# Regression Analysis of Labor Duration

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**Citation**

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**Abstract**

Hypothesis: To find important predictors of active phase of labor and to provide a tool to predict obstructed labor prospectively, based on individual characteristics of pregnant women.

Design: This is an observational prospective study on 230 laboring women in Tehran, studying 47 possible variables affecting labor duration using regression analysis.

Results: Durations of labor in three different categories, namely Labor duration (active phase); Labor duration (4 cm dilation till delivery); Rate of cervical dilation cm/hr, were studied and predicted with R-Square of 0.95, 0.52 and 0.72 respectively. The most important predictors of labor duration (for rate category which was the least bias category) were maternal BMI and maternal lifestyle. The equations were:
Rate = 0.57 + 0.09 BMI
Rate = 71/Framingham Health Risk Assessment Score.

The external validity of the equations were tested in a group of 43 laboring women. The estimated rate was fairly correlated with the observed values.

Conclusion: The important predictors of labor duration were maternal BMI and maternal lifestyle.

## INTRODUCTION

Determining labor duration has been the focus of different researches. The main aim is to lower the rate of cesarean section and undue hospitalization ([1]). Friedman's, Hendrick's, and Philpott's Partographs ([2]) and Nesheim's ([3]) regression equation are the results of such efforts. The four-hour gap between the Action and Alert Line of WHO's partograph is a wide range, and there are some mothers and fetuses that can wait more or may suffer harm from waiting, with such arbitrary cut-off points. The advantage of an equation over a partograph is its predictive value in determining obstructed/poor progress labor in advance and on an individualized basis.

## MATERIALS AND METHODS

A total of 230 laboring women were interviewed and examined according to a multi-item checklist from April to August 2004.

The inclusion criteria were:

1- Singleton pregnancy 2- Vertex presentation 3- Gestational age 36-42 weeks 4- No medical or obstetric disease 5- Bishop score of 10-12 6- Normal Fetal Heart Rate 7- Spontaneous initiation of labor 8- Non-elective cesarean section 9- No diagnosis of CPD([4])

The independent variables were:

1- Mother's height 2- Maternal age([5]) 3- Prepregnancy weight 4- Maternal BMI 5- Drugs used except oxytocin 6-9 Interventions (amniotomy ([6]); Cesarean Section/Vacuum Delivery; Enema or any other type of bowel preparation) 10-12 Duration, Intensity and Frequency of labor pain (in the

initial half-hour after hospitalization and before oxcytocin administration) 13- Abnormal events like cord prolapse or fetal heart abnormality or occiput posterior delivery 14- Housing district(socioeconomic status) 15-31 Lifestyle in terms of alcohol consumption, smoking, exercise, meals, grain , vegetables, fruit, dairy and type of dairy, meat and meat products, fat and dressings , water, snacks(4-1), and score as the sum of these items. 32- Gravidity **33- Parity ** 34- Last delivery**35- Education and Occupation36- Maternal Blood Group and Rh status

The confounding variables were:

37- Newborn weight ($_{7}$)(not known before delivery)38- Newborn sex($_{8}$) (not known before delivery) 39- Time of delivery($_{9}$):(8am – 8pm is considered as day time) (not known before delivery)40- Parity(based on crosstabs testing)41- Last delivery (based on crosstabs testing)42- Gravidity (based on crosstabs testing)

The dependent variables were:

43- Labor duration (active phase) 44- Labor duration (4 cm dilation till delivery) 45- Rate of cervical dilation cm/hr.

The measurements and interviews were done by the researcher. The Framingham questionnaire ($_{10}$) was used because it has been validated and previously used as a measurement instrument. Certain items like smoking, alcohol, fat consumption and exercise were modified according to Iranian setting.

The outcome or dependent variables were measured by the researcher by sequential vaginal examinations. No form of blinding was possible and it was not attempted.

The external validity of the results were tested on another group of 43 laboring women. The statistical analyses were done using SPSS Version 11.0. The following steps were taken to find the most important predictor of labor duration:

I. To find out the confounding variables, the correlation for all variables affecting labor duration (in three categories) was computed. This was done to test the hypothesis that the confounding and dependent variables are independent. Based on this test, the confounding variables were Gravidity, Parity, and Young Child (last delivery). Also, those independent variables determined after the delivery of the child were considered as confounding. To reduce the effect of these confounding variables, only selected cases entered the analysis.

II. Stepwise regression analysis was done to find the independent variable which has the smallest probability of F.

III. Curve fit for the most important variable was computed tocheck for a Model whose equation is Y = b0 + (b1 * t).

IV. If the correlation didn't follow a linear pattern, the best fit was checked:The Inverse Model Y = b0 + (b1 / t).The Quadratic Model Y = b0 + (b1 * t) + (b2 * t**2). The Cubic Model Y = b0 + (b1 * t) + (b2 * t**2) + (b3 * t**3).

The R-square values were calculated for the three dependent variables (Table 1). The stepwise regression analysis of rate and significant predictors is presented in Table 2.

**Figure 1**

Table 1: R and R-square values for dependent variables

| Model | R | R Square |
|---|---|---|
| 4cm-delivery | .717 | .515 |
| Active phase | .978 | .957 |
| Rate of dilation | .85 | .72 |

**Figure 2**

Table 2: stepwise regression analysis of rate of cervical dilation

Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Correlations | | |
|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Zero-order | Partial | Part |
| 1 | (Constant) | -2.723 | 2.007 | | -1.357 | .185 | | | |
| | BMI | .240 | .083 | .473 | 2.892 | .007 | .473 | .473 | .473 |
| 2 | (Constant) | -1.116 | 1.903 | | -.587 | .562 | | | |
| | BMI | .256 | .075 | .503 | 3.398 | .002 | .473 | .540 | .502 |
| | PHENERGA | -1.391 | .505 | -.408 | -2.753 | .010 | -.370 | -.462 | -.407 |
| 3 | (Constant) | .687 | 1.765 | | .389 | .700 | | | |
| | BMI | .248 | .066 | .488 | 3.761 | .001 | .473 | .586 | .486 |
| | PHENERGA | -1.486 | .443 | -.436 | -3.354 | .002 | -.370 | -.542 | -.433 |
| | EXERCISE | -.684 | .221 | -.401 | -3.094 | .005 | -.391 | -.512 | -.400 |
| 4 | (Constant) | -3.323 | 2.195 | | -1.514 | .142 | | | |
| | BMI | .294 | .062 | .579 | 4.741 | .000 | .473 | .681 | .554 |
| | PHENERGA | -1.214 | .413 | -.356 | -2.939 | .007 | -.370 | -.499 | -.343 |
| | EXERCISE | -.825 | .207 | -.484 | -3.990 | .000 | -.391 | -.616 | -.466 |
| | TEA | .858 | .323 | .347 | 2.658 | .013 | .145 | .462 | .310 |
| 5 | (Constant) | .323 | 2.548 | | .127 | .900 | | | |
| | BMI | .288 | .057 | .568 | 5.034 | .000 | .473 | .710 | .542 |
| | PHENERGA | -1.285 | .382 | -.377 | -3.361 | .002 | -.370 | -.558 | -.362 |
| | EXERCISE | -.393 | .265 | -.230 | -1.484 | .150 | -.391 | -.285 | -.160 |
| | TEA | 1.131 | .319 | .458 | 3.541 | .002 | .145 | .578 | .381 |
| | SCORE | -.205 | .087 | -.399 | -2.357 | .027 | -.363 | -.426 | -.254 |
| 6 | (Constant) | 1.794 | 2.401 | | .747 | .462 | | | |
| | BMI | .283 | .058 | .558 | 4.849 | .000 | .473 | .689 | .534 |
| | PHENERGA | -1.316 | .391 | -.386 | -3.368 | .002 | -.370 | -.551 | -.371 |
| | TEA | 1.169 | .326 | .473 | 3.589 | .001 | .145 | .576 | .395 |
| | SCORE | -.295 | .064 | -.574 | -4.592 | .000 | -.363 | -.669 | -.506 |

a. Dependent Variable: RATE

Examples of one of the variables were Caffeine consumption. The question was:

"How often do you consume Caffeine in your diet including coffee, tea, cola or chocolate? Note: A serving is one 8-oz glass.

_____1) Never _____2) Occasionally but not every day _____3) 1 to 3 servings daily _____4) 3 to 5 servings daily _____5) More than 5 servings daily"

Another variable was Exercise. The item for exercise was:

"On the average, how many days per week do you exercise? (based on Iranian lifestyle each session of exercise was defined as a 30-minute walking)

_____1) 3 or more days per week _____2) Less than 3 days per week _____3) No regular exercise program"

Another variable was the "Framingham Health Risk Assessment Score" which was the sum of lifestyle questionnaire items. Take the above question about caffeine consumption as an example. If the woman consumed one glass of tea, she scored 3 for this item. The answers to lifestyle questions are arranged from a low risk to high risk in terms of heart and cancer disease.

## RESULTS

The minimum value for BMI was 15.8 and the maximum was 36.6. The lifestyle score was between 18 to 34 (the higher the score, the higher the risk in terms of malnutrition and disease). Bowel preparation, fat consumption, and gestational age were significant variables affecting labor duration (4 cm – delivery)($p<0.05$). The R-square was 52% and the R value was 0.72.

Bowel preparation, fat consumption, time of labor (night or day), fruit consumption, socioeconomic status, meat, epidural procedure, and duration of pains were significant variables affecting active phase of labor ( 4cm – 10 cm ) ($p<0.05$). The R-square was 95% and the R value was 0.98.

BMI, drugs, exercise, caffeine consumption, and lifestyle score sum were significant variables affecting the rate of cervical dilation (cm/hr) ($p<0.05$). The R-square was 72% and the R value was 0.84.

The correlation for variable of the drug Phenergan was -0.51 ($p=0.005$). Those who didn't have the injection, had a longer active phase rate. The partial correlation of variable for Caffeine consumption was 0.46 ($p=0.013$) which revealed that those who consumed more caffeine had a shorter labour duration (higher rate). Another variable was Exercise.

The correlation of variable for Exercise was -0.51 ($p=0.005$). For the "Framingham Health Risk Assessment Score" which was the sum of lifestyle questionnaire items, the correlation was -0.43($p=0.027$). A higher lifestyle risk showed a lower rate or longer labor duration.

Of the dependent variables, namely Labor duration (active phase); Labor duration (4 cm dilation till delivery) and Rate of cervical dilation cm/hr, the best variable which was not biased by errors of measurement was Rate.

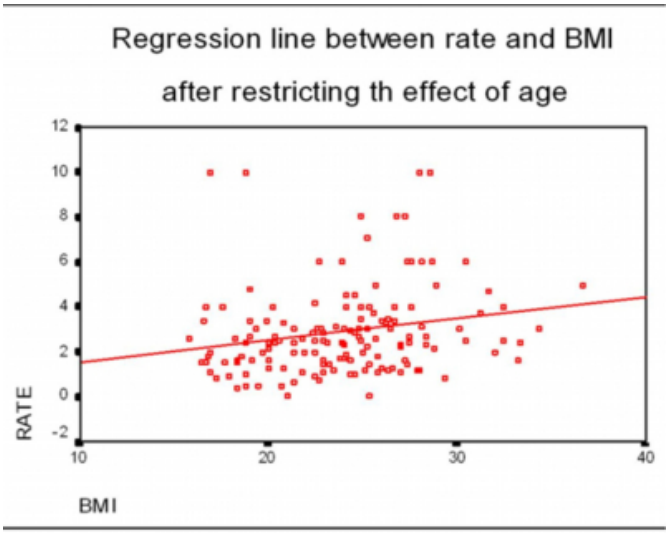
The equation proposed to estimate active phase of labor in terms of rate was:

Rate = 0.57 + 0.09 BMIRate= 71/Health Assessment Score

The equations were tested on a group of 43 parturients (by the same inclusion criteria listed in the main study and they were all primigravidas) and was correlated fairly well with the observed rate. ($p<0.05$)($r=0.354$)

### Figure 3

Figure 1: Regression line of Rate and BMI (after restricting the effect of age)




## DISCUSSION

As shown in Table-2, women who had a higher value had a shorter active phase (faster rate cm/hr). The minimum value of BMI was 15.8 and the maximum was 36.6. The partial correlation was -0.462 ($p=0.01$). The effect of maternal height and prepregnancy weight on the duration of labor are well known in obstetrics. Maternal height is closely related to pelvic size and fetal weight. It has been stated that each 10 cm of height can reduce the labor duration by 36 minutes([9]).

A study showed that women who weigh more than 90 kg will have bigger fetus and each 100 grams over 4000 newborn weight will cause a 3-minute increase in labor duration([9]). So we may consider a paradox in this study as women of lower BMI had a longer labor course. This can happen as overweight women were excluded (The distribution of BMI was: mean 23.71 with a SD of 4.19). In other words, underweight women had longer labor course.

In this study, the correlation on the drug Phenergan was -0.51 (p=0.005). Those who did not have the injection, had a longer active phase rate. A study had shown that phenergan can shorten labor in the multipara women but not the primigravida ($_6$).

## CONCLUSION

The important predictors of rate of cervical dilation in our study were the BMI and Health Assessment Score, both of which are also important issues in preventive medicine.

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