

Impact of Perceived Stress, Major Life Events And Pregnancy Attitudes on Low Birth Weight

By Marjorie R. Sable and Deborah Schild Wilkinson

Context: While low birth weight is the leading cause of infant mortality and morbidity, the factors influencing low birth weight are not well understood. In particular, the relationship between stressful life events and birth outcomes is unclear. It is important for health care providers to better understand the impact of stress on health outcomes.

Methods: Data from a statewide case-control study of 2,378 Missouri mothers are used to examine the relationship of perceived stress, pregnancy attitudes and major life events as psychosocial risk factors on very low birth weight (i.e., birth weight lower than 1,500 g). Such births are contrasted with moderately low birth weight births (those weighing between 1,500 and 2,499 g) and normal-birth-weight infants (those weighing 2,500 g or more). A stepwise logistic regression model is used to control for all study and control variables.

Results: The risk of very low birth weight is one and one-half times greater if the mother perceived that she "almost always" felt stress during her pregnancy. The regression model confirms that besides perceived stress, several other factors are independently associated with an increased risk of very low or moderately low birth weight. For example, getting back with a husband or partner or experiencing a major injury, accident or illness were associated with an elevated risk of low birth weight (odds ratio, 1.7), as was pregnancy denial (1.4–1.6) and unhappiness about the pregnancy (1.3). On the other hand, a few factors (taking out a mortgage or loan, having a close relative die and having a mistimed pregnancy) appear to have reduced the odds of low birth weight (odds ratio, 0.5–0.8).

Conclusions: Interventions with pregnant women, especially those assessing perceived stress and attitudes toward the pregnancy, have the potential to improve pregnancy outcomes. Additional prospective research with pregnant women on the origins and effects of stress, including the biological effects of stress, is needed.

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The lack of progress in reducing low birth weight, the leading cause of infant mortality and morbidity,¹ challenges us to persevere in our examination of potential risk factors. Although by 1997 the U.S. infant mortality rate had declined to 7.2 deaths per 1,000 live births,² as of 1996 this rate ranked 23rd internationally, below most other industrialized countries.³ Moreover, low birth weight has increased, with the 1997 level (7.5%) being the highest reported since 1973.⁴

Although not all low-birth-weight births are attributable to preterm delivery, this remains a major predictor of low birth weight. As such, nearly all research on the effects of stress, major life events and social support on pregnancy outcomes has focused either on preterm delivery and low birth weight or solely on preterm delivery. While the influence of stress and major life events on birth outcomes has been extensively investigated for at least 30 years, the findings have been equivocal,⁵ as methodological concerns have prevented any conclusions from being drawn.

There is some basis to believe, however, that maternal emotional distress is associated with poor pregnancy outcomes.⁶ An early study of stress and social support found a relationship between stress, social support and adverse pregnancy outcomes.⁷ In that study, however, the dependent variable was a composite of various birth outcomes and could not be used to isolate risks for low birth weight or preterm delivery.

Three recent examinations of stress and low birth weight each had different findings, measured stress differently and analyzed different risk factors. One used a 28-item psychosocial assessment scale with five separate subscales, one of which measured "stress" (although the authors did not describe how stress was defined).⁸ Among nearly 2,600 women studied, stress was significantly related to both low birth weight and preterm delivery, but not to intrauterine growth retardation.

In a study of the association of stress and health behaviors and low birth weight in a sample of more than 2,000 urban

women, the researchers measured stress using a 41-item scale developed specifically for use with pregnant women.⁹ (The scale included assessments of chronic stress conditions as well as stressful life events.) Women with high numbers of stressors were more likely to use alcohol, drugs or cocaine than were those with fewer stressors. Stress was not significantly related to low birth weight, either for the entire population or for white women; however, among black women, the likelihood of having a low-birth-weight baby was about half again as great for women with moderate-to-high stress as for those with low stress.

An investigator using structural equation modeling found no direct relationship between stress or social support factors and low birth weight, but observed an indirect association through the influence of these factors on certain health behaviors.¹⁰ The model included two sets of stress factors. A group of major life events were combined to describe "family stress," and factors related to employment status and sources of income were combined to create an "economic stress" variable. The study also used a variable to capture "social support," which included one pregnancy attitude concept—"ambivalence about pregnancy after 20 weeks gestation." Each of these three factors was strongly correlated to two deleterious health behaviors, smoking tobacco and consuming alcohol. In turn, health behaviors were directly associated with low birth weight, significantly increasing the likelihood of a negative outcome.

Two other recent analyses of the effects of major life events on preterm birth reached differing conclusions. An Australian study of women at high biological risk due to previous poor pregnancy out-

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comes found no significant association between life events and preterm birth.¹¹ In contrast, among Danish women, major life events themselves were not associated with shorter gestation or preterm delivery, but major life events identified as stressful by the women were associated with an increased risk of preterm delivery.¹²

Finally, in a review of studies spanning 30 years that explored the effects of stressful life events on preterm delivery and fetal growth retardation,¹³ the authors found no evidence for an association between stressful life events and the risk of preterm delivery.

Both pregnancy intention and attitudes about pregnancy have been studied as risk factors related to pregnancy outcomes.¹⁴ One suggested mechanism for the effects of these factors on birth outcomes is lifestyle factors, such as increased smoking,¹⁵ alcohol use¹⁶ or illicit drug use;¹⁷ these behaviors may be more common among women with unintended pregnancies.¹⁸

A second potential explanation for the increased risk of poor outcomes is that an unplanned or unwanted pregnancy may be a psychological stressor for a pregnant woman. Additionally, her attitudes about the pregnancy (whether she is happy to be pregnant, whether she is unsure about being pregnant or whether she denies her pregnancy) may also influence her level of perceived stress.

This article is designed to examine the relationship between perceived stress during pregnancy and birth outcomes. To understand better this relationship, we also study potential stressors such as major life events and pregnancy intention and attitudes. We hypothesize that stress and those intervening factors that create stress, such as major life events and pregnancy attitude and intention, increase the likelihood of adverse birth-weight outcomes.

Methods

Source of Data

Data used in this analysis were taken from maternal questionnaires collected in the National Institute of Child Health and Human Development/Missouri Maternal and Infant Health Survey (MMIHS). The MMIHS, a population-based case-control study, examined risk factors for very low birth weight among all infants born weighing less than 1,500 g to Missouri residents between December 1, 1989, and March 31, 1991. Cases were identified using Missouri's birth certificate and fetal death certificate database.

The MMIHS originally was intended to be a mailed questionnaire, but it was augmented after a pilot study yielded a low response rate to the mailed questionnaire among women who delivered at certain hospitals. Thus, several additional approaches were employed to increase the response rate for mothers: face-to-face interviews (conducted at five hospitals); questionnaires offered in the hospital and completed by the respondent; and telephone interviews.

For the MMIHS, each singleton very low birth weight infant was matched with two controls: a moderately low birth weight infant (one who weighed 1,500–2,499 gm) and a normal-birth-weight infant (one weighing 2500 gm or more). For the mailed questionnaire, stratified random sampling was used to select a similar number of moderately low birth weight and normal-birth-weight controls, stratified on race (black vs. nonblack), maternal age (13–19, 20–24 and 25 or older) and area of residence (major metropolitan areas—St. Louis and Kansas City—versus the rest of Missouri).

The matching was not a strict one-to-one match. Rather, a frequency match was used, with a goal of establishing the same distribution of the three matching variables. Controls were moderately low and normal-birth-weight infants matched by the above criteria, using birth certificate data. For the in-hospital interviews, control mothers were selected stratified on race and age. Delivery logs were used to identify cases and controls. Controls were the next mothers with a moderately low birth weight and a normal-birth-weight infant in the same stratum as the case.

The target sample of mothers was 4,104, and surveys were received from 3,102 (76%); response rates were 84% for the five in-hospital surveys and 70% for the mailed questionnaire. The refusal rate was 12%, and the nonresponse rate was 12%. In all, 66% of survey responses were by mailed questionnaire three months postpartum, 20% were through face-to-face interviews in five hospitals, 12% were by means of respondent-completed questionnaires in the hospital and 2% were through telephone interviews.

The 3,102 mothers represented 3,388 live births and fetal deaths. In this article, we have excluded fetal deaths, stillbirths and multiple births, leaving a final sample for analysis of 2,378 singleton infants—779 cases with very low birth weight, 799 controls with moderately low birth weight and 800 controls with normal birth weight.

Description of the Questionnaire

To identify risk factors for very low birth weight, the MMIHS maternal questionnaire was designed to elicit information from new mothers about pregnancy determination and prenatal care; general health and use of medications (including illegal drugs) during pregnancy; birth control and reproductive history; information on smoking and drinking; social support; employment and other daily activities; diet and nutrition; personal and household characteristics; postpartum health care; and baby's health and special care needs. The questionnaire was developed by an interdisciplinary advisory group to the MMIHS and consisted of 162 structured questions.

Dependent Variables

The primary outcomes of interest here are very low birth weight and moderately low birth weight. Because infants with very low birth weight are at greater risk for neonatal morbidity and mortality than those with moderately low birth weight, the MMIHS was designed specifically to identify risk factors for very low birth weight. We thus compared outcomes for very low birth weight and moderately low birth weight infants both with one another and with outcomes for normal-birth-weight infants.

Independent Variables

• *Perceived stress.* The survey included one question regarding women's perception of stress during pregnancy. As a measure of perceived stress, women were asked, "In general, how often did you feel stress during your recent pregnancy?" Possible responses were "almost always," "often," "sometimes," and "almost never." To identify women whose perceived stress was extreme, we compared women who stated that they "almost always" felt stress (21%) with women who responded that they "often" (27%), "sometimes" (39%) or "almost never" (14%) felt stress.

• *Major life events.* As a measure of major life events, women were asked, "During your most recent pregnancy, did any of the following events occur to you?" They were asked to check on a list any of 30 individual items that applied to them.* (A complete list of the major life events used in the survey appears elsewhere.¹⁹) Odds ratios were calculated from chi-square

*The list had been generated by the MMIHS advisory committee, and was derived largely from similar surveys. It did not come from a previously constructed scale, nor was the list intended to be used as a scale.

Table 1. Percentage distribution of recent mothers, by selected characteristics, according to birth weight of infant, Missouri, 1989–1991 (N=2,378)

Characteristic	Very low		Moderately low		Normal	
	N	%	N	%	N	%
Age						
<20	205	26.3	185	23.2	193	24.1
20–24	211	27.1	229	28.7	221	27.6
25–30	206	26.4	250	31.3	227	28.4
>30	157	20.2	135	16.9	159	19.9
Race						
Black	308	39.5	307	38.4	320	40.0
Other	492	61.6	480	60.0	471	60.5
Education (in years)						
<12	272	34.9	264	33.0	232	29.0
12	507	65.1	535	67.0	568	71.0
Enrolled in Medicaid						
Yes	317	40.7	394	49.3	369	46.1
No	462	59.3	405	50.7	431	53.9
Marital status						
Married	364	46.7	390	48.8	446	55.8
Unmarried	415	53.3	409	51.2	354	44.3
Health during pregnancy						
Excellent/good/fair	690	88.6	761	95.2	785	98.1
Poor	89	11.4	38	4.7	15	1.9
Adequacy of prenatal care						
Inadequate	297	38.1	302	37.8	308	38.5
Adequate	482	61.9	497	62.2	492	61.5
Prior live birth						
0	376	48.3	350	43.8	309	38.6
1	403	51.7	449	56.2	491	61.4
Smoked during pregnancy						
Yes	252	32.9	335	42.2	218	27.4
No	527	67.1	464	57.8	582	72.6
Type of survey						
In-hospital	320	41.1	318	39.8	339	42.4
Mailed	459	58.9	481	60.2	461	57.6
Total	779	100.0	799	100.0	800	100.0

Note: Percentages may not add to 100.0% due to rounding.

analyses for each of the 30 individual major life events to determine if they were significantly associated with birth weight.

• *Pregnancy attitudes and intentions.* The survey questions offer opportunities to examine retrospectively both the traditional measures of pregnancy intention used in the National Survey of Family Growth and other national surveys, as well as new measures of attitudes about pregnancy during the entire course of the pregnancy. We constructed from the survey three attitude variables—“unhappy about pregnancy,” “unsure about pregnancy” and “pregnancy denial.” Respondents had been asked, “How did you feel about being pregnant during your recent pregnancy?” Their response was measured on a four-point Likert-type scale anchored by answers of “very happy” and “very unhappy.” We classified those who stated that they were “unhappy” or “very unhappy”

as being unhappy with the pregnancy.

The MMIHS also included the following item: “Please tell us if any of the things listed below made it hard or impossible to get prenatal care during your recent pregnancy.” Of the 30 possible responses, including financial, access or life circumstances, four were used to create two new variables. Women who checked “I wasn’t sure I wanted to be pregnant” (n=186) were classified as being unsure about the pregnancy. If a woman checked any of three statements—“I didn’t want people to know I was pregnant” (n=106), “I didn’t want to think I was pregnant” (n=152), or “I didn’t know I was pregnant” (n=126)—she was classified as having pregnancy denial.

As an assessment of unintended, mistimed and unwanted pregnancy, women were asked to respond to a question and set of four replies taken from the National Survey of Family Growth: “Thinking back,

just before you became pregnant, did you want to become pregnant at that time? (1) I wanted this pregnancy at an earlier time, as well as at that time; (2) I wanted to become pregnant at that time; (3) I did not want to become pregnant at that time, but I wanted another child sometime in the future; or (4) I did not want to become pregnant at that time or any time in the future.”

Women who chose either the third or the fourth response were considered to have had an unintended pregnancy, with those who selected the third classified as having a mistimed pregnancy and those who selected the fourth considered as having an unwanted pregnancy.

• *Control variables.* We included factors previously shown to be associated with birth outcomes as control variables in our adjusted models. Six of these (education, Medicaid status, marital status, adequacy of prenatal care, previous parity and

smoking status) were taken from the birth certificate data. Health during pregnancy was measured from the women’s response to a subjective self-assessment question in the maternal survey. Adequacy of prenatal care was measured using Kotelchuck’s Adequacy of Prenatal Care Utilization Index.²⁰ Following Kotelchuck’s recommendations, we collapsed inadequate and intermediate care and classified them as inadequate prenatal care; we combined adequate and “adequate plus” care and classified them as adequate prenatal care. We controlled for data collection method (mailed questionnaire vs. in-hospital interview) because of the potential that responses might vary from the immediate postpartum period to several months postpartum, when women received the mailed survey. Because the cases and controls were matched on race, age and location, we did not include these variables in the models.

Statistical Analyses

The primary method that we used to analyze our research questions was logistic regression modeling. Using the model building method of Hosmer and Lemeshow,²¹ we separately determined the unadjusted odds ratios of birth outcomes while making three comparisons: very low birth weight compared with normal birth weight; moderately low birth weight compared with normal birth weight; and very low birth weight compared with moderately low birth weight. These comparisons were conducted for each life event, for perceived stress, for the attitude or intention variables, and for each potential control variable. Those variables that were found to be statistically significant at p<.05 were included in our further analyses.

Our second step was to examine odds ratios separately for birth-weight outcomes by each statistically significant independent variable, in a model that adjusted for the presence of the control variables. Finally, we ran stepwise regressions for each birth-weight comparison group with all of the independent variables that had remained statistically significant in the separate adjusted models and with the control variables. Variables significant at p<.10 were entered into the model, and those with p-values exceeding .05 were dropped. These final analyses resulted in the most parsimonious models for the odds ratios of each birth-weight comparison group. All analyses were conducted using SAS for Windows.

Findings

Sample Characteristics

The three groups of women were generally similar in their characteristics, with the majority being younger than 30, having 12 or more years of schooling and having received adequate prenatal care (Table 1).

Table 2 shows factors that were tested for association with birth outcomes. Women who had a very low birth weight baby most frequently said they almost always perceived stress during their pregnancy (25%). Perceived stress was also higher among women who a moderately low birth weight baby (21%) than among those who had a normal-birth-weight baby (16%). Similarly, several measures of negative pregnancy attitudes or intentions (such as pregnancy denial and unhappiness about the pregnancy) were more common among women who had a low birth weight baby than among the others.

Eight of the 30 major life events were found in chi-square analyses to be significantly associated with birth weight; these are shown in Table 2. The proportions who report having experienced these major life events were sometimes higher among women with a low-birth-weight baby. However, the patterns vary, and in the cases of having had a close family member die or of taking out a mortgage or loan, the proportion was highest among those with a normal-birth-weight baby and lowest among women with a very low birth weight baby.

Unadjusted Models

Perceived stress was related to both very low birth weight and moderately low birth weight when they were compared with normal birth weight (Table 3), but not when very low birth weight was compared with moderately low birth weight. In each model with a statistically significant association, the risk of an adverse outcome was increased, more so for very low birth weight compared with normal birth weight (odds ratio, 1.7) than for moderately low birth weight compared with normal birth weight (odds ratio, 1.4).

None of the eight major life events had consistent effects across all three comparison groups. Four (getting back with a husband or partner, having problems with parents or in-laws, having suffered a major injury, accident or illness, and having been in a physical fight) were associated with an increased risk in at least one of the birth-weight comparisons. In contrast, the other four (having a husband or partner change jobs, being arrested, taking out a mortgage or loan and having a

close family member die) were linked with a reduced risk of an adverse outcome (Table 3).

Two pregnancy attitude variables were associated with an increased risk of adverse outcomes. Women who felt unhappy about being pregnant were more likely to have a very low birth weight baby than a normal-birth-weight baby (odds ratio, 1.5) and were more likely to have a moderately low birth weight baby than a normal-birth-weight baby (odds ratio, 1.4). In addition, women who denied their pregnancy were more likely to have a very low birth weight baby than either a normal-birth-weight (odds ratio, 1.7) or a moderately low birth weight baby (odds ratio, 1.4).

Traditional measures of pregnancy intention revealed only one significant association with birth weight (Table 3). Women whose pregnancies were mistimed were slightly less likely to have a moderately low birth weight baby than a normal-birth-weight baby (odds ratio, 0.8).

Effect of Adjusting for Controls

Once we had adjusted for the effects of factors known to be associated with low birth weight, the associations between birth-weight outcomes and such measures as

Table 2. Among recent mothers, percentage who almost always felt stress, percentage reporting selected measures of pregnancy attitudes and intentions, and percentage who experienced selected major life events, all by birth weight of recent infant

Measure	Very low (N=779)	Moderately low (N=799)	Normal (N=800)
Almost always felt stress	25.0	21.2	16.1
Pregnancy attitude/intention			
Unhappy	18.6	17.3	13.3
Unsure	9.2	7.6	6.6
Pregnancy denial	15.9	12.1	9.9
Unintended pregnancy	57.9	59.3	61.9
Mistimed pregnancy	41.9	41.1	46.9
Unwanted pregnancy	16.1	18.3	15.0
Major life events			
Got back with husband/partner	10.3	12.6	7.3
Had problems with parents/in-laws	24.0	21.1	18.7
Husband/partner changed jobs	9.8	13.1	9.8
Was arrested	1.7	2.9	1.6
Took out mortgage/loan	3.5	5.9	6.7
Suffered major injury/illness	7.0	6.1	3.4
Was in physical fight	8.6	6.7	5.0
Close family member died	10.2	13.1	13.6

perceived stress and unhappiness over the pregnancy changed (Table 4, page 292). For both, associations with moderately low birth weight versus normal birth weight were no longer statistically significant. However, the remaining relationships with stress and with pregnancy attitude and intention changed only slightly, and did not differ significantly from the unadjusted models.

The addition of control variables also affected the association of birth weight with major life events. Three life events ("problems with parents or in-laws," "husband or partner changed jobs" and "I was arrested") were no longer associated with birth-weight outcomes. Additionally, the death of a close family member was no

Table 3. Unadjusted odds ratios (and 95% confidence intervals) of selected birth-weight comparisons, by effects of stress, major life events and pregnancy attitudes and intentions

Factor	Very low vs. normal	Moderately low vs. normal	Very low vs. moderately low
Stress			
Almost always felt stress	1.74* (1.36, 2.23)	1.40* (1.08, 1.80)	1.25 (0.98, 1.57)
Major life events†			
Got back with husband/partner	1.35 (0.96, 1.90)	1.75* (1.26, 2.81)	0.77 (0.57, 1.05)
Had problems with parents/in-laws	1.33* (1.05, 1.70)	1.16 (0.91, 1.48)	1.15 (0.91, 1.46)
Husband/partner changed jobs	0.82 (0.60, 1.12)	1.17 (0.87, 1.57)	0.70* (0.52, 0.95)
Was arrested	0.82 (0.42, 1.59)	1.52 (0.86, 2.70)	0.54* (0.29, 0.99)
Took out mortgage/loan	0.49* (0.32, 0.78)	0.89 (0.62, 1.37)	0.55* (0.35, 0.89)
Suffered major injury/accident/illness	1.78* (1.15, 2.75)	1.67* (1.07, 2.55)	1.07 (0.73, 1.57)
Was in physical fight	1.58* (1.08, 2.32)	1.30 (0.88, 1.93)	1.22 (0.85, 1.74)
Close family member died	0.70* (0.52, 0.95)	0.96 (0.73, 1.27)	0.73* (0.54, 0.99)
Pregnancy attitude/intention			
Unhappy about pregnancy	1.50* (1.14, 1.97)	1.37* (1.04, 1.80)	1.10 (0.85, 1.42)
Unsure wanted to be pregnant	1.44 (0.99, 2.08)	1.17 (0.80, 1.71)	1.23 (0.86, 1.76)
Pregnancy denial	1.73* (1.28, 2.34)	1.26 (0.92, 1.73)	1.37* (1.03, 1.82)
Unintended pregnancy	0.85 (0.69, 1.04)	0.90 (0.74, 1.10)	0.94 (0.77, 1.15)
Mistimed pregnancy	0.82 (0.67, 1.00)	0.79* (0.65, 0.96)	1.03 (0.85, 1.26)
Unwanted pregnancy	1.08 (0.83, 1.42)	1.27 (0.97, 1.65)	0.86 (0.66, 1.11)

*Statistically significant at $p < .05$. †Only major life events with statistically significant odds ratios are included in this table.

Table 4. Adjusted odds ratios (and 95% confidence intervals) of selected birth-weight comparisons, by effects of stress, major life events and pregnancy attitudes and intentions

Factor	Very low vs. normal	Moderately low vs. normal	Very low vs. moderately low
Stress			
Almost always felt stress	1.57* (1.21, 2.05)	1.26 (0.97, 1.64)	1.21 (0.94, 1.55)
Major life events†			
Got back with husband/partner	1.37 (0.94, 1.99)	1.69* (1.19, 2.41)	0.82 (0.59, 1.14)
Took out mortgage/loan	0.54* (0.33, 0.88)	0.94 (0.62, 1.44)	0.60* (0.36, 0.98)
Suffered major injury/accident/illness	1.70* (1.02, 2.81)	1.71* (1.04, 2.80)	0.99 (0.65, 1.51)
Was in physical fight	1.63* (1.06, 2.50)	1.19 (0.77, 1.85)	1.35 (0.91, 2.00)
Close family member died	0.69* (0.50, 0.96)	0.88 (0.65, 1.18)	0.75 (0.56, 1.07)
Pregnancy attitude/intention			
Unhappy about pregnancy	1.39* (1.03, 1.89)	1.21 (0.97, 1.73)	1.08 (0.82, 1.43)
Pregnancy denial	1.67* (1.20, 2.32)	1.70 (0.86, 1.67)	1.41* (1.04, 1.91)
Mistimed pregnancy	0.79* (0.63, 0.96)	0.75* (0.61, 0.93)	0.85 (0.85, 1.29)

*Statistically significant at p<.05. Notes: All analyses are adjusted for education, Medicaid status, marital status, health during pregnancy, inadequate prenatal care, no previous live birth, smoking and type of survey. Only variables that were statistically significant in at least one birth-weight comparison are shown in this table.

longer significantly related to comparisons of very low birth weight to moderately low birth weight. The other relationships remained unchanged in direction or in magnitude. Although the odds ratios were slightly different in the adjusted models, the point estimates of the adjusted odds ratios fell into the confidence intervals of the unadjusted odds ratios.

Stepwise Model

We tested the question of whether the addition of major life events and measures of pregnancy attitude or intentions changed the associations between perceived stress and birth-weight outcomes by running stepwise logistic models for each comparison (Table 5). Stress remained statistically significant and essentially unchanged in its relationship to very low birth weight compared with normal birth weight (odds ratio, 1.6), indicating an independent relationship of stress with very low birth weight.

There were some changes in the associ-

ations of birth-weight outcomes and major life events after both stress and attitudes and intentions were included in the models. One life event—being in a physical fight—was no longer significant in any of the birth-weight comparisons. Additionally, the relationship between major injury, accident or illness dropped out of the model for moderately low birth weight compared with normal birth weight. All other relationships with major life events remained unchanged by their inclusion in the complete adjusted models.

The attitude measure of unhappiness about the pregnancy dropped out of the model comparing very low birth weight with normal birth weight when stress, pregnancy denial and mistimed pregnancy were included. Although it was not significant in the adjusted model for moderately low birth weight compared with normal birth weight, the measure of unhappiness reached significance in the final model: Women who were unhappy about their pregnancy were about one-third more

likely to have a moderately low birth weight baby than to have a normal-birth-weight infant (odds ratio, 1.3). The associations with birth-weight outcomes for both pregnancy denial and mistimed pregnancy remained statistically the same even after the additional measures were included. This consistency indicates that the variables are not confounded; also, because they did not change after the control variables were introduced, each is an independent factor for birth-weight outcomes.

Several factors had a seemingly protective effect against very low birth weight. The results of the stepwise logistic regression indicate that having taken out a mortgage or loan reduced the odds of very low birth weight in both comparisons (0.5–0.6). Moreover, having a close family member die decreased the odds of a very low birth weight baby compared with a normal-birth-weight baby (0.7). Having a mistimed pregnancy was associated with lower odds of very low birth weight versus normal birth weight and of moderately low versus normal birth weight (0.8). Finally, Medicaid recipients had reduced odds of very low birth weight in each of the comparisons (0.6).

Discussion

The risk of very low birth weight appears to be associated with perceived stress during pregnancy, and some factors that might lead to stress, including major life events and pregnancy attitudes, seem to be independent risk factors for low birth weight. Our finding that women’s perception of stress during pregnancy is associated with an increased risk of very low birth weight supports earlier research relating stress with low birth weight and preterm delivery. Another study of psychosocial factors and preterm delivery showed that women who report stress during their pregnancies were 1.5 times as likely as those who do not to experience preterm delivery,²² a finding consistent with ours. Further, there may be a biological explanation for the relationship between stress and early birth, in that hormones excreted in response to stress affect uterine activity that may cause premature contractions and delivery.²³

The relationship between stress and birth outcomes seen in our study is moderate in size, but is not much smaller than the effect of many biological risk factors for low birth weight. The etiology of both low birth weight and preterm delivery is complex. No single factor explains most of the variance in the rates of these birth outcomes; instead, many biological, behav-

Table 5. Adjusted odds ratios (and 95% confidence intervals) from stepwise logistic regression analysis of factors affecting birth weight, by birth-weight comparison

Factor	Very low vs. normal	Moderately low vs. normal	Very low vs. moderately low
Almost always felt stress	1.58 (1.21, 2.07)	ns	ns
Got back with husband/partner	ns	1.74 (1.22, 2.46)	ns
Took out mortgage/loan	0.52 (0.32, 0.86)	ns	0.59 (0.36, 0.96)
Had major injury/accident/illness	1.74 (1.05, 2.90)	ns	ns
Close family member died	0.67 (0.49, 0.93)	ns	ns
Unhappy about pregnancy	ns	1.33 (1.00, 1.78)	ns
Pregnancy denial	1.55 (1.11, 2.15)	ns	1.41 (1.04, 1.90)
Mistimed pregnancy	0.76 (0.61, 0.94)	0.78 (0.64, 0.96)	ns
Poor health during pregnancy	6.14 (3.47, 10.87)	2.39 (1.29, 4.43)	2.73 (1.83, 4.01)
Medicaid	0.56 (0.44, 0.72)	ns	0.61 (0.48, 0.76)
Smoked during pregnancy	1.29 (1.02, 1.62)	2.01 (1.61, 2.50)	0.66 (0.54, 0.83)
Marital status (unmarried)	1.63 (1.26, 2.09)	ns	1.34 (1.06, 1.69)
No prior pregnancy	1.46 (1.18, 1.81)	1.37 (1.11, 1.69)	ns

Note: Final stepwise models for each birth-weight comparison include only the variables that were statistically significant at p<.05.

ioral and social factors work together.

Inadequate prenatal care has been found to be a major risk factor for low birth weight.²⁴ In previous studies, perceived stress,²⁵ pregnancy attitudes²⁶ and pregnancy intention²⁷ have been shown to be associated with an increased risk of inadequate prenatal care. In this article, however, we found that including both stress and pregnancy attitudes and intentions and controlling for the adequacy of prenatal care leaves use of prenatal care no longer statistically significant. The finding of a relationship of stress to very low birth weight appears to be independent of use of prenatal care, although stress may well be a factor that moderates the use of care.

As a first step, we examined the association between perceived stress and 30 major life events, finding a strong relationship between perceived stress and all but four of the events. While our survey did not inquire about causality, one can infer that at a minimum, stress is exacerbated by the occurrence of major life events. Two events in our final model were found to have a protective effect: taking out a mortgage or loan, and having a close family member die. The first is related to future planning, and may be coupled with similar activities related to preparing for a larger family, such as good self-care. Further, low socioeconomic status is a risk factor for low birth weight,²⁸ and taking out a mortgage may indicate higher income. In these data, there is no way to separate a loan from a mortgage, so we are unable to assess whether there may be different effects from incurring other types of debt.

The association with the death of a close family member and a reduced risk of having a very low birth weight infant may seem surprising. We suggest two possible explanations for this finding. First, when such a person dies, family members often gather and offer one another support. Such support may extend to other types of social support, and may encourage a pregnant woman to care for herself and her developing baby. Second, a woman who experiences a death in her family may seek meaning in the event, may come to view her developing fetus as a replacement for the lost family member and thus may take extra efforts to ensure the infant's health. One researcher points out in a recent article that adverse events bring forth a need for support from others, and notes that people seek meaning in adversity and will act to make positive changes in their lives as a result of the event.²⁹ Re-

searchers may want to investigate this area in subsequent studies.

An unexpected finding is the apparent (though small) protective factor on low birth weight of having a mistimed pregnancy. This finding is not easily explainable, and points to the need for a more informed understanding of the meaning of pregnancy intention, including issues regarding timing. Research on mistimed pregnancy has shown that the extent of mistiming varies widely, that it is often moderate and that serious mistiming occurs primarily among younger, never-married and poorer women.³⁰

Pregnancy denial was an important factor in the risk of very low birth weight, when compared with either normal birth weight or moderately low birth weight. Women who deny their pregnancies are less likely to seek early prenatal care and are less likely to obtain adequate care once they enter care.³¹ Though use of prenatal care was not statistically related to birth-weight outcomes in this article, use of care may reflect a woman's attitudes and feelings about her pregnancy. A woman who denies her pregnancy not only may be less likely to receive good care, but may also be less likely to make lifestyle changes that would improve the outcome of her pregnancy. Such changes include quitting smoking and alcohol consumption, improving her diet and exercise, and reducing stress. Women who do not recognize their pregnancies would be far less likely to take these measures than those who do.

Limitations of the Analysis

Retrospective studies are prone to recall bias, and this is one major limitation to our study. In particular, women who have had an adverse birth outcome such as very low or moderately low birth weight may be more likely to recall both stress during pregnancy and major stressful life events, as a way of explaining the birth outcome. Conversely, women with a poor birth outcome may feel guilty and may be less likely to admit having negative attitudes about the pregnancy. Even women who had a healthy, normal baby may hesitate to express their initial reservations about their pregnancy.

Responses could also vary with the length of time postpartum, and this might have influenced the results of our analyses, given that some surveys were completed soon after delivery while others were completed up to six months postpartum. Although this represents an inconsistency in the study methodology, we tried to address the time-lag problem by

controlling for data collection method. Notably, this variable was not statistically significant, indicating that there was no difference in the associations between women from whom data were collected later rather than sooner.

The lack of a time frame for the question, "How did you feel about being pregnant during your recent pregnancy?" is another limitation. Women's responses were assumed to reflect an overall feeling during pregnancy, but we do not know if they actually represented feelings at a particular time in the pregnancy. Future research would be strengthened if several questions were asked about women's feelings about the pregnancy rather than one. For example, respondents might be asked how they felt when they first found out they were pregnant, how their feelings about the pregnancy may have changed while they were pregnant, and when such changes may have occurred.

For some women, the pregnancy denial variable was based on their not knowing that they were pregnant. A total of 126 women who were classified as having pregnancy denial stated that they did not know they were pregnant. Although many of these women also indicated that they did not want others to know that they were pregnant or that they did not want to think about being pregnant, others did not. While it may be normative not to know at first that one is pregnant, we classified it as pregnancy denial because this lack of knowledge extended long enough to present a barrier to obtaining prenatal care. To the extent that some women who were classified as denying their pregnancy may not have done so, this produces a more conservative estimate for the risk of low birth weight associated with pregnancy denial.

Some questions used in this analysis were complex and may not have covered important issues. For example, there was no specific information about the character of injuries that women incurred. The one question about injury was grouped with accidents and illnesses not related to pregnancy. There was no question about a history of violence or victimization, including abuse by an intimate partner. The question that came closest to this concept was the major life event "I was in a physical fight," and it is possible that women who identified a "major personal injury, accident or illness" as a major life event experienced injury as the result of violence. Without clear data, however, we cannot assess if domestic violence represented a significant risk factor for poor birth outcomes.

Gestational age is generally the most important predictor of birth weight, but we could not differentiate between being born preterm and being small for gestational age, which may have different correlates. Very low birth weight is primarily a function of preterm birth, while moderate low birth weight includes both preterm birth and small size for gestational age. We did not stratify by gestational age because we stratified by birth weight, and because the purpose of the MMIHS was to identify risk factors for very low birth weight. However, since the etiology of preterm birth is less well-understood than for low birth weight in general, the lack of differentiation is a shortcoming of this analysis. In addition, because preterm birth and small size for gestational age were grouped together by birth weight, we were unable to assess whether perceived stress and major life events influenced either preterm delivery or small size for gestational age.

Implications

Given the effects of perceived stress on birth weight, interventions that focus on stress reduction and that address the effects of major life events and pregnancy attitudes may be an important method of reducing very low birth weight. An initial psychosocial assessment of pregnant women should include their level of stress, life circumstances, and attitudes and intention about the pregnancy. Appropriate service plans should be developed with the women to address issues that contribute to stress. Providing psychosocial services on a regular basis has been shown to be associated with a reduced risk of low birth weight and preterm birth.³²

Despite our finding that mistimed pregnancy is associated with a slightly reduced risk of adverse outcomes, other pregnancy intention studies³³ point to the need to improve access to and use of contraceptive methods for all women. All health and social service providers should be knowledgeable about family planning resources and be prepared to assist women to use them.

Our results have implications for health and social service providers who work with any pregnant woman, not only for those working in prenatal care settings.

Service providers for young families are likely to work with pregnant women or women who may become pregnant in the future and may have an opportunity to affect the outcomes of the pregnancies of those women.

Interventions with pregnant women, including those that assess stress and pregnancy attitudes, have the potential to improve pregnancy outcomes. Additional prospective research with pregnant women on the origins and effects of stress, including the biological effects of stress, are needed to further our understanding of the mechanisms behind low birth weight and to thereby enhance preventive interventions.

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