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British Journal of Obstetrics and Gynaecology
July 1995, Vol. 102, pp. 525–529

OBSTETRICS

Single pre-delivery symphysis–fundal height measurement as a predictor of birthweight and multiple pregnancy

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ABSTRACT

Objective To compare the value of different pre-delivery maternal indices for predicting birthweight, and to examine the usefulness of a single pre-delivery symphysis–fundal height measurement for the detection of low birthweight and twin pregnancy or macrosomia.

Design Symphysis–fundal height measurements were gathered from 1509 women who had both a singleton delivery and available data of pre-delivery weight, height and mid-upper arm circumference, and from 73 women who had a twin delivery.

Setting A district hospital in rural Tanzania.

Results Symphysis–fundal height, pre-delivery weight and mid-upper arm circumference, respectively, explain 41 %, 13 % and 4 % of the observed variation in birthweight. At a cut-off level of 30 cm for symphysis–fundal height, the detection rate for birthweight below 2500 g and 2000 g was 66 % and 68 %, respectively, and the false positive rate was 9 % and 14 %, respectively. At a cut-off level of 38 cm for symphysis–fundal height the detection rate for twin pregnancy or birthweight ⩾ 4000 g was 76 %, and the false positive rate was 4 %.

Conclusion Symphysis–fundal height was a better predictor of birthweight than maternal height, pre-delivery weight or mid-upper arm circumference. It seems justified to investigate the value of a simple tricoloured symphysis–fundal height measuring tape for use in antenatal care in developing countries at village level.

Tape measurement of symphysis–fundal height has been suggested as a screening test for the detection of fetal growth retardation, macrosomia and multiple pregnancy (Westin 1977; Belizan *et al.* 1978; Quaranta *et al.* 1981; Calvert *et al.* 1982; Cnattingius *et al.* 1984; Mathai *et al.* 1987; Pearce & Campbell 1987; Neilson *et al.* 1988). It is regarded as a simple, inexpensive and non-invasive procedure. Measures for the prediction of birthweight include symphysis–fundal height, maternal height, pre-pregnancy weight, weight gain and mid-upper arm circumference, but published studies have given conflicting results. Möller (1988) found the highest sensitivity and specificity for symphysis–fundal height and pregnancy weight gain, with mid-upper arm circumference as the least useful predictor. Lechtig (1988) concluded that: *arm circumference, independently of gestational age, had the same sensitivity and specificity as weight gain during pregnancy for gestational age*. He proposed the use of arm circumference with either uterine height or weight for height. In Tanzania, maternal height and weight are measured routinely in antenatal services, but not fundal height.

We therefore compared the value of different maternal anthropometric indices for predicting birthweight and examined the usefulness of a single, pre-delivery symphysis–fundal height measurement for the prediction of low birthweight and twin pregnancy or macrosomia without calculation of gestational age. This is useful since gestational age is often not known. Furthermore, if the screening tests proved useful, a simple tricoloured symphysis–fundal height measuring tape for use in

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antenatal care could be designed, similar to the mid-upper arm circumference tape for children younger than five years of age developed by Shakir (1974).

Subjects and methods

The study was performed at Sumve Hospital, the district hospital of Kwimba District in Mwanza Region of Northwestern Tanzania between July 1989 and December 1990. At the hospital, an integrated mother and child clinic with a daily average attendance of 45 women and 90 children was held.

Fundal heights were measured on arrival in the labour room when the membranes were still intact, using a non-elastic tape marked in centimetres. The women were asked to empty their bladder before the fundal height was measured lying supine with their head slightly raised. The measurement was taken from the superior rim of the pubic bone in the midline to the fetal pole at the top of the uterine fundus. Maternal height was measured erect without shoes against a measure on the wall, and maternal weight was measured to the nearest 0·1 kg on a beam balance–scale. Mid-upper arm circumference was measured to the nearest 0·1 cm with a measuring tape. The newborn was weighed to the nearest 10 g by a midwife with a beam balance scale, within half an hour after birth. Midwives were carefully instructed at the beginning of the study about all methods used, and their performance was supervised (by G. E. L. W.).

Statistical methods

The χ^2 test with Yate's correction was calculated for comparison of proportions. The Statistical Package for the Social Sciences (SPSS PC+) was used to measure correlation and to perform linear multiple regression. To assess the performance of the screening tests detection rate, false positive rate and odds of being affected, given a positive result, were calculated (Wald & Cuckle 1989).

Results

Of 2390 women who were delivered in the study period, 1509 had both a singleton delivery and complete data on symphysis–fundal height, maternal pre-delivery weight, mid-upper arm circumference and height. Furthermore, data were gathered from 73 women who had a twin delivery. Table 1 shows characteristics of the two study subgroups. Thirty-eight per cent of the women were sure of the date of their last menstrual period, 10 % had some idea, and 52 % did not know the date at all.

All maternal anthropometric indices in singleton deliveries were significantly correlated with birthweight and to each other, except height with symphysis–fundal height (Table 2). Linear regression analysis showed that symphysis–fundal height, pre-delivery weight, mid-upper arm circumference and maternal height explained, respectively, 41 %, 13 %, 4 % and 2 % of the observed variation in

Table 1. Characteristics of the two subgroups (singleton and twin deliveries) in the study population. Medians are shown for parity, number of children alive and education; means are shown for other characteristics, unless otherwise indicated. Ranges are given in brackets. MUAC = Mid-upper arm circumference.

	Study population			
	Singletons $n = 1509$		Twins $n = 73$	
Parity	2	(0–15)	4	(0–9)
No. of children alive	2	(0–13)	3	(0–9)
Education (years)	4	(0–16)	3	(0–12)
Age (years)	25·1	(14–49)	29·0	(17–45)
Primiparous (%)	26		7	
Height (cm)	159	(140–188)	159	(145–174)
Pre-delivery weight (kg)	59·6	(37·5–95·5)	64·1	(43·4–90·0)
MUAC (cm)	24·5	(16·0–33·8)	24·5	(18·5–30·2)
Fundal height (cm)	33·1	(20–45)	39·6	(29–48)
Birthweight (kg)	3·075	(1·00–4·65)	2·476	(1·05–3·34)
Perinatal mortality rate	49/1000		132/1000	

Table 2. The correlation between birthweight, symphysis–fundal height (SFH), maternal pre-delivery weight, mid-upper arm circumference (MUAC) and maternal height ($n = 1509$).

	Birthweight	SFH	Weight	MUAC	Height
Birthweight (g)	1·0	0·64*	0·36*	0·19*	0·13*
SFH (cm)		1·00	0·30*	0·21*	0·004
Maternal weight (kg)			1·00	0·71*	0·46*
Maternal MUAC (cm)				1·00	0·18*
Maternal height (cm)					1·00

* Correlation coefficient (r) significant at a level of $P < 0·001$.

Table 3. Stepwise multiple regression analysis with birthweight as the dependent variable and symphysis–fundal height (SFH), pre-delivery weight (PDW), and mid-upper arm circumference (MUAC) as independent variables ($n = 1509$). Significance of t-test = 0·00 for all variables. B = regression coefficient; SE B = standard error of coefficient B; β = standardised regression coefficient.

Model variables	B	SE B	β	t-test	r^2
SFH (cm)	109·92	3·38	0·64	32·546	0·41
PDW (kg)	22·14	1·50	0·36	14·755	0·13
Maternal height (cm)	9·83	2·00	0·13	4·917	0·02
Maternal MUAC (cm)	4·49	0·58	0·19	7·705	0·04
SFH + PDW					0·44
SFH (cm)	100·75	3·45	0·59	29·211	
PDW (kg)	11·21	1·26	0·18	8·924	
SFH + PDW + maternal MUAC					0·45
SFH (cm)	100·76	3·43	0·59	29·387	
Maternal weight (kg)	16·47	1·74	0·26	9·477	
Maternal MUAC (cm)	−2·73	0·63	−0·12	−4·353	

birthweight. A model including fundal height, pre-delivery weight and mid-upper arm circumference accounted for 45 % of the variation in birthweight (Table 3). Inspection of the residuals did not show any obvious nonlinear features. Table 4 shows the results obtained using the different maternal anthropometric indicators for prediction of low birthweight in this study group; cut-off levels were chosen to include arbitrarily the (approximately) lower 20 % of women. The detection rate for symphysis–fundal height (26 %) was two to three times greater than that for the other three variables (range 29–37 %). The same trend was noted for the odds of being affected, given a positive result (1:1·2 for symphysis–fundal height and 1:4·2 to 6·1 for the other variables).

Detection rate, false positive rate, the odds of a positive result and their 95 % confidence intervals (CI) for different cut-off points of symphysis–fundal height are presented in Table 5 (singleton deliveries, screening for infants weighing less than 2500 g and less than 2000 g) and Table 6 (for twin deliveries or infants weighing 4000 g or more). At a cut-off level of 30 cm for symphysis–fundal height, the detection rate for birthweight less than 2500 g was 65·6 % (95 % CI 58·2–73·0), and the false positive rate was 9·4 % (95 % CI 7·8–11·0). For the prediction of twin pregnancy or a birthweight of 4000 g or more, the detection rates were reasonably high and false positive rates were acceptably low; for example, at a cut-off level of 38 cm for symphysis–fundal height the false positive rate was only 4·2 % (95 % CI 3·2–5·2), and the detection rate was 75·7 % (95 % CI 67·6–83·8) (Table 6).

A pre-delivery fundal height of 30 cm or less was a highly significant predictor of perinatal mortality (Table 7) and carried a relative risk of 2·65 (95 % CI 1·70–4·13). The increase in perinatal mortality in women with a symphysis–fundal height of 38 cm or more is due to a high number of twin deliveries in this group. Fifty-six of the 73

Table 4. Assessment of the performance of anthropometric screening tests for a low infant birthweight (< 2500 g; prevalence 10·4 %). The cut-off point for each variable was chosen so to include approximately the lower 20 % of the mothers ($n = 1509$). 95 % Confidence intervals in brackets. SFH = symphysis–fundal height; MUAC = mid-upper arm circumference; FPR = false positive rate; PDW = pre-delivery weight; DR = detection rate; OAPR = odds of being affected, given a positive result.

	SFH	PDW	MUAC	Height
Cut-off level	⩽ 30 cm	⩽ 53·1 kg	⩽ 22·9 cm	⩽ 153 cm
At risk (%)	15·2 (13·4–17·1)	19·9 (17·9–21·9)	20·5 (18·4–22·5)	21·2 (19·1–23·3)
DR (%)	65·6 (58·2–73·0)	36·9 (29·4–44·5)	29·3 (22·2–36·4)	28·7 (21·6–35·7)
FPR (%)	9·4 (7·8–11·0)	17·9 (15·9–19·9)	19·5 (17·3–21·6)	20·3 (18·2–22·5)
OAPR	1:1·2 (0·9–1·6)	1:4·2 (3·2–5·7)	1:5·7 (4·3–8·2)	1:6·1 (4·6–8·8)

Table 5. Performance of symphysis–fundal height (SFH) measurements in prediction of a birthweight < 2500 g (prevalence 10·4 %) and < 2000 g (prevalence 1·7 %) in singleton deliveries ($n = 1509$). 95 % Confidence intervals in brackets. DR = detection rate; FPR = false positive rate; OAPR = odds of being affected, given a positive result; % at risk = the percentage of women having a positive test result.

SFH performance	DR (%)	FPR (%)	OAPR	% at risk
Birthweight < 2500 g				
⩽ 29 cm	48·4 (40·6–56·2)	3·3 (2·3–4·2)	1·7:1 (1·2–2·6)	8·0 (6·6–9·3)
⩽ 30 cm	65·6 (58·2–73·0)	9·4 (7·8–11·0)	1:1·2 (1·0–1·6)	15·2 (13·4–17·1)
⩽ 31 cm	72·0 (65·0–79·0)	19·7 (17·6–21·8)	1:2·4 (1·9–3·0)	25·1 (22·9–27·3)
Birthweight < 2000 g				
⩽ 28 cm	56·0 (36·5–75·5)	4·0 (3·0–5·0)	1:4·2 (2·5–8·9)	4·8 (3·8–5·9)
⩽ 29 cm	64·0 (45·2–82·8)	7·0 (5·7–8·3)	1:6·5 (4·2–12·8)	8·0 (6·6–9·3)
⩽ 30 cm	68·0 (49·7–86·3)	14·4 (12·6–16·1)	1:12·5 (8·3–23·9)	15·2 (13·4–17·1)

Table 6. Performance of symphysis–fundal height (SFH) measurements in prediction of twin pregnancy (prevalence 4·6%) or a birthweight of ⩾ 4000 g (prevalence 2·1%) ($n = 1582$). 95% Confidence intervals in brackets. DR = detection rate; FPR = false positive rate; OAPR = odds of being affected given a positive result. % at risk = the percentage of women having a positive test result.

SFH performance	DR (%)	FPR (%)	OAPR	% at risk
⩾ 37 cm	83·2 (76·1–90·3)	8·1 (6·7–9·6)	1 : 1·3 (1·0–1·8)	13·2 (11·5–14·8)
⩾ 38 cm	75·7 (67·6–83·8)	4·2 (3·2–5·2)	1·3 : 1 (0·9–1·8)	9·0 (7·6–10·5)
⩾ 39 cm	58·9 (49·6–68·2)	1·6 (0·9–2·2)	2·7 : 1 (1·8–4·8)	5·4 (4·3–6·6)

Table 7. Pre-delivery symphysis–fundal height (SFH) and perinatal mortality rate (PMR) ($n = 1655$). 95% Confidence intervals (CI) in brackets. RR = relative risk.

SFH	*n*	%	PMR (95% CI)	RR (95% CI)	*P*
⩽ 30	238	14·4	113·4 (73·2–153·7)	2·65 (1·70–4·13)	< 0·001
31–37	1215	73·4	42·8 (31·4–54·2)	1·00	
⩾ 38	202	12·2	69·3 (34·3–104·3)	1·62 (0·92–2·87)	0·098
TOTAL	1655	100·0	56·2 (45·1–67·3)		

twin deliveries (77%) had a pre-delivery fundal height of 38 cm or more, and in this group there were 10 perinatal deaths.

Discussion

In this northwestern part of Tanzania, symphysis–fundal height was a better predictor of birthweight than maternal height, pre-delivery weight or mid-upper arm circumference. The overall results were better than those from central Tanzania (Möller 1988). One explanation could be the motivation, training and regular surveillance of the health workers involved.

Detection rate, false positive rate and the odds of being affected, given a positive result in this study of single pre-delivery symphysis–fundal height measurements in detecting low birthweight and macrosomia or twin pregnancy are comparable to results from serial measurements for the detection of fetal growth retardation, macrosomia and multiple pregnancy (Westin 1977; Belizan *et al.* 1978; Quaranta *et al.* 1981; Calvert *et al.* 1982; Rosenberg *et al.* 1982; Cnattingius *et al.* 1984; Mathai *et al.* 1987; Neilson *et al.* 1988). Also, in agreement with other symphysis–fundal height measurement studies, we obtained good results on false positive rates and relatively moderate test performances for detection rates and the odds of being affected, given a positive result. Alternative approaches are limited. A comparison of serial measurements of symphysis–fundal height with a single measurement of fetal abdominal circumference by ultrasound (often not available in developing countries) in the third trimester for the prediction of fetal growth retardation (Pearce & Campbell 1987) showed a slightly higher detection rate: having set the false positive rate to be equal at 21%, the detection rates for ultrasound and symphysis–fundal height measurements were 83% and 76%, respectively, and the odds of being affected, given a positive result in both tests was approximately 1:2. When, as in our study, the aim is to detect infants weighing less than 2000 g, a level at which hospitals in developing countries often admit newborns for specialised neonatal care (Singh *et al.* 1988), the detection rate is slightly greater. However, due to the lower prevalence of newborns weighing less than 2000 g, the odds of being affected, given a positive result is reduced.

A simple symphysis–fundal height measuring tape, similar to the mid-upper arm circumference tape developed by Shakir (1974) for children younger than five years, could be designed for use in antenatal care. Based on the results of this study, we propose a tape which has a red range of 38 cm or more, a green range of between 30 and 38 cm, and a yellow range of 30 cm or less. The red range indicates an infant weighing 4000 g or more, with increased risk to both mother and infant due to dystocia, or a twin delivery. If a woman says she is nine months pregnant or comes in with labour pains and has a fundal height in the yellow range (⩽ 30 cm), a health worker should be aware that the infant may be small, for whatever reason. As female village health workers are already measuring mid-upper arm circumference in toddlers, using Shakir's tricoloured tape, they should be able to measure fundal height and refer women to hospital for further assessment.

Gerein (1988) argued: *that the potential of growth monitoring will not be realised unless attention is paid to pre-eminent issues of planning, training, resources, supervision, management and evaluation in child health services.* These issues, and assessment of intra- and inter-observer variation need similar evaluation before introducing the proposed symphysis–fundal height tape.

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Received 7 September 1994
Accepted 25 January 1995