Symphysis-fundus measurement – the predictive value of a new reference curve

BACKGROUND Symphysis-fundus measurement is used in pregnancy care to detect poor fetal growth. Symphysis-fundus measurement curves (percentile curves) and prediction of fetuses with a birth weight below the10th percentile have been published previously. The percentile curves show the distribution of symphysis-fundus measurements in the reference population and are recommended as the national standard. This article discusses the predictive value of this method for identification of neonates who are small for gestational age (SGA).

MATERIAL AND METHOD This is a population-based registry study of pregnant women who gave birth at Sahlgrenska University Hospital in Gothenburg in the period 2005–2010. Diagnostic accuracy was analysed using ROC curves and presented with the area under the curve (AUC) from gestational week 24 to 42. Sensitivity, specificity, and positive and negative predictive value were calculated.

RESULTS A total of 42 018 pregnant women carrying a single fetus were included. The AUC values showed that a symphysis-fundus measurement late in pregnancy was a stronger predictor for determining fetuses that are small for gestational age than a measurement early in pregnancy. The AUC value increased from 0.61 in week 24 to 0.74 in week 40. With a threshold value at the 10th percentile, symphysis-fundus measurement has a total sensitivity of 47 % and a specificity of 79 %. A positive total test was defined as at least one measurement below the 10th percentile curve in the course of the pregnancy.

INTERPRETATION Symphysis-fundus measurement may be important for the identification of high-risk pregnancies, but should preferably be used in conjunction with other clinical variables.

Aase Serine Devold Pay
aase.serine.devold.pay@helsedir.no
Department of Hospital Services
Norwegian Directorate of Health
and
Department of Global Health – Women and Children
Norwegian Institute of Public Health

J. Frederik Frøen
Department of Global Health – Women and Children
Norwegian Institute of Public Health
and
Centre for Intervention Science in Maternal and Child Health (CISMAC)

Anne Cathrine Staff
Faculty of Medicine
University of Oslo
and
Division of Obstetrics and Gynaecology
Oslo University Hospital

Bo Jacobsson
Sahlgrenska Academy
and
Department of Obstetrics and Gynaecology
Gothenburg University
and
Department of Health Data and Digitisation
Norwegian Institute of Public Health

Håkon K. Gjessing
Department of Child Health
Norwegian Institute of Public Health
and
Department of Global Public Health and Primary Care
University of Bergen

MAIN MESSAGE

The predictive value of symphysis-fundus measurement is highest late in pregnancy, but this must be weighed against the clinical benefit of early identification.

Using a threshold value at the 10th percentile, symphysis-fundus measurement in weeks 24–42 has a total sensitivity of 47 % and a specificity of 79 %.

Symphysis-fundus measurement is routinely used in pregnancy care to identify fetuses with restricted growth or that are small for gestational age (SGA). The method involves measuring the distance between the symphysis and the top of the uterus with a measuring tape. The measurement is performed with the pregnant woman lying on her back, with an empty urinary bladder and legs outstretched (1). If the uterus and the infant's anteroposterior axis are not in alignment, measurement is taken lengthwise along the infant's anteroposterior axis.

The measurement is compared with a reference curve on the pregnancy health record (2). Guidelines for pregnancy care and the health record instructions recommend that when the value is below the 2.5 percentile, the patient should be referred to the specialist healthcare services, while with values between the 2.5th and 10th percentile, the patient should be individually assessed (3).

Fetal growth restriction / small for gestational age

Fetal growth restriction (FGR) means that a fetus is not growing satisfactorily in relation to its genetic potential, and therefore indicates pathological growth (4). Small for gestational age applies to all infants who have a birth weight below a defined percentile in relation to length of gestation. In Norway this is defined as a birth weight below the 10th percentile (5).

A proportion of the small for gestational age infants will not have fetal growth restriction because some are genetically small. Of those who are not classified as small for gestational age, some will also have fetal growth restriction. There is no general agreement on the required deviation from a reference curve and on the duration of this deviation in order for the fetus to be classified as growth-restricted.

Fetal growth restriction signals deviation in fetal health for a number of conditions, mainly malformations, chromosomal abnormalities and various forms of placental insufficiency. These fetuses have a significantly increased risk of injury, acute interventions and mortality during the pregnancy, birth, and as neonates (6–10). More than half of stillborn babies in Norway have restricted growth before birth (11). Identification of these fetuses is highly prioritized in order to reduce the risk of perinatal morbidity and mortality (12).

New national reference curves and their predictive value

We have previously published percentile curves for symphysis-fundus measurement

Table 1 Characteristics of women who gave birth in Sahlgrenska University Hospital in the period 1 January 2005–30 September 2010 and their newborn infants (13, 14). The data are presented as a number (%) if not otherwise indicated

Characteristic	Value
Maternal (N = 42 018)	
Age (years), average (SD)	30 (5.0)
Height (cm), average (SD)	166 (6.7)
Pre-pregnant weight (kg), average (SD)	67 (12.6)
Body mass index (kg/m^2), average (SD)	22.2 (4.5)
Nulliparous	14 147 (33.7)
Multiparous	27 871 (66.3)
Smokers	2 629 (6.3)
Infant (N = 42 018)	
Birth weight (g), average (SD)	3 498 (545.8)
Gestational age < 259 days	1 812 (4.3)
Gestational age 259–294 days	37 077 (88.2)
Gestational age > 294 days	3 129 (7.4)
Boys	21 547 (51.3)
Girls	20 470 (48.7)
Stillbirths (> 22 weeks)	109 (0.3)

from gestational week 24 to 42; the curves are recommended by the Norwegian Directorate of Health as the national standard (13). We have also published a prediction model for small- for- gestational- age, where we developed relative risk curves (RR) as an alternative to traditional percentile curves. (14). Only percentile curves are used in Norwegian practice. These are as such not directly related to risk of being small for gestational age; they only describe the distribution of symphysis-fundus measurements in the reference population. The clinical benefit of the percentile curves must therefore be assessed in relation to detection limits and identification of reduced fetal weight.

We now present the degree to which symphysis-fundus measurement can predict small-for gestational- age in neonates, including information on sensitivity, specificity, and positive and negative predictive value.

Table 2 Area under the curve (AUC) for symphysis-fundus threshold value at the 10th percentile for selected lengths of gestation (gestational weeks 24, 28, 32, 36 and 40) with 95 % confidence interval (CI). Women who gave birth in Sahlgrenska University Hospital in the period 1 January 2005–30 September 2010. N = 42 018

Week	AUC (95 % CI)
24	0.61 (0.60–0.62)
28	0.63 (0.63–0.64)
32	0.66 (0.66–0.67)
36	0.71 (0.70–0.71)
40	0.74 (0.73–0.74)

Material and method

The percentile curves assessed in this article have been developed by the Norwegian Institute of Public Health in collaboration with Oslo University Hospital and Sahlgrenska University Hospital in Gothenburg (13). The curves are implemented in the pregnancy health record and may be downloaded from the Directorate of Health's website (2). Small-for-gestational-age is defined as birthweight below the 10th percentile for a given length of gestation (15).

The development of the percentile curves as well as the present assessment are based on the same population material, consisting of a total of 42 018 pregnant women with 282 713 symphysis-fundus measurements. All women who had a singleton birth at Sahlgrenska University Hospital in the period 1 January 2005 to 30 September 2010 (N = 44 056) were included by using the hospital's obstetric database. Women were excluded from the study if they had no ultrasound-based due date or symphysis-fundus measurement (n = 2 038). The population is described in Table 1 and is discussed in more detail in previous articles (13, 14).

The statistical data processing was performed in the R Statistical Computing Environment, version 3.3.2 (16). Receiver Operating Characteristics (ROC) curves were prepared for selected gestational weeks in order to show sensitivity and specificity for all threshold values of the symphysis-fundus measurements, and the area under the curve was calculated to obtain an expression of the total diagnostic accuracy. The area under the ROC curve (AUC) can vary between 0.5 and 1.0. A value of 0.5 means that the test is worthless, while a value of 1.0 means a perfectly discriminating test.

Since symphysis-fundus measurement is performed several times throughout the pregnancy, we also calculated a total sensitivity, specificity, and positive and negative predictive value for smallness for gestational age. The symphysis-fundus test was defined as positive if at least one measurement during the pregnancy fell below the given threshold value for symphysis-fundus measurement.

Results

We present the results primarily using symphysis-fundus threshold values at the 10th and 2.5th percentiles, since these are the values used in Norway. In Table 2 we show AUC values for selected gestational weeks with a 95 % confidence interval. Figure 1 shows the total predictive value for all symphysis-fundus threshold values.

Symphysis-fundus threshold value at the 10th percentile

Using a symphysis-fundus threshold value at the 10th percentile, the total sensitivity was 47 % for the entire period from week 24 until the due date, with an associated specificity of 79 %. This means that five out of ten SGA births can be identified correctly by using symphysis-fundus measurement in pregnancy, whereas for non-SGA births, eight out of ten are identified correctly. Correspondingly the total positive predictive value was 22 % and the negative predictive value was 92 %.

This means that for approximately two out of ten positive findings from symphysis-

fundus screening, the infant was small for gestational age, but as many as nine out of ten women with negative symphysis-fundus screening did not give birth to a small baby. With a symphysis-fundus threshold value equal to the 10th percentile, around 25 % of the pregnant population will fall below the threshold value at least once in the course of their pregnancy.

Symphysis-fundus threshold value at the 2.5th percentile

If the symphysis-fundus threshold value is reduced to the 2.5th percentile, total sensitivity is reduced from 47 % to 23 %, while specificity increases from 79 % to 93 %. The positive predictive value of the test increases from 22 % to 29 %, while the negative predictive value falls from 92 % to 90 %. The proportion of pregnant women who fall below the threshold value at least once is reduced from 25 % to 8 %.

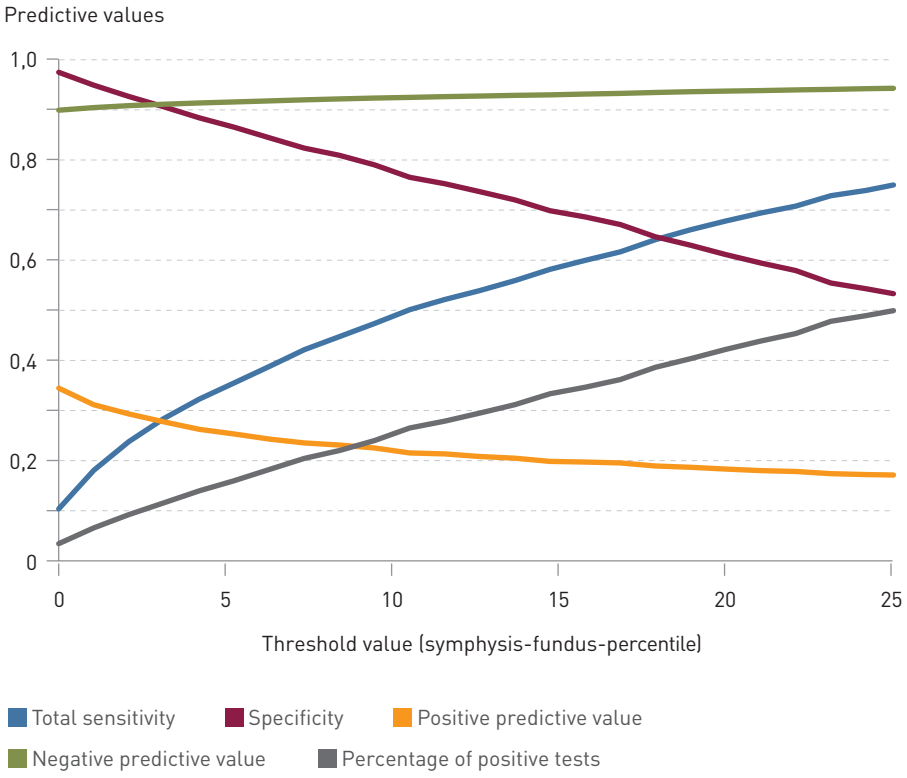

Figure 1 *Total sensitivity, specificity, positive predictive value, negative predictive value and percentage of positive tests of symphysis-fundus measurement for identification of cases in which the newborn is small for gestational age (birth weight below the 10th percentile). Women who gave birth in Sahlgrenska University Hospital in the period 1 January 2005–30 September 2010. N = 42 018*

Discussion

Symphysis-fundus measurement early in pregnancy has limited value for identifying infants who are small for gestational age at birth, but the closer the measurement is taken to the due date, the greater the diagnostic accuracy. Symphysis-fundus screening will be a balance between the highest-quality symphysis-fundus measurement late in pregnancy and the clinical benefit of early identification of infants who are small for gestational age.

Total sensitivity is moderate when a symphysis-fundus threshold value at the 10th percentile is used, since it only detects one in two fetuses that are small for gestational age. Specificity is better, since four out of five fetuses that are not small for gestational age are correctly identified. Positive predictive value shows that one out of five fetuses with a positive test on screening at birth is small for gestational age. Negative predictive value shows that as many as nine out of ten fetuses with a negative test are correctly identified, i.e. are not small for gestational age. Choice of a lower symphysis-fundus threshold value (2.5th percentile) resulted in significantly reduced sensitivity, but somewhat better specificity. The positive predictive value increased somewhat, whereas the negative predictive value was reduced.

Comparison with previous studies

The conclusion that symphysis-fundus measurement has moderate sensitivity is consistent with the findings of a previously published systematic review (17) and is yet a further confirmation of the measurement's limited accuracy in identifying cases in which an infant is small for gestational age. We have shown in a previous study (14) based upon the same population that longitudinal symphysis-fundus measurements with static or flat curve patterns did not improve the prediction of small-for-gestational-age cases compared with only using the last (most recent) symphysis-fundus measurement. Theoretically, information about a falling or static symphysis-fundus curve may be clinically useful, and the possibility that it may provide a general indication of increased perinatal morbidity and mortality cannot be excluded. However, the correlation with the risk of the infant being small for gestational age is not sufficiently strong to be of practical value when symphysis-fundus measurement is used.

Change in threshold value/criteria for symphysis-fundus measurement

The choice of threshold value determines the balance between sensitivity and specificity. The threshold value also dictates how many patients will be referred to specialist health care, and is therefore of great practical significance. A lower cut-off for positive screening (2.5th percentile) entails considerably reduced sensitivity; in this case the test will only detect one in five pregnancies with growth retardation, in contrast to one in two with a threshold value at the 10th percentile. However, it results in a clear improvement in specificity.

The test therefore became less accurate for identifying actual births where the infant was small for gestational age, but there was a reduction in the number of false positive tests. A practical consequence of choosing the 10th percentile as a threshold for referral would be that 25 % of pregnant women would be referred to a specialist, in contrast to 8 % when choosing the 2.5th percentile.

Strengths and weaknesses

The present study is a population-based registry study that includes a large number of symphysis-fundus measurements. The study population from Västra Götaland county can be expected to be sufficiently representative of Norwegian conditions, and in a previous study we have shown that of the available variables, only the mother's height and weight had an effect on the symphysis-fundus measurement. Smoking, parity and age had a minimal effect, which indicates that moderate differences in the variable distribution between Norway and Sweden will have little effect on the results (13).

The measurements are performed by a

number of different midwives and doctors, and different individuals will measure in different ways. The percentile curves nevertheless represent a population of healthcare personnel performing measurements (13). This will smooth out systematic biases and make them representative in a population context. Individual errors of measurement will reduce predictive value. Since the data are retrieved from a clinical population database, measurement errors will already be present. However, this also implies that our calculated predictive value will be realistic in relation to what may be anticipated in clinical practice.

The clinician's knowledge of any general risk profile the women may have had with regard to intrauterine growth restriction or a small infant may have affected the symphysis-fundus measurement. We had no information on the times when possible diagnoses were made, nor on whether the clinician had knowledge of these when the symphysis-fundus measurement was performed.

Another element of uncertainty in the study is that pregnancy with a risk of intrauterine growth restriction or a small infant is excluded at some point in the pregnancy from symphysis-fundus screening and further growth is estimated exclusively with the use of ultrasound. This may produce an apparently weaker predictive value of the symphysis-fundus measurement. We found, however, that the number of measurements in low-risk pregnant women was on average only 0.2 more than in the rest of the population, which does not indicate a significant degree of selection (13).

Consequences for clinical practice

The study shows that symphysis-fundus measurement identifies only half the number of small fetuses, and it is essential that midwives and doctors are aware of the moderate sensitivity of the test. In pregnancy care, symphysis-fundus measurement is not used as the only screening tool to identify risk; it is combined with clinical findings, medical factors and previous obstetric history which together constitute the woman's total risk profile for intrauterine growth restriction or a small infant.

Symphysis-fundus measurement has a relatively high specificity. This means that there are few cases in which the pregnant woman is further referred that the fetus is in fact *not* small for gestational age. However, false positive results with use of symphysis-fundus measurement are of less concern than failing to identify a pregnancy with intrauterine growth restriction or a small infant.

When screening is performed in primary health care, emphasis should therefore be placed on the importance of sensitivity at the expense of specificity in order to identify as many cases as possible where there is a risk of the fetus being small for gestational age.

Conclusion

Symphysis-fundus measurement may be an important method of identifying risk pregnancies. The predictive value is highest late in pregnancy, but this must be weighed against the clinical benefit of early identification. It is essential that healthcare personnel are aware of the test's limitations.

Aase Serine Devold Pay (born 1966)
senior adviser and midwife with a PhD in perinatal epidemiology.
The author has completed the ICMJE form and reports no conflicts of interest.

J. Frederik Frøen (born 1968)
medical doctor and research manager. He is group leader at the Center for Intervention Science for Maternal and Child Health (CISMAC).
The author has completed the ICMJE form and reports no conflicts of interest.

Anne Cathrine Staff (born 1962)
professor, research manager and senior consultant.
The author has completed the ICMJE form and reports no conflicts of interest.

Bo Jacobsson (born 1960)
professor, senior researcher and senior consultant.
The author has completed the ICMJE form and reports no conflicts of interest.

Håkon K. Gjessing (born 1965)
senior researcher and professor II.
The author has completed the ICMJE form and reports no conflicts of interest.

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