THE EFFECTS OF PREGNANCY SPACING ON WHETHER PREGNANCIES RESULT IN LIVE OR NON-LIVE BIRTH OUTCOMES IN MATLAB, BANGLADESH*

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We use a large, high-quality longitudinal dataset on around 65,000 pregnancy outcomes gathered over a period of more than twenty years from the MCH-FP Area of Matlab, Bangladesh, to estimate the effects of the lengths of interpregnancy intervals (IPIs) on pregnancy outcomes and pregnancy duration. We find that, compared with IPIs of 27-50 months in duration, shorter preceding intervals increase the risk that the index pregnancy will result in a non-live birth (particularly an induced abortion) and to some extent they also increase the likelihood of a premature live birth. IPIs less than 6 months in duration are associated with a 10-fold risk of an induced abortion, a 5.8-fold risk of miscarriage, and a 2.3-fold risk of a stillbirth compared to IPIs of 27-50 months. A similarly short IPI is associated with a 0.3-week reduction in gestation duration compared to IPIs of 27-50 months in duration for live births and stillbirths.

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Introduction

There is renewed programmatic interest in the effects of pregnancy spacing on infant, child, and maternal health and survival because family planning programs have the potential to affect the timing of pregnancies. This study investigates whether pregnancy spacing also affects pregnancy outcomes and gestational duration.

Study Setting and Data

Our study uses data on pregnancies and their outcomes from the Matlab subdistrict of Bangladesh, a poor, traditional, religiously conservative, country in South Asia. These data have been collected through the Demographic Surveillance System (DSS) of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). The DSS data on the timing of pregnancy outcomes are of very high quality because they have been collected during regular household visits (every two weeks until 1997 and every month since then) by trusted female community health workers.

The DSS data we use to study pregnancy outcomes contain information on 65,378 pregnancies that occurred in the MCH-FP Area of Matlab between 1982 and 2002; 6,823 of these resulted in non-live births. We restrict our attention to the MCH-FP Area because in this area information has been collected on the date of the last menstrual period, enabling estimation of the gestation of pregnancy and of the duration of the interpregnancy interval – the amount of time between the outcome of one pregnancy and the conception of the next. We exclude from the analysis pregnancies that resulted in multiple births, because such pregnancies are likely to be shorter.

Our analyses also control for variables that may affect pregnancy spacing, whether the pregnancy resulted in a live birth, and the gestation of the pregnancy: the woman's age and education, household space (a proxy for the household's economic status), religion, whether the pregnancy was intended, and the calendar time of the events.

Methods

We have two dependent variables for this paper: **pregnancy outcome** and **duration of pregnancy**. As noted above, the sample is 65,378 reported pregnancies that occurred between 1982 and 2002 in the MCH-FP Area that resulted in a singleton live birth or a non-live birth. We explain whether the pregnancy ended with a miscarriage (5.6%), induced abortion (3.3%), stillbirth (3.0%), or live birth

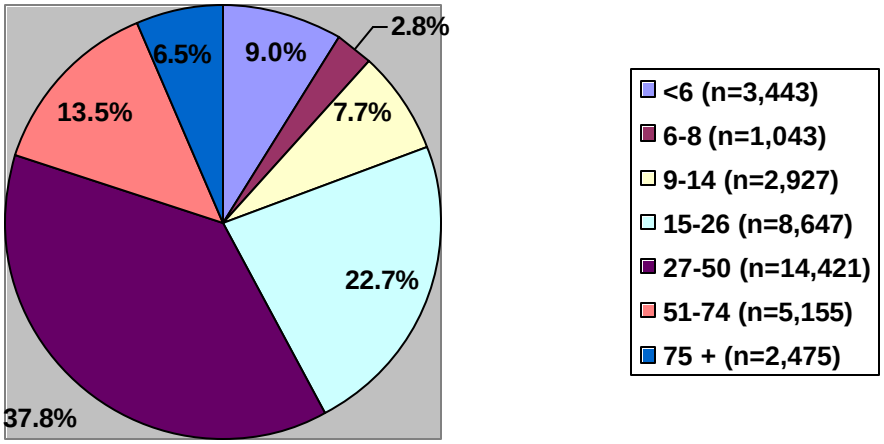
(88.0%). For this same sample we also estimate equations explaining the duration of pregnancy, separately for pregnancies that ended with a live birth or stillbirth, a miscarriage, or an induced abortion.

When pregnancy outcome is our dependent variable of interest, we estimate a polytomous logit regression that explains how the explanatory variables affect the likelihood of a miscarriage, induced abortion, or stillbirth, relative to the likelihood of a live birth. We use OLS to estimate equations explaining the duration of pregnancy.

We measure interpregnancy interval (IPI) by calculating the amount of time between the date of the outcome of the preceding pregnancy and date of last-menstrual period before the index pregnancy. Figure 1 shows a distribution of the preceding IPIs for second and higher-order pregnancies in the MCH-FP Area for which we have data of the date of the last menstrual period before the conception.[1] Nearly twenty percent of these pregnancies were preceded by an inter-pregnancy interval of less than 15 months, which is comparable to a two-year interval between births for index pregnancies that last nine months, and just over 42 percent were preceded by an inter-pregnancy interval of less than 27 months, which is comparable to a three-year interval between births for index pregnancies that last nine months.

[1] Date of last menstrual period (and hence estimated duration of pregnancy) is reported for 93.7% of pregnancies in the MCH-FP Area.

Figure 1. Distribution of Interpregnancy Intervals of Known Duration, in Months, in the MCH-FP Area (excluding first pregnancies and index pregnancies that resulted in twins or triplets) (n=38,121)



How Does the Duration of the Preceding Interpregnancy Interval Affect Whether that Pregnancy Results in a Live Birth?

Table 1 shows the results of our polytomous logistic regression that explains whether a pregnancy ends in an induced abortion, a miscarriage, or a stillbirth; live birth is the reference category. Selected graphical results are shown in Figure 2.

Relative to a live birth, short interpregnancy intervals are highly associated with a very large increase in the odds ratio of a non-live birth outcome. The odds of having an abortion is 10 ($p<.001$) times that of having a live birth when a woman becomes pregnant within 6 months of a previous pregnancy outcome. This suggests that many of the women who became pregnant within 6 months of a previous pregnancy did not intend to do so and opted for an abortion to terminate the pregnancy. The odds of having a miscarriage or a stillbirth after an interpregnancy interval of less than 6 months are also elevated relative to having a live birth (OR=5.8, $p<.001$, and OR=2.3, $p<.001$, respectively).

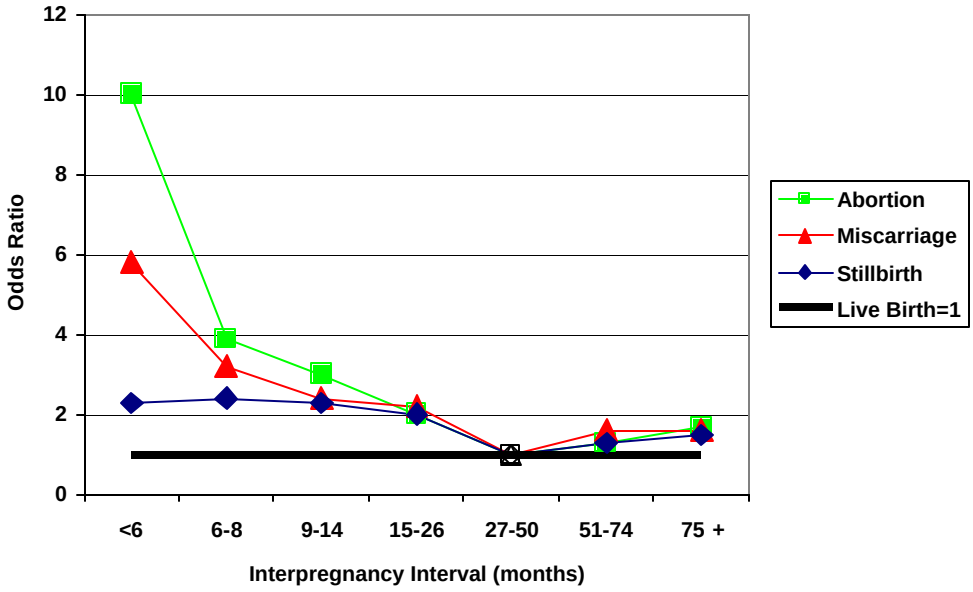
Many of the other explanatory variables have statistically significant effects. For example, unwanted pregnancies are 3.95 ($p<.001$) times more likely than wanted pregnancies to end with an induced abortion and 1.56 ($p<.001$) times more likely to end in a miscarriage compared to wanted

pregnancies. Other things the same, first pregnancies are much more likely to end in a non-live birth (particularly a miscarriage or stillbirth), whereas high parity is associated with a significant decrease in odds of abortion, miscarriage, and stillbirth, compared to parity of 2 or 3. Higher maternal education (1-5 years and 6-10 years) and paternal education (6-10 years) are associated with increased odds of induced abortion relative to those for mothers and fathers with no education. Higher maternal education is associated with a decreased odds ratio of miscarriage or stillbirth relative to mothers with no education, perhaps because educated women are more likely to get good prenatal care. With regard to maternal age, abortions are least likely among the women aged 18-19 and 20-24, whereas they are most likely among women who are 35 or more (OR=8.74, $p<.001$). Miscarriages and stillbirths are both more common among older women, and have generally decreased over time. Non-Muslim women are significantly more likely to have an induced abortion (OR=1.35, $p<.001$) relative to Muslim women.

We find interesting effects of the type of preceding pregnancy outcome. Having had a preceding pregnancy end with an induced abortion increases the risk that the current pregnancy will end with an induced abortion (OR=1.86, $p<.001$) compared to if the preceding outcome was a live birth, implying the some women get repeat abortions. However, if the preceding pregnancy ended in a miscarriage or a stillbirth, the odds that the index pregnancy will end with an induced abortion are reduced by 89% and 79%, respectively ($p<.001$ for both). This may be due to the fact that women who recently had an involuntary non-live birth outcome want to replace their loss. We find that having any preceding non-live birth outcome significantly decreased the risk of having a miscarriage for the index pregnancy. There is a reduction in the odds of having a stillbirth if the preceding pregnancy ended in a miscarriage. Perhaps women who recently had a non-live birth outcome are taking additional precautions not to lose the baby to a miscarriage or stillbirth again.

Figure 2 Odds Ratios of Effect of Duration of Preceding Interpregnancy Interval on Type of Pregnancy Outcome

(Numbers come from Table 1; hollow symbols indicate that the relative risk is not different from 1.0 at significance level of p<.05.)



Influences on Pregnancy Duration

We estimate OLS regression models in which gestation in weeks is the dependent variable for three different samples of pregnancies: (1) those that resulted in a stillbirth or a live birth, (2) those that ended in miscarriage, and (3) those that ended with an induced abortion. The results of these models are shown in Table 2.

There is a statistically significant relationship between short interpregnancy intervals and gestation for live birth and stillbirths. For inter-pregnancy intervals shorter than 6 months, for example, gestation duration is 0.31 weeks shorter on average (p<.001) than for pregnancies following 27-to-50-month intervals. For inter-pregnancy intervals between 6 and 8 months in duration, the reduction in gestation is 0.27 weeks (p<.05) compared to pregnancies following 27-to-50-month intervals. The magnitudes of these reductions in gestation are not very large, but they are statistically significant. Conde-Aguldo's (2004) systematic review of the literature on the effects of pregnancy intervals on prematurity finds that approximately two-thirds of the studies found an association between short intervals and preterm birth, whereas the remaining one-third of the studies found no association. Other characteristics that relate to pregnancy duration are month of birth (February is associated with longest gestation, and August with the shortest), parity (higher parity decreases gestation duration), maternal education (more education

increases gestation, perhaps because educated women are more likely to get prenatal care), and maternal age (older women have shorter gestation).

For the model that includes only miscarriages, there is no evidence of a relationship between short interpregnancy intervals and the timing of miscarriages. Older maternal age (>34) is associated with a shorter gestation among the miscarried pregnancies, as is a termination date in March or April.

For the sample that includes only pregnancies that end with an induced abortion, interpregnancy intervals between 9 and 14 months are associated with earlier abortions (0.86 weeks less than the pregnancies following intervals of 27 to 50 months, $p<.05$). However, for the pregnancies that end in abortion after very short interpregnancy intervals (less than 9 months), there is no difference between the duration of the pregnancy compared to those following intervals of 27 to 50 months. Women with high maternal education (>11 years) have induced abortions that are 2.3 weeks earlier on average than women with no education. This is probably because educated women who have induced abortions in Bangladesh are more likely to use menstrual regulation rather than less safe methods to terminate their pregnancies (DaVanzo et al., 2004). Menstrual regulations (MR) are typically done earlier in a pregnancy than other forms of pregnancy termination because MR is only legal before a pregnancy is clinically confirmed. First pregnancies and those of parity 8 or higher are aborted considerably later (1.05 weeks and 1.32 weeks later, $P<0.05$ for both) than pregnancies of parity 2-3.

Additional Analyses to be Included in the PAA Paper

In addition to the analyses included in this extended abstract, our paper will investigate the following variations in how we specify the models described above. First, we will interact the shortest intervals (IPIs<6 months) with the type of pregnancy outcome that began the interval to see if effects of very short intervals differ depending on the type of outcome that begins the interval. Second, we will see whether the interval effects differs when we don't control for whether the pregnancy was wanted, particularly with regard to induced abortion options. Finally, we will redefine the month variables to refer to the time of conception rather than to the time of outcome. In addition, the PAA paper will compare our results to those in other studies of fetal loss, abortion, and preterm birth, and will discuss the implications of our findings.

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Table 1. Results of Polytomous Logistic Regression for Pregnancy Outcome where Live Birth is the Reference Category (n=65,378)

	Abortion		Miscarriage		Stillbirth	
	exp(ß)	Std. Err.	exp(ß)	Std. Err.	exp(ß)	Std. Err.
Interpregnancy Interval Duration						
IPI<6 months	10.03	0.11***	5.81	0.09***	2.32	0.13***
IPI: 6-8 months	3.89	0.21***	3.22	0.14***	2.43	0.18***
IPI: 9-14 months	3.02	0.14***	2.37	0.10***	2.28	0.13***
IPI: 15-26 months	1.97	0.11***	2.15	0.07***	1.98	0.09***
IPI: 27-50 months (RC)	1.00	(--)	1.00	(--)	1.00	(--)
IPI: 51-74 months	1.33	0.12*	1.64	0.08***	1.30	0.11*
IPI: 75 plus months	1.74	0.12***	1.64	0.10***	1.53	0.14**
IPI unknown	1.63	0.11***	1.43	0.08***	1.42	0.10**
Wantedness Status						
Not Wanted	3.95	0.10***	1.56	0.11***	1.06	0.17
Wanted (RC)	1.00	(--)	1.00	(--)	1.00	(--)
Wanted unknown	0.92	0.09	0.66	0.06***	0.76	0.07***
Parity						
First pregnancy	4.77	0.10***	9.75	0.06***	11.06	0.08***
Parity 4-7	0.57	0.08***	0.35	0.06***	0.39	0.08***
Parity 8 plus	0.31	0.15***	0.22	0.13***	0.27	0.16***
Maternal Education						
Mother's Ed: 0 years (RC)	1.00	(--)	1.00	(--)	1.00	(--)
Mother's Ed: 1-5 years	1.19	0.07*	0.94	0.04	0.89	0.06+
Mother's Ed: 6-10 years	1.60	0.08***	0.80	0.06***	0.71	0.08***
Mother's Ed: 11-16 years	1.00	0.18	0.56	0.12***	0.39	0.18***
Mother's Ed unknown	0.55	0.31+	0.64	0.14**	0.80	0.17
Father's Education						
Father's Ed: 0 years (RC)	1.00	(--)	1.00	(--)	1.00	(--)
Father's Ed: 1-5 years	1.16	0.08+	0.97	0.05	1.12	0.07+
Father's Ed: 6-10 years	1.29	0.09**	1.05	0.06	1.15	0.08+
Father's Ed: 11-16 years	1.14	0.13	1.08	0.09	0.92	0.13
Father's Ed unknown	1.02	0.09	0.92	0.06	0.99	0.07
Maternal Age						
Mother's Age <18	0.84	0.17	0.41	0.10***	0.17	0.18***
Mother's Age: 18-19	0.37	0.15***	0.30	0.08***	0.24	0.10***
Mother's Age: 20-24	0.41	0.10***	0.35	0.05***	0.36	0.07***
Mother's Age: 25-29 (RC)	1.00	(--)	1.00	(--)	1.00	(--)
Mother's Age: 30-34	2.97	0.09***	1.79	0.06***	2.29	0.08***
Mother's Age: 35 plus	8.74	0.10***	4.55	0.08***	4.68	0.10***
Religion						
Non-Muslim	1.35	0.08***	0.91	0.05+	1.09	0.07
Muslim (RC)	1.00	(--)	1.00	(--)	1.00	(--)
Household Space Size						
House Size Smallest Quartile (RC)	1.00	(--)	1.00	(--)	1.00	(--)

House Size 2nd Quartile	1.21	0.08 *	1.00	0.05	0.94	0.07
House Size 3rd Quartile	1.27	0.08 **	0.97	0.05	0.95	0.06
House Size Largest Quartile	1.53	0.09 ***	0.94	0.06	0.85	0.08 +
House Size unknown	1.66	0.14 ***	0.91	0.05 +	1.05	0.13
Preceding Pregnancy Outcome						
Preceding Outcome Live Birth (RC)	1.00	(--)	1.00	(--)	1.00	(--)
Preceding Outcome Abortion	1.86	0.15 ***	0.48	0.20 ***	1.12	0.22
Preceding Outcome Miscarriage	0.11	0.21 ***	0.45	0.10 ***	0.57	0.14 ***
Preceding Outcome Stillbirth	0.21	0.23 ***	0.44	0.12 ***	1.10	0.13
Year						
Year 1982-1986 (RC)	1.00	(--)	1.00	(--)	1.00	(--)
Year 1987-1991	1.41	0.09 ***	0.88	0.06 *	0.84	0.07 *
Year 1992-1996	0.91	0.12	0.56	0.07 ***	0.57	0.09 ***
Year 1997-1999	0.85	0.13	0.49	0.08 ***	0.48	0.10 ***
Year 2000-2002	1.15	0.12	0.70	0.07 ***	0.53	0.10 ***
Month of Outcome						
January	1.21	0.16	1.39	0.10 **	1.01	0.11
February	1.73	0.15 ***	1.63	0.10 ***	0.89	0.12
March	2.65	0.14 ***	2.08	0.10 ***	1.05	0.11
April	2.65	0.14 ***	2.54	0.09 ***	1.05	0.12
May	2.54	0.14 ***	2.91	0.09 ***	0.99	0.12
June	2.89	0.14 ***	3.13	0.09 ***	0.78	0.13 +
July	2.20	0.14 ***	2.66	0.09 ***	0.87	0.12
August	1.74	0.15 ***	2.05	0.09 ***	0.96	0.11
September	1.52	0.14 **	1.68	0.09 ***	1.03	0.10
October	1.18	0.15	1.37	0.09 **	0.99	0.10
November	0.90	0.15	1.15	0.10	1.05	0.10
December (RC)	1.00	(--)	1.00	(--)	1.00	(--)
Constant	0.003	0.20 ***	0.03	0.12 ***	0.03	0.14 ***

+ p<.10, * p<.05, ** p<.01, *** p<.001
note: exp(ß) = odds ratio

Table 2. OLS Regressions on Pregnancy Duration in Weeks by Types of Pregnancy Outcomes

	Stillbirth and Livebirths Only (n=57,759)		Miscarriages Only (n=2,623)		Abortions Only (n=945)	
	ß	Std. Err.	ß	Std. Err.	ß	Std. Err.
Interpregnancy Interval Duration						
IPI<6 months	-0.31	0.07***	-0.22	0.37	-0.19	0.45
IPI: 6-8 months	-0.27	0.10*	-0.33	0.53	-0.03	0.63
IPI: 9-14 months	-0.04	0.07	0.65	0.38+	-0.86	0.40*
IPI: 15-26 months	-0.07	0.04	-0.24	0.24	-0.53	0.29+
IPI: 27-50 months (RC)	(--)		(--)		(--)	
IPI: 51-74 months	-0.02	0.05	0.00	0.28	-0.03	0.33
IPI: 75 plus months	-0.22	0.07**	-0.08	0.34	-0.31	0.34
IPI unknown	0.29	0.05***	0.05	0.32	-0.52	0.39
Wantedness Status						
Not Wanted	-0.09	0.08	0.69	0.40+	-0.58	0.30+
Wanted (RC)	(--)		(--)		(--)	
Wanted unknown	-0.12	0.04**	-0.12	0.21	-0.72	0.31*
Parity						
First pregnancy	0.02	0.04	-0.17	0.23	1.05	0.38**
Parity 4-7	-0.18	0.04***	-0.52	0.26*	0.40	0.27
Parity 8 plus	-0.43	0.08***	-0.07	0.50	1.32	0.49**
Maternal Education						
Mother's Ed: 0 years (RC)	(--)		(--)		(--)	
Mother's Ed: 1-5 years	0.08	0.03*	0.10	0.17	-0.19	0.24
Mother's Ed: 6-10 years	0.26	0.04***	-0.36	0.22	-0.13	0.29
Mother's Ed: 11-16 years	0.61	0.09***	-0.65	0.46	-2.31	0.58***
Mother's Ed unknown	0.12	0.09	0.20	0.68	-0.56	1.21
Father's Education						
Father's Ed: 0 years (RC)	(--)		(--)		(--)	
Father's Ed: 1-5 years	0.01	0.04	-0.32	0.20	0.29	0.27
Father's Ed: 6-10 years	0.02	0.04	0.09	0.23	0.02	0.29
Father's Ed: 11-16 years	0.07	0.06	0.08	0.33	0.19	0.42
Father's Ed unknown	0.04	0.04	0.00	0.24	0.13	0.37
Maternal Age						
Mother's Age <18	-0.16	0.09+	0.19	0.40	-1.17	0.72
Mother's Age: 18-19	-0.09	0.06	0.54	0.31+	-0.74	0.64
Mother's Age: 20-24	-0.01	0.04	-0.02	0.21	0.23	0.39
Mother's Age: 25-29 (RC)	(--)		(--)		(--)	
Mother's Age: 30-34	-0.09	0.04*	-0.42	0.25+	-0.36	0.31
Mother's Age: 35 plus	-0.33	0.06***	-0.60	0.30*	-0.12	0.35
Religion						
Non-Muslim	1.35	0.08***	0.18	0.21	-0.38	0.26
Muslim (RC)	(--)		(--)		(--)	
Household Space Size						
House Size Smallest Quartile (RC)	(--)		(--)		(--)	
House Size 2nd Quartile	0.00	0.03	-0.26	0.20	-0.14	0.30

House Size 3rd Quartile	0.02	0.03	-0.15	0.20	-0.28	0.29
House Size Largest Quartile	-0.02	0.04	0.29	0.25	-0.49	0.33
House Size unknown	-0.04	0.07	-0.28	0.39	-0.46	0.50
Preceding Pregnancy Outcome						
Preceding Outcome Live Birth (RC)	(--)		(--)		(--)	
Preceding Outcome Abortion	0.09	0.14	0.49	0.76	-0.53	0.43
Preceding Outcome Miscarriage	0.14	0.08 +	0.00	0.36	-0.74	0.74
Preceding Outcome Stillbirth	0.10	0.09	0.17	0.46	-0.02	0.79
Year						
Year 1982-1986 (RC)	(--)		(--)		(--)	
Year 1987-1991	-1.82	0.05 ***	-2.08	0.29 ***	-0.82	0.46 +
Year 1992-1996	-0.80	0.05 ***	-0.35	0.25	0.52	0.34
Year 1997-1999	-0.41	0.04 ***	-0.16	0.23	0.79	0.30 **
Year 2000-2002	-0.20	0.05 ***	-0.06	0.25	0.68	0.32 *
Month of Outcome						
January	0.01	0.06	-0.57	0.41	-0.13	0.53
February	0.13	0.06 *	-0.38	0.40	0.17	0.51
March	-0.01	0.06	-1.00	0.38 *	0.15	0.46
April	0.01	0.06	-1.04	0.37 **	-0.19	0.47
May	0.00	0.06	-0.61	0.37 +	0.38	0.48
June	-0.16	0.06 *	-0.03	0.37	0.44	0.47
July	-0.22	0.06 ***	0.06	0.37	0.74	0.49
August	-0.43	0.06 ***	0.19	0.37	0.39	0.49
September	-0.27	0.05 ***	-0.74	0.39 +	0.16	0.50
October	-0.27	0.05 ***	-0.49	0.38	0.04	0.53
November	-0.21	0.05 ***	-0.28	0.39	-0.67	0.53
December (RC)	(--)		(--)		(--)	
Constant	36.46	0.07 ***	10.53	0.42 ***	7.16	0.58 ***

+ p<.10, * p<.05, ** p<.01, *** p<.001