Fetal growth variation and global consequences

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Bergen 2019-01-09
Fetal growth variation and global consequences

Worldmapper; accessed Nov 15, 2018
Fetal growth variation and global consequences
Fetal growth variation and global consequences
Non-communicable diseases (developmental origin)

Standardised mortality ratio (%)

Coronary heart disease

Martyn et al.
Lancet 1996;1269-73
Non-communicable diseases (developmental origin)

Standardised mortality ratio (%)

Coronary heart disease

Cardiovascular
Brain
Fat/adiposity
Diabetes/metabolism
Kidney
Skeletal
Lungs
Immunology

Birthweight (lb)

Martyn et al. Lancet 1996;1269-73
Aim:

...aimed to develop international growth and size standards for fetuses.

Conclusion:

...we have generated the first international standards (as opposed to references) for fetal growth...

...a unique set of clinical tools for use across all health-care systems to diagnose fetal growth restriction uniformly...
The World Health Organization fetal growth charts: a multinational longitudinal study of ultrasound biometric measurements and estimated fetal weight

Torvid Kiserud, Gilda Piaggio, Guillermo Carroli, Mariana Widmer, José Carvalho, Lisa Neerup Jensen, Daniel Giordano, José Guilherme Cecatti, Hany Abdel Aleem, Sameera A Talegawkar, Alexandra Benachi, Anke Diemert, Antoinette Tshefu Kitoto, Jadsada Thinkhamrop, Pisake Lumbiganon, Ann Tabor, Alka Kriplani, Rogelio Gonzalez Perez, Kurt Hecher, Mark A Hanson, A Metin Gülmezoglu, Lawrence D. Platt


Aim:

...to provide the present fetal growth charts ... intended for worldwide use.

Conclusion:

This study provides WHO fetal growth charts ...and shows variation between different parts of the world.
The World Health Organization fetal growth charts: a multinational longitudinal study of ultrasound biometric measurements and estimated fetal weight

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Participants:

Argentina (Rosario)
Brazil (Campinas)
Democratic Republic of Congo (Kinshasa)
Denmark (Copenhagen)
Egypt (Assiut)
France (Paris)
Germany (Hamburg)
India (New Delhi)
Norway (Bergen)
Thailand (Khon Kaen)
Methods

Prospective longitudinal observational study

‘Prescriptive’ inclusion criteria

10 centres

1400 inclusions

7 scheduled ultrasound sessions

Statistics: Quantile regression
## Results

<table>
<thead>
<tr>
<th>Maternal</th>
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<th>Inter-quartile</th>
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1. Participants appeared to be affluent, urban women undergoing the varied strategies of modern obstetrics

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Results

Estimated fetal weight

Estimated Fetal Weight (g) vs. Gestational Age (weeks)
Results

2. ‘Optimised maternal conditions’ permit a considerable variation in fetal growth.
House sparrow

Courtesy Thomas Kvalnes, Centre for Biological Diversity Dynamics, NTNU, Norway
House sparrow

Egg volume
2.2–3.5 cm$^3$

Fledge body mass
10–36 g

Kvalnes T et al. J Aviate Biol 2018;e01786

Courtesy Thomas Kvalnes, Centre for Biological Diversity Dynamics, NTNU, Norway
Mortality among sparrows according to egg volume and rain or temperature

Kvalnes T et al. J Aviate Biol 2018;e01786
Mortality among sparrows according to egg volume and rain or temperature
Results

Estimated fetal weight

Bowley coefficient of asymmetry +0.111

Bowley coefficient of asymmetry -0.016
Results

Estimated fetal weight

Bowley coefficient of asymmetry +0.111

Bowley coefficient of asymmetry -0.016
Results

3. Growth has an asymmetric distribution in the fetal population, widest among large fetuses in late pregnancy.
Influencing factors

Country/ethnicity

Maternal height
Maternal weight
Maternal age
Parity

Fetal sex
Results

Estimated fetal weight
Country variation
(90th percentile)
Results (10th percentile)
4. There are significant differences between countries/ethnic groups both in fetal size and growth trajectory.
Influencing factors

<table>
<thead>
<tr>
<th>Country/ethnicity</th>
<th>Maternal height</th>
<th>Maternal weight</th>
<th>Maternal age</th>
<th>Parity</th>
<th>Fetal sex</th>
<th>≤ 2%</th>
</tr>
</thead>
</table>
Results

Influence on EFW percentiles

- Maternal height
- Maternal weight
- Maternal age
- Parity
- Country
Results

Influence on EFW percentiles

Mother Weight

1%  50%  99%
Results

Influencing factors

Country/ethnicity
Maternal height
Maternal weight
Maternal age
Parity
Fetal sex
Results

Estimated fetal weight
Fetal sex differences

3.5–4.5%
5. Maternal factors and fetal sex influence fetal growth, but in a differential fashion across the percentiles.
Some points for discussion

Agenda: Perinatal mortality and morbidity
Customised and Noncustomised Birth Weight Centiles and Prediction of Stillbirth and Infant Mortality and Morbidity: A Cohort Study of 979,912 Term Singleton Pregnancies in Scotland

Customised and Noncustomised Birth Weight Centiles and Prediction of Stillbirth and Infant Mortality and Morbidity: A Cohort Study of 979,912 Term Singleton Pregnancies in Scotland

Perinatal survival according to birthweight percentile 
(37–42 weeks of gestation)

\[ N = 1170534 \]
Some points for discussion

Agenda: Non-communicable diseases
Low birthweight (<2500g)

WHO stats
Low birthweight (<2500g)

Japan
Low birthweight (<2500g)

Birthweight 1970 \(\approx 3.100g\)
Birthweight 2017 \(\approx 3.000g\)
Low birthweight (<2500g)

Low birthweight mortality world ranking: 183
Low birthweight (<2500g)

Low birthweight mortality world ranking: 183
Cardiovascular diseases world ranking: 182
Low birthweight (<2500g)

Low birthweight mortality world ranking: 183
Cardiovascular diseases world ranking: 182
Life expectancy (F 87y; M 81y) world ranking: 1
Some points for discussion

Is optimal growth uniform?

Is weight or size a cause of disease?

Is a uniform optimal size biologically plausible?

Optimal weight or optimal adaptation?
Conclusion

The WHO fetal growth charts are available for international use.

Fetal growth varies widely and has an asymmetric distribution.

There are significant population variations, influence of maternal factors and fetal sex.

Such factors tend to have a differential influence on the percentiles, and do not explain all country variation.
In relation to clinical management:
It is prudent to check/test whether the reference ranges function according to the intended use.

Concerning intrauterine development and life course health:
Optimal growth is not uniform and possibly not a useful concept; rather think optimal adaption.
Thank you!
### 10th percentile of EFW (g)

<table>
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<tr>
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<th>gestational week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>USA white</td>
<td>289</td>
</tr>
<tr>
<td>DR Congo</td>
<td>288</td>
</tr>
<tr>
<td>WHO</td>
<td>286</td>
</tr>
<tr>
<td>USA black</td>
<td>286</td>
</tr>
<tr>
<td>Norway</td>
<td>283</td>
</tr>
<tr>
<td>USA Hispanic</td>
<td>279</td>
</tr>
<tr>
<td>USA Asian</td>
<td>275</td>
</tr>
<tr>
<td>Intergrowth-21st</td>
<td>602</td>
</tr>
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\(^{\dagger}\) Buck Louis et al.\(^{19}\); \(^{\#}\) Landis et al.\(^{59}\); \(^{\&}\&\) Kiserud et al.\(^{16}\); \(^{*}\) Johnsen et al.\(^{29}\); \(^{3}\) Stirmemann et al.\(^{18}\)
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<td>Norway*</td>
<td>408</td>
</tr>
<tr>
<td>USA white†</td>
<td>381</td>
</tr>
<tr>
<td>WHO‡</td>
<td>380</td>
</tr>
<tr>
<td>USA Hispanic†</td>
<td>379</td>
</tr>
<tr>
<td>USA black†</td>
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<td>DR Congo#</td>
<td>345</td>
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<tr>
<td>Intergrowth-21st³</td>
<td>751</td>
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† Buck Louis et al.¹⁹; ‡ Landis et al.⁵⁹; § Kiserud et al.¹⁶; * Johnsen et al.²⁹; Stirnemann et al.¹⁸
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<tr>
<td>Participants</td>
<td></td>
</tr>
<tr>
<td>enrolled</td>
<td>1,439</td>
</tr>
<tr>
<td>for statistics</td>
<td>1,362</td>
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<td>Sets of ultrasound measurements</td>
<td>7,071</td>
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**Median**

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**Mode of delivery**  Caes. sect.  32% (range 5.5-70%)

**Maternal complications**  137

**Fetal conditions**  8

**Neonatal conditions**  83

**Perinatal mortality**  0.4%
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<td>1848</td>
<td>1487-2222</td>
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- **Maternal complications**: 137
- **Fetal conditions**: 8
- **Neonatal conditions**: 83
- **Perinatal mortality**: 0.4%
Promoting Healthy choices in early life the international policy environment

Fetal & early childhood development conditioning lifecourse risks

Hanson et al.
WHO report, January 2013