ID: 4709 Methods to measure fetal growth velocity: a systematic review

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Introduction

Altered growth velocity has been proposed as a method to better define pathologic growth, with particular attention given to reduced growth velocity. Several reference ranges for fetal growth velocity have been published for biometric measures of bi-parietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and area (AA), femur length (FL) and estimated fetal weight (EFW). The aims of this study were to review reported techniques to calculate growth velocity and thresholds use to define altered growth velocity.

Methods

Electronic searches in CINAHL, PUBMED, Web of Science and The Cochrane Library databases between 1992 to 2022 were conducted to identify potentially relevant English language articles on the measurement of fetal growth velocity and/or the relationship between altered growth velocity and clinical outcome. The search terms were (fetal or foetal) and (growth velocit* or growth traject* or growth rate). 81 articles were identified (figure 1).

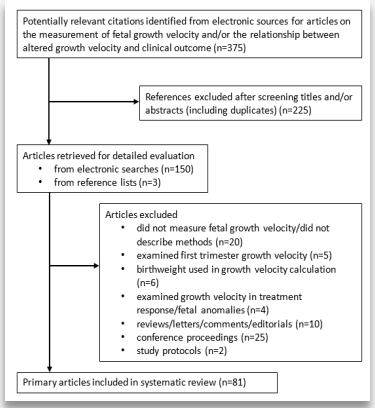

Figure 1. Flow diagram of literature assessment

Table 1. Articles reporting thresholds for altered growth velocity

Publication	Population	Method	Threshold(s) for reduced GV	Findings and associations
Wu et al 2021	Low risk cohort Retrospective n=9075	Instantaneous velocity curves g/week v GA	1. EFW GV <10th centile 2. AC GV <10th centile	1. Neonatal complications 2. Preterm birth 3. SGA
Schreiber et al 2021	Prospective Longitudinal n=246	Δ EFW percentile (27-35w and 'near term')/interval (weeks) between measurements	1. 10 % of cohort with maximum negative GV 2. EFW crossing 2 quartiles on growth chart 3. lowest quartile of last EFW	↑ unplanned CS due to non reassuring FHR
Price et al 2020	Prospective n=612	Δ z-score AC & EFW 18-24w and 26-36w	1. EFW GV <10th centile 2. AC GV <10th centile	SGA at birth
Kennedy et al 2020	AGA cohort Prospective n=305	Δ percentile AC & EFW between 20 - 28w and 20 - 36w	1. Drop >30 centiles EFW 2. Drop >30 centiles AC	1. Placental insufficiency (CPR < 5th centile) 2. Neonatal acidosis
Deter et al 2019	SGA cohort Retrospective n=24	Instantaneous velocity in second trimester cm/week using iGAP software	AC < 0.08cm per week	AC GV can discriminate between SGA and growth restricted SGA
MacDonald et al 2017	AGA cohort Prospective n=308	Δ EFW & AC centile 28-36w	1. Drop >30 centiles EFW 2. Drop >30 centiles AC	1. Placental insufficiency (CPR < 5th centile) 2. Neonatal acidosis when > 35 centile drop
Vannuccini et al 2017	Unselected cohort Prospective n=3334	AC GV equation and reference range 20-36w	AC GV < -1.3091	–
Partap et al 2016	Prospective n=3892	Δ z-score between 20-28w	< 10th centile	↓ FL GV associated with preterm birth
Sovio et al 2015	Prospective n=3977	AC GV = Δ AC Z score between 20w and last scan before birth (28 or 36w)	1. EFW <10th centile 2. AC GV <10th centile	1. Neonatal morbidity 2. SGA at birth
Jensen et al 2015	AGA cohort Retrospective n=123	Δ EFW per 28d	<10th centile	No association with EFW GV and adolescent IQ
Salomon et al 2005	Prospective n=386	Formula to calculate FGP expressed in mm/day	FGP<40	FGR at birth
De Jong et al 1999	High risk cohort n=200	Average GV in g/day for 6w prior to birth	<2.19 g/day	Neonatal compications (fetal distress, cord pH<7.15, NNICU admission)
Owen et al 1998	Prospective Longitudinal n=274	Velocity z-score abdominal area in measurements 28d apart	Z-score ≤ -1.55	Reduced skin fold thickness and ponderal index
Stratton et al 1995	AGA cohort Prospective, longitudinal n=196	Δ EFW centile between 2 measurements 2-11w apart	>20 centile drop in EFW	Increased incidence NNICU admission
Publication	**Population**	**Method**	**Threshold(s) for increased GV**	**Findings and associations**
MacDonald et al 2021	AGA cohort Prospective, longitudinal n=308	Δ EFW & AC centile 28-36w	1. Increase >30 centiles EFW 2. Increase >30 centiles AC	Shoulder dystocia
Vannuccini et al 2017	Unselected cohort Prospective n=3334	AC GV equation and reference range 20-36w	AC GV > 1.3324	–
Kernaghan et al 2007	Diabetic cohort Prospective, longitudinal n=242	Δ EFW z-score 21-35 days apart	z-score 1.7	Did not improve prediction of LGA at birth or hypoglycaemia
Salomon et al 2005	Prospective n=386	Formula to calculate FGP expressed in mm/day	FGP>60	Macrosomia at birth

GA – gestational age GV- growth velocity CS – Caesarean section SGA – small for gestational age FHR – fetal heart rate AGA – appropriate size for gestational age FGP – fetal growth potential FGR – fetal growth restriction

References

https://anu365-my.sharepoint.com/:f:/g/personal/u6146524_anu_edu_au/EqNqPij6zLBAtQVEweWh1xwBIjLMsEoER8w0-lKmyyElEg?e=Xp0FWf

Results

Methods to measure fetal growth velocity varied in complexity and included: calculation of instantaneous velocity derived from individual or population growth curves, expressed as a regression coefficient, incremental change in mm/week or g/week, or velocity Z score, and calculation of the change in Z score or percentile of a given measurement between a specific interval, expressed as Δ Z score, Δ percentile or as a ratio. The time interval between measurements was inconsistent, with some studies assessing growth velocity between the second trimester (20w) and third trimester (anywhere from 28w to 40w) and others assessing growth velocity in the third trimester (anywhere from 26w to 40w). Other studies compared EFW in the second or third trimester to birthweight. Outcome measures included birthweight outside thresholds for 'normal range', neonatal complications or morbidity, unplanned Caesarean section, and markers of placental insufficiency. Thresholds for defining altered growth velocity varied with 14 publications reporting thresholds for reduced velocity and 4 publications defining increased growth velocity (table 1).

Discussion

Several approaches to measuring fetal growth velocity have been described yet none seem ideally suited to clinical practice. To use velocity references ranges and charts it is necessary to first calculate the growth velocity following methods defined by the reference and then compare the result to tables or charts. Comparison of measurement percentiles between two time points presents a simple alternative, but may not be applicable to clinical practice due to variability in the interval between ultrasound examinations

Conclusion

How to best incorporate growth velocity references into clinical practice and which thresholds best define altered growth velocity remains unclear.