# Employment, Job Strain, and Preterm Delivery among Women in North Carolina

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## ABSTRACT

*Objectives.* A population-based case–control study was conducted in central North Carolina to assess the relationship between occupational stress and preterm delivery.

*Methods.* Four hundred twenty-one women delivering infants before 37 weeks' gestation and 612 women delivering infants at term were interviewed a median of 6 months after delivery. Exposure information was collected for all jobs held for at least 1 month during pregnancy.

*Results.* Work in a "high strain" job (i.e., high demand and low control) was not associated with increased risk of preterm delivery compared with work in "low strain" jobs (all other combinations of job demand and control). Narrowing the exposure window to the third trimester did not modify the results. However, women who worked at a high-strain job full-time (odds ratio [OR] = 1.4, 95% confidence interval [CI] = 0.9, 2.0) or for 30 or more weeks (OR = 1.4, CI = 1.0, 2.2) had a modestly increased risk. Several analyses suggested that Black women were at greater risk from job strain than White women.

*Conclusions.* This study suggests that chronic exposure during pregnancy to work characterized by high demand and low control may be modestly associated with preterm delivery. (*Am J Public Health.* 1997; 87:199–204)


## *Introduction*

The United States has one of the highest infant mortality rates among industrialized nations, which is mainly attributable to the high proportions of preterm and low-birthweight infants.[1] Established risk factors provide an incomplete explanation of poor birth outcomes and have failed to motivate effective prevention programs. The proportion of women of reproductive age employed outside the home in the United States has increased substantially over the past 3 decades, even among women who are living with a partner,[2] prompting closer scrutiny of occupational risk factors for adverse pregnancy outcomes.

Participation in the paid workforce does not itself appear to be detrimental to pregnancy and may actually be associated with a reduced incidence of preterm delivery,[3,4] since women in the workforce generally have a more favorable sociodemographic risk factor profile for good health[5,6] as well as the expanded social support and access to medical insurance granted by outside employment. The absence of an association between employment per se and poor pregnancy outcomes has been found among women of both high[7] and moderate to low socioeconomic status.[4]

Psychosocial stress has been targeted as a potential risk factor for preterm delivery.[1] There have been a number of studies examining the relationship between nonoccupational stress, most often measured as the number of stressful life events, and poor pregnancy outcomes.[8] No clear association has emerged from this body of research; many of the studies have not controlled for other important risk factors or have used composite measures of adverse outcomes.[9]

Occupational stress has proven difficult to measure. One measure of occupational stress, the demand/control model, defines "job strain" as the response to jobs that have both high demands (e.g., a fast pace and high levels of expectations) and low job control (e.g., the command the worker has over the use of his or her abilities and the way in which work is accomplished).[10] Although this measure has most often been used in the analysis of heart disease, three studies of pregnancy have used job strain as an exposure variable. Two measured job strain by asking women about the conditions of their jobs,[11,12] but only one found an association with low birthweight (odds ratio [OR] = 1.86).[11] No association with any pregnancy outcome was found when job titles were used to assign job strain scores based on the average strain in a given occupation.[11,13]

Job strain may be associated with preterm delivery through two pathways. High-demand, low-control jobs have been found to increase the risk of hypertension[14–16] through the heightened production of catecholamines.[17] The increase in catecholamine levels appears to continue even after leaving work.[17] Although it is difficult to test for increased catecholamine levels, it has been suggested that they may be associated with preterm

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delivery.[8] In addition, hypertension itself appears to increase the risk of preterm delivery.[18,19] Job strain may also act indirectly by increasing women's level of cigarette smoking. Smokers have a higher risk than nonsmokers of delivering before 37 weeks' gestation,[20,21] and workers in high-strain jobs appear to both smoke more[22] and be less able to quit smoking.[23]

Black women in the United States are at approximately twice the risk of preterm delivery compared with White women.[24] Some but not all of the difference can be explained by socioeconomic differences,[25] leading some researchers to conclude that Black women are chronically exposed to higher levels of stressors that adversely affect their pregnancy outcomes.[26] Following this line of reasoning, it has been suggested that research should look for racial differences in the level and effect of stress on reproductive outcomes, specifically preterm delivery.

In this study, we investigate the association between occupational stress, as measured by self-reported job strain, and preterm delivery. This population-based case–control study was carried out in a region that is heterogeneous in terms of employment opportunity, social class, and race. This heterogeneity allowed for the study of this association across a wide distribution of job strain situations, as well as the study of the role of occupational strain in preterm delivery among Black and White women.

## Methods

The data for this analysis come from a case–control study carried out in Alamance, Durham, and Orange counties in central North Carolina to investigate the relationship between occupational exposures and several adverse pregnancy outcomes (low-birthweight delivery, preterm delivery, miscarriage, and stillbirth). All Black and White women at least 18 years of age delivering between September 1, 1988, and August 31, 1989, in hospitals serving Orange and Durham counties plus those delivering between September 1, 1988, and April 30, 1991, in hospitals serving Alamance County were eligible to be included in the study. Ninety-seven percent of the counties' residents delivered in these hospitals. Women who had multiple gestations (twins, triplets) or whose infants were put up for adoption were excluded. The eligible women who delivered low-birthweight (<2500 g) or preterm (<37 weeks' gestation) infants were selected as case patients. The next woman of the same race who delivered a normal-weight (≥2500 g), full-term (≥37 weeks' gestation) infant at that hospital was selected as the control patient. A higher proportion of Black women in the target population had low-birthweight or preterm infants, resulting in an overall effective sampling fraction for control patients of 0.165 for Black women and 0.066 for White women. Because the purpose of the current analysis is to estimate the risk of preterm delivery due to job strain, only the 575 women who delivered preterm infants (regardless of birthweight) were retained as case patients for this analysis, while the entire control group of 847 women was used to maximize precision of the estimates.[27]

Telephone interviews were attempted with all subjects after consent was obtained from the attending obstetricians. In-person interviews were used in the first year of the study for those unreachable by telephone. Interviews were conducted a median of 6 months after delivery. After permission was obtained, medical records were abstracted for complications of pregnancy.

Twelve percent of the subjects refused to be interviewed, and another 13% either could not be traced or were never available for the interview. Finally, language problems and other problems eliminated 1.5% of the subjects. Thus, successful interviews were conducted with 448 case patients (78%) and 650 control patients (77%). Participation was greater among White women (82%) than among Black women (73%); among women over 30 years of age (85%) than among women 18 through 29 years of age (75%); and among married or cohabitating women (83%) than among single women (73%). Response rates did not differ by hospital of delivery or pregnancy outcome (77% to 78% for both case and control patients). After removing subjects for whom one or more key items in the interview was missing, we retained 421 case patients and 612 control patients (73% and 72% of the initial sample, respectively).

### *Measurement of Employment and Job Strain*

All jobs, both paid and volunteer, held for at least 1 month during pregnancy were considered in this study. A total of 831 eligible women (case and control patients) worked outside the home for 1 month or more during pregnancy. Most women (79%) worked only in one job during this period, but some worked in two (19%), three (2%), or four (1 respondent) jobs. The mean length of time worked during pregnancy was 30 weeks.

Fourteen questions obtained from the Framingham Study version of the Job Content Survey instrument were asked to assess job strain (R. A. Karasek, Department of Industrial and Systems Engineering, University of Southern California, Los Angeles, unpublished job content questionnaire, 1985). Five questions measure psychological demand (job demand), amount of workload, and responsibility at work. Nine questions measure job decision latitude (job control), amount of decision-making latitude, creativity, clarity of work requirements, and control over the pace and content of work. Responses to each question, which ranged from "strongly agree" to "strongly disagree," were weighted and summed to total job demand and job control scores, ranging from 12 to 48.

Because control subjects in case–control studies are chosen to represent exposure in the source population,[28] the jobs held by control patients in this study were used to define median scores. However, Black women had a lower mean job control score (31.9; SD = 6.3) than did White women (35.7; SD = 7.0). The job demand scores were also lower among Black women (30.9; SD = 5.5) than among White women (32.1; SD = 6.1). Because Black women had a higher probability of being selected as control patients, each job score was weighted by the inverse of the race-specific probability for selection to obtain a single cutpoint that reflected the racial mix in the source population. The resulting median score was 31 for job demand and 33 for job control. The tertile boundaries were 29 and 34 for job demand and 31 and 36 for job control.

Women were characterized by exposure to job strain for two time periods. The first time period consisted of the entire pregnancy. Women who were exposed for at least 1 month during pregnancy to a job with high job strain were defined as exposed in the first analysis. The second definition of exposure was restricted to the third trimester of pregnancy, beginning at the 27th week of gestation. This is the time period hypothesized to be most critical in precipitating the onset of labor. In this analysis, only women who were employed in a high-strain job at some time during the third trimester were classified as exposed. All other women working outside the home were consid-

ered unexposed to job strain, regardless of their job history before the third trimester.

Two other categorizations of job strain were employed to explore the importance of the duration, or dose, of job strain exposure. First, women who were exposed to high strain were divided by whether the exposure was full-time (35 or more hours per week) or part-time in order to test whether longer recovery time between exposures would lessen the impact of job strain. Second, women who worked at least 75% of a typical pregnancy (defined as ≥ 30 weeks) in a high-strain job were differentiated from those who were in a high-strain job for a shorter proportion of their pregnancy. This exposure categorization was different from exposure during the third trimester in that women who began a high-strain job after the first trimester of pregnancy might be exposed during the third trimester but not throughout most of the pregnancy.

An additional category of exposure, nonemployment, was needed because subjects were selected into the study regardless of their employment status. For the analysis using exposure in any trimester, women were considered nonemployed if they had not worked at any job for at least 1 month during pregnancy. For the analysis focusing on exposure in the third trimester, two nonemployment categories were used: (1) employed sometime earlier in pregnancy but stopped before the end of the first month of the third trimester and (2) nonemployed throughout the pregnancy.

**TABLE 1—Selected Characteristics (%) of Women Delivering Preterm Infants (Case Patients) and Term Infants (Control Patients), by Race: Central North Carolina, 1988 through 1991**

| | Black Patients | | White Patients | |
|---|---|---|---|---|
| | Case (n = 191) | Control (n = 309) | Case (n = 230) | Control (n = 303) |
| Age, y | | | | |
| 18–20 | 29 | 20 | 12 | 10 |
| 21–29 | 47 | 56 | 59 | 50 |
| >30 | 24 | 24 | 29 | 40 |
| Education, y | | | | |
| <12 | 25 | 17 | 11 | 13 |
| 12 | 45 | 41 | 33 | 33 |
| >12 | 30 | 43 | 56 | 54 |
| Unmarried status | 59 | 48 | 8 | 6 |
| Cigarette smoking | 24 | 19 | 20 | 22 |
| Prenatal care: 0–5 visits | 22 | 6 | 7 | 1 |
| Primiparous status | 24 | 28 | 37 | 32 |
| Previous low birthweight or preterm delivery | 24 | 10 | 16 | 7 |
| Family income | | | | |
| <100% poverty level | 32 | 27 | 13 | 10 |
| 100%–185% poverty level | 28 | 26 | 13 | 13 |
| ≥186% poverty level | 27 | 36 | 69 | 72 |
| Missing | 13 | 12 | 5 | 5 |
| Chronic hypertension | 6 | 4 | 3 | 1 |
| Missing | 22 | 27 | 5 | 3 |
| Pregnancy-induced hypertension | 5 | 4 | 3 | 4 |
| Missing | 16 | 26 | 4 | 3 |
| Pre-eclampsia/eclampsia | 14 | 3 | 9 | 3 |
| Missing | 14 | 26 | 4 | 3 |

### *Measurement of Other Variables*

The outcome of interest, preterm delivery, was judged on the basis of gestational age from first-trimester ultrasounds, last menstrual period, or the obstetrician's best estimates, in that order of priority.[29] A number of potential confounders were considered in the analysis. Age (younger than 21, 21 through 29, 30 years and older), marital status (married or cohabiting, not married) and education (less than 12, 12, or 13 or more years) were obtained from interviews, medical records, and delivery log records. Cigarette smoking during the last trimester (yes, no), parity (primiparous, multiparous), number of prenatal visits (0 through 5, 6 or more), and obstetrical history of previous low-birthweight and/or preterm births (yes, no) were collected during the interview and from medical records. Poverty status (family income less than the federal poverty line, family income at or greater than the federal poverty line) was obtained from the interview only. Finally, high blood pressure (pregnancy-induced hypertension, chronic hypertension, and pre-eclampsia/eclampsia) was obtained only from medical records. When there was more than one source of information, data used in the analysis were obtained preferentially from the interview, medical record, and delivery log, in that order.

### *Analysis*

Contingency tables were constructed to analyze the crude association between the various job strain definitions and preterm delivery. Odds ratios and Taylor series 95% confidence intervals (CIs) were calculated to characterize the strength and precision of these associations.[30] Multiple logistic regression was used to quantify the association between job strain and preterm delivery while controlling for most of the potential confounders, from which adjusted odds ratios (aORs) were calculated. Separate sensitivity analyses were run, controlling for poverty and high blood pressure, as these variables were incompletely ascertained but considered important.

It has been hypothesized that some of the excess risk of preterm delivery among Black women may be due to differences in the effect of job strain. Therefore, all analyses were run stratified by race to look for a possible interaction. If none was found, the data were analyzed together, controlling for race.

## *Results*

The distribution of women by race differed for many of the potential confounders (Table 1). White women were more likely to be older, more educated, and primiparous, while Black women were more likely to be single, to smoke cigarettes during their last trimester, to complete five or fewer prenatal care visits, and to have had a low-birthweight or preterm infant in the past. Each of these factors was associated with an increased risk of preterm delivery in both ethnic groups except for older age and primipar-

**TABLE 2—Adjusted Odds Ratios (aORs) for Preterm Delivery, by Any Exposure to Job Strain during Pregnancy, Overall and by Race: Central North Carolina, 1988 through 1991**

| | No. of Case Patients | No. of Control Patients | aOR (95% Confidence Interval) |
|---|---|---|---|
| High strain | 104 | 134 | 1.3 (0.9, 1.8) |
| Black | 59 | 82 | 1.5 (0.9, 2.3) |
| White | 45 | 52 | 1.2 (0.7, 1.9) |
| Not employed | 91 | 111 | 1.1 (0.8, 1.6) |
| Black | 47 | 55 | 1.2 (0.7, 2.0) |
| White | 44 | 56 | 1.1 (0.7, 1.8) |
| Low strain | 226 | 367 | Referent |
| Black | 85 | 172 | |
| White | 141 | 195 | |

*Note.* The analysis controlled for age, education, marital status, smoking, number of prenatal care visits, parity, and previous low-birthweight or preterm births. Race is controlled in all models not stratified by race.

**TABLE 3—Adjusted Odds Ratios (aORs) for Preterm Delivery among Women with Different Exposures to High-Strain Work Compared with Women with Low-Strain Work (Referent Category): Central North Carolina, 1988 through 1991**

| | Black Women | White Women | Total |
|---|---|---|---|
| Amount of Exposure to Strain | aOR (95% CI) | aOR (95% CI) | aOR (95% CI) |
| Full-time (≥35 h/wk), high strain | 1.5 (0.9, 2.5) | 1.2 (0.7, 2.1) | 1.4 (0.9, 2.0) |
| Part-time (<35 h/wk), high strain | 1.3 (0.6, 2.9) | 1.0 (0.4, 2.5) | 1.1 (0.6, 2.1) |
| ≥30 wks of pregnancy, high strain | 1.8 (1.1, 3.1) | 1.0 (0.5, 2.0) | 1.4 (1.0, 2.2) |
| 4–29 wks of pregnancy, high strain | 1.0 (0.5, 2.0) | 1.3 (0.7, 2.4) | 1.1 (0.7, 1.8) |

*Note.* CI = confidence interval. The analysis controlled for age, education, marital status, smoking, number of prenatal care visits, parity, previous low-birthweight or preterm births, and race.

ity, both of which were associated with a decreased probability of preterm delivery among White, but not Black, women.

Work in high-strain jobs was associated with a small, nonsignificant increase in the risk of having a preterm infant relative to working in a low-strain job (aOR = 1.3) (Table 2). While the relative risk of preterm delivery after exposure to a high-strain job was greater among Black women (aOR = 1.5) than among White women (aOR = 1.2), this interaction was not statistically significant. Nonemployment was not associated with preterm delivery. When job strain was defined by tertiles, Black women exposed to the highest-strain jobs were at an elevated risk of preterm delivery (aOR = 1.6, 95% CI = 1.0, 2.8), whereas no association was found among White women.

Refinement of the job strain exposure window from anytime during pregnancy to the third trimester did not produce any change in the relationships with preterm delivery. There was no association between preterm delivery and either nonemployment (aOR = 1.1) or working in a high-strain job (aOR = 1.2) and no difference by race. Compared with the referent group, women who worked at some point during pregnancy but not during the third trimester also had no increased risk of preterm delivery (aOR = 1.2).

Compared with any exposure to job strain, full-time exposure to job strain (35 or more hours per week) was somewhat more strongly associated with preterm delivery, particularly among Black women, although the association was not statistically significant (Table 3). The adjusted odds ratio for women who worked for 30 or more weeks of their pregnancy at high-strain jobs, compared with women who worked at low-strain jobs (regardless of the hours per week), was 1.4 (95% CI = 1.0, 2.2). No adverse effect was seen among women who worked fewer weeks. Again, the odds ratio for preterm birth among women with long exposures to job strain was greater for Black women than for White women (aOR = 1.8, 95% CI = 1.1, 3.1, and aOR = 1.0, 95% CI = 0.5, 2.0, respectively), although the interaction was not statistically significant.

Each of the models was analyzed with the addition of poverty and high blood pressure, which were considered important but were missing for a substantial proportion of the study participants. The addition of hypertension, both chronic and pregnancy-induced, did not change the results. The inclusion of poverty did not change any of the associations between preterm delivery and either job strain or nonemployment.

Smoking was thought to be one mechanism through which job strain might influence delivery timing. The control of smoking in these models, however, did not change the small association between job strain and preterm delivery.

## *Discussion*

This study provides limited support for an association between chronic exposure to high-strain work and risk of preterm delivery. Women who were employed at high-strain jobs during most of their pregnancies had a higher risk of delivering a preterm infant than did women working only at low-strain jobs, while women who worked at high-strain jobs for less than 30 weeks during pregnancy did not have an elevated risk. Although we had hypothesized that high-strain work would have the greatest association with preterm delivery during the third trimester, there was no association in that exposure window. Job strain was somewhat more consistently associated with preterm delivery among Black women, supporting the hypothesis that Black women may be at higher risk for this pregnancy outcome partially as a result of their increased exposure and response to stress.[26] The population-attributable risk of job strain on preterm delivery among Black women based on these findings is 9%.

Ideally, we would have also measured the stress to which the respondents were exposed outside the work environment, in order to isolate the effects of occupational stress. Other stress measures were not included in the questionnaire,

however. If women who work at more stressful jobs are more likely to encounter high levels of stress outside work and stress outside work is related to preterm delivery, then our estimates of the effect of occupational stress may be biased away from the null. Poverty is a major stressor in this population, and controlling for poverty among the 92% of the respondents with complete data did not change the associations between job strain and preterm delivery.

It also would have been preferable to measure job control and demand both subjectively (through self-report) and objectively. However, the only method of assessing job strain objectively is to use census industry and occupation codes to link scores to jobs, and these codes do not capture the full amount of variance between jobs.[31,32] One study of adverse pregnancy outcomes that analyzed both self-reported and linked demand and control scores found that only self-reported scores were associated with differences in birth outcomes.[11]

The modest positive association between job strain and preterm delivery found in this study may be partially due to recall bias, as the measurement of job strain occurred during an interview several months after delivery. A better method of studying this potential association would be to use a prospective design in which job histories are collected during pregnancy. For this first US study of pregnancy outcome and job strain based on self-reported exposure, we chose the case–control design because of cost and logistical considerations.

Job strain has not previously been examined thoroughly in relation to race. Only one published study included a sufficient number of Black subjects to analyze job strain separately by race, and in that study Blacks had lower job control scores than Whites but similar job demand scores.[16] The current study corroborates the lower job control that Black women have compared with White women, but it also found that Black women experience lower job demand. Because 91% of the respondents in the previous study were men, and women are more likely than men to have high-demand, low-control jobs,[33] these differences may reflect differences in the distribution of job strain by gender and race.

The results of this study strengthen the previous research indicating that employment in general has no adverse effect on, or even a slightly favorable association with, pregnancy outcomes.[3] Unlike previous studies, this study compared nonemployed women only with women employed at low-strain jobs. Should high-strain work be detrimental to pregnancy outcome, the contrast between all nonemployed women and all employed women will be less favorable for employment in populations where high-strain work is prevalent.

In conclusion, it appears that work at low-strain jobs outside the home during pregnancy does not increase the risk of preterm delivery. Persistent or full-time employment in a high-strain job may be related to preterm delivery, particularly among Black women. Given these modestly positive associations, further research in this area should be directed toward refining the measurement of occupational stress to more clearly specify what type of stress at the workplace, if any, is associated with poor pregnancy outcomes. □

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