ASUM

Standards of Practice

Promoting ultrasound excellence



Guidelines, Policies and Statements

Normal Ultrasonic Fetal Measurements Standard

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Australasian Society for Ultrasound in Medicine

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1. Introduction

The Australasian Society for Ultrasound in Medicine (ASUM) is a multidisciplinary society whose mission is to advance the clinical practice of diagnostic medical ultrasound for the highest standards of patient care. A primary aim of ASUM is to promote, educate and disseminate standards of ultrasound practice in this continually developing specialty.

1.1. Statement

This standard implements suggested fetal biometry charts to aid uniform reporting of obstetric measurements across Australia and New Zealand. The data used for the Australian charts is based on the results of a three-year research project involving Australasian populations. There were 26 ultrasound practices involved in measuring 11,600 fetal parameters from 3,800 pregnancies.

The fetal biometry measurements are used to assess gestational age, fetal growth and estimating fetal weight.

1.2. Purpose

This standard ensures uniform reporting of obstetric measurements across Australia and New Zealand.

1.3. Scope/Applicability

This guideline is applicable to all ultrasound practitioners.

2. Gestational Age

2.1. Intention

After the first trimester of pregnancy a multi-parameter assessment of gestational age is advocated. This should include at least three fetal measurements (usually biparietal diameter (BPD) and/or head circumference (HC), abdominal circumference (AC) and femur length (FL). A guide to fetal measurement standards is included in Appendix 1 and 2.

2.2. Context

- The accuracy of fetal measurements relies on obtaining correct imaging planes of the fetal parameters.
- Once gestational age has been established, subsequent examinations are used as a reflection of fetal growth in the intervening period.
- At any gestation, if the ultrasound fetal measurements of each parameter are not in agreement, the reason for this difference should be evaluated. This is preferable to just averaging all values to arrive at an estimated gestational age.

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- The wide normal range of BPD in late pregnancy must be appreciated. It is not expected that BPD be used to assess gestational age late in pregnancy due to head moulding.

2.3. Criterion/Criteria to Achieve Standard

A multi-parameter assessment of gestational age.

Confirmation of ultrasound measurement of gestational age by comparing with the gestational assessment taken from menstrual dating.

2.4. Requirements

Criterion requirement	Action to meet requirement
After the first trimester of pregnancy, a multi-parameter assessment of gestational age is advocated	Three (3) fetal measurements Usually: 1. biparietal diameter (BPD); 2. abdominal circumference (AC); 3. femur length (FL). Additional parameters (for consideration): 1. head circumference (HC); 2. occipitofrontal diameter (OFD); 3. humerus length (HL).
Confirming ultrasound measurement of gestational age.	Comparing ultrasound measurement of gestational age with the gestational assessment taken from menstrual dating

2.5. Measurement 1 – Crown-Rump Length

The CRL is measured between the fetal poles, excluding the limbs.

The quadratic regression formula used to describe the relationship between CRL / gestational age is:

CRL = 0.5967 $(GA)^2$ – 2.1413 – 3.4966 (r^2 = 0.985) and

GA = –0.0007 $(CRL)^2$ + 0.1584 (CRL) + 5.2876 (r^2 = 0.99)

For *Crown-Rump Length Measurements for an Australian Population*, compiled by S Campbell Westerway, see Appendix 3.

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2.6. Measurement 2 – Biparietal Diameter and Head Circumference

The BPD, OFD and HC are measured on a transverse axial section of the fetal head, which includes the falx cerebri anteriorly and posteriorly, the cavum septum pellucidum anteriorly in the midline and the thalami.

The BPD is measured from the outer edge of the nearer parietal bone to the inner edge of the more distant parietal bone.

The OFD is measured perpendicular to the BPD from the outer edge of the occipital bone to the outer edge of the frontal bone in line with the falx cerebri.

The HC is measured with either a trace or ellipse mode around the edge of the outer skull bone.

The SCW charts uses the formula HC = (BPD+OFD) x1.57 if only utilizing BPD and OFD measurements

The quadratic regression formula used to describe the relationship between BPD, OFD, HC and gestational age are:

BPD = –0.0371 (GA)² + 4.69 (GA) – 31.546 (r^2 = 0.969) and

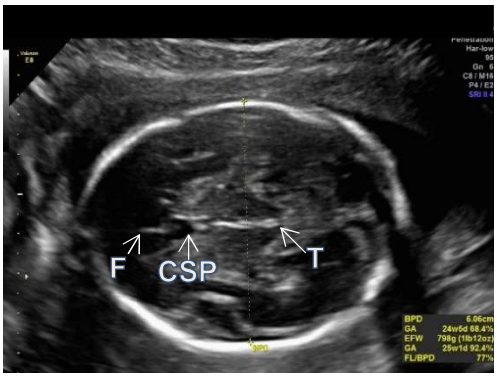
GA = 0.397 (BPD) – 0.00306 (BPD)² + 0.00002788 (BPD)³ + 4.933

OFD = –0.0665 (GA)² + 6.8881 (GA) – 49.08 (r^2 = 0.963) and

GA = 0.381 (OFD) – 0.00344 (OFD)² + 0.00002298 (OFD)³ + 4.189

HC = –0.1699 (GA)² + 18.494 (GA) – 127.91 (r^2= 0.991)

GA = 0.0001797 (HC)² + 0.02631 (HC) + 9.667 (r^2 = 0.996)

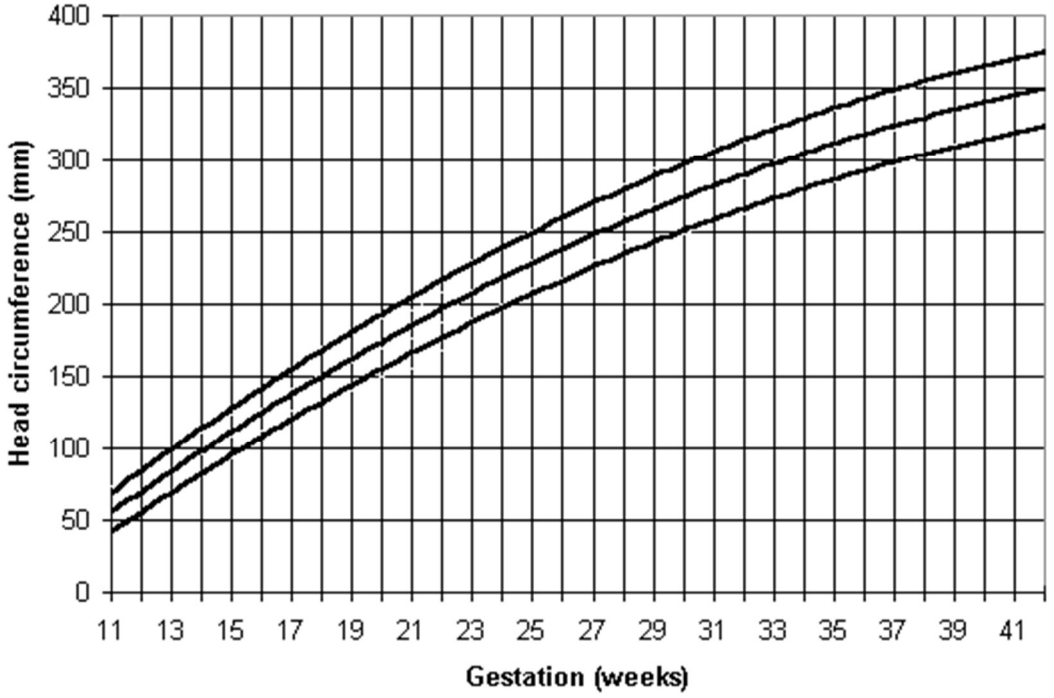


Biparietal diameter and head circumference measurements

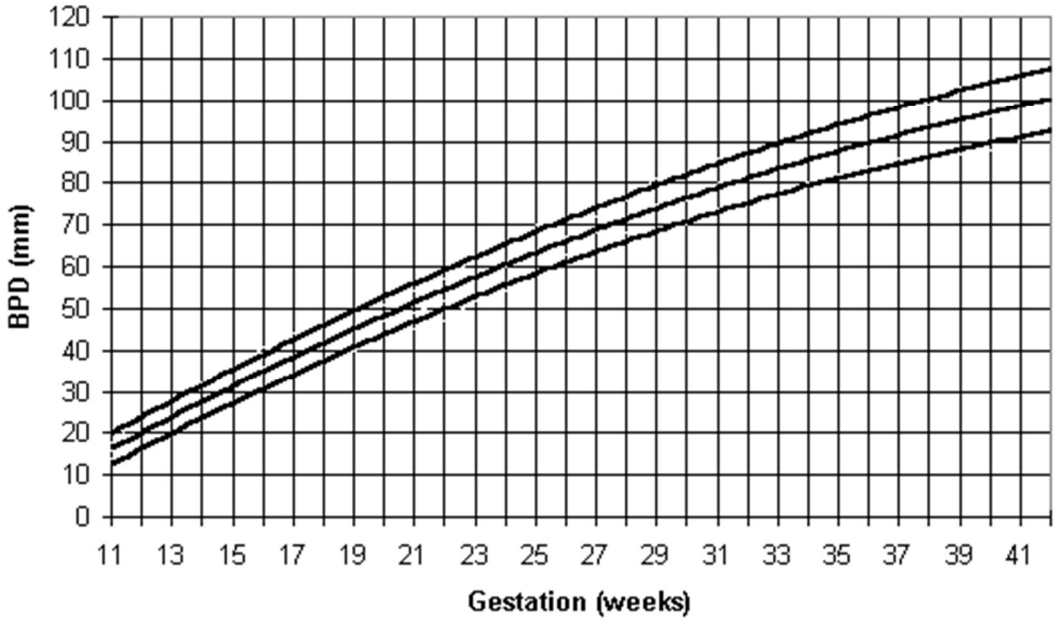
F = falx; CSP = cavum septi pellucidum; T = thalami

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ASUM Head Circumference



ASUM Biparietal Diameter



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2.7. Measurement 3 – Femur and Humerus Length

The long bones are measured with the bone imaged across the beam axis.

The strong acoustic shadow behind the femoral or humeral shaft and the visualisation of both cartilaginous ends indicates that the image plane is on the longest axis and is the optimal measurement plane.

The calipers are placed along the diaphyseal shaft excluding the epiphysis.

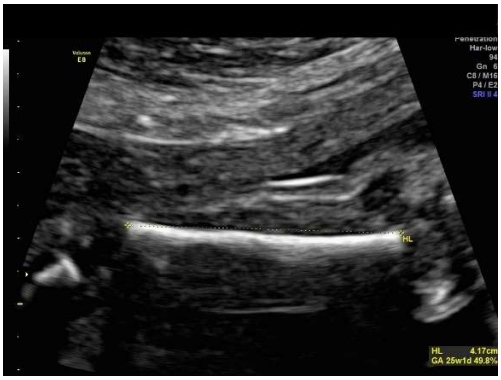
The quadratic regression formula used to describe the relationship between FL, HL and gestational age are:

FL = –0.0004 $(GA)^3$ + 0.0032 $(GA)^2$ + 3.1263 (GA) – 28.489 (r^2= 0.974)

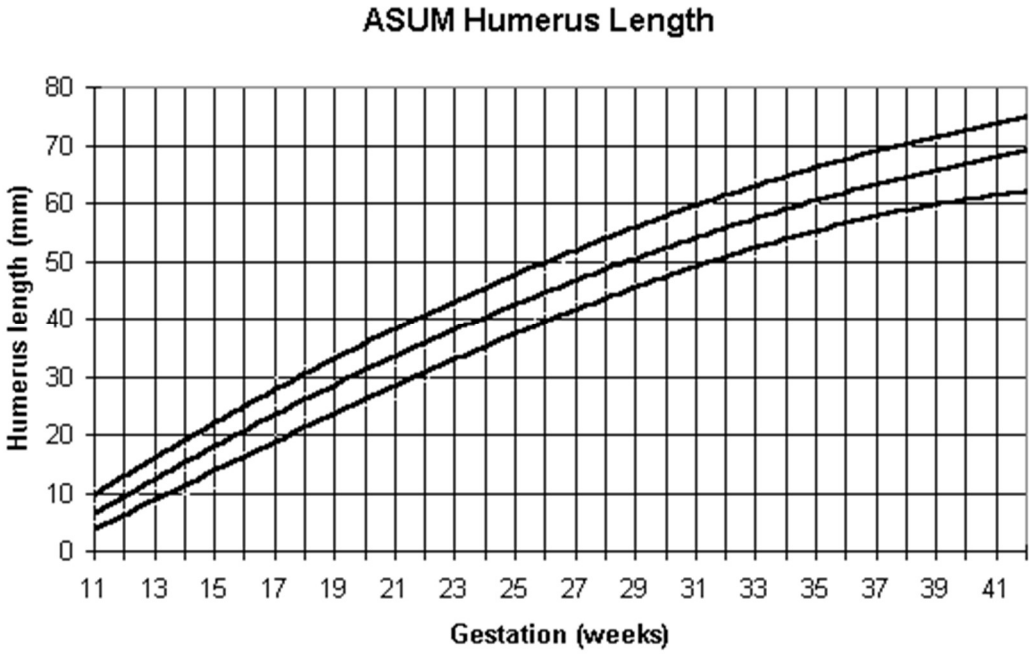
GA = 0.41 (FL) – 0.002884 $(FL)^2$ + 0.00003924 $(FL)^3$+ 8.284

HL = –0.0001 $(GA)^3$ – 0.0235 $(GA)^2$ + 3.5386 (GA) – 29.452 (r^2 = 0.956)

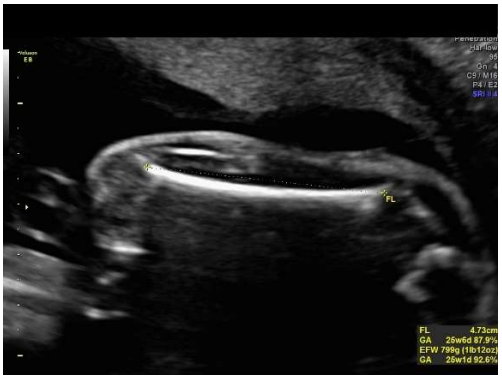
GA = 0.406 (HL) – 0.002804 $(HL)^2$ + 0.0000563 $(HL)^3$ + 8.411 (r^2 = 0.999)



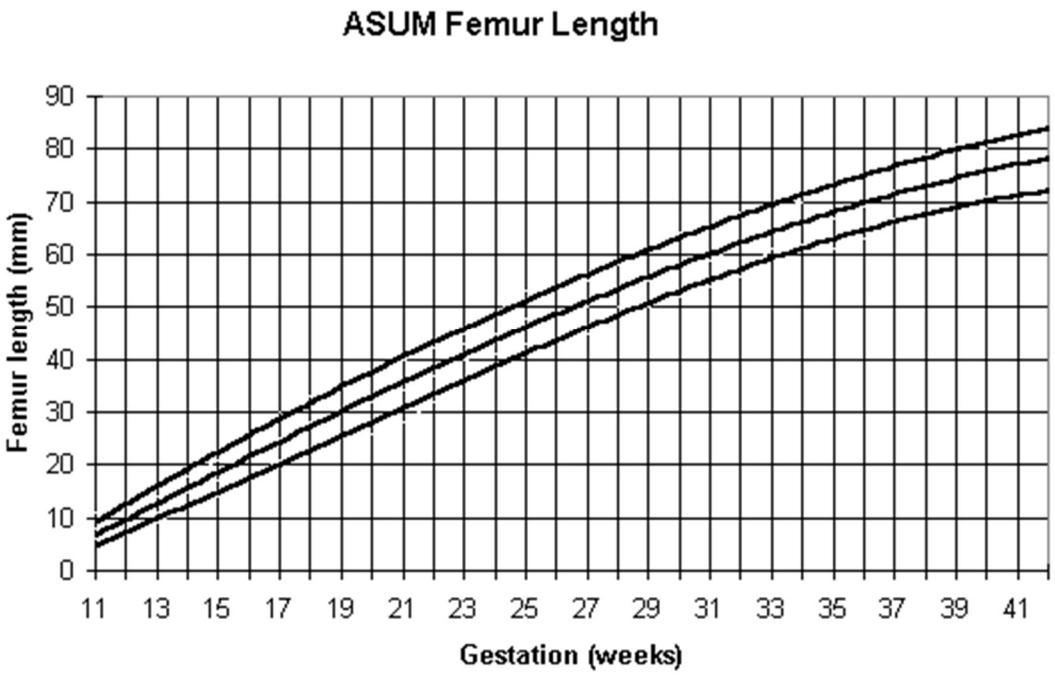
Humerus length measurement



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Femur length measurement



3. Fetal Growth

3.1. Intention

As well as gestational age, the AC measurement is important for the assessment of fetal growth, particularly in the second half of the pregnancy. Measurements should be at least 2 weeks apart to avoid false positive rates for fetal growth restriction.

3.2. Measurement 4 – Abdominal Circumference

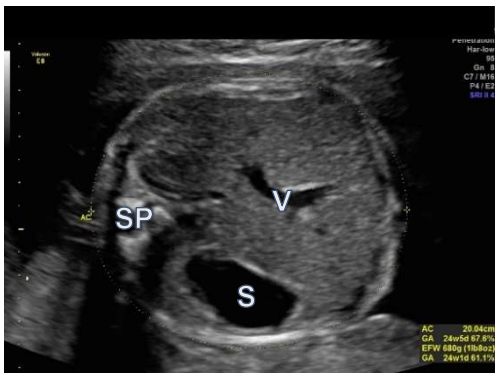
The AC is measured from a true transverse image of the abdomen at the level of the liver and stomach, including the left portal vein at the umbilical region. The fetal fat layer must be included.

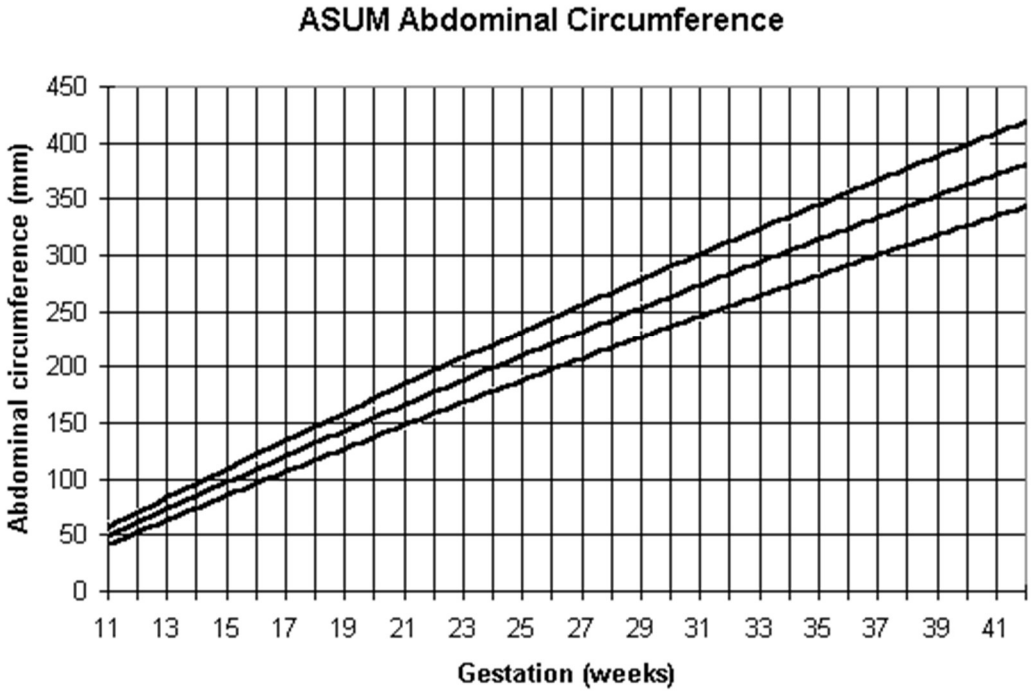
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The quadratic regression formula used to describe the relationship between AC and gestational age is:

AC = –0.0469 (GA)² + 13.204 (GA) – 90.946 (r^2 = 0.984)

GA = 0.0000367 (AC)²+ 0.07715 (AC) + 7.192 (r^2 = 0.999)





3.3. Criterion/Criteria to Achieve Standard

1. Assessment of gestational age
2. Assessment of fetal growth by AC measurement.

For *Ultrasonic Fetal Measurement Standards for an Australian Population*, compiled by S Campbell Westerway, see Appendix 4.

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4. Estimating Fetal Weight

4.1. Intention

No one EFW formula has been found to be suitable across all weight ranges.

4.2. Measurement 5 – Estimating Fetal Weight

There are two reliable EFW formulas, both giving low deviations from actual birth weight and with low random error of 7.7 and 7.9% across the weight ranges.

1. Hadlock formula HC, AC and FL; or
2. Hadlock formula with BPD, HC, AC and FL

Both fit the criteria of Altman et al for choosing an EFW formula.

Considering the possible problems of head moulding and measuring BPD, ASUM suggests the use of:

Formula incorporating HC/AC/FL:

Log10 BW = 1.5662 – 0.0108 (HC) + 0.0468(AC) + 0.171 (FL) + 0.00034 (HC)10 – 0.003685 (AC x FL)

(Hadlock et al)

4.3. Criterion/Criteria to Achieve Standard

Estimate fetal weight by ultrasound obstetric measurements.

4.4. Requirements

Criterion requirement	Action to meet requirement
Estimate fetal weight by ultrasound obstetric measurements.	Three (3) fetal measurements; Usually: 1. head circumference (HC); 2. abdominal circumference (AC); 3. femur length (FL). Calculate: Log10 BW = 1.5662 – 0.0108 (HC) + 0.0468(AC) + 0.171 (FL) + 0.00034 (HC)10 – 0.003685 (AC x FL)

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5. Related/Supporting documents

The following documents are required to give effect to this standard:

1. ASUM Guidelines for the Performance of First Trimester Ultrasound.
2. ASUM Guidelines for the Performance of Second Trimester Ultrasound.
3. ASUM Guidelines for the Performance of Third Trimester Ultrasound.
4. ASUM Guidelines for Abdominal Scanning.
5. ASUM Guidelines on the Performance of a Gynaecological Scan.
6. ASUM Guidelines for Reprocessing Ultrasound Transducers.

6. Supporting information/References

The following documents inform this standard:

1. Westerway SC, Davison A, Cowell S. Ultrasonic Fetal Measurements: New Australian standards for the new millennium. Aust N Z J Obstet Gynaecol. 2000;40:297-302. https://doi.org/10.1111/j.1479-828X.2000.tb03338.x
2. Altman DG, Chitty LS. Charts of fetal size, 1. Methodology. Br J Obstet Gynaecol. 1994;101:29-34.
3. Hadlock FP, Harrist RB, Carpenter RJ, Deter RL, Park SK. Sonographic estimation of fetal weight. The value of femur length in addition to head and abdomen measurements. Radiology. 1984;150:535-40.
4. Edwards A. In the balance: the accuracy of sonographic estimation of fetal weight. ASUM Bulletin. 2001;4(1):3-6.
5. Westerway SC. Estimating fetal weight for best clinical outcomes. Australas J Ultrasound Med. 2012;15(1):13-17.
6. Napolitano R, Dhami J, Ohuma EO, Ioannou C, Conde-Agudelo A, Kennedy SH, et al. Pregnancy dating by fetal crown-rump length: A systematic review of charts. BJOG. 2014;121(5):556-65.
7. Butt K, Lim K. Determination of gestational age by ultrasound. JOGC. 2014;36(2):171-83.
8. Papageorghiou AT, Kemp B, Stones W, Ohuma EO, Kennedy SH, Purwar M, et al. Ultrasound-based gestational-age estimation in late pregnancy. Ultrasound in Obstetrics & Gynaecology. 2016;48(6):719-26.
9. ISUOG Practice Guidelines: Performance of first-trimester fetal ultrasound scan. Ultrasound in Obstetrics & Gynaecology. 2013;41(1):102-113.

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Glossary

The following definitions are relevant to this standard.

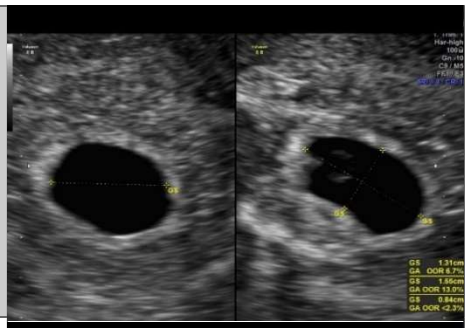
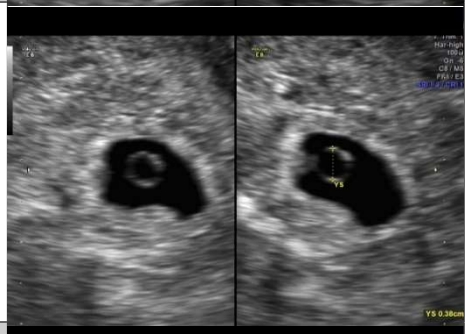
Term	Definition
AC	abdominal circumference
BPD	biparietal diameter
CRL	crown rump length
EFW	estimating fetal weight
FL	femur length
GA	gestational age
HC	head circumference
Hadlock	see References
HL	humerus length
OFD	occipitofrontal diameter
SCW charts	see Appendix 3 and Appendix 4

Notes

This document uses the image planes & measuring protocols used by the author of selected charts. Please check the measuring methodology of your chosen charts.

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Appendix 1 - First Trimester Measurements

Parameter	Imaging plane	Measurement	Image
MSD	**Mean of 3 orthogonal sac measurements** •image well magnified •MSD should not be used once CRL can be measured	Callipers should be placed on the inner margin of the gestational sac	
YS	**Maximal diameter of yolk sac** •image well magnified •visible at 5 – 6 w GA •Grows to a maximal size of 6mm by 10 w •note direct measurement not useful in determining GA	Callipers placed at the maximal diameter on the centre of the yolk sac wall	
CRL	**Before 8w:** •image well magnified •longest straight line length of embryo	Callipers placed on the outer margin of the cephalic end to the rump	
	8w – 11w: •image well magnified •mid sagittal plane •neck in a neutral position •horizontal across screen	Callipers placed on the outer margin of the cephalic end to the rump	
	11w – 14w: •image well magnified •mid sagittal section •neck in a neutral position with fluid between the chin and chest •horizontal across screen •crown and rump clearly seen		

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Appendix 2 - Second Trimester Measurements

Parameter	Imaging plane	Measurement	Image
BPD	**Axial plane through the fetal head** •image well magnified •head horizontal, oval and symmetrical •centrally positioned falx cerebri •CSP in the anterior third •thalami located symmetrically	Callipers placed at the maximal diameter from the outer edge of the nearest parietal bone to the inner edge of the farthest	
HC	**Identical plane to BPD**	The ellipse should follow the outer perimeter of the bony skull (not overlying skin)	
AC	**Axial plane through the fetal abdomen** •image well magnified •circular section with spine lateral •stomach bubble visible •short segment of umbilical vein at the level of the portal sinus visible	The ellipse should be as close to the skin as possible and include the fetal fat layer	
FL	**Length of femoral diaphysis** •image well magnified •as close as possible to horizontal across screen •longest axis can be determined by the strong acoustic shadow and visualisation of both cartilaginous ends	The femur closest to the transducer should be measured and callipers should be placed on the outer edges of the diaphysis at the junction of bone and cartilage	
HL	**Length of humeral diaphysis** •image well magnified •as close as possible to horizontal across screen •longest axis can be determined by the strong acoustic shadow and visualisation of both cartilaginous ends	The humerus closest to the transducer should be measured and callipers should be placed on the outer edges of the diaphysis at the junction of bone and cartilage	

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Appendix 3 - Crown-Rump Length Measurements for an Australian Population

Compiled by S Campbell Westerway (Westerway SC et al)

Gestation (weeks/days)	CRL (mm)	Gestation (weeks/days)	CRL (mm)	Gestation (weeks/days)	CRL (mm)
5.2	1	8.3	20	11.4	52
5.3	2	8.4	21	11.5	55
5.4	3	8.5	22	11.6	56
5.5	3	8.6	22	12.0	57
5.6	4	9.0	23	12.1	58
6.0	4	9.1	24	12.2	60
6.1	5	9.2	26	12.3	61
6.2	6	9.3	27	12.4	63
6.3	7	9.4	28	12.5	64
6.4	8	9.5	29	12.6	65
6.5	9	9.6	31	13.0	68
6.6	10	10.0	34	13.1	70
7.0	11	10.1	36	13.2	72
7.1	11	10.2	37	13.3	74
7.2	12	10.3	38	13.4	76
7.3	12	10.4	39	13.5	77
7.4	13	10.5	39	13.6	80
7.5	14	10.6	40	14.0	81
7.6	15	11.0	44	14.1	84
8.0	17	11.1	45	14.2	85
8.1	18	11.2	47	14.3	86
8.2	19	11.3	48	14.4	87

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Appendix 4 - Ultrasonic Fetal Measurement Standards for an Australian Population

Compiled by S Campbell Westerway (Westerway SC et al)

Gestation (weeks)	BPD (mm)	OFD (mm)	Head circumference (mm)	Abdominal circumference (mm)	Femur (mm)	Humerus (mm)	Gestation (weeks)
+/-2 standard deviations shown in brackets. Measurements are completed weeks.							
11	16 (2.0)	21 (2.0)	59 (15)	52 (10)	8 (2.0)	8 (3.0)	11
12	20 (4.0)	24 (2.0)	70 (15)	63 (10)	10 (2.5)	9 (2.0)	12
13	24 (4.0)	29 (3.0)	84 (15)	74 (10)	11 (2.5)	11 (3.0)	13
14	28 (4.0)	34 (3.0)	96 (15)	84 (10)	15 (3.0)	14 (4.0)	14
15	31 (4.0)	38 (3.0)	108 (15)	96 (10)	17 (3.5)	17 (5.5)	15
16	36 (5.0)	46 (3.0)	128 (15)	106 (10)	22 (4.0)	21 (4.0)	16
17	39 (5.0)	50 (3.0)	141 (15)	120 (15)	25 (4.0)	25 (5.0)	17
18	42 (4.0)	54 (3.5)	151 (20)	131 (15)	28 (5.0)	27 (5.5)	18
19	45 (5.0)	57 (3.5)	160 (20)	140 (15)	30 (5.0)	29 (5.0)	19
20	47 (4.0)	61 (3.5)	170 (20)	151 (15)	32 (6.0)	31 (5.0)	20
21	49 (4.0)	63 (4.0)	176 (20)	164 (20)	34 (6.0)	32 (6.0)	21
22	52 (5.0)	68 (3.5)	188 (20)	176 (20)	37 (5.0)	35 (6.0)	22
23	57 (5.0)	76 (4.0)	210 (20)	186 (20)	43 (5.0)	38 (4.0)	23
24	60 (6.0)	79 (4.0)	220 (20)	201 (20)	45 (4.0)	40 (6.0)	24
25	64 (6.0)	82 (4.5)	231 (20)	212 (20)	48 (5.0)	43 (5.0)	25
26	67 (4.0)	84 (4.5)	238 (20)	223 (25)	49 (5.0)	44 (4.0)	26
27	68 (5.0)	86 (4.5)	250 (20)	230 (25)	50 (5.0)	47 (4.0)	27
28	72 (4.0)	95 (5.0)	263 (20)	242 (25)	54 (4.0)	50 (5.0)	28
29	75 (4.0)	97 (5.5)	269 (25)	259 (25)	55 (5.5)	51 (5.0)	29
30	76 (4.0)	98 (5.5)	274 (25)	262 (25)	58 (6.0)	52 (5.0)	30
31	80 (6.0)	101 (5.0)	284 (25)	272 (30)	59 (5.5)	54 (5.0)	31
32	81 (4.0)	102 (5.0)	288 (25)	283 (30)	62 (6.0)	56 (5.0)	32
33	84 (6.0)	107 (5.5)	300 (25)	294 (30)	65 (4.0)	57 (6.0)	33
34	86 (6.0)	108 (5.5)	305 (25)	305 (30)	66 (4.0)	59 (5.5)	34
35	88 (6.5)	109 (5.5)	310 (25)	315 (30)	67 (6.0)	60 (6.0)	35
36	90 (6.0)	112 (5.5)	317 (25)	325 (35)	69 (6.0)	62 (5.0)	36
37	92 (6.5)	113 (6.0)	321 (25)	333 (35)	72 (5.0)	63 (6.0)	37
38	93 (6.0)	116 (5.5)	328 (25)	342 (35)	73 (5.5)	64 (6.0)	38
39	95 (8.0)	119 (6.0)	336 (25)	356 (35)	75 (6.0)	65 (5.5)	39
40	96 (8.0)	120 (6.0)	340 (25)	362 (35)	76 (4.0)	66 (6.0)	40
41	98 (8.0)	122 (6.0)	344 (25)	367 (35)	77 (5.0)	68 (6.0)	41

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