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ORIGINAL ARTICLE

## Evaluation of maternal serum levels of dehydroepiandrosterone sulphate and its association with successful labour outcome among parturients undergoing spontaneous labour at term

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### ABSTRACT

This study evaluated maternal serum levels of dehydroepiandrosterone sulphate (DHEAS) in spontaneous labour and its association with successful labour at term. A cross-sectional observational study was carried out on 140 parturients. Their blood samples were collected in active labour; allowed to clot, centrifuged, separated and stored at  $-20^{\circ}\text{C}$  before analysis for DHEAS was done using the ELISA method. Labour was termed successful when vaginal delivery was achieved. Serum DHEAS levels were higher among parturients with successful labour compared to women with unsuccessful outcome ( $p = 0.001$ ). DHEAS level was also higher among parturients who did not require oxytocin augmentation compared with those who required it ( $p = .001$ ). The odds ratio and incidence of successful labour increased significantly as DHEAS level increased above a critical value of  $1.5\ \mu\text{g/ml}$  ( $p = .001$ ). The association between serum DHEAS level and successful labour remained significant after adjusting for other variables ( $p = .002$ ).

### KEYWORDS

Dehydroepiandrosterone sulphate; spontaneous labour; labour outcome; parturients; pregnant women; term

### Introduction

A multitude of biochemical substances have been observed to interact in the control of the human birth process (Calder 2007). The foetus, placenta, and maternal activity contribute to this biochemical activity during pregnancy and parturition (Kepkep et al. 2005). One such biochemical substance that is key to the process of successful parturition in humans is DHEAS (Procianoy and Cecin 1985; Hercz et al. 1990; Mazor et al. 1996; Mecenas et al. 1996). Dehydroepiandrosterone 3-sulphate is a weak androgenic steroid produced by the adrenal cortices of both the pregnant woman and the foetus (Maciulla et al. 1998), and this is converted to oestrogen in the human placenta (Oh et al. 2006).

It is believed that the concentration of DHEAS at critical levels trigger the process of cervical ripening, onset of labour and eventually cervical dilatation (Imai et al. 1992; Ajayi 1993). Several studies have been carried out to investigate the effect of exogenous administration of DHEAS on pregnant women, and majority reported successful induction of cervical ripening and labour (Procianoy and Cecin 1985; Maciulla et al. 1998; Kumagai et al. 2000).

Similarly, the endogenous concentration of DHEAS in the maternal serum, human umbilical cord plasma and human uterine cervixes has been found to increase significantly in late pregnancy and at the onset of labour, indicating that DHEAS is concerned directly or indirectly with labour process and labour outcome (Imai et al. 1992; Ajayi 1993; Oh et al. 2006). This means that the level of endogenous DHEAS in

maternal serum during labour may influence the outcome of labour.

Unfortunately, studies done to investigate the influence of endogenous maternal serum DHEAS levels upon the outcome of spontaneous labour or induction of labour are very few (Goolsby et al. 1996; Doganay et al. 2004) and a search of the literature does not reveal any studies that have been done among black African parturients.

The aim of this study was to evaluate the maternal serum levels of endogenous DHEAS among Nigerian parturients undergoing spontaneous labour at term and to determine its association with the success of such labour.

### Materials and methods

This was an observational cross-sectional study conducted at the labour ward complex of the Lagos University Teaching Hospital [LUTH], Lagos, Nigeria, after obtaining institutional ethical approval between 1 January 2012 and 31 March 2012.

Parturients admitted into the labour ward between gestational age 37 and 42 weeks scheduled for vaginal delivery, who spontaneously progressed to active phase of labour (cervical dilatation  $\geq 4\text{ cm}$ ) and who gave informed written consent were recruited into the study. The study was limited to term parturients and women in the active phase of labour.

Exclusion criteria included the presence of hypertension, diabetes, intrauterine growth restriction and abnormal pelvic anatomy, such as previous pelvic fracture and contracted

pelvis. Others are presence of multiple gestation, previous caesarean section, chorioamnionitis and history of smoking. Those who delivered macrosomic babies (birth weight  $\geq 4.0$  kg) were also excluded. Women who were uncertain about their last menstrual period and who did not have an early ultrasound scan were excluded from the study.

A total of 140 consecutive parturients who met the inclusion criteria participated in the study. Using a proforma, information on the socio-demographic data, obstetric, medical and drug histories were obtained. Bishop score, duration of active phase of labour, rate of cervical dilatation, the use, indication and dose of oxytocin infusion were noted. Foetal birth weight was also noted. Labour was termed successful when the parturient achieved vaginal delivery.

Approximately ten millilitres of venous blood was collected from the antecubital vein into plain vacutainer bottles as soon as spontaneous progression into active phase of labour was observed and allowed to clot. The bottle was centrifuged at room temperature, the serum separated and stored at  $-20^{\circ}\text{C}$  until analysis was done at the prenatal diagnosis and therapy centre laboratory, College of Medicine, University of Lagos, Idi-araba, Lagos. DHEAS level was measured using the enzyme-linked immunosorbent assay [ELISA] technique according to the manufacturer's instruction.

Statistical analysis was done using Epi-info 3.5.4 version (Atlanta, GA). Categorical variables were compared with the chi-square test and the Fisher exact test as appropriate, while continuous variable were compared using Students' *t*-test. Linear and multiple regressions were used to analyse the associations between maternal serum DHEAS levels and success of labour. A *p* value of  $< .05$  was considered significant.

## Results

The mean age of the participants was  $30.45 \pm 4.34$  years (range 19–42 years), mean parity was  $1.04 \pm 1.01$  (range 0–6) and mean gestational age was  $39.34 \pm 1.02$  weeks (range 37–41 weeks).

One hundred and twenty (85.7%) parturients had successful vaginal delivery, i.e. successful labour outcome, while 20 {14.3%} had caesarean delivery, i.e. unsuccessful labour outcome. The mean cervical dilation at presentation, Bishop Score, rate of cervical dilatation and DHEAS level were  $3.22 \pm 1.05$  cm,  $7.59 \pm 1.73$ ,  $1.51 \pm 1.27$  cm/hour, and  $1.57 \pm 0.91$   $\mu\text{g/ml}$ , respectively. The rate of cervical dilation, Bishop Score and DHEAS levels were significantly higher among women who had successful labour outcome compared with women who had unsuccessful labour outcome ( $p = .001$ ,  $.04$  and  $.001$ , respectively) (Table 1).

A linear relationship with significant positive correlation was observed between DHEAS level and the rate of cervical dilatation among parturients with successful labour outcome ( $r = +.63$ ,  $p = .005$ ). Likewise, a statistically significant association with positive correlation was observed between Bishop Score and maternal DHEAS level ( $r = +.69$ ,  $p = .010$ ). On the other hand, a reversed linear relationship with negative correlation was observed between the DHEAS level and duration of active phase of labour in parturients with successful labour outcome ( $r = -.51$ ,  $p = .04$ ).

Among the 120 parturients who had successful labour outcome, maternal DHEAS levels were significantly higher in women (36) without oxytocin augmentation compared with women (84) who had oxytocin augmentation ( $2.44 \pm 0.80$   $\mu\text{g/ml}$  versus  $1.28 \pm 0.91$   $\mu\text{g/ml}$ , respectively,  $p = .001$ ). The occurrence of successful labour outcome was significantly higher among parturients who did not require oxytocin augmentation ( $p = .030$ ).

Maternal age, parity and gestational age did not influence the DHEAS level in parturients with successful labour outcome ( $p = .120$ ,  $.950$  and  $.440$ , respectively) and unsuccessful labour outcome ( $p = .250$ ,  $.880$  and  $.670$ , respectively).

The association between the level of maternal DHEAS and incidence of successful labour outcome is shown in Table 2. Parturients with DHEAS level  $> 1.5$   $\mu\text{g/ml}$  were 7 times more likely to have successful labour than parturients with DHEAS level  $\leq 1.5$   $\mu\text{g/ml}$  (OR = 7.32, CI = 1.32–8.44 and  $p = .001$ ). At this threshold level, serum DHEAS significantly predicts successful spontaneous labour with a sensitivity of 84.17% and specificity of 80.00%.

The association between maternal DHEAS levels and successful labour outcome remained significant ( $p = .002$ ) after adjusting for Bishop score, rate of cervical dilation, duration of active labour, birth weight, parity and gestational age using multiple logistic regression (Table 3).

**Table 1.** Comparison of labour characteristics and outcome among parturients with successful and unsuccessful labour outcome.

Variables	Successful labour outcome (n = 120)	Unsuccessful labour outcome (n = 20)	<i>p</i> Value
Mean cervical dilatation at presentation (cm).	$3.26 \pm 1.07$	$3.00 \pm 0.92$	.308
Mean rate of cervical dilatation (cm/hour)	$2.43 \pm 0.76$	$0.95 \pm 0.41$	.001
Mean Bishop score	$7.59 \pm 1.79$	$6.55 \pm 1.28$	.040
Mean duration of active labour (hours)	$6.37 \pm 1.76$	$7.30 \pm 1.75$	.594
Mean foetal birth weight (kg)	$3.31 \pm 0.35$	$3.36 \pm 0.31$	.505
Apgar at 1 min	$9.25 \pm 0.17$	$8.70 \pm 0.42$	.060
5 min	$9.87 \pm 0.01$	$9.72 \pm 0.07$	.642
Mean DHEAS level ( $\mu\text{g/ml}$ )	$1.79 \pm 0.92$	$0.61 \pm 0.61$	.001
(Range)	1.00 – 3.30	0.30 – 1.21	
Mean gestational age (weeks)	$39.10 \pm 1.15$	$39.60 \pm 1.15$	.080
Mean parity	$1.10 \pm 1.02$	$1.17 \pm 1.00$	.940
(Range)	0 – 6	0 – 5	
Maternal age (years)	$30.60 \pm 3.95$	$30.25 \pm 4.02$	.840

**Table 2.** Association between maternal serum DHEAS levels and incidence of successful labour outcome.

DHEAS Level ( $\mu\text{g/ml}$ )	Incidence of successful labour outcome (n = 140)	Odds Ratio	95% Confidence interval	<i>p</i> Value
	Rate (%)			
$\leq 1.0$	2/11 (18.18%)	4.80	0.44–10.21	.099
$> 1.0$	118/129 (91.47%)			
$\leq 1.5$	19/35 (54.29%)	7.32	1.32–8.44	.001
$> 1.5$	101/105 (96.19%)			
$\leq 2.0$	71/91 (78.02%)	10.78	2.88–9.43	.001
$> 2.0$	49/49 (100.00%)			
$\leq 2.5$	112/132 (84.85%)	14.35	2.75–9.88	.001
$> 2.5$	8/8 (100.00%)			

**Table 3.** Multiple logistic regression showing the relationship between adjusted variables and successful labour outcome.

Variables	Regression coefficient ( $\beta$ )	Odds ratio	<i>p</i> Value
DHEAS	1.94	18.60	.002
Bishop score	0.12	2.34	.010
Rate of cervical dilatation	0.53	1.04	.054
Duration of active labour	-0.41	0.35	.162
Birth weight	0.62	1.8	.056
Parity	0.16	0.127	.680
Gestational age	0.36	0.72	.720

## Discussion

DHEAS has been shown to play a vital role in the process of cervical ripening, induction of labour and labour outcome when administered exogenously to pregnant women (Procianoy and Cecin 1985; Goolsby et al. 1996; Rechberger et al. 1996; Maciulla et al. 1998; Kumagai et al. 2000; Doganay et al. 2004). Similarly, some studies though limited have shown that endogenous maternal serum level of DHEAS may influence the process and outcome of spontaneous or induced labour (Goolsby et al. 1996; Doganay et al. 2004). In this study, attempts were made to contribute to the existing body of knowledge by providing scientific evidence from black African parturients undergoing spontaneous labour on this subject matter.

Although maternal age and parity were noted to contribute to the variation in the outcome of labour process and DHEAS levels in some studies (Musey et al. 1987a, 1987b), however, this was not the case in our study. Parity, maternal age and gestational age did not significantly influence the labour outcome, neither did they significantly influence the maternal serum level of DHEAS. This may be due to the fact that there was no significant difference observed in parity, maternal age and gestational age between parturients who had successful and unsuccessful labour outcomes. Similar observations were made in some other studies (Maciulla et al. 1998; Doganay et al. 2004).

In this study, DHEAS was found to be significantly higher among the women who had successful labour outcome. This may be due to a possible association between the DHEAS level and successful labour outcome. Apart from the DHEAS level, other variables and indicators of labour outcome such as the rate of cervical dilatation and Bishop Score were also significantly associated with successful labour outcome. The higher the rate of cervical dilatation and Bishop score, the higher the occurrence of a successful labour outcome. On the other hand, though the duration of active labour was lower among parturients with successful labour, it was not statistically significant. These findings were comparable with findings in other studies (Maciulla et al. 1998; Modarres et al. 2001; Doganay et al. 2004).

These findings may possibly suggest an association between DHEAS levels and other indicators of successful labour outcome observed in the study. Interestingly, this suspicion was confirmed with further statistical analyses.

A linear relationship with significant positive correlation was observed between maternal serum DHEAS level and the rate of cervical dilatation among women with successful labour outcome. This relationship suggests that the rate of cervical dilatation increases as the maternal serum DHEAS

level increases. This is in keeping with the assertion that DHEAS significantly increases the collagenolytic activity in the uterine cervix leading to rapid cervical ripening and cervical dilatation (Mochizuki and Tojo 1980; Imai et al. 1992; Maciulla et al. 1998).

Regarding Bishop Score, a linear relationship with significant positive correlation was also observed. The higher the Bishop Score in parturients undergoing spontaneous labour, the higher the maternal serum DHEAS levels. Several studies have confirmed this relationship in both spontaneous and induced labour (Liapis et al. 1993; Goolsby et al. 1996; Doganay et al. 2004). However, a contrary finding of no significant correlation was found in a study by Modarres et al. (2001).

The study showed that the need for oxytocin augmentation of labour was significantly influenced by the maternal serum DHEAS level, which subsequently influenced the labour outcome. Parturients that progressed without the need for oxytocin augmentation had higher DHEAS values compared with those who had oxytocin augmentation. Similar results were observed in other studies (Goolsby et al. 1996; Doganay et al. 2004). Furthermore, the incidence of successful labour outcome was significantly higher among parturients who did not require oxytocin augmentation. These findings suggest that high DHEAS level could be an indicator for efficient labour process, just as the use of oxytocin may indicate less efficient labour process. This was comparable to findings in another study (Goolsby et al. 1996).

Similar to other studies (Goolsby et al. 1996; Maciulla et al. 1998; Modarres et al. 2001; Doganay et al. 2004), this study showed that the maternal serum DHEAS levels were significantly higher in women with successful labour outcome than those with unsuccessful outcome. This observation cut across ethnicity or racial differences, as these studies were carried out in countries with parturients of different ethnicities. However, differences were observed in maternal serum DHEAS levels among these parturients compared to the African parturients in our study. The mean maternal serum DHEAS level among parturients who progressed spontaneously without oxytocin augmentation was higher among African parturients in our study ( $2.44 \pm 0.80 \mu\text{g/ml}$ ) compared to the level among parturients in USA ( $1.35 \pm 0.12 \mu\text{g/ml}$ ) (Goolsby et al. 1996). On the other hand, the mean maternal serum DHEAS level among parturients who had spontaneous labour was lower among the African parturients in our study ( $1.57 \pm 0.91 \mu\text{g/ml}$ ) compared to the level among parturients in Turkey ( $3.04 \pm 1.1 \mu\text{g/ml}$ ) (Doganay et al. 2004). However, the mode of DHEAS assay in our study was different from that used in these other studies. Radioimmunoassay (RIA) technique was used in the other studies, while ELISA technique was used in our study.

The study further showed that a threshold level of maternal serum DHEAS  $>1.5 \mu\text{g/ml}$  is associated with successful labour outcome. The higher the DHEAS level is above  $1.5 \mu\text{g/ml}$ , the higher the chances of successful labour outcome to the extent that all parturients with DHEAS level  $>2.0 \mu\text{g/ml}$  had successful labour outcomes. This association between maternal DHEAS level and successful labour outcome

remained statistically significant ( $p = .002$ ) after adjusting for Bishop score, rate of cervical dilatation, duration of active phase of labour, birth weight, parity and gestational age through multiple logistic regression. This shows that maternal serum DHEAS level is an independent factor that significantly influences successful labour outcome.

### Disclosure statement

The authors report no declarations of interest.

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