Thai Journal of Obstetrics and Gynaecology
December 2001, Vol. 13, pp. 197-206

OBSTETRICS

Standard Curve of Symphysial-Fundal Height Measurement and Pregnancy Characteristics In Pregnant Women at King Chulalongkorn Memorial Hospital

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ABSTRACT

Objective To determine the symphysial-fundal height across the gestational age and to investigate the relationship between maternal pregnancy characteristics and each symphysial-fundal height value.

Study design A prospective descriptive study (Crossectional Study)

Setting The Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology, King Chulalongkorn Memorial Hospital

Subjects 199 pregnant women attending the antenatal clinic at King Chulalongkorn Memorial Hospital between November 1, 1999 to June 30, 2001

Intervention A series of symphysial-fundal height measurements with ultrasound scan was done. Gestational age was confirmed by an ultrasound examination before 12 weeks gestation in every case. During 16-40 weeks, a series of symphysial-fundal height measurement with ultrasound was done. Pregnancy characteristics were recorded. The mean and standard deviations were then estimated and compared with other studies. A regression analysis by polynomial equation of second degree was applied to construct a graph of fundal height. Symphysial-fundal height measurements were analyzed by multivariate regression analysis in relation to pregnancy characteristics, and construct a graph to each characteristics.

Main outcome measurement The mean and standard deviation of symphysial-fundal height at each gestational age, the standard curve of symphysial-fundal height.

Result 879 measurements were done in 199 pregnant women. This allows the mean and standard deviation to be estimated. A chart of symphysial-fundal height across gestational age was also constructed with the median, 5th and 95th percentiles. The study suggests that gestational age was the most important determinant of the symphysial-fundal height, followed by the BMI. The other variables were not significantly correlated.

Conclusion A normative data of symphysial-fundal height was obtained from a Thai population. This could serve as a basis for follow up of fetal growth. However, the study also found that maternal characteristics have significant effects on the expected symphysial-fundal height. This suggests that individually adjusted fundal height charts may improve the precision of the clinical screening for fetal growth restriction.

Key words: symphysial-fundal height, gestational age, pre-pregnant BMI

Symphysial-fundal height measurements are routinely used in the clinical practice of obstetrics for estimating the gestation age and assessing the fetal growth over a long period of time.

McDonald[1] was the first to use the symphysial-fundal height measurement in order to estimate the duration of pregnancy in 1906. Several researchers have studied the predictive values of symphysial-fundal height. Westin,[2] Belizan,[3] Quaranta,[4] Calvert,[5] Jimenez,[6] Linasmita[7-9] and Praditstawong[10] recommended the clinical use of symphysial-fundal height to estimate the gestational age as well as to detect the growth retarded fetus. On the other hand Beazely,[11] as well as Lindhard[12] found the measurement of disappointing value in multiphysician setting.

Cnattigius,[13] Jensen,[14] Grover,[15] and Bogaert[16] used symphysial-fundal height for the prediction of altered fetal growth and the detection of any small change in the gestational age. Nonetheless, the authors suggested that the standard curve of symphysial-fundal height should be generated from the local population, as there are variability in the symphysial-fundal height curves across different population groups.

Most previous studies estimated the gestational age from menstrual date rather than sonographically determining the dates to derive the normal symphysial-fundal height curve and where these curves were constructed from longitudinal measurements. Only the studies from Mongelli[17] and Steingrimsdottir T[18] allowed for maternal characteristic

The aim of this study is to construct a chart of symphysial-fundal height from a Thai population and investigates the relationship of individual characteristics.

Subjects and Methods

Pregnant women were recruited from general antenatal clinic at King Chulalongkorn Memorial Hospital. Research protocol was approved by the hospital ethics committee. All subjects gave written consent. Only singleton pregnancies with certain LMP and gestational age less than 12 weeks were enrolled, ultrasonography examination was performed to confirm gestational age. Cases with LMP-ultrasound discrepancy more than 5 days were excluded. Women with medical disease or obstetrical complications were also excluded from the study. From 16 to 40 weeks gestation, subjects were examined by the investigator every 4 weeks. Most of the subjects had successfully participated in a series of examinations.

Subjects were examined in supine position after emptying bladder. Ultrasound examinations were performed to ensure emptied bladder, to determine fetal lie, adequate amniotic fluid and abnormality of the fetal growth. Symphysial-fundal height was then measured in centimeters with inch side of non elastic tape, the symphysial-fundal height was record to nearest 0.5 centimeter starting from the uterine fundus (the variable) to the symphysis pubis (the fixed point), in accordance with the method described by Westin.[2] Only one investigator was blinded to subject's gestational age. Only cases with normal birth weight (between 10th and 90th percentiles) was included for statistic analysis. All measurements were done by the principal investigator.

The data collected from the longitudinal measurement was used to calculate mean and standard deviation of the symphysial-fundal height for each gestational week. This forms the basis for comparison with other studies. For regression analysis, only one symphysial-fundal height measurement from each subject was chosen from a certain gestational week in a pseudo-random way as follows. First the latest useable measurement was chosen until enough data were gathered for 40th weeks, then the earliest possible measurement was used from 16th week and upward.[18] A regression analysis using a polynomial equation of second degree was then applied on the median, 5th and 95th percentiles to construct a graph of symphysial-fundal height. The effects of the pregnancy characteristics on symphysial-fundal height were evaluated using stepwise multiple regression analysis. The following variables were entered which, include the gestational

age, height, weight before booking, parity, body mass index, ideal body weight, and the sex of the infant. All statistical analysis was generated using statistical software from Microsoft Windows (SPSS for Windows, release 10.0).

Results

The population characteristics (Table 1) were typical of the women who visited our clinic.

Table 1. Population Characteristics

Characteristics	Results
Maternal age[year]	27.64 (5.01)
Range	15-39
Maternal height[cm.]	154.73(5.50)
Range	141-173
Weight at booking [kg.]	51.72(8.18)
range	35-79.5
BMI[kg/m^2]	21.17(3.11)
range	15-31
Parity(%)	
Nulliparous	38.7
Parous	61.3
Percent male(fetus)	55.3
Percent female(fetus)	44.7

Data are presented as mean, SD, range and Percentage

Table 2 shows the mean and standard deviation of symphysial-fundal height according to the week of progressive gestational age. There was an increase in the symphysial-fundal height as the pregnancy progressed. The largest increase was observed from week 16 to week 29, after which the rate of growth gradually decreased until week 39. The mean symphysial-fundal height and gestational age were plotted as shown in Figure 1.

Table 2. Mean and standard deviation of the symphysial-fundal height measurement in centimeter for each completed gestational weeks

Gestational age (weeks)	Mean	Number	Std. Deviation
15	14.43	7	1.13
16	15.89	28	1.47
17	17.00	38	1.27
18	18.09	32	1.42
19	19.00	21	1.34
20	20.12	43	1.71
21	20.93	40	1.47
22	21.91	33	1.55
23	22.94	36	1.64
24	24.18	39	1.67
25	25.26	42	1.62

Gestational age (weeks)	Mean	Number	Std. Deviation
26	26.03	38	1.44
27	27.23	39	1.66
28	28.73	33	1.44
29	29.75	36	1.57
30	30.10	40	1.75
31	30.83	35	1.71
32	32.03	33	1.69
33	32.97	32	1.86
34	33.33	36	1.62
35	34.79	39	1.38
36	35.75	32	1.34
37	36.63	40	1.44
38	36.86	35	1.54
39	37.39	33	1.88
40	36.94	19	1.95

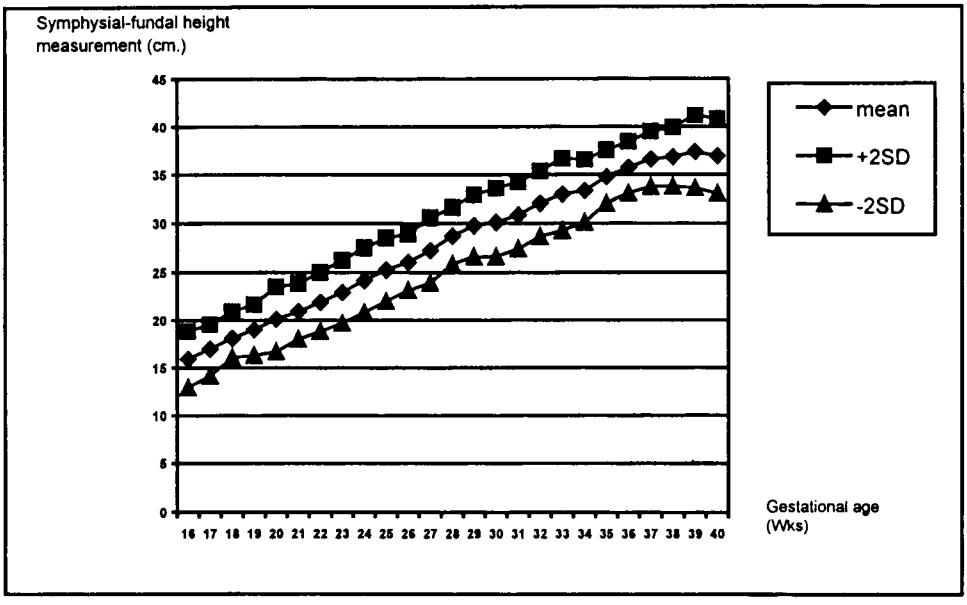

Fig. 1. Mean symphysial-fundal height measurement with + 2SD from 16-40 complete gestational weeks.

By regression analysis, quadratic equation fits best with the scatter plot, the equation was as follow.

Y=-7.7152+1.6365X-0.0124X2

(Y= symphysial-fundal height, X= gestational age)

SD=1.253x(0.642+0.02099xgestational age),

R square=0.947, P=0.000

Standard curve of symphysial-fundal height and gestational age for general pregnant women were constructed from median, 5th and 95th percentiles (Table 3. and Fig.2). Determinants of symphysial-fundal height with pregnancy characteristics (age, gestational age, pre-pregnant BMI, parity, sex of fetus) by stepwise multiple regression analysis, found that gestational age was the strongest predictor followed by pre-pregnant BMI. The other variables were not significantly correlated. The formula for calculation symphysial-fundal height as follow:

for pre-pregnant BMI < 20

symphysial-fundal height = $-8.6778+1.6875X-0.0138X^2$

for pre-pregnant $20 \leq BMI \leq 24$

symphysial-fundal height = $-6.8441+1.5707X-0.0112X^2$

for pre-pregnant BMI > 24

symphysial-fundal height = $-5.0796+1.5030X-0.0097X^2$

The fit of curve by quadratic regression and calculate median, 5th and 95th percentiles from standard error and standard deviation to construct each curve for each group of BMI

Fig.3, 4 and 5 show relationship of symphysial-fundal height and gestational age in each group of BMI for practical use

Table 3. Median, 5th and 95th percentiles of symphysial-fundal height in centimeters for each gestational age in weeks

Gestational age (weeks)	5th percentile (cm.)	50th percentile (cm.)	95th percentile (cm)
16	13.27	15.29	17.31
17	14.46	16.52	18.58
18	15.62	17.72	19.83
19	16.76	18.90	21.05
20	17.87	20.05	22.24
21	18.95	21.18	23.41
22	20.01	22.29	24.56
23	21.05	23.36	25.68
24	22.06	24.42	26.78
25	23.04	25.45	27.85
26	24.00	26.45	28.90
27	24.94	27.43	29.92
28	25.85	28.39	30.92
29	26.74	29.31	31.89
30	27.60	30.22	32.84
31	28.44	31.01	33.67
32	29.25	31.96	34.66
33	30.03	32.79	35.54
34	30.80	33.59	36.39
35	31.53	34.37	37.21
36	32.25	35.13	38.01
37	32.94	35.86	38.78
38	33.60	36.57	39.53
39	34.24	37.25	40.26
40	34.85	37.90	1.95

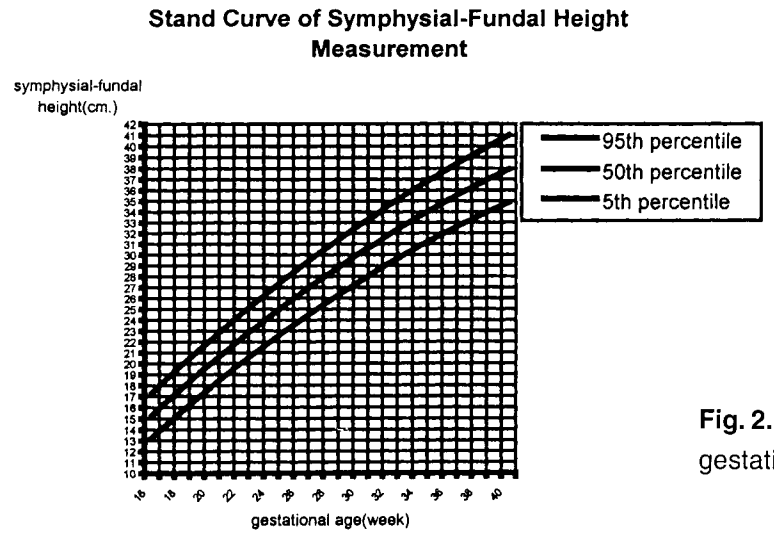

Fig. 2. Standard curve of symphysial-fundal height and gestational age fitted by a quadratic regression model.

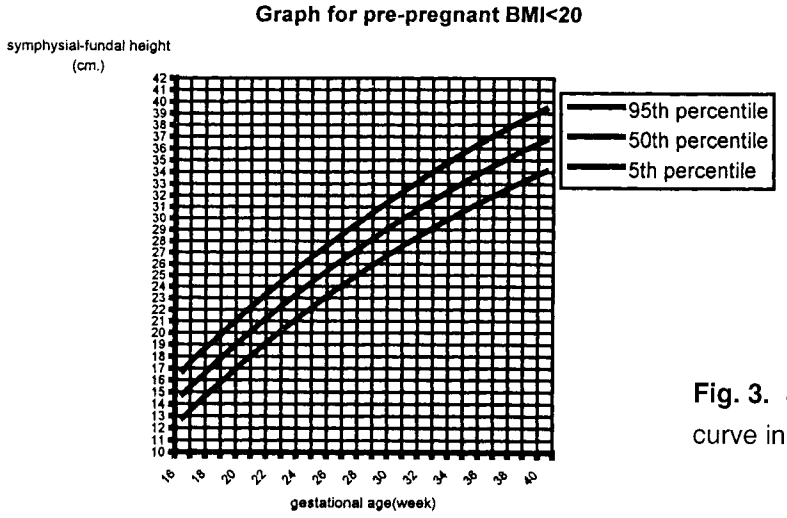

Fig. 3. Symphysial-fundal height and gestational age curve in women with pre-pregnant BMI < 20.

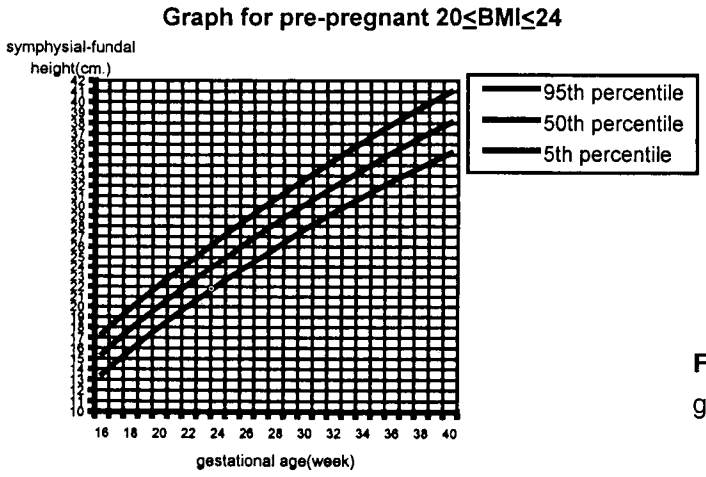

Fig. 4. Standard curve of symphysial-fundal height and gestational age fitted by a quadratic regression model.

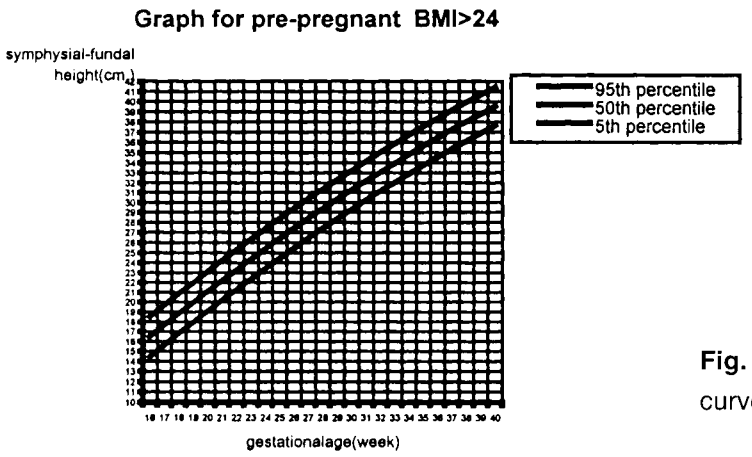

Fig. 5. Symphysial-fundal height and gestational age curve in women with pre-pregnant BMI < 20.

Discussion

This study presents a new symphysial-fundal height growth chart, which is the first based on ultrasound confirmed menstrual date in Thai population. To ensure accuracy, the bladder of the subject is emptied on every visit and the subject is also checked for the abnormality of the fetus and adequacy of the amniotic fluid. In addition, the longitudinal lie and the normality of the fetal weight during the gestational age were also validated by ultrasound before the final measurement of the symphysial-fundal height

Table 4. The comparison of standard symphysial-fundal height growth charts from various studies

	Mean symphysial-fundal height (cm.) gestational (weeks)					
Sources	**20**	**24**	**28**	**32**	**36**	**40**
Westin2, 1977, Sweden	18	22	26	29.5	33	35.5
Belinzan3 ,1978,The Argentine	18.5	22.5	26.5	30.5	33.5	34.5
Qaranta 4,1981,UK	20.2	24.1	28.1	31.8	34.7	36.3
Calvert 5,1982,UK	18.8	22.9	26.8	30.2	33.7	36.2
Jimenez6 ,1983	20.0	24.0	28.0	33.0	38.0	39.0
Linasmita 7 ,1984,Thailand	17.7	23.12	26.38	30.39	32.87	34.55
Praditstawong10 ,1987,Thailand	15.58	19	23.8	26.67	29.99	31.33
Mathai20 ,1987,India		21.5	24.5	27.5	31.5	33.5
Azziz21 , 1988, USA	20.5	24.6	28.3	32.8	36.5	39.8
Hakansson22 ,1995,Sweden	19	23	27	30.5	33.5	35.5
Steingrimsdottir 18,1995,Sweden	19	23.1	27.1	30.1	33.6	35.8
This study	20.11	24.18	28.72	32.03	35.75	36.94

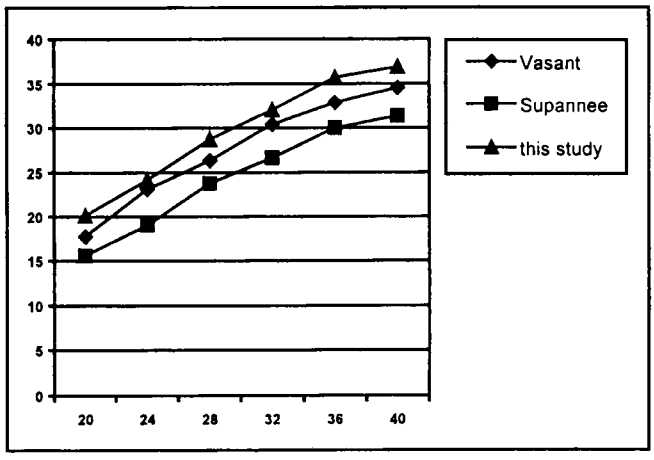

Fig. 6. Different studies of symphysial-fundal height in Thai people.

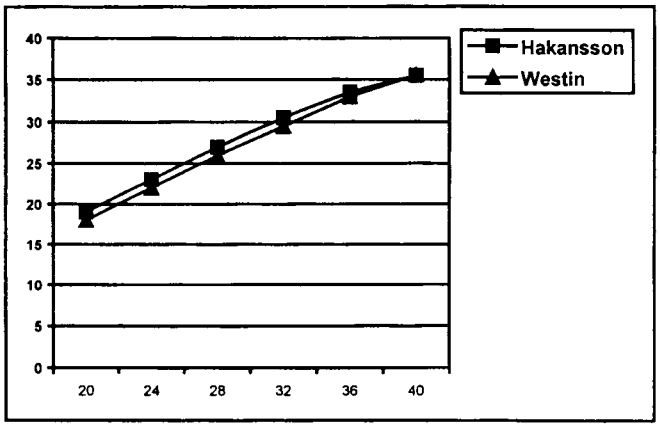

Fig. 7. Different studies of symphysial-fundal height in Swedish people.

Table 4 compares mean values of symphysial-fundal height curves with previous studies, Praditstawong's Thai curve[10] gives the lowest values while the American curve the highest.[21] When comparing symphysial-fundal height values from previous studies which used only menstrual date with studies with ultrasound- confirmed gestational age,[18,22,23] symphysial-fundal height from ultrasound-confirmed gestational age show a more linear curve and the weekly mean measurements were also higher than those of the menstrual date symphysial-fundal height curves (Fig.6,7). Ultrasound dating of pregnancies is, as compared to menstrual date, generally considered to increase the number of preterm infants and decrease the number of postterm infants,[24] mean ultrasound dating is lower than menstrual dating and symphysial-fundal height from ultrasound dating is higher than menstrual dating.

Most of the investigations have been based on longitudinal data.[1,2,4-15] One of the problems with using the longitudinal data solely for the study is that the number of measurements collected often differs from one week to another. This effects the normal range of the curve through pregnancy. The longitudinal data is dependent data that it can not be analyzed by regression. The only exception is in the Steingrimsdottir T[18] study, which is based on the stratified cross-sectional data where the measurements were taken from each subject for each pregnancy weeks.

In this study, each subject has been screened to ensure the normality of the weight gain and that there are no IUGR as well as no medical and obstetric complications. Additionally, the data used to construct the symphysial-fundal height curve has been randomly chosen a certain gestational age. Only one

measurement from each subject was used for regression analysis.

Formal measurement of symphysial-fundal height has been advocated[13] but also questioned as to usefulness.[12] Symphysial-fundal height measurement can be subject to considerable inter-observer variation[25] but in this study all measurements were done by an author and Intraclass Correlation Coefficient (ICC) from intra-observer equal to 0.99 which mean that there is no different in each measurement of gestational age.

While other studies showed that pregnancy characteristics such as maternal weight,[18] sex of fetus,[17] parity[17,26] and ethic group,[15] have significant influence on symphysial-fundal height, none of these studies construct a specific graph for each characteristic. In comparison, this study indicated that the pre-pregnant BMI was the most important pregnancy characteristic while the other variables did not appear to have significantly influence on symphysial-fundal height. This study is the first to integrate separate graphs from each group of pre-pregnant BMI for use in different group of women. For example, a women with pre-pregnant BMI 19 kg/m^2, the expected symphysial-fundal height at 28 weeks would be:

Symphysial-fundal height=-8.6778+1.6875x28-0.0138x(28)^2 =27.75 cm.

On the other hand, a woman with pre-pregnant BMI 25 kg/m^2, the expected symphysial -fundal height at 28 weeks would be:

Symphysial-fundal height=-5.0796+1.5030x28-0.0097x(28)^2 =29.40 cm.

Practically, use of separate graph for each pre-pregnant BMI group is easier than doing calculation in every antenatal visit.

There is recent evidence that individually adjusted symphysial-fundal height charts improve the antenatal detection of abnormal fetal growth while reducing unnecessary referral for further investigation,[27] and this study show separated graph from each group BMI for use each group of pregnancy in Thai population.

In conclusion, the study presented symphysial-fundal height curves constructed from the subjects who were recruited from King Chulalongkorn Memorial Hospital. Since factors such as the BMI, weight, height varies from one population to the other, it is recommended that use of separate symphysial-fundal height curve for each group may be beneficial for detection of abnormal fetal growth. Further study is needed for evaluation of the sensitivity, specificity and positive predictive value of a curve to predict the IUGR infant.

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