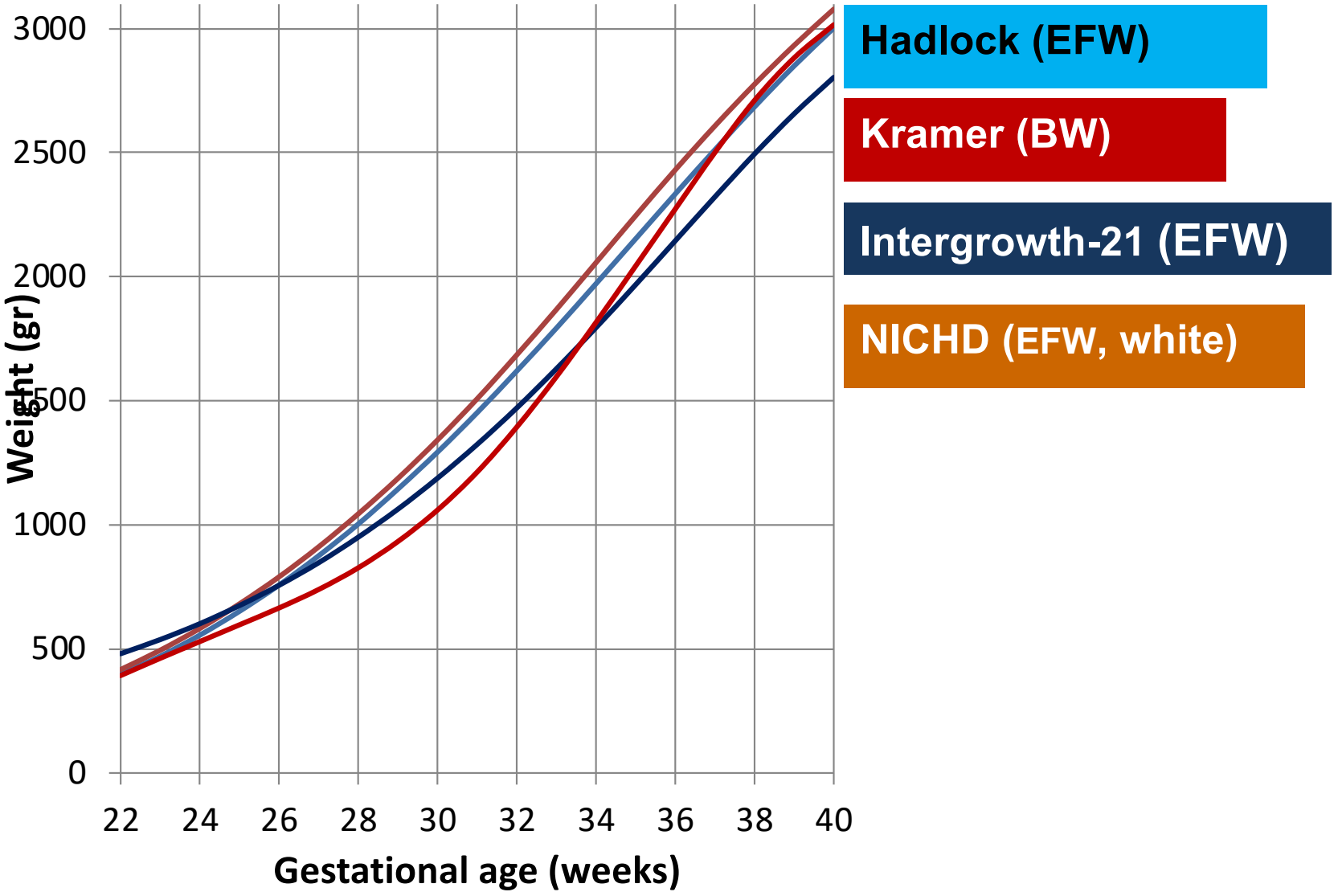
Model assumptions: linear mixed models, assuming a normal distribution of the fetal growth trajectories (after log transformation)

Smoothing technique over gestational age: cubic splines

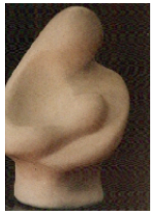
ESTIMATED FETAL WEIGHT

Calculated EFW from HC, AC and FL using the Hadlock 1985 formula[26]

Growth charts



Customised GROW charts



Gestation Network

Contact Us

Home | Growth Charts | Centile Calculator | Calculating Gestational Age | Estimating Fetal Weight | Calculating Scan Errors | Reference Literature

Growth Charts

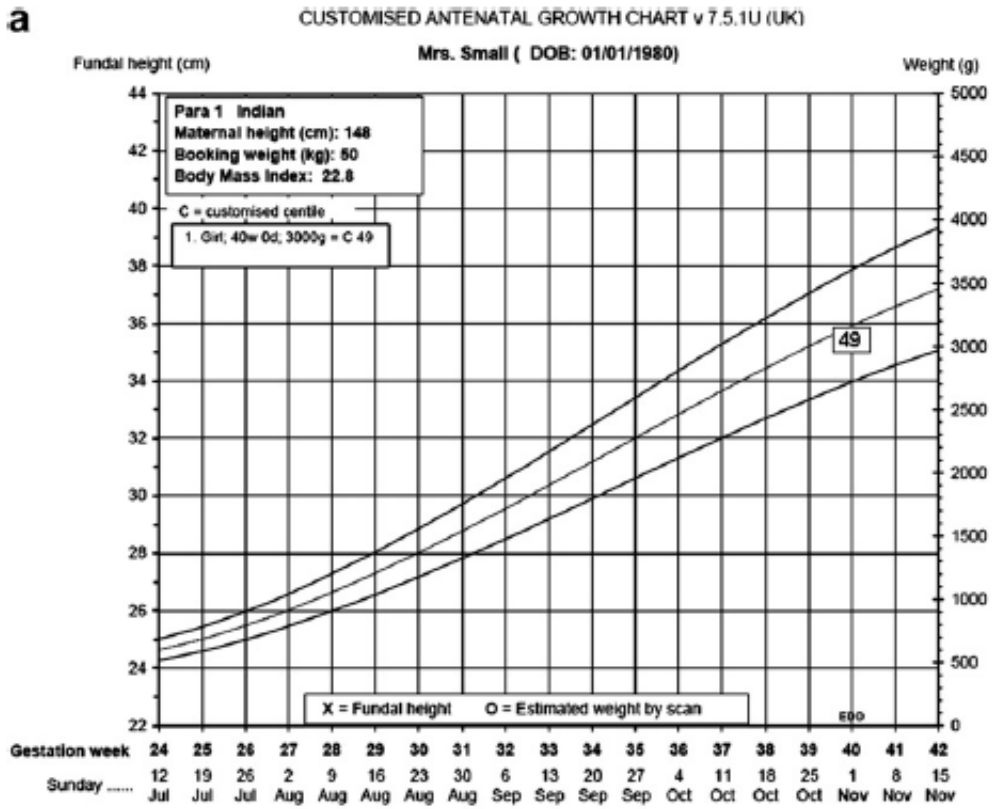
- **Country specific – not Canada**
- International charts available
- Fetal weight charts
- Term optimal weight and multiple regression analyses

Customise for:

- Maternal height
- Maternal weight
- Ethnicity
- Parity
- Fetal sex
- Country of residence

Customised GROW charts

a



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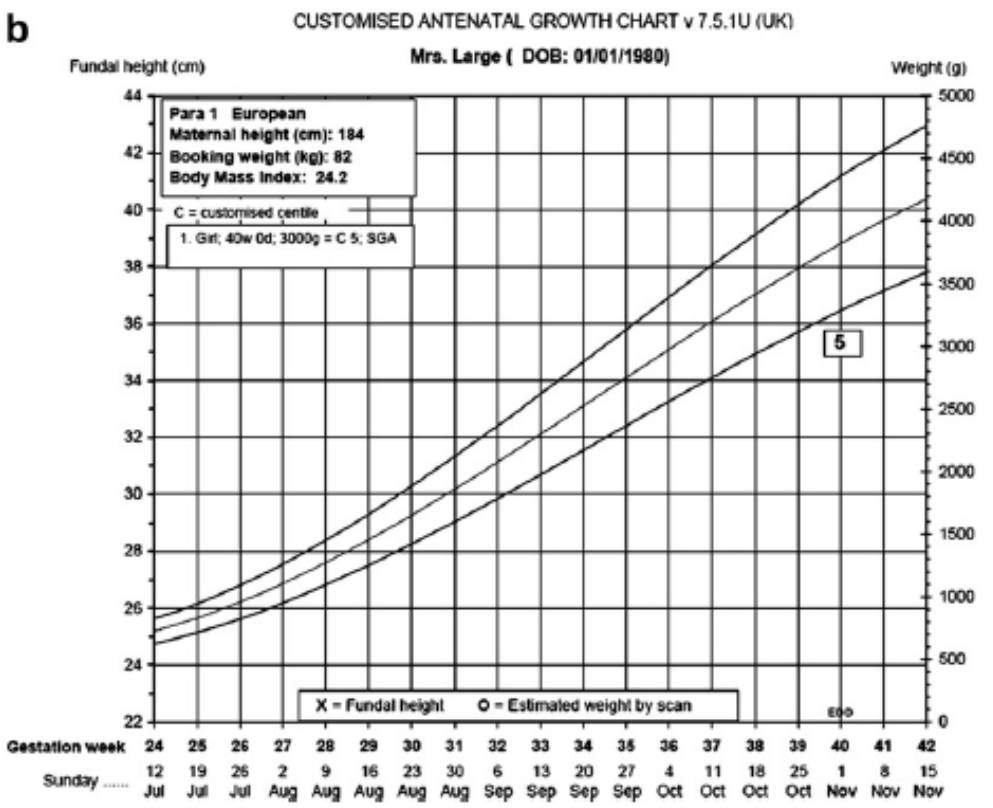
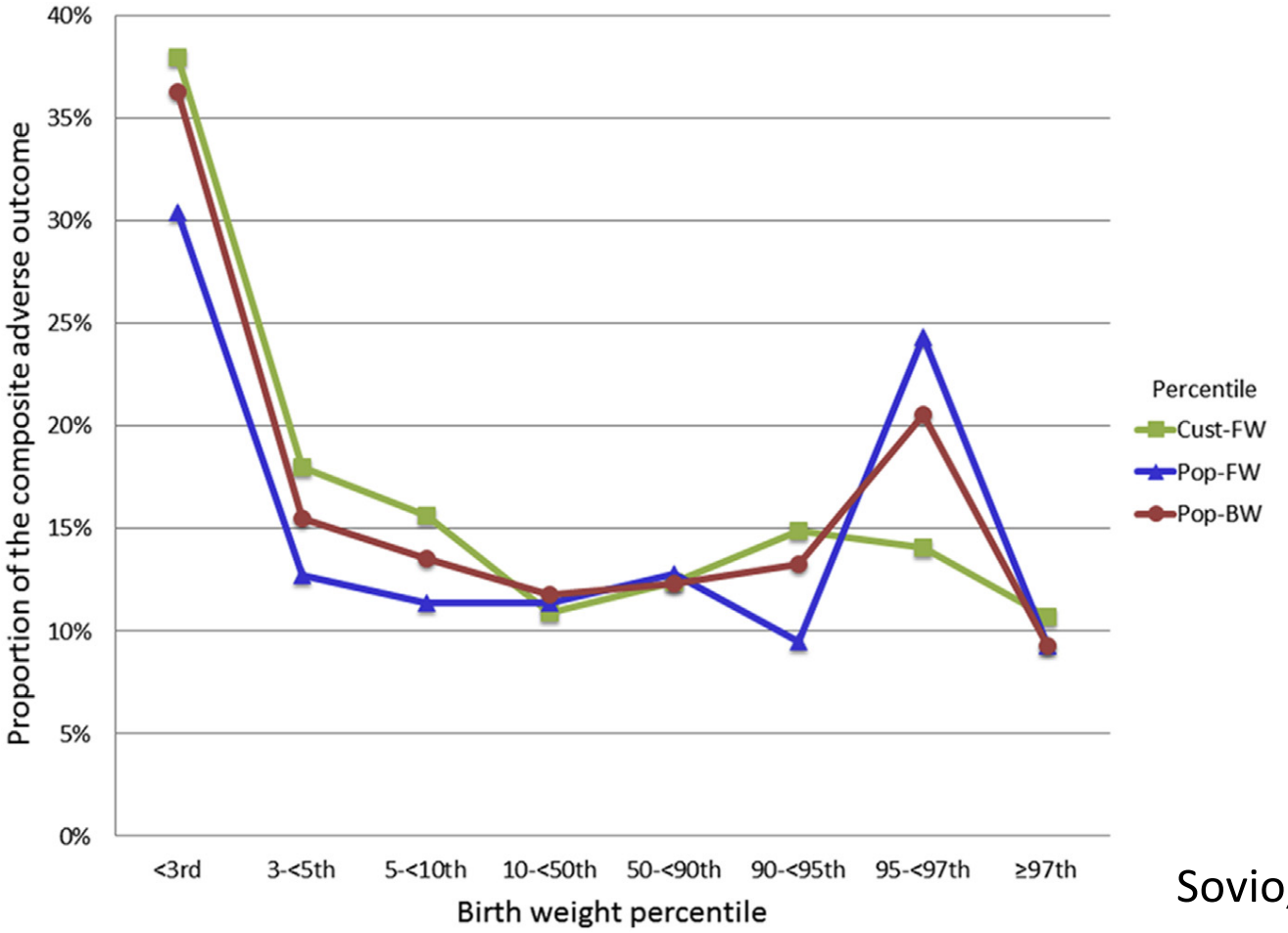


3 kg baby at 40 weeks

- **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



Sovio, AJOG 2018

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