What A Laborious Task

By

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Glossary of Terms

Amniotomy - surgical rupture of the fetal membranes. An instrument is used to tear the membrane of the sac containing the amniotic fluid.

Cephalopelvic Disproportion - the size of the pelvic outlet through which the fetal head will pass during delivery is not large enough to accommodate the size of the fetus's head.

Epidural - a device that is implanted between the woman's spinal bones to provide an access for various medications, mostly pain relievers.

Gestation - the length of time from conception to birth. For humans, the normal is 40 weeks.

Nulliparous - never having borne a child.

Oxytocin - a hormone that stimulates the uterus to contract. Also referred to as Syntocinon and Pitocin.

Pre-eclampsia - a condition in pregnancy where the blood pressure increases and swelling of the extremities occurs.

Primagravida - a woman during her first pregnancy.

Executive Summary

- The unpredictability of labor can cause much anxiety for a woman having her first baby. One of the biggest concerns for a primagravida is the length of labor. This analysis seeks to predict the length of labor for nulliparous pregnancies of single births.
- The data in the model includes 76 observations. The initial model includes the type of delivery experienced, the week of gestation of the pregnancy, the age of the mother at the time of the birth, the amount of weight the mother gained during the pregnancy, the amount of hours per week the mother exercised during the first two trimesters, the gender, weight and length of the baby, the use of pharmaceutical intervention during the labor for pain control, whether amniotomy was used or not, the presence of a coach and/or midwife, and the length in hours of the labors experienced.
- When moving from model A to model D the following variables were eliminated because the estimated coefficients' signs did not reflect the predicted effect on labor duration: Midwife, coach, age, weight, length and gender of the baby. The variable "Type" was also removed to eliminate a simultaneous bias. Furthermore, exercise was consolidated to one variable to determine if exercise itself had a significant effect on labor length versus no exercise at all. A review of the t-statistics and probabilities reduced the independent variables to week and drug.
- Model D does not prove that the variables chosen can predict the length of labor for a nulliparous pregnancy.
- To address the length of labor, other variables that could be tested would include race, prenatal education and care, the effect of prescribed bed rest, the effect of other medical conditions such as diabetes and cardiovascular disease, the effect of previously aborted fetuses, cephalopelvic disproportion, and the effect of familial history.

Introduction

For pregnant women, the thought of labor can be quite unnerving. This is especially true for women experiencing their first (nulliparous) birth. In order to improve a woman's birth experience, obstetrical medicine has attempted to alter nature. For example, labor is induced and pain is controlled with the use of medications. Furthermore, scientific studies have been conducted to learn the effects of exercise and weight gain on labor. Many studies have focused on the role of coaches and midwives in assisting women through labor. All these studies are conducted to help the science of medicine to control and to improve the labor process.

Though the literature addresses various aspects of the labor experience, very few studies have been conducted regarding factors that control the length of labor. When discussing their labor experiences, many women recount the amount of time they were in labor. Obviously, shorter labors are preferred to longer labors. However, no research has been done to predict how long a primigravida will be in labor. The purpose of this study was to determine if the length of labor could be predicted for a primigravida having a single birth.

We identified several variables that might affect the length of labor. The independent variables we examined focused on the woman, the child, and the environment surrounding the birth. No studies involving statistics of the baby were noted in the literature. Few studies were noted regarding issues concerning only the laboring woman. However, review of the literature did present many studies regarding the environment of her labor.

Exercise is one topic often discussed in the literature regarding pregnant women. Research suggests that women who continue to exercise regularly throughout their pregnancy will gain less weight and often have shorter labors (Goldberg et al., 1998). Although the literature does not directly address the effect of weight gain on the length of labor, excessive weight gain may cause medical conditions such as pre-eclampsia and

gestational diabetes that could negatively affect the outcome of labor (Eisenberg et al., 1996). Research of amniotomy, or the intervention of "breaking the water", has shown that it is performed in hopes of shortening the length of labor. However, in many cases it is performed at the wrong time and can actually increase the length of labor (Barrett et al., 1992).

Literature review of the environment surrounding a woman's labor was plentiful. Environmental interventions during labor include the use of pain medications, the assistance of a midwife, and the support of a coach during labor. Rosenfeld (1995) found that the use of an epidural for pain control did increase the length of labor. Others did not find this result specifically but did conclude that the use of an epidural would more likely lead to a cesarean section rather than a vaginal birth (Thorp et al., 1993). As for support during labor, many studies have shown the benefits of midwifery during the labor. Although the length of labor was reduced with the use of a midwife, the results were not very significant (Gagnon et al., 1997). However, this study also noted that one-to-one midwife care during labor lead to a decrease use of pain medication and oxytocin, a medication used to increase strength of contractions. Other studies have concluded that interaction with a midwife prior to labor resulted in the women being better prepared for the birth process (McCourt et al., 1998). Finally, having a coach (husband, friend, mother, etc.) present during the labor resulted in a higher frequency of normal deliveries. The women were less anxious and less likely to have amniotomy, epidurals, and oxytocin. Even more significant, the women suffered less pain, anxiety, and tension with a female companion present (Madi et al., 1999). As a result, labor may be quicker for women who feel more in control.

Data

Since a normal pregnancy is 40 weeks gestation, women who delivered between weeks 36 and 42 of gestation were surveyed to avoid premature births. Also, pregnancies

that continue beyond 42 weeks gestation are terminated via cesarean section and labor is not experienced. Since the field of obstetrics has changed from generation to generation, we decided to only survey women who had delivered their first baby in the past 15 years. The subjects included in this study were interviewed via survey regarding their first pregnancy. No multiple birth pregnancies were included. Women must have experienced labor. Therefore, no scheduled Cesarean sections were included. The surveys were conducted at mall, via email through friends and colleagues at work, and at a local running race. Few female participants of the race were surveyed to avoid skewing the data regarding exercise. 76 subjects were eligible for the study.

The dependent variable is the length of time a woman will be in labor after a full-term pregnancy and vaginal delivery or unscheduled Cesarean section.

Initially, fourteen independent variables were included in this study:

- Drug: Drug = 1 for any type of pharmaceutical intervention used, Drug = 0, for otherwise
- Exercise: Average number of hours a woman exercises per week during the first two trimesters.
    - Exercise 1: Exercise 1 = 1 for less than 1.5 hours/week, Exercise 1 = 0 for otherwise
    - Exercise 2: Exercise 2 = 1 for 1.5 to 3 hours/week, Exercise 2 = 0 for otherwise
    - Exercise 3: Exercise 3 = 1 for more than 3 hours/week, Exercise 3 = 0 for otherwise
- WtGain: Change in weight between discovery of pregnancy to delivery, in pounds.
- Midwife: Midwife = 1 for midwife present during entire labor, Midwife = 0 for otherwise
- Week: Week of gestation at time of delivery
- Age: Age of woman at time of delivery, in years
- Type: Type = 1 for vaginal delivery, Type = 0 for unscheduled Cesarean section
- Gender: Gender = 1 for male baby, Gender = 0 for female baby
- Weight: Weight of baby in ounces
- Length: Length of baby in inches
- Water: Water = 1 for amniotomy (medical intervention to break water), Water = 0 for otherwise
- Coach: Coach = 1 for coach present during entire labor, Coach = 0 for otherwise

Regression Estimations

MODEL A

Method: Least Squares
Date: 11/20/99 Time: 12:37
Sample: 1 76
Included observations: 76

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXERCISE3	-2.052991	4.865428	-0.421955	0.6745
EXERCISE2	3.183066	4.910612	0.648201	0.5193
EXERCISE1	-4.609166	4.753490	-0.969638	0.3361
WATER	2.362427	3.066059	0.770509	0.4440
DRUG	6.460781	3.894343	1.659017	0.1022
MIDWIFE	3.579338	5.047203	0.709173	0.4809
COACH	4.687099	6.719349	0.697553	0.4881
WTGAIN	0.157426	0.096996	1.623017	0.1097
WEEK	2.371145	0.945596	2.507566	0.0148
AGE	-0.109928	0.286282	-0.383986	0.7023
TYPE	-4.813094	4.373693	-1.100465	0.2755
WEIGHT	-0.042151	0.108571	-0.388233	0.6992
LENGTH	-1.036707	1.644663	-0.630346	0.5308
GENDER	-2.403913	3.061320	-0.785254	0.4353
C	-60.29269	43.09405	-1.399095	0.1668

R-squared	0.291544	Mean dependent var	14.57237
Adjusted R-squared	0.128948	S.D. dependent var	12.98716
S.E. of regression	12.12094	Akaike info criterion	8.002624
Sum squared resid	8961.950	Schwarz criterion	8.462637
Log likelihood	-289.0997	F-statistic	1.793054
Durbin-Watson stat	2.357618	Prob(F-statistic)	0.060397

The variables in Model A were selected in this order to represent findings in the literature. Exercise was determined to have an effect on length of labor as well as weight gain. Next, we included the variables that reflected the environment around the woman's birth. We also then included the rest of the variables relating to the woman herself. And, finally we concluded with variables describing the child since there was no data on this in the literature. The variable "Type" was determined to have a simultaneous bias since the coefficient showed that a woman having a Cesarean section would have a longer labor. Long labors will eventually result in a Cesarean section to prevent trauma to the child and/or mother. Therefore, a simultaneous bias is proven. When reviewing the independent

variables for multicollinearity, none was noted. (See Appendix). The highest relationship noted was a 40% relationship between “Exercise2” and “Exercise3”.

MODEL B

Method: Least Squares
Date: 11/20/99 Time: 12:28
Sample: 1 76
Included observations: 76

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXERCISE3	-1.772728	4.867020	-0.364233	0.7169
EXERCISE2	4.533571	4.762878	0.951855	0.3449
EXERCISE1	-3.749710	4.696865	-0.798343	0.4277
WATER	2.614438	3.062693	0.853640	0.3966
DRUG	7.636102	3.751396	2.035536	0.0461
MIDWIFE	4.825115	4.926974	0.979326	0.3312
COACH	4.985258	6.725300	0.741269	0.4613
WTGAIN	0.154637	0.097127	1.592101	0.1164
WEEK	2.504215	0.939427	2.665682	0.0098
AGE	-0.091550	0.286280	-0.319793	0.7502
WEIGHT	-0.022014	0.107200	-0.205359	0.8380
LENGTH	-0.968824	1.646300	-0.588486	0.5583
GENDER	-2.331294	3.065813	-0.760416	0.4499
C	-76.05492	40.71319	-1.868066	0.0665

R-squared	0.277479	Mean dependent var	14.57237
Adjusted R-squared	0.125983	S.D. dependent var	12.98716
S.E. of regression	12.14155	Akaike info criterion	7.995966
Sum squared resid	9139.870	Schwarz criterion	8.425312
Log likelihood	-289.8467	F-statistic	1.831592
Durbin-Watson stat	2.335115	Prob(F-statistic)	0.057624

In Model B, the F-statistic probability is .057 ; therefore, there is not a relationship between the independent and dependent variables at the 5% significance level. The adjusted R-squared of .13 indicates that 13% of the duration of labor is explained by our model. Only the probability of the t-statistic for “week” and “drug” are significant with a value of less than .05. The remaining independent variables have p-values greater than .05 indicating that they are not significant. Contrary to logical assumptions, “Exercise2”, “Midwife”, “Coach”, “Age”, “Weight”, “Length” and “Gender” all had opposite signs for their coefficients than would be expected.

MODEL C

Method: Least Squares
Date: 11/20/99 Time: 12:56
Sample: 1 76
Included observations: 76

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXERCISE	-0.490707	4.218398	-0.116326	0.9078
WATER	3.275078	3.112488	1.052238	0.2966
DRUG	7.338506	3.826765	1.917679	0.0596
MIDWIFE	3.189999	4.631608	0.688745	0.4935
COACH	7.118991	6.789637	1.048508	0.2983
WTGAIN	0.127394	0.095622	1.332263	0.1875
WEEK	2.119081	0.935873	2.264283	0.0270
AGE	-0.029229	0.288313	-0.101381	0.9196
WEIGHT	-0.023440	0.108196	-0.216640	0.8292
LENGTH	-1.337002	1.672534	-0.799387	0.4270
GENDER	-2.859802	3.101815	-0.921977	0.3600
C	-55.20199	40.17813	-1.373931	0.1743

R-squared	0.221805	Mean dependent var	14.57237
Adjusted R-squared	0.088052	S.D. dependent var	12.98716
S.E. of regression	12.40221	Akaike info criterion	8.017566
Sum squared resid	9844.152	Schwarz criterion	8.385577
Log likelihood	-292.6675	F-statistic	1.658325
Durbin-Watson stat	2.369241	Prob(F-statistic)	0.103892

In Model C, we combined the dummy variables for “Exercise” from four categories into two since “Exercise2” had a positive coefficient indicating that moderate exercise would increase the length of labor. When we ran the regression with a two-category dummy variable for exercise, the overall model proved not to be significant (Probability F-stat = .104). Also, the only independent variable significant at the 5% level was “Week”.

MODEL D

Method: Least Squares
Date: 11/20/99 Time: 13:07
Sample: 1 76
Included observations: 76

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXERCISE	0.888922	3.865646	0.229954	0.8188
WATER	2.212490	2.890845	0.765344	0.4466
DRUG	9.148396	3.452004	2.650169	0.0099
WTGAIN	0.122097	0.092145	1.325052	0.1895
WEEK	1.804465	0.818314	2.205101	0.0307
C	-70.13335	32.33850	-2.168726	0.0335

R-squared	0.179278	Mean dependent var	14.57237
Adjusted R-squared	0.120655	S.D. dependent var	12.98716

S.E. of regression	12.17851	Akaike info criterion	7.912879
Sum squared resid	10382.12	Schwarz criterion	8.096884
Log likelihood	-294.6894	F-statistic	3.058144
Durbin-Watson stat	2.381389	Prob(F-statistic)	0.014871

The independent variables chosen for Model D were included since the sign of their coefficients matched expectations. With this model, the Probability F-statistic shows significance between the independent and dependent variables. Again, “Drug” and “Week” are the only independent variables that are significant at the 5% level. The adjusted R-squared has not significantly changed from Model B. Therefore, this model is not a good predictor for the length of labor.

Heteroskedasticity was not a factor with this model as noted on the next page:

Heteroskedasticity Model

Dependent Variable: LABOR
Method: Least Squares
Date: 11/20/99 Time: 16:11
Sample: 1 76
Included observations: 76
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXERCISE	0.888922	3.137777	0.283297	0.7778
WATER	2.212490	2.403390	0.920570	0.3604
DRUG	9.148396	2.189865	4.177608	0.0001
WTGAIN	0.122097	0.090300	1.352121	0.1807
WEEK	1.804465	0.804569	2.242773	0.0281
C	-70.13335	34.39041	-2.039329	0.0452

R-squared	0.179278	Mean dependent var	14.57237
Adjusted R-squared	0.120655	S.D. dependent var	12.98716
S.E. of regression	12.17851	Akaike info criterion	7.912879
Sum squared resid	10382.12	Schwarz criterion	8.096884
Log likelihood	-294.6894	F-statistic	3.058144
Durbin-Watson stat	2.381389	Prob(F-statistic)	0.014871

MODEL E

Method: Least Squares
Date: 11/20/99 Time: 13:37
Sample: 1 76
Included observations: 76

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXERCISE3	-0.107046	0.263390	-0.406417	0.6858

EXERCISE2	0.303059	0.257754	1.175766	0.2442
EXERCISE1	-0.145242	0.254182	-0.571409	0.5698
WATER	0.017059	0.165745	0.102924	0.9184
DRUG	0.712299	0.203016	3.508589	0.0008
MIDWIFE	0.423611	0.266635	1.588730	0.1172
COACH	0.720269	0.363956	1.979003	0.0523
WTGAIN	0.006594	0.005256	1.254476	0.2144
WEEK	0.134075	0.050839	2.637222	0.0106
AGE	-0.030875	0.015493	-1.992863	0.0507
WEIGHT	-0.000153	0.005801	-0.026386	0.9790
LENGTH	0.000706	0.089093	0.007921	0.9937
GENDER	-0.070601	0.165914	-0.425529	0.6719
C	-3.536121	2.203291	-1.604927	0.1136
R-squared	0.368470	Mean dependent var		2.396692
Adjusted R-squared	0.236053	S.D. dependent var		0.751760
S.E. of regression	0.657069	Akaike info criterion		2.162766
Sum squared resid	26.76784	Schwarz criterion		2.592111
Log likelihood	-68.18510	F-statistic		2.782641
Durbin-Watson stat	2.228678	Prob(F-statistic)		0.003510

Model E was created to determine if taking the logarithm of our dependent variable would increase the significance of our model. As a result, the adjusted R-squared does increase to 24%. Therefore, the model remains a poor predictor of labor duration.

Summary

To date, no models have been specifically studied to indicate which variables would predict the length of labor for a woman having her first child. Our model was unable to provide an effective prediction. To address this issue, other variables might be considered. For example, articles have been written discussing the cultural differences with how labor is addressed in various countries. Perhaps race has a factor in the length of labor. Also, the more knowledge a woman has, the more control she feels during labor. Therefore, prenatal education and care may lead to shorter labors. If a woman is prescribed bed rest, her labor might be negatively affected. Of course, this might need to be addressed by studying the reasons why she is put on bed rest during her pregnancy. Bed rest might be prescribed due to certain medical conditions such as diabetes or cardiovascular disease. The effect of previous elective abortions may negatively affect the length of labor since muscle tissue of the uterus is scarred during the procedure. Another factor worth considering is cephalopelvic

disproportion. If the child's head is disproportionately large in proportion to the woman's birth canal, the length of labor might increase. However, this may be a simultaneous bias. Lastly, familial history may be a factor in predicting the length of labor. Women whose mothers' had fast labors may also be prone to fast labors.

Since labor is basically uncontrollable in nature, it is very possible that medical science may never be able to successfully determine what variables can accurately predict the outcome of labor. However, science has made strides in controlling areas such as pain and strength of contractions that definitely have improved the labor process for women. Therefore, other aspects of the labor process might also be altered with positive results.

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APPENDIX

COMPARISON OF MODELS

Measure	Model B	Model C	Model D	Choice
Prob (F-Statisic)	0.057624	0.103892	0.014871	Model D
Adj R2	0.125983	0.088052	0.120655	Model B
Akaike Info Criteria	7.995966	8.017566	7.912879	Model D
Schwarz Criteria	8.425312	8.385577	8.096884	Model D

We excluded Model A due to the simultaneous bias of the variable “Type”. Model E was excluded as we had taken the logarithm of the dependent variables. Therefore, the dependent variable of Model E could not be compared to the other dependent variables of Models B, C, and D. In comparing the Models in the graph above, it is apparent that the best model is Model D.