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The Relationship Between Individual Life Events and Preterm Delivery

Nedra Whitehead

Abstract

Stressful life events have been associated with preterm delivery in some studies but not in others. One cause of this inconsistency may be that different life events have different effects. The author used data collected by the Pregnancy Risk Assessment Monitoring System, a survey of American women with a recent live birth, for 1990–1995 to examine the relationship between individual life events and the risk of preterm delivery overall and by levels of severity. Four events of the 18 examined were associated with an increased risk of at least one category of preterm delivery: being in debt, being injured by a partner, having someone close attempt suicide, and being divorced. Women who reported being in debt had an increased risk of preterm delivery overall and for each level of severity. One event, having a partner who lost his (or her) job, was associated with a decreased risk of preterm delivery. These results provide some support for the theory that increased stress from life events causes preterm delivery. The lack of a pattern by type of stress, expected stressfulness, or severity of prematurity are hard to reconcile with those theories, however.

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Introduction

Stress has long been believed to precipitate delivery, and similarities between physiologic responses to stress and the initiation of labor support that belief. Physical or psychological stress activates the hypothalamic-pituitary-adrenal (HPA) axis[1,2] and the release of corticotrophin-releasing hormone (CRH) from the hypothalamus. CRH, which rises during the last few weeks of pregnancy, promotes prostaglandin production and, by priming the uterus to respond to oxytocin, cervical softening and uterine contractions.[2]

A recent Institute of Medicine report reviewed studies of the relationship between experiencing life events and preterm birth.[3] The authors concluded that the evidence was consistent with an association between major life events and preterm birth but that the evidence was not uniform. Three of the eight studies they reviewed found no association between stressful life events and preterm delivery.[4-6] The other five found that some aspect of experiencing life events was associated with preterm delivery, although the association was sometimes limited to a subset of women in the study.[7-11] Earlier studies were similar, with some studies finding an association,[12-15] whereas others did not.[5,16-18]

The lack of reproducibility in the association of stressful life events and preterm delivery, even when the same study design is applied to different cohorts, makes it difficult to identify which women who experience stress may be at increased risk of preterm delivery. Although previous studies have found that events were associated with preterm delivery only if women consider them highly stressful[19] or negative,[8] whether some events are considered highly stressful or negative by most or all women or whether life events affect individual women differently is not yet clear. Women may also react to events differently at different points in pregnancy; women who were in early pregnancy at the time of an earthquake found it more stressful than women whose pregnancy was further along.[20] Information on which life events drive associations with preterm delivery may help identify which women are most at risk from stress, but this requires breaking life event scales down into their component parts. Some studies have examined the effect of a single life event, but studies of single events cannot explore or control for clustering among events.[21-23] Clustering may be addressed by using methods such as principal components analysis to group life events into related groups. One study grouped events from a 13-item stress inventory and behavioral factors into four types of emotional stress and considered these as risk factors in a study of the association between multiple risk factors and small-for-gestational-age birth. That study found that women who experienced multiple risk factors were more likely to deliver a small-for-gestational-age infant, although the association was driven primarily by the woman's smoking behavior.[24]

In a previous analysis of these data, I and others found an inconsistent relationship between the number of life events women experienced and the risk of preterm delivery between two cohorts.[9] In the 1990–1993 birth cohort, multiparous women who experienced five or more stressful life events were more likely to deliver preterm, but there was no association among primiparous women. In the 1994–1995 birth cohort, life events and preterm birth were not associated among multiparous women, but primiparous women who experienced two or more stressful life events were more likely to deliver preterm. In this study, I investigate whether individual events affect preterm delivery.

Materials and Methods

Study Design and Population

I used data from the Center for Disease Control and Prevention's Pregnancy Risk Assessment Monitoring System (PRAMS). Since its inception, PRAMS has maintained a similar study design and protocol, which has been described in detail elsewhere.[25-27] Briefly, PRAMS draws a monthly sample of live births from the state birth certificate file using a single-stage stratified systematic sample. Each state chooses one or two stratification variables from those available on the state birth certificate file. The sample designs under which these data are collected uses maternal race, maternal age, adequacy of prenatal care, or birth weight as stratification variables. Annual state samples range from 1,500 to 3,000, and women from high-risk populations are oversampled. Many states oversample women who have given birth to low-birth-weight infants, enriching the sample of preterm births.

Women are mailed a self-administered questionnaire 2 to 6 months after delivery. Multiple mail contacts of different types are made, following Dillman's Total Design Method,[28] and nonrespondents are contacted by telephone. In addition to data from the PRAMS questionnaire, the PRAMS data set contains selected information from the infant's birth certificate and information on the timing and mode of data collection. Data are weighted to account for sampling design, nonresponse, and noncoverage. The mailing packet and telephone scripts include information on the purpose and goals of PRAMS and indicate that consent is voluntary. Consent is implied by returning the questionnaire or agreeing to proceed with the interview. PRAMS has been reviewed and approved by an institutional review board at the Centers for Disease Control and Prevention. More information on PRAMS is available on the Web site at www.cdc.gov/prams.

I analyzed data from singleton births that occurred from 1990 through 1995 in Alabama, Alaska, Florida, Georgia, Indiana, Maine, Michigan, New York, Oklahoma, South Carolina, and West Virginia. These states were chosen because they collected data for some or all of the birth years included and achieved a combined response rate of at least 70 percent for the included years. The birth years chosen encompass the time the second version of the PRAMS questionnaire was in the field. Of the 94,561 women in the sample, 70,840 women responded to the survey (response rate: 75 percent).

Variables

I measured stressful life events using an 18-item subset[9] of the Modified Life Events Inventory.[29] The events include legal conflicts, changes in relationships, financial difficulties, physical conflicts, and family illness or death.

Information needed to determine gestational age (infant's birth data, date of last menstrual period [LMP], and clinical estimate [CE] of gestational age) was taken from the birth certificate. Gestational age was calculated using the composite of LMP and CE described by Alexander et al.[30] LMP age was used if LMP age and CE age differed by no more than 13 days, and CE age was used if LMP age was unknown or differed from CE age by 14 or more days. If neither LMP nor CE age was available, gestational age was calculated from the mother's due date reported on the questionnaire. Observations were dropped if the birth weight–gestational age combination was implausible based on the birth weight for gestational age ranges reported by Adams et al.[31] Gestational age was available for 69,574 (98.2 percent) of the infants of study respondents and was determined from LMP for 57,312 (80.9 percent), from CE for 9,545 (13.5 percent), and from delivery due date for 2,717 (3.8 percent) infants.

Preterm delivery was defined as birth at a gestational age of less than 37 weeks. Severity of prematurity was classified as follows: borderline as 35 to 36 weeks of gestation; moderate as 33 to 34 weeks; and very preterm as less than 33 weeks.

Mother's race, age, education level, marital status, and parity were obtained from the infant's birth certificate. Pregnancy history (any previous live birth and whether the infant was low birth weight or preterm), source of income, and tobacco and alcohol use were obtained from the PRAMS questionnaire. Tobacco and alcohol use were available for the 3 months before pregnancy and the last 3 months of pregnancy. For both time periods, smoking was grouped into six categories of cigarettes smoked per day: none, 1 to 9, 10 to 19, 20 to 29, 30 to 39, or 40 or more. Alcohol use was grouped into five categories of drinks had per week: none, 1 to 2, 3 to 7, 8 to 14, or 15 or more. Income from public aid was included as a measure of socioeconomic status. Women were considered as having income from aid if they indicated that one source of family income was aid, such as Aid to Families with Dependent Children, welfare, public assistance, general assistance, food stamps, or Supplemental Security Income.

Analytic Methods

SUDAAN software, version 7.0, was used to account for the disproportionate stratified sampling when calculating the characteristics of the overall population represented by the study, the prevalence of each event, and the unadjusted risk ratio for preterm delivery among women who experienced each event. The sampling within each stratum is a simple systematic sample. The purpose of the logistic regression was to examine the relationships

between stress and preterm delivery in groups of individuals rather than to weight the sample so it was proportionally representative of the source population. Because the stratification variables (except for low birth weight) used in the sample design were all included in the regression model as covariates, the modeling analysis essentially controls for the original sampling design. Hence, as in our earlier analysis,[9] we followed the course suggested by Groves[32] and did not adjust for the sample design or weighting in the modeling analysis. We conducted the modeling analyses using SAS software, version 6.

A model with all the life events, potential confounders, and potential interactions terms would not converge, so we modeled the relationship of each life event individually with preterm delivery to determine potential confounding variables and interactions. Each model included the event, the potential confounders, and interaction terms between the event and each potential confounder except the state of residence. The characteristics considered to be potential confounders were maternal age, race, education, marital status, receipt of income from public assistance, and state of residence; tobacco use in the 3 months before or the last 3 months of pregnancy; alcohol use in the 3 months before or the last 3 months of pregnancy; and pregnancy history. Interaction terms were tested as a group first. If the grouped test was significant at the p = .05 level, each interaction was tested individually and kept if it was significant. A variable was considered a confounder and kept in the model if it changed the odds ratio for any event by 10 percent or more. Variables identified as confounders or effect modifiers in the single event models were included initially in the multiple event model and then tested again.

The final model contained all 18 stressful life events, race, receipt of income from public assistance, state of residence, use of tobacco or alcohol in the 3 months before and the last 3 months of pregnancy, and pregnancy history. No interactions were significant in the final model. The same independent variables were used in logistic regression models to examine the association between the life events and severity of preterm delivery. Separate models for each level of severity were fit because the proportional odds assumption for the ordinal logistic model was rejected. We use adjusted odds ratios to estimate the adjusted risk ratio. Although an odds ratios overestimates the corresponding risk ratio, the amount of bias is related to the prevalence of the disease.[33] Because preterm delivery occurred in less than 10 percent of singleton births during the study period, we consider the bias in this approach to be small.

Results

Twenty-six percent of the respondents with known gestational age delivered preterm, reflecting the oversampling of low-birth-weight infants (Table 1). The majority of women in the study were white (67 percent), nonsmokers before (65 percent) and during pregnancy (76 percent; not shown in table), and nondrinkers before (56 percent) and during pregnancy (91 percent; not shown in table); did not receive income from public assistance (69 percent); and were either primiparous (45 percent) or had a previous full-term infant of normal birth weight (41 percent). The prevalence of the studied life events ranged from 0.4 percent (death of a partner) to 31.7 percent (family member ill) (Table 2).

Before adjusting for confounding, all except five events (having one or two relatives ill, having a friend or family member [including a partner] die, and being divorced) were associated with an increased risk of preterm delivery (Table 2). After controlling for race, maternal age, socioeconomic status, tobacco or alcohol use, pregnancy history, and state of residence, however, only two events, being in debt and being injured by a partner, were still associated with an increased risk of preterm delivery. Having a partner who lost his or her job was associated with a decreased risk of preterm delivery (odds ratio [OR]: 0.92, 95% confidence interval [CI]: 0.86 to 0.98).

Being in debt was associated with preterm delivery overall and with the earliness of delivery. Women who reported being in debt were 9 percent more likely to deliver at 35 to 36 weeks of gestation, 14 percent more likely to deliver at 33 to 34 weeks, and 16 percent more likely to deliver at less than 33 weeks (Table 3). The increased risk of preterm delivery associated with being injured by a partner was limited to delivery at 33 to 34 weeks (OR:

Table 1. Characteristics of sample, respondents, and represented population: United States, 1990–1995

Characteristic	Sample (94,561)		Respondents (70,840)		Population[a]
	Number	Percent	Number	Percent	Percent
Gestational age					
<33 weeks	9,334	9.9	6,724	9.5	4.7
33–34 weeks	5,372	5.7	3,895	5.5	1.4
35–36 weeks	8,861	9.4	6,511	9.2	3.8
37 weeks or older	61,810	65.4	47,921	67.6	90.1
Missing	9,184	9.6	5,789	8.2	NA
Maternal race					
White	59,717	63.2	47,649	67.3	77.1
Black	24,658	26.1	16,226	22.9	19.3
Native American	7,819	8.3	5,341	7.5	1.6
Asian/Pacific Islander	1,185	1.2	834	1.2	1.4
Missing	1,182	1.2	790	1.1	0.6
Tobacco use in 3 months before pregnancy[b]					
None			46,329	65.4	68.9
1–9/day			4,468	6.3	5.6
10–19/day			5,815	8.2	7.4
20–29/day			8,182	11.6	11.1
30–39/day			1,594	2.3	1.9
40 or more/day			1,817	2.6	2.1
Missing			2,635	3.6	3.0
Alcohol consumption in 3 months before pregnancy[b]					
None			39,365	55.6	52.2
1–2/week			20,380	28.8	32.7
3–7/week			5,773	8.2	8.7
8–14/week			1,198	1.7	1.7
15/week or more			582	0.8	0.8
Missing			3,542	5.0	4.0
Income from aid[b]					
Yes			21,858	30.9	25.9
No			48,903	69.0	74.0
Missing			79	0.1	0.1
Pregnancy history[b]					
No previous birth			31,856	45.0	43.4
Previous full-term birth, normal birth weight			29,305	41.4	46.9
Previous birth, low birth weight			1,570	2.2	1.5
Previous birth, preterm			2,546	3.6	2.8
Previous birth, low birth weight and preterm			3,645	5.1	2.7
Missing			1,918	2.7	2.7
State					
Alabama	7,140	7.6	5,345	7.5	6.9
Alaska	13,758	14.6	10,075	14.2	2.3
Florida	8,406	8.9	6,606	9.3	19.7
Georgia	7,408	7.8	5,332	7.5	12.0
Indiana	6,859	7.3	4,854	6.9	9.0
Maine	6,964	7.4	5,628	7.9	2.9
Michigan	6,041	6.4	4,807	6.8	14.8
New York	5,173	5.5	3,780	5.3	14.2
Oklahoma	13,182	13.9	9,640	13.6	9.1
South Carolina	7,950	8.4	5,575	7.9	5.2
West Virginia	11,680	12.4	9,198	13.0	4.0

[a] Estimated percent weighted to represent population. Numbers may not add to 100% due to rounding. Participants who were missing gestational age were excluded from the analysis.

[b] Data from questionnaire. Not available for nonrespondents.

Source: Pregnancy Risk Assessment Monitoring System

1.28, 95% CI: 1.06 to 1.55). Two events that were not associated with preterm delivery overall were associated with an increased risk of one level of preterm delivery. Having someone close who attempted suicide was associated with a 22 percent increased risk of delivering at 35 to 36 weeks but not at earlier gestations. Being divorced was associated with an increased risk of a very preterm delivery (OR: 1.34, 95% CI: 1.11 to 1.62), and a nonsignificant increase in risk for a moderate preterm delivery (OR: 1.23, 95% CI: 0.97 to 1.56).

Discussion

Four events of the 18 examined here were associated with an increased risk of some level of preterm delivery: being in debt, being injured by a partner, being divorced, and having someone close attempt suicide. The association with being in debt, which was associated with preterm delivery overall and each level of severity, was most consistent. One event, having a partner who lost his or her job, was associated with a decreased risk of preterm delivery.

Table 2. Prevalence of stressful life events and their association with preterm delivery: United States, 1990–1995

Event	Number[a]	Prevalence of Event (%)[b]	Unadjusted RR	95% CI	Adjusted[c] OR	95% CI
Financial						
In debt	12,061	16.6	1.20	1.09–1.33	1.13	1.07–1.20
Loss of job (self)	6,947	10	1.25	1.11–1.41	1.03	0.96–1.10
Loss of job (partner)	9,191	12.5	1.13	1.01–1.27	0.92	0.86–0.98
Becoming homeless	2,425	3	1.57	1.28–1.93	1.06	0.94–1.19
Illness/death						
1 family member ill	9,187	31.7	1.01	0.93–1.09	0.95	0.90–1.00
2 family members ill	11,220	16.2	0.99	0.90–1.10	0.99	0.93–1.06
Drug/alcohol problem (someone close)	12,812	16.3	1.17	1.06–1.30	1.00	0.94–1.06
Suicide attempt (family member)	2,191	2.5	1.43	1.17–1.75	1.07	0.95–1.21
Death of a friend	6,414	8.4	1.14	1.01–1.28	0.99	0.92–1.06
Death of a family member	13,384	18.4	1.03	0.94–1.13	0.96	0.91–1.02
Death of partner	390	0.4	1.12	0.70–1.78	0.82	0.60–1.12
Injury						
In a fight	6,092	7.5	1.48	1.30–1.68	1.07	0.98–1.17
Injured by partner	3,877	4.8	1.37	1.15–1.63	1.14	1.02–1.27
Legal matters						
Arrest	1,162	1.5	1.43	1.09–1.88	1.03	0.84–1.26
Conviction	868	1.1	1.68	1.24–2.29	1.02	0.81–1.29
Partner in jail	3,928	5.2	1.37	1.17–1.60	0.98	0.89–1.08
Relationship						
Separation from partner	12,962	16.6	1.36	1.24–1.49	1.01	0.96–1.07
Divorce	1,604	2	1.25	0.99–1.57	1.14	0.99–1.30

RR = relative risk; CI = confidence interval; OR = odds ratio

[a] Number of women who reported event.

[b] Percentage of population who reported event.

[c] All events yes or no, reference no; adjusted for income from aid, reference no; tobacco use and alcohol use before pregnancy, reference none; maternal race, reference white; pregnancy history, reference previous birth, not low birth weight or preterm delivery; US state: categorical, reference Alabama.

Source: Pregnancy Risk Assessment Monitoring System

These findings provide little support for a general hypothesis that stressful life events cause preterm delivery. If such events had a biological, causal effect on preterm delivery, the effect should be consistent in magnitude and direction for events of the same type and severity. Most events were not associated with preterm delivery at all; the odds ratios were very close to 1, with narrow confidence intervals. The four events associated with preterm delivery are not similar in type of stress or expected severity. It is unclear why women who reported that their partners lost their jobs would have a decreased risk of preterm delivery. Although women who do not have partners or whose partners do not have jobs may be at higher risk, most women in this study were married, and only 31 percent received income from public assistance.

Other explanations for the study findings are possible. Previous research has shown that most life events are strongly related to socioeconomic status.[9] Thus, the associations found may be caused by incomplete control of confounding by socioeconomic status, an idea supported by the fact that two of

Table 3. Adjusted relationship of stressful life events to severity of preterm delivery: United States, 1990–1995

	35–36 weeks		33–34 weeks		<33 weeks	
Event	OR	95% CI	OR	95% CI	OR	95% CI
Financial						
In debt	1.09	1.00–1.18	1.14	1.03–1.27	1.16	1.07–1.26
Loss of job (self)	1.04	0.94–1.15	1.04	0.92–1.18	1.02	0.93–1.13
Loss of job (partner)	0.92	0.83–1.01	0.94	0.83–1.05	0.91	0.83–1.01
Becoming homeless	1.07	0.91–1.27	1.01	0.81–1.25	1.01	0.85–1.20
Illness/death						
1 family member ill	0.95	0.88–1.03	0.92	0.83–1.01	0.96	0.89–1.04
2 family members ill	0.99	0.90–1.08	1.03	0.92–1.16	0.97	0.87–1.07
Drug/alcohol problem (someone close)	0.99	0.91–1.08	1.00	0.90–1.12	1.00	0.92–1.09
Suicide attempt (family member)	1.22	1.03–1.44	0.93	0.74–1.17	0.99	0.82–1.19
Death of a friend	1.06	0.96–1.18	1.12	0.98–1.27	0.85	0.76–0.94
Death of a family member	0.99	0.92–1.07	0.98	0.89–1.08	0.92	0.85–1.00
Death of partner	0.83	0.53–1.30	0.78	0.44–1.40	0.89	0.56–1.42
Injury						
In a fight	1.10	0.97–1.25	0.99	0.84–1.16	1.07	0.95–1.22
Injured by partner	1.05	0.90–1.23	1.28	1.06–1.55	1.12	0.96–1.31
Legal matters						
Arrest	1.08	0.80–1.46	0.95	0.65–1.40	1.02	0.76–1.37
Conviction	0.83	0.58–1.18	1.09	0.71–1.67	1.12	0.80–1.56
Partner in jail	1.04	0.90–1.19	0.91	0.76–1.08	0.99	0.86–1.13
Relationship						
Separation from partner	1.03	0.95–1.12	0.99	0.89–1.10	1.00	0.92–1.08
Divorce	0.95	0.77–1.17	1.23	0.97–1.56	1.34	1.11–1.62

OR = odds ratio; CI = confidence interval

Note: All events yes or no, reference no; adjusted for income from aid, reference no; tobacco use and alcohol use before pregnancy, reference none; maternal race, reference white; pregnancy history, reference previous birth, not low birth weight or preterm delivery; US state: categorical, reference Alabama.

Source: Pregnancy Risk Assessment Monitoring System

the events (being in debt and having a partner lose a job) are financial stressors. The associations may also be caused by factors such as drug use, for which I lacked information and could not control. I also lacked information on factors such as social support or coping style, which might modify the effect of life events.

This study has additional limitations that may be responsible for the inconsistent effects between similar life events. The PRAMS stress measure is limited, and women may have experienced other stressful events that affected the relationship of the studied events with preterm delivery. I did not have any information on the timing of the events within the year before birth or on mothers' perceptions of the stressfulness of the events. Differences in these factors could affect the association between stressful life events and preterm delivery.[8,19,20] Finally, the data are collected after birth, and women may have forgotten some events or may have reported events that occurred after birth. These limitations would tend to bias my results toward a lack of association, but the bias would have to be substantial to explain the lack of association between the stressful life events studied and preterm delivery.

Some of my findings are consistent with other studies, but others are not. Hedegaard et al. found a significant association between substantially decreased income and preterm delivery and a large, but not significant, estimated association with physical cruelty.[19] Hedegaard et al. also found a nonsignificant effect with becoming homeless and with being in a fight, which were not associated with preterm delivery in my study. As I did, Cepicky and Mandys found that being widowed during pregnancy was not associated with gestational length.[22] My findings are also consistent with those of Ramsey et al., who found that financial stress was associated with decreased birth weight but that lifestyle, employment, and family stress were not.[34] The findings differ slightly from McFarlane et al., who found that abuse by a partner was not associated with birth weight after adjusting for tobacco and drug use.[23] I found physical abuse by a partner was associated with preterm delivery, but I did not have information on drug use, which may account for this finding.

In general, PRAMS data have not supported the hypothesis that stress is related to pregnancy outcome in the general population. My study provides weak support for an association of some individual life events with preterm delivery. Previous work found a relationship between the number of life events experienced and preterm delivery, but the effect was not consistent between cohorts.[9] Using a slightly different measure of stress, Ahluwalia et al. found an association between multiple psychosocial and lifestyle risks and small-for-gestational-age birth, but the predominant risk was smoking during pregnancy.[24] None of the four (emotional, financial, partner-related, and traumatic) types of stress studied was independently related to small-for-gestational-age birth. Lu and Chen examined the association between these four stress constructs and preterm delivery and found they were not associated with preterm delivery and did not contribute to racial disparities in preterm delivery.[6] However, life event stress may be associated with preterm delivery or small-for-gestational-age birth in some population subgroups, and other types of stress may be associated with pregnancy outcome.

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