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Maternal Health Task Force



INTERGROWTH-21st course

Module 2

Assessing Maternal Anthropometry and Weight Gain During Pregnancy



On successful completion of this module you should be able to:

- List the instruments used for maternal anthropometry.
- Accurately measure maternal weight, height and body mass index (BMI).
- Use the INTERGROWTH-21st Gestational Weight Gain Standard for normal-weight women



- The lack of growth standards for pregnancy dating, fetal growth, maternal weight gain, newborn size and preterm postnatal growth greatly limits our understanding of early growth and development during pregnancy and comparisons across international populations (Bhutta, 2013; Villar et al., 2015).
- The aetiology and epidemiology of fetal growth restriction and preterm birth syndromes are also significantly impaired by the absence of an international standard for intrauterine growth with which to compare deviations and identify phenotypes (Bhutta, 2013; Villar et al., 2015).
- Since optimal fetal and neonatal growth and their implications for long-term outcomes are of utmost importance, it is a priority to define optimal intrauterine growth in populations where nutrition and health needs are met (Bhutta, 2013; Villar et al., 2015).



- The International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st) Project aimed to prospectively define fetal and newborn growth, and postnatal growth among preterm infants (Bhutta, 2013).
- The INTERGROWTH-21st Project was a multicentre, multi-ethnic, population-based project in eight urban study sites (Villar et al., 2015).
- Populations were first selected by geographical location (altitude, level of antenatal care, absence or low levels of major known non-microbiological contamination) and then by individual characteristics (e.g. maternal demographics and medical history) (Villar et al., 2014).



The INTERGROWTH-21st Project produced international standards for:

- [Gestational age estimation](#)
- [First-trimester fetal size](#)
- [Fetal growth](#)
- [Newborn size for gestational age](#)
- [Postnatal growth of preterm infants](#)
- [Maternal gestational weight gain](#) (also references for overweight women)



- Implementing equipment calibration and measurement protocols at each INTERGROWTH-21st Project's study site ensured the highest quality anthropometric data for the construction of the international standards (Cheikh Ismail et al., 2013).
- The [Anthropometry Handbook](#) used in this project describes how to perform accurate, precise and standardised anthropometric measurements for the assessment of maternal and newborn size.

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Module 2
Maternal weight gain
and anthropometry size



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Maternal anthropometry



Equipment

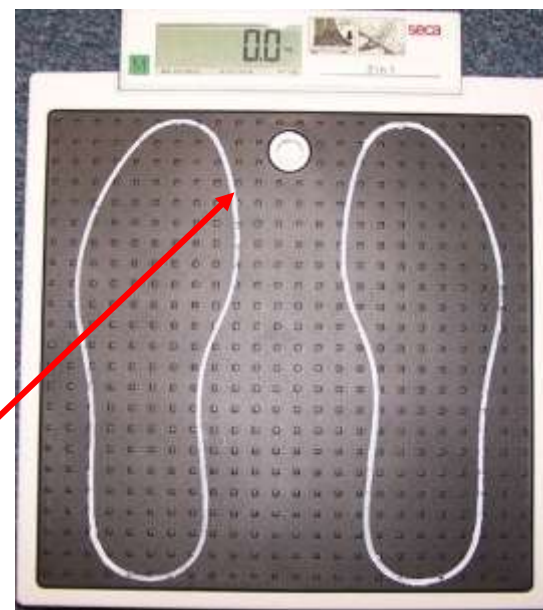
1. Adult Scale:

An example is the Seca 877 Scale used to measure maternal weight in the INTERGROWTH-21st project.

The scale has a capacity up to 200 kg, and precision to 100g below 150 kg and to 200g above 150 kg.

The scale has footmarks pasted on to show exactly where subjects stand.

The scale also has a built in spirit level to ensure that it is on a flat and level surface.



Seca 877 scale



Equipment

2. Stadiometers:

For example, the 2 models of stadiometers used in the INTERGROWTH-21st Project were:

- Seca Stadiometer 242 (range 62-210 cm)
- Seca Stadiometer 264 (range 30-220 cm), which superseded the Seca Stadiometer 242 model, has a foot mat on which the person to be measured stands on and the display housing is integrated into the head stop.

These should measure adult height with an accuracy of $\pm 2\text{mm}$.





Equipment

3. Body mass index (BMI) Calculator:

- The Seca BMI calculator 491 was used to calculate BMI of women in the INTERGROWTH-21st Project.
- BMI (in kg/m²) can also be calculated using the following formula of the body mass (in kg) divided by the square of the body height (in m), expressed as:

$$BMI = \frac{Weight (kg)}{Height^2 (m^2)}$$



Seca BMI calculator 491



Equipment calibration

- Calibration of the adult scale and the stadiometer should be done twice a week at a minimum.
- It is not necessary to calibrate the BMI calculator.
- If the equipment is being transported for home visits or between clinics, it should be calibrated every day.





Equipment maintenance

- Maintenance is important for keeping the equipment accurate and extending its lifespan.
- All equipment should be handled with care during storage, transportation and use.
- It should be kept clean and stored and transported with care.
- Cool, dry and clean storage is a standard requirement for anthropometric equipment. Different instruments and parts will require different materials for cleaning and regular care.

To know more about the calibration and maintenance of the equipment, please consult the [Anthropometry Handbook](#).



Knowledge test

How do you make sure that the equipment for adult anthropometry is working?

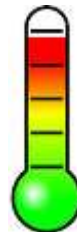
Answer: To make sure that the equipment is working:

- It should be calibrated at least twice a week (more often if transported for home visits).
- It should be kept in a cool, dry, and clean storage.
- It should be transported carefully according to instructions.

NO!



NO!



NO!





Measurement Technique: **Height**

1. Ask the subject to remove their shoes and any headwear or hair ornaments. *Measure the thickness of any irremovable braids/corn rows with a small plastic ruler and deduct this from the total height at the end.*
2. Turn the stadiometer on. “----” is displayed initially. *Slightly move the head piece so that the present height appears on the display. Make sure the height is **displayed in centimetres** and not inches.*
3. Raise the head piece far enough up so that the subject can stand under the headboard comfortably.

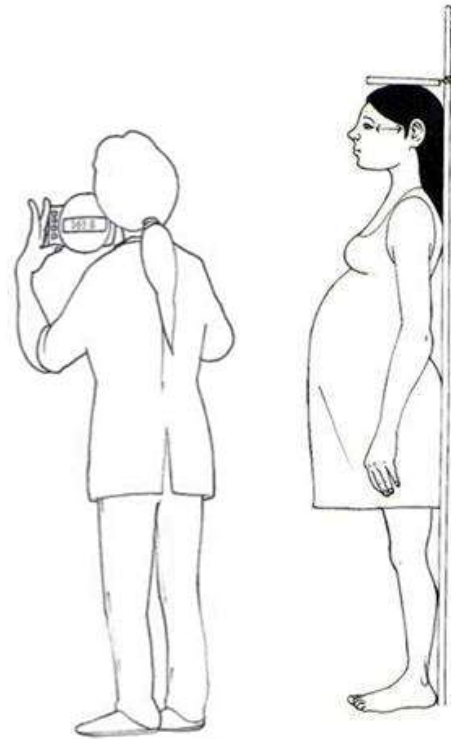


Measurement Technique: Height

4. Ask the subject to stand with their back to the measuring rod, with feet slightly apart, the trunk balanced over the waist, knees straight, arms and shoulders relaxed as shown in the next slide.

5. The subject's head, shoulders, buttocks, calves and heels should touch the measuring rod.

Ensure that the subject is not leaning against the rod.



In contact with the measuring rod:

Head

Shoulders

Buttocks

Calves

Heels

Subject stands with back to the measuring rod, feet slightly apart, trunk balanced over the waist, knees straight, arms and shoulders relaxed.



Measurement Technique: **Height**

If the subject is much taller than the measurer, the latter should stand on a chair or stool to correctly position the subject.





Measurement Technique: Height

6. Ask the subject to look straight ahead. Their head should be held in the Frankfort horizontal plane.



Frankfort horizontal plane

The Frankfort horizontal plane is the plane running along the imaginary line running between the corner of the eye and the auditory canal.

Ensure to adjust the head position into the Frankfurt horizontal plane.



7. Now slide the head stop down until it touches the top of the head. *If using a stadiometer with a brake button like the Seca Stadiometer 462, remember to hold the brake button down when moving the head stop.*
8. Ask the subject to take a deep breath; this straightens the spine and gives a consistent measurement.
9. Read off the measurement from the digital display and record the height as it appears on the display, **i.e. to one decimal place.**



Knowledge test

What standard position should the subject take to measure height?

Answer: The standard and correct position to measure height is:

- The subject should stand with their back to the measuring rod, with feet slightly apart, the trunk balanced over the waist, knees straight, arms and shoulders relaxed.
- Their head should be in the Frankfurt horizontal plane.
- The subject's head, shoulders, buttocks, calves and heels should touch the measuring rod but they should not lean on it.



Measurement Technique: **Weight**

1. The woman should wear minimal, light clothing. *If it is not possible/appropriate for her to remove heavy clothing, you should have available a list of weights for local, typical adult clothing items, the weights of which can be subtracted from the total weight before recording the value.*
2. Ask the mother to empty her pockets, remove any heavy objects and take off her shoes.
3. Ensure the scale is on a perfectly flat surface with no obstructions. *Remember that the Seca 877 scale has a built-in spirit level.*
4. Turn the scale on by gently pressing a foot on the surface of the scale. The word SECA should appear, followed by 88:8888. When the value 0.0 appears, the scale is ready for use.



Measurement Technique: **Weight**

5. Ask the mother to stand on the scale, placing her feet on the footmarks on the scale and remain still until the weight is stable on the display.



6. Read and record the weight as it appears on the display, **i.e. to one decimal place.**



Knowledge test

How do you measure weight?

Answer:

Weight should be measured using a scale with an appropriate range and precision.

The subject should remove their shoes and ideally wear minimal, light clothing.

They should then stand on the scale until the weight stabilises.





How to calculate BMI using the Seca BMI calculator

1. Activate the calculator by pressing ON/C
2. Press KG and enter the weight of the woman in kilograms.
3. Press M and enter the height of the woman **in metres**.

Please note that height is entered in metres not centimetres. To convert height in centimetres to metres, divide the value by 100. For example, if the height in centimetres is 160, the height in metres is 1.6.

4. Press the green BMI button.
5. Read and record the BMI value displayed on the screen



How to calculate BMI using the Seca BMI calculator - Example

If the weight is 80.5kg, and height is 1.82 metres, then:

1. Press KG
2. Enter 80.5
3. Press M
4. Enter 1.82
5. Press BMI
6. The calculated BMI should be 24.3



How to calculate BMI using a regular calculator - Example

Working the same example as previously, if the weight is 80.5kg, and height is 1.82 metres:

You need to divide the weight by the height, twice

1. Divide the weight by the height: $80.5 / 1.82 = 44.23 \text{ kg/m}$
2. Divide that number by the height again: $44.23 / 1.82 = 24.3 \text{ kg/m}^2$



How to interpret BMI?

We used the WHO BMI cut-off values to interpret the BMI.

Classification	BMI principal cut-off points
Underweight	<18.50
Normal range	18.50 – 24.99
Overweight	≥ 25.00
Obese	≥ 30.00
Obese class I	30.00 – 34.99
Obese class II	35.00 – 39.99
Obese class III	≥ 40.00



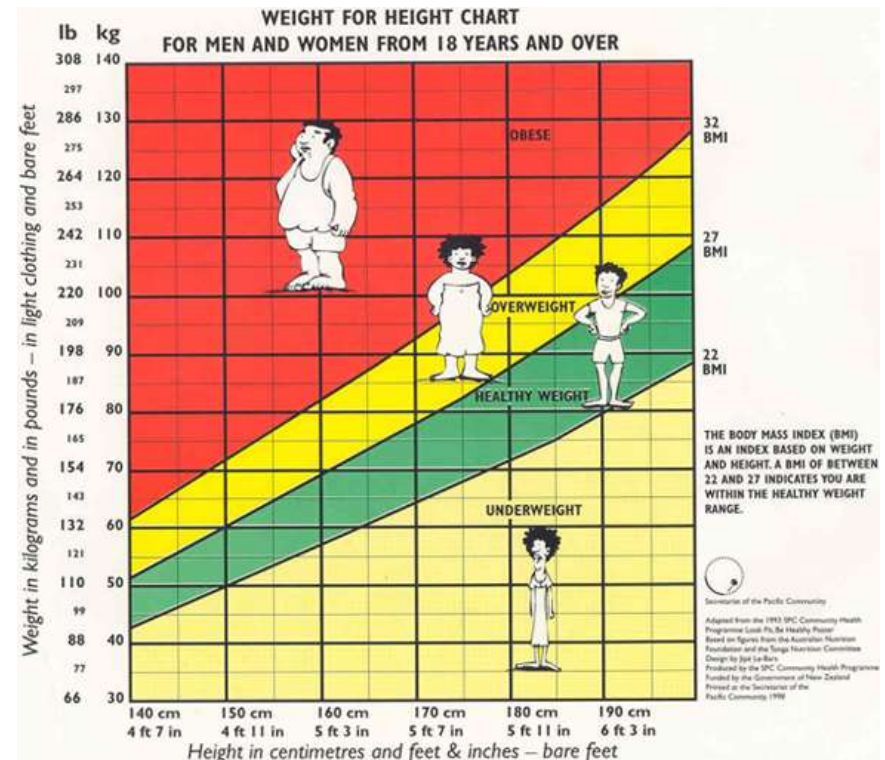
Knowledge test

Exercise: using a calculator (e.g. a BMI calculator, one on your mobile phone or on a computer) calculate the following BMI:

1. Height: 165cm, weight: 90kg
2. Height: 1.73m, weight: 65kg

Answer:

1. $BMI = 33.05 \text{ kg/m}^2$
2. $BMI = 21.71 \text{ kg/m}^2$





Adult Anthropometry Checklist

Height:

1. Remove shoes and hair ornaments
2. Subject stands with their back to measuring rod, feet slightly apart, trunk balanced over the waist, knees straight, arms and shoulders relaxed
3. Position head
4. Take deep breath in and stand tall
5. Headboard touches top of head
6. Record height as it appears on the display



Adult Anthropometry Checklist

Weight:

1. Subject wears minimal, light clothing
2. Remove shoes and heavy objects
3. Zero scale
4. Subject stands centrally on scale
5. Read subject's weight
6. If the weight of heavy clothing needs to be subtracted, please refer to your local list



INTERGROWTH-21st standards for Maternal gestational weight gain



INTERGROWTH-21st standards for Maternal Gestational Weight Gain

- To describe patterns in maternal gestational weight gain (GWG) in healthy pregnancies with good maternal and perinatal outcomes.
- Healthy, well nourished, and educated women enrolled in the Fetal Growth Longitudinal Study component of the INTERGROWTH-21st Project, who had a body mass index (BMI) of 18.50-24.99 in the first trimester of pregnancy.



Gestational weight gain standards based on women enrolled in the Fetal Growth Longitudinal Study of the INTERGROWTH-21st Project: a prospective longitudinal cohort study

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Pre-requisite:

- Weight should be measured in the 1st trimester.
- Gestational age should be known either from LMP and/or dating scan (CRL at <14 weeks' gestation).
- The standards represent **cumulative** gestational weight gain.
- It is not possible to infer more appropriate GWG pattern for women who are underweight (BMI < 18.50 kg/m²) or obese (BMI > 30.00 kg/m²) as our population consisted only of healthy women with a BMI range of 18.5- 29.99 kg/m². *Reference charts for overweight women are under preparation.*

INTERGROWTH-21st Module 2 Maternal weight gain and anthropometry

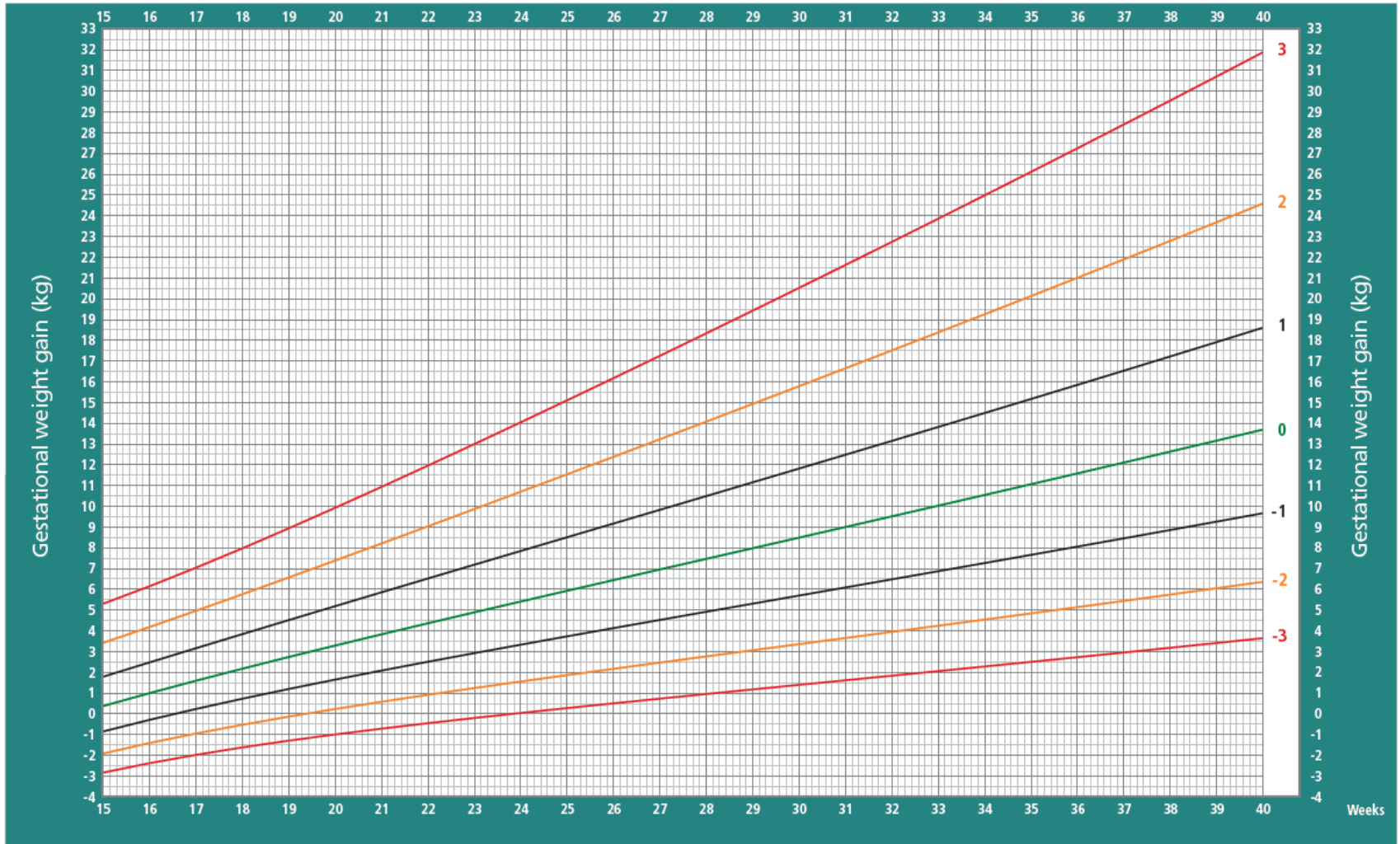


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The International Gestational Weight Gain Standards

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The International Gestational Weight Gain Standards
 For Women of Normal Weight



Gestational Weight Gain (Kg)

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Gestational age (exact weeks)	centiles						
	3 rd	5 th	10 th	50 th	90 th	95 th	97 th
15	-1.77	-1.52	-1.14	0.39	2.24	2.82	3.23
16	-1.26	-1.00	-0.60	1.01	2.95	3.55	3.98
17	-0.80	-0.52	-0.09	1.61	3.65	4.30	4.75
18	-0.37	-0.08	0.38	2.19	4.36	5.05	5.53
19	0.03	0.34	0.82	2.75	5.07	5.80	6.31
20	0.41	0.74	1.25	3.30	5.78	6.56	7.11
21	0.77	1.11	1.66	3.84	6.49	7.33	7.91
22	1.11	1.48	2.05	4.37	7.19	8.09	8.72
23	1.45	1.83	2.44	4.90	7.90	8.86	9.52
24	1.77	2.18	2.82	5.42	8.61	9.62	10.34
25	2.09	2.52	3.19	5.94	9.31	10.39	11.15
26	2.40	2.85	3.56	6.45	10.02	11.17	11.97
27	2.71	3.18	3.93	6.96	10.73	11.94	12.79
28	3.02	3.51	4.29	7.47	11.43	12.71	13.61
29	3.33	3.84	4.65	7.98	12.14	13.49	14.44
30	3.63	4.17	5.01	8.49	12.86	14.27	15.27
31	3.94	4.49	5.37	9.00	13.57	15.06	16.10
32	4.24	4.82	5.73	9.52	14.29	15.84	16.94
33	4.55	5.15	6.10	10.03	15.01	16.63	17.78
34	4.85	5.47	6.46	10.55	15.73	17.43	18.62
35	5.16	5.80	6.82	11.06	16.46	18.22	19.47
36	5.47	6.14	7.19	11.58	17.19	19.03	20.32
37	5.78	6.47	7.56	12.11	17.92	19.83	21.18
38	6.10	6.80	7.93	12.63	18.66	20.64	22.04
39	6.41	7.14	8.30	13.16	19.40	21.46	22.91
40	6.73	7.48	8.68	13.69	20.15	22.28	23.79



How to use the GWG?

Example 1:

Dating scan visit at 9+3 weeks' gestation, weight = 44.5kg

Visit at 25+0 weeks' gestation, weight = 46.1 kg

Visit at 39+1 weeks' gestation, weight = 50.2 kg



1. Calculate the weight gain between baseline and subsequent visit:

Dating scan visit at 9+3 weeks' gestation, weight = 44.5kg

→ Baseline

Visit at 25+0 weeks' gestation, weight = 46.1 kg

→ Weight gain = $46.1 - 44.5 = 1.6$ kg

Visit at 39+1 weeks' gestation, weight = 50.2 kg

→ Weight gain = $50.2 - 44.5 = 5.7$ kg

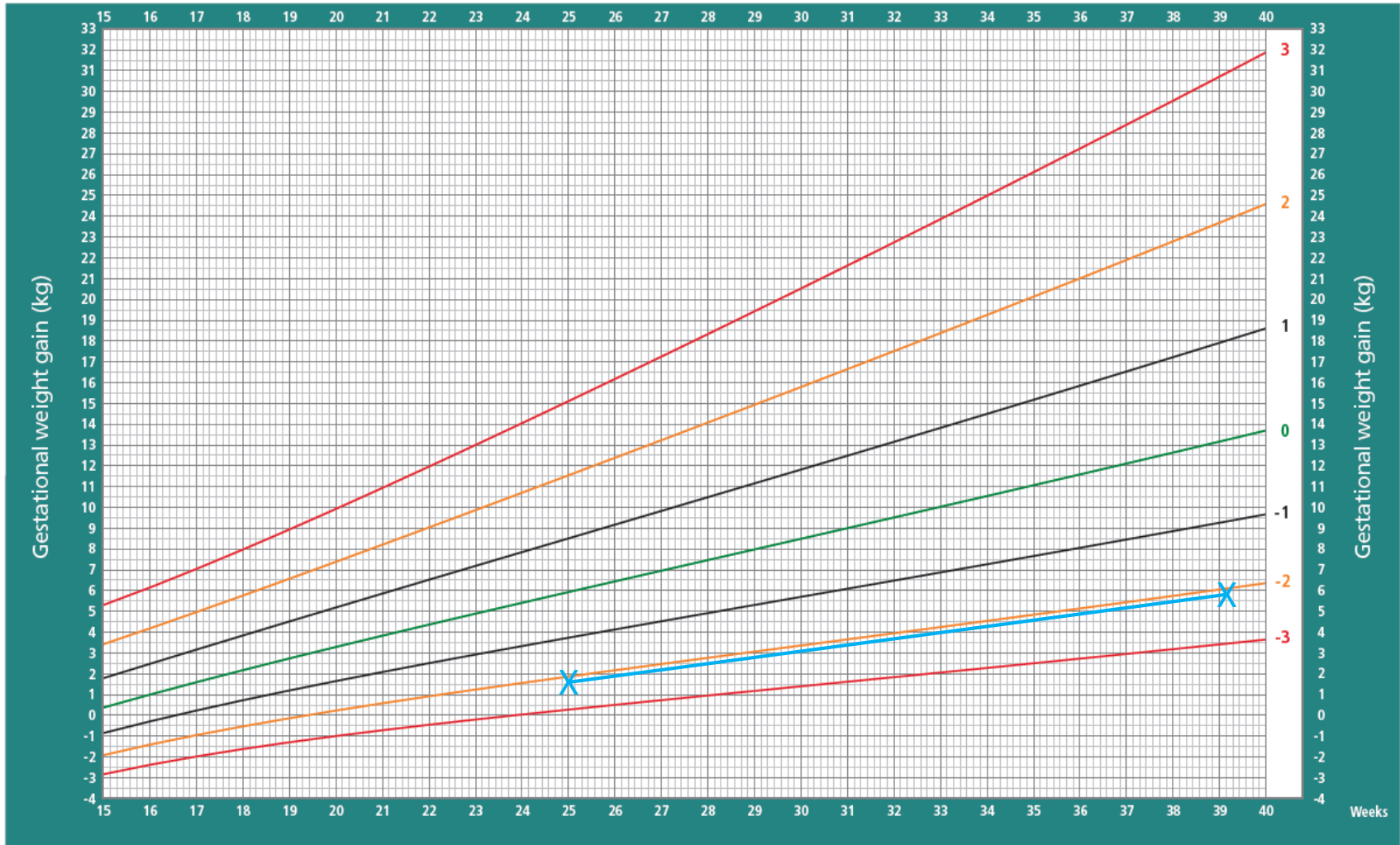
2. Plot the weight on the charts:

- Find the correct gestational age (X-axis)
- Find the weight (Y-axis)
- Join the data on the plot



The International Gestational Weight Gain Standards

INTERGROWTH-21st





How to use the GWG?

Example 2:

Dating scan visit at 13+6 weeks' gestation, weight = 54.4kg

Visit at 22+2 weeks' gestation, weight = 64.3 kg

Visit at 36+3 weeks' gestation, weight = 71.0 kg



1. Calculate the weight gain between baseline and subsequent visit:

Dating scan visit at 13+6 weeks' gestation, weight = 54.4kg

→ Baseline

Visit at 22+2 weeks' gestation, weight = 64.3 kg

→ Weight gain = $64.3 - 54.4 = 9.9$ kg

Visit at 36+3 weeks' gestation, weight = 71.0 kg

→ Weight gain = $71.0 - 54.4 = 16.6$ kg

2. On the table find the gestational age in completed week (here 22 and 36)

3. Select the column with the weight gain the closest to your data

4. Read the top of the column for the centiles or z-scores

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The International Gestational Weight Gain Standards
 For Women of Normal Weight



Gestational Weight Gain (Kg)



Gestational age (exact weeks)	centiles						
	3 rd	5 th	10 th	50 th	90 th	95 th	97 th
15	-1.77	-1.52	-1.14	0.39	2.24	2.82	3.23
16	-1.26	-1.00	-0.60	1.01	2.95	3.55	3.98
17	-0.80	-0.52	-0.09	1.61	3.55	4.30	4.75
18	-0.37	-0.08	0.38	2.19	4.36	5.05	5.53
19	0.03	0.34	0.82	2.75	5.07	5.80	6.31
20	0.41	0.74	1.25	3.30	5.78	6.56	7.11
21	0.77	1.11	1.66	3.84	6.49	7.33	7.91
22	1.11	1.48	2.05	4.37	7.15	8.03	8.72
23	1.45	1.83	2.44	4.90	7.90	8.86	9.52
24	1.77	2.18	2.82	5.42	8.61	9.62	10.34
25	2.09	2.52	3.19	5.94	9.31	10.39	11.15
26	2.40	2.85	3.56	6.45	10.02	11.17	11.97
27	2.71	3.18	3.93	6.96	10.73	11.94	12.79
28	3.02	3.51	4.29	7.47	11.43	12.71	13.61
29	3.33	3.84	4.65	7.98	12.14	13.49	14.44
30	3.63	4.17	5.01	8.49	12.86	14.27	15.27
31	3.94	4.49	5.37	9.00	13.57	15.06	16.10
32	4.24	4.82	5.73	9.52	14.29	15.84	16.94
33	4.55	5.15	6.10	10.03	15.01	16.63	17.78
34	4.85	5.47	6.46	10.55	15.73	17.43	18.62
35	5.16	5.80	6.82	11.06	16.46	18.22	19.47
36	5.47	6.14	7.19	11.58	17.19	19.03	20.32
37	5.78	6.47	7.56	12.11	17.92	19.83	21.18
38	6.10	6.80	7.93	12.63	18.66	20.64	22.04
39	6.41	7.14	8.30	13.16	19.40	21.46	22.91
40	6.73	7.48	8.68	13.69	20.15	22.28	23.79



How to read GWG?

- In the first example, the woman's weight gain remained just below -2 z-scores throughout the pregnancy.
- In the second example, the women's weight gain was above the 97th centiles at 22+2 weeks' gestation but below the 90th centiles at 36+3 weeks' gestation.



How to interpret the GWG charts?

- There are no cut-off values for gestational weight gain.
- The standards (as part of first level nutritional screening) can be used to alert clinicians to deviations in weight, triggering clinical inquiries as to whether such deviations are associated with complications related to pregnancy, medical conditions, or eating disorders.
- Those standards should not be used, however, to tell women that deviations are due to pregnancy complications or recommending immediate behaviour changes as our data do not provide sufficient evidence for the standards to be interpreted in this way.
- Women who are underweight before pregnancy should be referred for nutritional advice and treatment if necessary. Also it is safe to suggest that during pregnancy such women should have GWG at least compatible with those of normal weight women.



Knowledge test

Exercise:

Calculate the weight gain at the 2 time points and plot them on the graph.

Joan came for her dating scan at 13+1 weeks' gestation. She was weighed by the midwife, and her weight was 68.8kg.

She had an uneventful pregnancy until end of the 2nd trimester when she fainted. She went to the hospital, she was then 31+6 weeks' gestation and the midwife checked her then and it was 80.8kg.

Finally she had a visit with her consultant at 37+0 to discuss delivery options and she was weighted again at 86.7kg.

INTERGROWTH-21st Module 2 Maternal weight gain and anthropometry

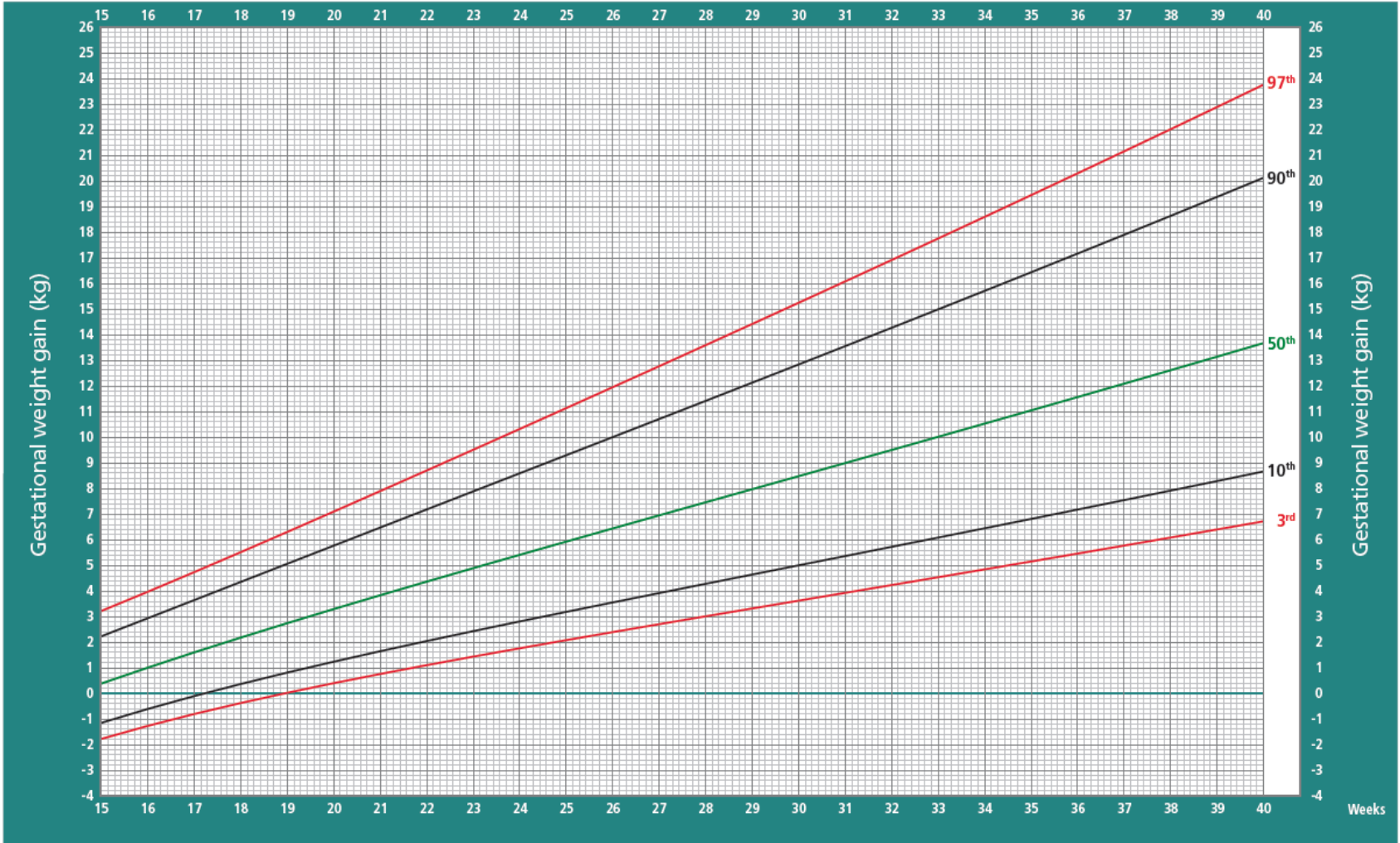


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The International Gestational Weight Gain Standards

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Knowledge test

Answer:

Joan has an early weight (<14 weeks' gestation) so the charts can be used.

At 31+6 weeks, her weight gain was $80.8 - 68.8 = 12$ kg

At 37+0 weeks $86.7 - 68.8 = 17.9$ kg

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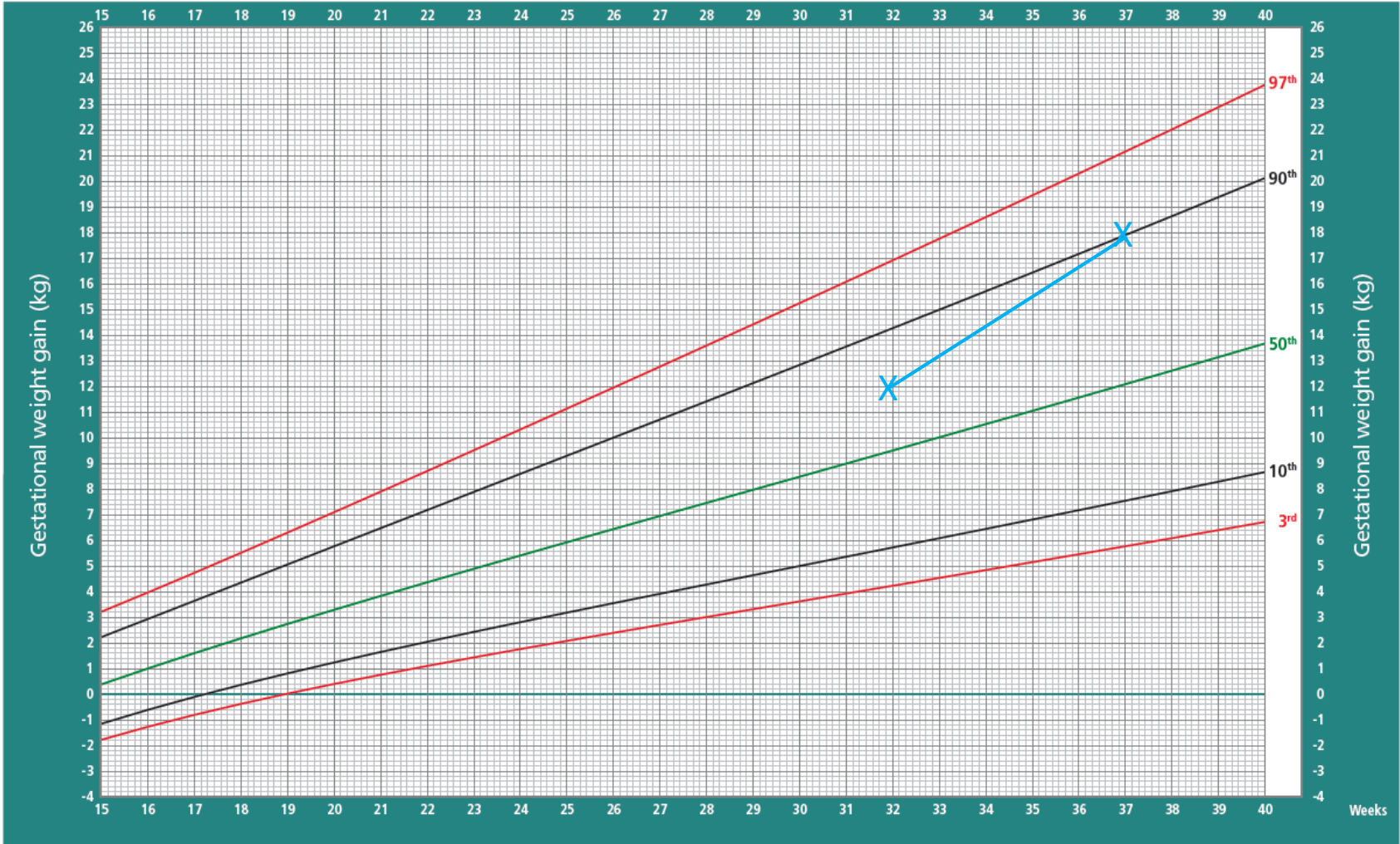


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The International Gestational Weight Gain Standards

INTERGROWTH-21st





- Reference for Maternal Gestational Weight Gain for overweight women are under preparation.
- Online resources to help health professionals implement these standards will be available in our Training Toolkit in the near future.
- Check for updates on <https://intergrowth21.tghn.org/>.



You have completed the module Assessing maternal weight gain and anthropometry and you should now be able to:

- List the instruments used for maternal anthropometry.
- Accurately measure maternal weight, height and Body mass index (BMI).
- Use the INTERGROWTH-21st Gestational Weight Gain Standard for normal-weight women.



References

- Bhutta Z, for the International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st). Introduction. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2013 Sep;120:1-2. doi.org/10.1111/1471-0528.12032
- Cheikh Ismail L, Knight H, Bhutta Z, et al. Anthropometric protocols for the construction of new international fetal and newborn growth standards: the INTERGROWTH-21st Project. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2013 Sep;120:42-7. doi.org/10.1111/1471-0528.12125
- Cheikh Ismail L, Bishop DC, Pang R, et al: Gestational weight gain standards based on women enrolled in the Fetal Growth Longitudinal Study of the INTERGROWTH-21st Project: a prospective longitudinal cohort study. *BMJ* 2016, 352(i):555. [doi: 10.1136/bmj.i555](https://doi.org/10.1136/bmj.i555).
- INTERGROWTH-21st. International Fetal and Newborn Growth Standards for the 21st Century: Anthropometry handbook. The International Fetal and Newborn Growth Consortium; 2012. Available from: https://intergrowth21.tghn.org/site_media/media/articles/Anthropometry_Handbook_April_2012.pdf
- Villar J, Cheikh Ismail L, Victora CG, Ohuma EO, Bertino E, Altman DG, Lambert A, Papageorghiou AT, Carvalho M, Jaffer YA, Gravett MG, Purwar M, Frederick IO, Noble AJ, Pang R, Barros FC, Chumlea C, Bhutta ZA, Kennedy SH, International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st). 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 Sep 6;384(9946):857-68. [http://dx.doi.org/10.1016/S0140-6736\(14\)60932-6](http://dx.doi.org/10.1016/S0140-6736(14)60932-6)
- Villar J, Papageorghiou AT, Pang R, et al. Monitoring human growth and development: a continuum from the womb to the classroom. *American Journal of Obstetrics & Gynecology*. 2015 Oct 1;213(4):494-9. doi.org/10.1016/j.ajog.2015.07.002



Additional resources

- Ohadike CO, Cheikh-Ismail L, Ohuma EO, et al: Systematic Review of the Methodological Quality of Studies Aimed at Creating Gestational Weight Gain Charts. *Adv Nutr* 2016, 7(2):313-322. [doi: 10.3945/an.115.010413](https://doi.org/10.3945/an.115.010413)
- Papageorghiou AT, Ohuma EO, Altman DG, Todros T, Cheikh Ismail L, Lambert A, Jaffer YA, Bertino E, Gravett MG, Purwar M, Noble JA, Pang R, Victora CG, Barros FC, Carvalho M, Salomon LJ, Bhutta ZA, Kennedy SH, Villar J, International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st). International standards for fetal growth based on serial ultrasound measurements: the Fetal Growth Longitudinal Study of the INTERGROWTH-21st Project. *Lancet*. 2014 Sep 6;384(9946):869-79. [http://dx.doi.org/10.1016/S0140-6736\(14\)61490-2](http://dx.doi.org/10.1016/S0140-6736(14)61490-2)
- Papageorghiou AT, Kennedy SH, Salomon LJ, Ohuma EO, Cheikh Ismail L, Barros FC, Lambert A, Carvalho M, Jaffer YA, Bertino E, Gravett MG, Altman DG, Purwar M, Noble JA, Pang R, Victora CG, Bhutta ZA, Villar J, International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st). International standards for early fetal size and pregnancy dating based on ultrasound measurement of crown-rump length in the first trimester of pregnancy. *Ultrasound Obstet Gynecol*. 2014 Dec;44(6):641-8. <http://dx.doi.org/10.1002/uog.13448>
- Villar J, Altman DG, Purwar M, Noble JA, Knight HE, Ruyan P, Cheikh Ismail L, Barros FC, Lambert A, Papageorghiou AT, Carvalho M, Jaffer YA, Bertino E, Gravett MG, Bhutta ZA, Kennedy SH, International Fetal and Newborn Growth Consortium for the 21st Century. The objectives, design and implementation of the INTERGROWTH-21st Project. *BJOG*. 2013 Sep;120 Suppl 2:9-26, v. <http://dx.doi.org/10.1111/1471-0528.12047>
- Villar J, Giuliani F, Fenton TR, Ohuma EO, Ismail LC, Kennedy SH, INTERGROWTH-21st Consortium. INTERGROWTH-21st very preterm size at birth reference charts. *Lancet*. 2016 Feb 27;387(10021):844-5. [http://dx.doi.org/10.1016/S0140-6736\(16\)00384-6](http://dx.doi.org/10.1016/S0140-6736(16)00384-6)