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Full Length Research paper

The correlation of pre-pregnancy body surface area and the rate of cervical dilation in term nulliparous women

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The objective of this study is to examine the correlation of maternal body surface area with cervical dilation in nulliparous women at term. Data from nulliparous women with a term pregnancy referred to Al-Zahra Maternity Hospital in Rasht were collected from November 2008 - May 2009. Inclusion criteria were: singleton pregnancy, nulliparity, estimated fetal weight of less than 4000 g, gestational age of 37 - 41 weeks, pre-pregnancy BMI of less than 30 kg/m², no history of medical disorders, no probable CPD, contractions of at least 3/10 min of more than 45 s duration, Bishop score of more than 10, vertex presentation, occiput anterior position and at least two dilation measurements on vaginal examinations by one person within one hour. Results showed that cervical dilation had a positive correlation with body surface area (r = 0.21, p < 0.012). It is concluded that maternal pre-pregnancy body surface area was independently affecting labor duration in the subjects studied.

Key words: Maternal pre pregnancy body surface area, active phase, rate of cervical dilation, duration of labor, body mass index, Rohrer index.

INTRODUCTION

Initially, labor duration was defined on a retrospective basis until Friedman introduced a sigmoid pattern of cervical dilation through time in 1955. He stated the mean duration of labor for nulliparas to be 4.9 with a wide standard deviation of 3.4. The rate of cervical dilation was 1.2 - 6.8 cm/h (Freidman, 1955). Later he proposed another curve for multiparas (Freidman, 1956). WHO proposed a partograph (1988) which was based on several assumptions: active phase of labor begins at 3 cm dilation, it should not pass 8 h (rate of less than 1 cm/h), and there is no different pattern of cervical dilation between nulliparous and multiparous women (WHO, 1988).

Literature review defines several variables affecting labor duration. List of variable characteristics that can predict a favorable labor course is as follows.

1.) Multiparity (Vaharatian et al., 2006),
2.) Term gestational age (Neshiem, 1988),
3.) Singleton pregnancies (Cunningham et al., 2007),
4.) Vertex presentation (Cunningham et al., 2007),
5.) OA position (Randhawa et al., 1991),
6.) High Bishop Score (Turner et al., 1990),
7.) Less fetal weight (Eogan et al., 2003),
8.) Female fetal sex (Eogan et al. 2003),
9.) Drugs used like oxytocin or atropine or promethazin (Fallahian, 1992),
10.) Interventions like amniotomy (Wetrich, 1970),
11.) Time of labor between 8 am till 12 MN (Circadian effect) (Backe, 1991),
12.) Appropriate maternal pre pregnancy height, weight (BMI < 25) (Leddy et al. 2008),
13.) Maternal age < 35 years old (Jonas, 1986)and(Kweon, 1998),
14.) Favorable weight gain in pregnancy (Soltani, 1993),
15.) Low risk lifestyle based on Framingham lifestyle questionnaire (Soltani, 2006),

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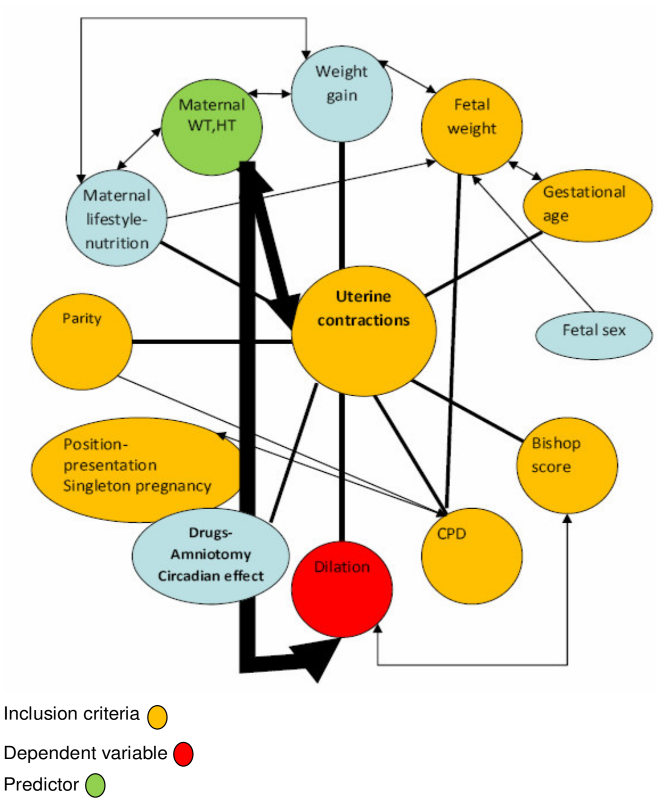

Figure 1. Variable Chart - Is maternal BSA independently correlated with cervical dilation? Or it is effective by uterine contractions?

16.) Nutrition (Konje and Ladipo, 2000),
17.) High maternal Mid Arm Circumference (Tabbakh and Said, 2006).

Variable chart (Figure 1) summarizes the complex pattern of relationship among variables involved in studies on labor duration.

The rationale for the investigation is to better define an adjustable variable to reach a favorable labor progress. The idea of relating maternal height and weight with labor progression stems from Kramer's studies on the impact of obesity on pregnancy outcome. In his article's conclusion part, it is emphasized that a low BMI does not necessarily reflect good health especially in the context of a developing country where a low BMI is more likely to result from malnutrition (Cnattingius et al., 1998). Considering variable chart (Figure 1), the question of this research is how mother's anthropometric characteristics can explain labor course. BMI, Rohrer's index and body surface area are based on four basic blocks of anthropometry (age, sex. weight and height). They are noninvasive way of determining and predicting function, health and survival of individuals. Rohrer's index is a modified form of BMI, dividing weight by height cubed (rather than squared). The cubed form produces tighter maximum and minimum levels for standard combinations of height and weight, making it less age dependent (Cojill, 2001). Body Surface area, according to Mosteller is the square root of product of the weight in kg times the height in cm divided by 3600. The "normal" BSA is generally taken to be 1.7 m^2 but, in actual fact, the BSA depends on more than just height and weight. Other influential factors include the age and gender of the individual. For example:

Average BSA for adult men: 1.9 m2
Average BSA for adult women: 1.6 m2
Average BSA for children (9 years): 1.07 m2
Average BSA for children (10 years): 1.14 m2
Average BSA for children (12-13 years): 1.33 m2

BSA is used for the calculation of Glomerular Filtration Rate (GFR) and cardiac index. Drugs (like Glucocorticoid and MTX) are often dosed according to the patient's BSA (Mosteller, 1987). BSA is also claimed to be correlated with fetal birth weight (Desai et al., 2004) and associated with higher oxytocin dosage in women undergoing induction of labor (Satin et al., 1992).

MATERIALS AND METHODS

This observational study was conducted to examine the correlation of maternal pre-pregnancy body surface area (predictor variable) with rate of cervical dilation (dependent variable). An approval was obtained from the Institutional Review Board of the Guilan University of Medical Sciences- OB-GYN Department.

Of the total of 1021 referrals to Al-Zahra Maternity Hospital from November 2008 - May 2009, 577 were primigravidas of whom 123 women met the inclusion criteria, which are nulliparity, Bishop score of 10 on admission, no prediction of CPD, estimated fetal weight of less than 4000, singleton pregnancy, gestational age (beginning of 37 to the end of 41 weeks gestation), uterine contractions of at least 3/10 min of more than 45 s duration.

Three women were excluded before the second vaginal exam could be done within an hour because of C/S due to fetal distress. One subject was excluded because of OP position and one subject was excluded because her newborn weighed more than 4000 g.

Women's prenatal care records were used as a source for pre-pregnancy weight data. Height and at least two vaginal examinations were measured by the author. Data were analyzed by SPSS (version 14).

RESULTS

Table 1 summarizes descriptive statistics of rate, BSA, BMI, Rohrer's Index and weight gain in pregnancy. Rate of cervical dilation had the mean of 3.61 (± 2.82) cm/h. Body surface area mean was 1.64 m^2 (± 0.17). Maternal

Table 1. Descriptive statistics of rate, BSA, BMI, Rohrer's Index and weight gain in pregnancy.

	Mean	Std. Deviation	N
RATE	3.6152	2.82737	118
BSA	1.6365	.16998	118
BMI	23.0560	3.83294	118
ROHRER1	14.3064	2.39736	118
GAIN	11.9153	5.08992	118

Table 2. Correlation between rate and BSA.

		RATE	BSA	BMI	ROHRER1	GAIN
Pearson correlation	RATE	1.000	.207	.121	.074	.118
	BSA	.207	1.000	.813	.655	-.139
	BMI	.121	.813	1.000	.972	-.287
	ROHRER1	.074	.655	. 972	1.000	-.317
	GAIN	.118	-.139	-.287	-.317	1.000
Sig.(1-tailed)	RATE	.	.012	.096	.211	.102
	BSA	.012	.	.000	.000	.066
	BMI	.096	.000	.	.000	.001
	ROHRER1	.211	.000	.000	.	.000
	GAIN	.102	.066	.001	.000	.
N	RATE	118	118	118	118	118
	BSA	118	118	118	118	118
	BMI	118	118	118	118	118
	ROHRER1	118	118	118	118	118
	GAIN	118	118	118	118	118

Table 3. ANOVA of BSA as the predictor and rate of cervical dilation as the dependent variable to test the null hypothesis of B=0.

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	40.025	1	40.025	5.186	.025[a]
	Residual	895.274	116	7.718		
	Total	935.299	117			

a. Predictors: (constant), BSA; b. Dependent variable: RATE.

weight gain was 11.92 kg (± 5.09).

Table 2 demonstrates that the correlation between the rate of cervical dilation and maternal pre-pregnancy weight (divided by height squared, or height cubed or square root of its multiplication with height) was positive. Only body surface area showed significant correlation with the rate of cervical dilation ($r = 0.21$, $P < 0.012$). Table 2 also shows women of higher BMI put on less weight during their pregnancies.

If the formula for a line predicting the rate of cervical

Table 4. The constant value in the regression formula of rate and BSA Index.

Model		Coefficients[a] Unstandardized coefficient B	Std. error	Standardized coefficient Beta	t	Sig.	Correlations Zero- order	Partial	Part
1	(Constant)	-2.016	2.486		-.811	.419			
	BSA	3.441	1.511	.207	2.277	.025	.207	.207	.207

a. Dependent variable: RATE.

Table 5. Regression line of rate of cervical dilation and BSA.

Independent: BSA									
Dependent	**Mth**	**Rsq**	**df**	**F**	**Sig.**	**b0**	**b1**	**b2**	**b3**
RATE	LIN	.043	116	5.19	0.25	-2.0159	3.4409		
RATE	CUB	.047	115	2.83	0.63	-10.346	10.8797		-.8489

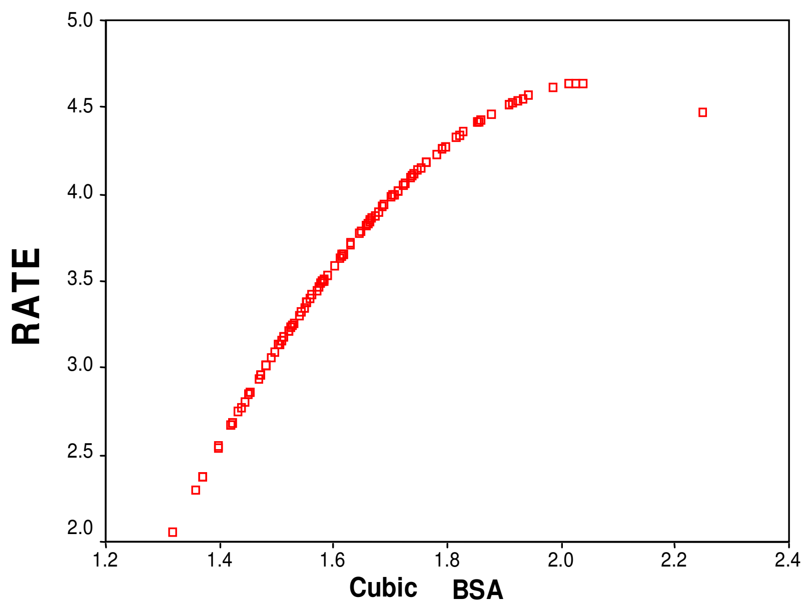

Figure 2. Regression line of rate of cervical dilation and BSA.

dilation fits a linear pattern, it would be:

$$\hat{Y}_i = a + b_1 X_{1i}$$

In this formula, Y_i is BSA.

Table 3 is an ANOVA of BSA, which is the predictor, and rate of cervical dilation is the dependent variable, which is used to test the null hypothesis- B = 0. B is a coefficient representing the slope of a presumed line. The result rejects this null hypothesis at p = 0.025. In other words, these two variables are not independent in the subjects studied.

The constant value (the point at which the line crosses the Y axis when X = 0) was not significant (Table 4).

According to Table 5 and Figure 2, regression line of rate of cervical dilation and BSA fits a cubic curve. This model is defined by the equation:

$$Y = b_0 + (b_1 * x) + (b_2 * x^2) + (b_3 * x^3).$$

That would mean in the subjects studied:

Rate of cervical dilation (cm/h) = $-10.35 + (10.88 \times BSA) - (0.85 \times BSA^3)$

DISCUSSION

Regardless of non-significant effects of Rohrer's Index/ BMI/weight gain on the rate of cervical dilation of the subjects studied, Table 2 demonstrates that the correlations were positive. This can be explained as the subjects were chosen to have BMI of less than 30 (not obese). Women of lower Indices showed longer active phase.

BMI, Rohrer's Index and BSA can be estimates of adipose tissue as well as lean mass in the body (Leddy et al., 2008).

For obese persons what happens at cellular level is the change in a structure called "Caveolae" (invaginations of the surface membrane that can be regarded as a type of raft). Caveolae is a particular feature of membranes of uterine smooth muscle that can be disrupted by cholestrol. The uterus expresses all three isoforms of caveolin and caveolae may increase in number towards the end of pregnancy under hormonal control. Oxytocin receptor exists in high affinity state only when it is in caveolae. Cholesterol can disrupt the caveolae and attach to oxytocin receptor and reduce its affinity to oxytocin. As a result, uterine force is markedly reduced or even abolished (Noble et al., 2006).

When body composition is severely altered as it happens in obesity, weight increases because of increasing fat mass and any measure that is body weight dependent (like body surface area) does not represent the real impact of body size (Simone et al., 2001). Weight lifters and athletes have high BMI because of high muscle mass, not adipose tissue. The observed correlation of cholesterol level and anthropometric indices (Harrell, 2009) of athlete groups does not follow the same trend as that of obese subjects (Simone et al., 2001).

This may explain the reverse relationship found between rate of cervical dilation and obesity (Vahratian et al., 2004). As seen in Variable Chart (Figure 1) maternal anthropometric indices may act indirectly by a change in uterine contraction pattern or directly. If the first assumption is correct, favorable uterine contractions (by any means like induction, amniotomy, or other interventions) can overcome the effect of adipose tissue on labor duration. On the other hand, if there is significant variations in labor pattern despite favorable uterine contractions, there are other pathways involved such as inappropriate uterus composition from scars, fibroids, congenital (or as suggested here fat/muscle proportion) which can disrupt communications between adjacent segments of uterus and may cause conduction dystocia (Joy et al., 2008) even in the context of favorable uterine contractions.

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