Employment-Related Stress and Preterm Delivery: A Contextual Examination

CAROL A. HICKEY, PhD
SUZANNE P. CLIVER, BA
FRANCIS X. MULVIHILL, PhD
SANDRE F. McNEAL, BS
HOWARD J. HOFFMAN, MA
ROBERT L. GOLDENBERG, MD

Dr. Hickey, Ms. Cliver, Dr. Mulvihill, Ms. McNeal, and Dr. Goldenberg are with the University of Alabama at Birmingham. Dr. Hickey and Dr. Mulvihill are in the Department of Maternal and Child Health, School of Public Health. Dr Goldenberg, Ms. Cliver, and Ms. McNeal are in the Perinatal Epidemiology Unit, Department of Obstetrics and Gynecology, School of Medicine. Mr. Hoffman is with the Epidemiology, Statistics and Data Systems Branch, National Institute on Deafness and Other Communication Disorders, National Institutes of Health.

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Tearsheet requests to Carol A. Hickey, PhD, Department of Maternal and Child Health, School of Public Health, 112 Mortimer Jordan Hall, University of Alabama at Birmingham, 1825 University Blvd., Birmingham, AL 35294-2010; tel. 205-934-7161; FAX 205-934-8248.

Synopsis

Studies of employment-related stress as a risk factor for preterm delivery suggest that contextual factors unrelated to occupation, as well as work-related characteristics, must be examined in assessing this relationship.

In this study, the relationship of work and contextual characteristics—assessed at midpregnancy and including scores on an occupational fatigue index—to preterm delivery was examined among 943 black and 425 white low-income multiparous women who were at risk for a poor pregnancy outcome.

At 24 to 26 weeks gestational age, a 77-item questionnaire was self-administered to obtain detailed information on sociodemographic and contextual characteristics, home physical activities, and occupational characteristics. Questions in the occupational section of the questionnaire included most of those previously used by Mamelle and coworkers in 1984 and 1987 to construct an occupational fatigue index.

The overall preterm delivery rate for black women was 14.0 percent and for white women, 9.6 percent. No relationships were observed between age, education, or marital status and preterm delivery, or between work status, hours per week, transportation, travel time, reliability of child care, or home physical activity and preterm delivery for either black women or white women.

Black (but not white) women who continued to work at midpregnancy and who reported being able to take rest breaks when they felt tired had a lower preterm delivery rate (10.4 percent versus 21.9 percent; P = 0.031) compared with those who could or did not.

Generally, scores for individual sources and levels of occupational fatigue, as well as total occupational fatigue index scores, were unrelated to preterm delivery in this relatively homogeneous group of low-income high-risk women.

THE RELATIONSHIP OF PRENATAL occupational activity to pregnancy outcome and, more specifically, the relationship of work-related ergonomic stress to preterm delivery (PTD) has been the subject of increasing attention during the past decade. Ergonomic stressors (*1*) are commonly considered to include factors related to physical exertion (such as heavy lifting, prolonged standing or sitting, work with heavy machinery, and climbing stairs) or to work organization (including hours worked, shift work, machine-paced work, and speed of work).

After observing that women in certain occupational categories were at increased risk of PTD, Mamelle and coworkers carried out an analytical breakdown of various occupations into specific components (*2*). This information was used to construct an index of occupational fatigue based on five sources of fatigue—posture, work on industrial machines, physical exertion, mental stress, and environment. A positive relationship was observed between the rate of PTD and the number of high fatigue scores associated with a particular occupation. When the number of

high scores increased from 0 to 5, the rate of PTD increased from 2.3 percent to 11.1 percent; this relationship remained statistically significant after controlling for confounding factors.

Subsequent studies have also reported an association of employment-related stressors with PTD (*3–12*), particularly when the stressors have been quantified by a cumulative score on a questionnaire. Associations between individual stressors and PTD have been inconsistent, however, and the association between employment-related stressors and PTD has been reported to vary within the same group of women, depending on whether occupational titles or specific working conditions were used to assess stress (*13*). Additionally, a substantial number of studies have not confirmed the association of employment-related stressors with PTD (*14–23*).

Recent reviews of the association of work or ergonomic stress with pregnancy outcome (*1,24,25*) have suggested a number of contextual characteristics and confounding factors that must be examined and controlled for in studies of work during pregnancy. In addition to recall and selection bias, these include a variety of demographic, economic, psychosocial, anthropometric, substance use, medical, and reproductive characteristics, as well as physical activity or stress unrelated to occupation.

In this study, we investigated the relationship of work characteristics—assessed at midpregnancy and including scores on an occupational fatigue index—to PTD among low-income black women and white women who were at risk for a poor pregnancy outcome. Contextual information related to selected demographic, reproductive, socioeconomic, and nonoccupational physical activity characteristics was also collected and examined to allow the discernment of, and statistical control for, factors considered to be potential confounders in studies of work during pregnancy.

Methods

Study group. The women in this study were enrolled in a prospective cohort study of low-income black and white mothers expecting their second and third births (para 1 and para 2) who were at risk of having a small for gestational age (SGA) infant (*26*). Medical records of all mothers enrolled for prenatal care in one of the seven prenatal clinics operated jointly by the Jefferson County Health Department and the Department of Obstetrics and Gynecology at the University of Alabama at Birmingham (UAB) were reviewed. Women were determined to be eligible for enrollment in the study if they exhibited one or more of the following risk factors at the time of their first visit:

- history of more than two spontaneous abortions,
- previous fetal or neonatal death,
- previous live birth of less than 37 weeks gestational age (GA),
- previous infant weighing less than 2,750 grams (g),
- maternal height less than 157 centimeters (cm),
- prepregnancy weight less than 50 kilograms (kg),
- first prenatal visit at more than 26 weeks GA,
- hypertension (systolic blood pressure more than 140 millimeters (mm) of mercury or diastolic blood pressure more than 90 mm, on two occasions),
- currently using alcohol or smoking,
- history of phlebitis.

A 15-percent random sample of the multiparous women (para 1 and 2) in the clinic population was also included in the study group after determining that 70 percent of these women also exhibited one or more of the previously listed risk factors. This strategy permitted a preliminary evaluation of the distribution and suitability of the selected risk factors.

A total of 3,721 multiparous women were screened, 2,661 were eligible for inclusion on the basis of risk factor identification, and 1,518 participated in the study and delivered their infants at one of two UAB affiliated hospitals (Cooper Green or University Hospital) between December 1985 and October 1988. Within the final sample of 1,518 women were 1,177 (77.5 percent) who had been selected on the basis of risk identification and 341 (22.5 percent) who had been selected on the basis of random sampling; all but 78 of the 341 women selected on the basis of random sampling had one or more of the risk factors used in the risk sampling. There were no significant differences in ethnicity, age, height, smoking status, and infant birth weight between those who enrolled in the study and those who did not. Significantly more participants weighed less than 50 kg at their first prenatal visit. Twenty-seven women delivering multiple infants were excluded prior to data analysis for this study, resulting in an initial study group of 1,491 women and their infants (1,031 black, 460 white).

Procedures. At 24 to 26 weeks GA, women participating in the study came to the Perinatal Epidemiology Unit at UAB rather than to their usual neighborhood clinic for their prenatal clinic appointment (one of four study visits). During that study visit a 77-item questionnaire was self-administered (with assistance as required) to obtain detailed information on their area of residence, housing, frequency of residence

Occupational Fatigue Index as Defined by Five Major Sources of Fatigue[1]

Source of occupational fatigue	*High score if one or more of these elements are present*[2]
Posture	Stand for more than 3 hours per day at work.
Work on industrial machine	Work on an assembly line. Deal with machinery that produces vibrations.
Physical exertion	Often engage in strenuous physical activity at work. Often carry loads of more than 20 pounds at work.
Mental stress	Often do repetitive tasks at work. Work is boring.
Environment	Significant noise level at work. Work in a cold or wet area.

[1]Adapted from References 2,7.
[2] High score = 1, low score = 0 (element absent). Possible range 0–5. Score of 3 or more = intense occupational fatigue.

changes, marital status, household composition, transportation, education, income, physical activity at home, school, or work, and occupation.

Questions in the occupational section of the questionnaire are the focus of this report. The questionnaire was administered to 91.5 percent of the 1,031 black women and to 92.4 percent of the 460 white women in the initial study group, reducing the effective sample size to 1,368 women (943 black, 425 white). Reasons for not administering the questionnaire included late entry into the study, missed study visits, and delivery prior to the 24 to 26 week GA visit.

The questionnaire included most of the items used by Mamelle and coworkers (*2,7*) to construct an occupational fatigue index. These questions (see box) target five sources of occupational fatigue: posture, work on industrial machines, physical exertion, mental stress, and environment. A score of 1 (high fatigue) for each of the five sources was given if the women reported experiencing one or more of the elements listed. If these elements were not present, a score of 0 was given for that source. The possible range of scores was 0–5.

This questionnaire differed slightly from the index constructed by Mamelle in that only two elements of environmental fatigue were included—significant noise at work and a cold or wet work area. Mamelle included four separate elements of environmental fatigue—significant noise level, cold temperature, very wet atmosphere, and manipulation of chemical substances. In both the Mamelle index and the index used in this study occupational fatigue was quantified by the number of high scores, that is, by the total number of fatigue sources that the woman experienced while working. Fatigue was considered to be high when three or more sources were simultaneously rated as high (*2,7*).

Reproductive history data and reported prepregnancy weight were obtained by interview during the first visit. Maternal height measurements without shoes were obtained at the first clinic visit, using standard anthropometric procedures. Prepregnancy body mass index (BMI) was calculated as reported prepregnancy weight (kg) divided by height in meters squared (m^2). Gestational age was computed in completed weeks from the first day of the last menstrual period (LMP), when that GA agreed within 2 weeks with one based on the first ultrasound examination prior to 20 weeks GA. If there was more than a 2-week discrepancy or if the woman was unsure of the LMP date, gestational age was based on the first ultrasound examination. Information on infant birth weight, GA, and other descriptive or confounding variables was obtained from a computerized obstetric record system designed to follow women through their pregnancies and deliveries (*27*).

In this analysis, PTD was defined as delivery prior to 37 completed weeks of gestation and included both spontaneous and indicated PTD.

Statistical analysis. All analyses were completed separately for black women and white women. Descriptive statistics included means and standard deviations for continuous variables and frequency distributions for categorical variables. Relationships between pairs of categorical variables were determined by chi-square analysis; significance was determined for 2 × 2 tables with Fisher's exact test and for higher order tables with the likelihood ratio chi square. Preliminary univariate analyses were used to investigate the relationship between the initial risk criteria used to screen the subjects in the overall study and PTD, as well as to investigate the relationship of contextual characteristics to PTD. Univariate analyses were also used to investigate the relationship of the index of occupational fatigue (and its individual items) to PTD, and to examine the roles of physical activity at home in modifying this relationship. Multiple regression analysis, logistic regression analysis, and analysis of covariance were used to

Table 1. Selected sociodemographic and occupational characteristics by ethnicity and preterm delivery (PTD)

Characteristic	Black (N = 943)				White (N = 425)			
	Number	Percent	PTD percent	P[1]	Number	Percent	PTD percent	P[1]
Age (years):				.295				.864
Younger than 20	105	11.1	19.0		50	11.8	12.0	
20–25	472	50.1	14.2		232	54.6	9.5	
26–30	264	28.0	11.4		99	23.3	8.1	
Older than 30	102	10.8	14.7		44	10.3	11.4	
Education (highest grade completed):				.810				.850
Lower than 9th	10	1.1	10.0		40	9.4	7.5	
9th–11th	220	23.3	14.1		206	48.6	9.7	
12th	369	39.2	15.2		115	27.1	11.3	
Higher than 12th	343	36.4	12.8		63	14.9	7.9	
Marital status:				.268				.044
Married or partnered	275	29.4	12.7		299	71.0	11.4	
Separated, widowed, divorced	169	18.1	11.2		88	20.9	3.4	
Single	491	52.5	15.7		34	8.1	11.8	
Worked during this pregnancy:				.851				.168
No	473	50.3	14.2		274	64.6	11.3	
Yes	467	49.7	13.7		150	35.4	6.7	
Currently working at 24–26 weeks gestation[2]:				.683				1.000
No	198	43.5	14.6		77	52.7	6.5	
Yes	257	56.5	13.2		69	47.3	7.3	
Hours worked per week when working[2]:				.064				.807
1–20	101	21.9	8.9		34	22.8	8.8	
21–30	107	23.3	20.6		33	22.2	9.1	
31–40	224	48.7	13.0		62	41.6	4.8	
More than 40	28	6.1	7.1		20	13.4	5.0	
Mode of transportation to work:[2]				.960				.711
Own car	242	52.6	12.8		117	81.8	5.1	
Public	68	14.8	14.7		2	1.4	0.0	
Friend	109	23.7	15.6		11	7.7	9.1	
Walk	17	3.7	11.8		5	3.5	20.0	
Other	24	5.2	12.5		8	5.6	12.5	
Total travel time to and from work:[2]				.702				.461
1–30 minutes	174	38.1	12.1		57	42.2	8.8	
31–60 minutes	175	38.3	14.9		44	32.6	4.6	
More than 60 minutes	108	23.6	14.8		34	25.2	2.9	
Reliable child care:[2]				.491				.436
No	18	4.1	5.6		8	6.0	12.5	
Yes	420	95.9	13.1		126	94.0	6.5	

[1]Chi-square: significance determined for 2 × 2 tables with Fisher's exact test and for higher order tables with the likelihood ratio chi-square.

[2]Answered only by the 467 black and 150 white women who worked at some time during this pregnancy.

confirm the results of the univariate analyses. Logistic regression was used with PTD as a categorical variable; linear regression and analysis of covariance were used with gestational age as a continuous variable. Data analysis was performed with the Statistical Analysis Software package (*28*).

The study was approved by the Institutional Review Board of the University of Alabama at Birmingham, and human subject protection procedures were followed throughout the study.

Results

Only two of the risk factors originally applied as screening criteria to select women at risk for having a small for gestational age (SGA) infant, were significantly related to PTD. Both black women and white women with a history of having delivered a previous infant at less than 37 weeks GA were more likely to have PTD during this pregnancy (black 35.6 percent PTD versus 9.6 percent PTD, $P = < 0.001$; white 26.1 percent PTD versus 7.7 percent PTD, $P = < 0.001$). Similarly, women with a history of having delivered a previous infant weighing less than 2,750 g were more likely to have a PTD during this pregnancy (black 21.5 percent PTD versus 8.1 percent PTD, $P = < 0.001$; white 17.1 percent PTD versus 7.0 percent PTD, $P = 0.004$). Although a substantial proportion of both black women (25.5 percent) and white women (31.0 percent) had a low prepregnancy

Table 2. Occupational fatigue source and level by ethnicity and preterm delivery (PTD) of women who worked at some time during first 24–26 weeks of gestation

Fatigue source and level[2]	Black (N = 463)[1]				White (N = 149)[1]			
	Number	Percent	PTD percent	P[3]	Number	Percent	PTD percent	P[3]
Posture:				.437				.245
Low	116	25.1	11.2		35	23.5	11.4	
High	347	74.9	14.7		114	76.5	5.3	
Work on machine:				.703				.512
Low	397	85.8	13.6		139	93.3	6.5	
High	66	14.2	15.2		10	6.7	10.0	
Physical exertion:				.344				.332
Low	254	54.9	15.4		71	47.6	4.3	
High	209	45.1	12.0		78	52.4	9.0	
Mental stress:				.670				.744
Low	155	33.5	14.8		56	37.6	5.4	
High	308	66.5	13.3		93	62.4	7.5	
Environment:				.581				1.000
Low	288	62.2	14.6		89	59.7	6.7	
High	175	37.8	12.6		60	40.3	6.7	

[1]Occupational fatigue scores were available for 463 of 467 black women and 149 of 150 white women who reported working at some time during this pregnancy.

[2]References *2* and *7*; see box for scoring system.

[3]Chi-square: significance determined with Fisher's exact test.

BMI (less than 19.8), the relationship of prepregnancy BMI to PTD was not significant for either group.

The overall PTD rate for black women was 14.0 percent and for white women, 9.6 percent. Approximately 12 percent of the PTD among both black women (11.4 percent) and white women (12.2 percent) occurred prior to 32 weeks GA; one delivery occurred prior to 26 weeks GA for each group. All of the women were either para 1 (black 59.7 percent; white 67.1 percent) or para 2 (black 40.3 percent; white 32.9 percent); the differences in rate of PTD between the two parity groups were not significant for either ethnic group.

Rates of PTD for women with various sociodemographic and occupational characteristics are shown in table 1. The majority of the women were in the 20- to 30-year age range; only 8 black and 5 white women were younger than age 17. Univariate analysis indicated that neither age nor education was related to PTD in this low-income population. Marital status was not related to PTD among black women and was only weakly related to PTD among white women; white women who reported being separated, widowed, or divorced had a lower rate of PTD.

At the time the study questionnaire was completed (24 to 26 weeks GA), 467 black women (49.7 percent) and 150 white women (35.4 percent) reported that they had been employed at some time during this pregnancy, and approximately half of these reported that they continued to work at 24 to 26 weeks gestation. No relationship was observed between work status, hours per week, form of transportation, work travel time, or reliability of child care and PTD (table 1). Black women who continued to work at 24 to 26 weeks GA and who reported being able to take rest breaks at work when they felt tired, had a lower PTD rate (21.9 percent versus 10.4 percent; $P = 0.031$) than women who were not able to do this (data not shown). This relationship, which was not observed among white women, was confirmed in logistic regression analysis that controlled for maternal age, smoking, alcohol use, prepregnancy BMI, history of PTD, and hours worked per week ($P = 0.045$).

Information on physical activity at home was gathered via the following 10 questions:

1. children in the household (number),
2. preschool children cared for (number),
3. small children lifted or carried (no or yes),
4. loads weighing more than 20 pounds regularly carried (no or yes),
5. hours standing per day (number),
6. hours walking per day (number),
7. stairs climbed (no or yes),
8. strenuous inside chores (no or yes),
9. strenuous outside chores (no or yes), and
10. strenuous recreational activity (no or yes).

Only two home activities were related to PTD; white women, but not black women, who reported carrying loads weighing more than 20 pounds (5.7 percent of 424 white women answering the question) had a higher PTD rate (25.0 percent versus 8.8 per-

Table 3. Occupational fatigue index by ethnicity and preterm delivery (PTD) for women working at some time during first 24–26 weeks of gestation

Index score[1]	Black (N = 463) Number	Percent	PTD percent[2]	P[3]	White (N = 149) Number	Percent	PTD percent[3]	P[3]
				.276				.239
0	25	5.4	8.0		12	8.0	8.3	
1	105	22.7	14.3		24	16.1	12.5	
2	125	27.0	19.2		43	28.9	2.3	
3	106	22.9	10.4		38	25.5	2.6	
4–5	102	22.0	11.8		32	21.5	12.5	

[1]0 = lowest level of fatigue, 4-5 = highest level of fatigue; references *2,7*
[2]As a comparison value, PTD among all women who worked at some time during the first 24 to 26 weeks of gestation was 13.2 percent black and 7.3 percent white versus 14.6 percent black and 6.5 percent white among those who did not work (table 1).
[3]Chi-square: significance determined with likelihood ratio chi square.

Table 4. Distribution of preterm delivery (PTD) by low versus high occupational fatigue index and low versus high levels of home physical activity among 401 black women who worked at some time during first 24–26 weeks gestation

Home physical activity scale[2,3]	Low fatigue index (N = 210)[1] Number	Percent	PTD percent[4]	High fatigue index (N = 191)[1] Number	Percent	PTD percent[4]
Low	136	64.8	16.2	105	55.0	9.5
High	74	35.2	14.9	86	45.0	11.6

[1]Possible range: 0–5; Low = less than 3, high = 3 or higher. References *2,7.*
[2]Home physical activity scale (low versus high item scores): number of children in household (1 or fewer versus 2 or more), number of preschoolers cared for (0 versus 1 or more), small children lifted (no, yes), loads of more than 20 pounds carried (no or yes), number of hours walking per day (4 or less versus 5 or more), number of hours standing (2 or less versus 3 or more), stairs climbed at home (no, yes), strenuous inside chores (no, yes), strenuous outside chores (no, yes), strenuous recreational activity (no, yes). Low scores given a value of 0, high scores given a value of 1. Possible range for total score 0–10, observed range 0–9, mean 4.1 ± 1.6, median 4.
[3]Low = less than 4, high = 4 or more.
[4]As a comparison value, PTD among all black women who worked at some time during the first 24–26 weeks of gestation was 13.2 percent versus 14.6 percent for those who did not work (see table 1).

cent, $P = 0.020$) than those who did not carry such loads. Black women, but not white women, who reported that they often did strenuous inside chores (73.6 percent of 941 black women answering the question) had a lower PTD rate (12.3 percent versus 19.0 percent; $P = 0.011$) than those who did not. These associations may have been an artifact of multiple comparisons, that is, they may have resulted from the fact that when multiple independent comparisons are completed, on average, 1 of every 20 will occur by chance alone.

Scores for individual sources and levels of occupational fatigue (table 2) were not significantly related to PTD for either black or white women who reported working at some time during the first 24 to 26 weeks of gestation. This was also true when only women with spontaneous PTD were considered (data not shown), and when only women who were still working at 24 to 26 weeks GA were considered (data not shown); nor were any of the individual elements included within each source of occupational fatigue (box) related to PTD (data not shown).

Similarly, scores on the occupational fatigue index (table 3) were not significantly related to PTD for either black or white women who reported working at some time during the first 24 to 26 weeks of gestation. This was also the case when only those women with spontaneous PTD were considered (data not shown), as well as when only those women who continued to work at 24 to 26 weeks GA (257 black, 69 white) were considered (data not shown). These negative results were confirmed by regression analysis of the impact of occupational fatigue index scores on PTD and on GA, while controlling for maternal smoking, alcohol use, prepregnancy BMI, age, history of preterm delivery, and hours worked per week (data not presented).

Preterm delivery was then examined among black women with low or high levels of occupational fatigue and with low or high levels of physical activity at home (table 4); a similar analysis of white women was precluded by the small sample size. Answers for each of the 10 questions regarding home physical activity (discussed previously) were dichotomized into low values (given a score of 0) or high values (given a score of 1) to develop a composite score for home physical activity (possible range 0–10, observed range 0–9, mean 4.1 ± 1.6,

'This study used a measure of occupational fatigue reported in other studies while controlling for some rarely available contextual variables to add a new dimension to this complex and poorly understood area of research.'

median 4).

A total of 401 black women who had worked at some time during the first 24 to 26 weeks of this pregnancy had complete data for both the occupational fatigue index and the composite home activity scale. PTD was not significantly higher for black women with low (less than 3) versus high (3 or higher) occupational fatigue scores and low (score less than 4) versus high (4 or higher) levels of physical activity at home. These negative results were confirmed by regression analysis of the combined impact of occupational fatigue index and home physical activity scores on PTD and GA, while controlling for maternal smoking, alcohol use, prepregnancy BMI, age, history of preterm delivery, and hours worked per week (data not presented).

Many of the 467 black (95.1 percent) and 150 white (90.7 percent) women who reported working at some time during the first 24 to 26 weeks of gestation were employed in jobs with titles that could be coded using the 1980 U.S. Census occupational classification system. The majority of these were employed in occupations categorized as technical, sales, and administrative support (44.6 percent black, 50.0 percent white) or as service occupations (46.8 percent black, 36.0 percent white); a significant relationship was not observed between occupational category and PTD for either black women or white women.

Of the 467 black women who were employed at some time during the first 24 to 26 weeks of gestation, 373 (79.7 percent) were employed in jobs with titles that could be classified according to the three categories of Teitelman and coworkers (*12*)—sedentary, active, and standing (the smaller number of white women in the sample precluded a similar analysis). The PTD rate for 40 black women employed in sedentary jobs (defined as requiring less than 1 hour of standing and less than 1 hour of active motion per day) was 7.5 percent. Among the 196 black women employed in active jobs (defined as involving continuous or intermittent walking with active range of motion) the PTD rate was 13.3 percent. The 137 women employed in standing jobs (defined as requiring standing for more than 3 hours per day, predominantly in one position, without much activity) had a PTD rate of 18.2 percent. However, none of these percentages was significantly different from any of the others in univariate analysis (data not shown). This negative conclusion was confirmed by regression analysis with PTD as the dependent variable, and by analysis of covariance with GA as the dependent variable, while controlling for maternal smoking, alcohol use, prepregnancy BMI, age, history of preterm delivery, and hours worked per week (data not shown).

Discussion

Work-related characteristics, assessed by a questionnaire administered at midpregnancy (24 to 26 weeks GA), were unrelated to PTD among the 943 black and 425 white low-income women in this study. The one exception to this finding was a significant reduction in the rate of PTD among black women who were able to take unscheduled rest breaks at work. This was not true for white women. The practical significance or replicability of this finding is not clear.

The questionnaire included questions designed to elicit individual elements and major sources of occupational fatigue. No relationship was observed between any of the five major sources of occupational fatigue (posture, work on industrial machine, physical exertion, mental stress, environment) and PTD, or between individual elements within these sources and PTD; nor was the overall score on the occupational fatigue index related to PTD among the women in this study.

PTD was also observed to be unrelated to maternal age and education for women in both ethnic groups and unrelated to marital status for black women (marital status was only weakly and paradoxically related to PTD among white women, that is, it was lower in divorced, widowed, or separated women). These results confirm previous observations that these well established and readily obtainable sociodemographic variables may not discriminate between high- and low-risk women in relatively homogeneous low-income groups nearly as well as they do in population-based studies. This is because the variables themselves may, in part, be markers for poverty *per se* (*29,30*).

Approximately half of black women (46.8 percent) and one-third of white women (36.0 percent) who worked at some time during the first 24 to 26 weeks of gestation reported working in occupations cate-

gorized by the U.S. Census occupational classification system as service occupations. This is in contrast to recent U.S. Department of Labor statistics (*31*) indicating that only 17.7 percent of employed females of all ages in the United States worked in such occupations, and it is reflective of the low-income nature of this study group (76.7 percent of black women and 53.9 percent of white women reported gross annual household incomes of $9,999 or less; data were available for 88 percent of both ethnic groups).

The occupations of 373 black women (80 percent) could be further classified according to the sedentary (7.5 percent PTD), active (13.3 percent PTD), and standing (18.2 percent PTD) categories developed by Teitelman and coworkers (*12*). The differences in PTD among the three categories, although not statistically significant, were somewhat in agreement with the report of Teitelman (*12*) for 1,206 women in the New Haven study group (sedentary 4.2 percent PTD, active 2.8 percent PTD, standing 7.7 percent PTD) in that women in jobs requiring prolonged standing had the highest rate of PTD.

Klebanoff (*20*) was able to classify the occupations of 1,252 women (70 percent) in the collaborative Vaginal Infections and Prematurity Study (New York City, Seattle, Oklahoma City, San Antonio, New Orleans) according to the categories of Teitelman and also observed insignificant differences in PTD among the three categories (sedentary 8.2 percent PTD, active 10.5 percent PTD, standing 11.0 percent PTD).

The women in our study were judged to be at risk for poor pregnancy outcome (SGA) on the basis of risk factor identification; two of these risk factors (previous birth at less than 37 weeks GA, previous infant weighing less than 2,750 g) were present for a considerable proportion of both black women and white women and were significantly related to PTD. As an example, although the overall rate of PTD was 14.0 percent for black women and 9.6 percent for white women, among the 17 percent of black women with a history of prior PTD delivery, the rate of PTD in this pregnancy was 35.6 percent; among the 10.8 percent of white women with a history of PTD the rate of PTD in this pregnancy was 26.1 percent. It may be that the generally high-risk nature of this clinic-based study group obscured the effect of occupational fatigue on PTD.

An alternative explanation for the negative findings in our study, compared with previous studies with positive findings, is that in previous studies occupational stress may have been an indirect marker for socioeconomic status. In this study, where the study group exhibited relatively little socioeconomic variability, occupational fatigue did not have an impact on PTD.

It has been observed that traditional definitions of physical activity and work, based on participation in the formal labor force, ignore a considerable amount of activity related to the demands of child care, housework, and leisure activity (*32–34*). It was for this reason that the questionnaires administered in the study included questions related to these activities. Among the 401 black women who worked at some time during the first 24 to 26 weeks of gestation, and who had complete data for the home physical activity score and the occupational fatigue index, PTD was not significantly greater with high versus low levels of occupational fatigue and high versus low levels of physical activity at home.

Although this study had a number of strengths—including the evaluation of possible contextual confounders, the homogeneity of the population studied and the avoidance of recall bias by assessing work related factors at midpregnancy—it also had several limitations. The small number of white women in the overall clinic population and therefore in the sample resulted in a lack of statistical power and prevented several subanalyses for white women. Although recall bias was avoided, changes in work activity after midpregnancy were not assessed, nor were reported levels of occupational stress verified by direct observation. Although the effect of occupational fatigue on indicated versus spontaneous PTD was considered, the study was limited by the lack of data analysis related to early versus late PTD (*35*); the latter was prevented by the comparatively small number of both black and white women experiencing early PTD. Finally, as noted previously, because of the generally high risk nature of the study group, the results of this study cannot be generalized to other dissimilar groups.

This study used a measure of occupational fatigue reported in other studies while controlling for some rarely available contextual variables to add a new dimension to this complex and poorly understood area of research. Future research should include attention to other contextual variables, especially those related to perceived psychosocial stress (both within and outside the work environment) and available social support (*36*). Sources of perceived stress as well as the language used to describe stress may be community- and culture-specific (*37*). Since PTD and other poor pregnancy outcomes also vary markedly by ethnic and other groups, future research that attempts to discover how social and occupational stressors affect biological functioning during pregnancy may need to include a cross-cultural focus as

well as replication in groups of varying socioeconomic status.

References

1. Marbury, M. C.: Relationship of ergonomic stressors to birthweight and gestational age. Scand J Work Environ Health 18: 73–83 (1992).
2. Mamelle, N., Laumon, B., and Lazar, P.: Prematurity and occupational activity during pregnancy. Am J Epidemiol 119: 309–322 (1984).
3. Armstrong, B. G., Nolin, A. D., and McDonald, A. D.: Work in pregnancy and birth weight for gestational age. Br J Indust Med 46: 196–199 (1989).
4. Homer, C. J., James, S. A., and Siegel, E.: Work-related psychosocial stress and risk of preterm, low birthweight delivery. Am J Public Health 80: 173–177 (1990).
5. Launer, L. J., Villar, J., Kestler, E., and DeOnis, M.: The effect of maternal work on fetal growth and duration of pregnancy: a prospective study. Br J Obstet Gynecol 97: 62–70 (1990).
6. McDonald, A. D., et al.: Prematurity and work in pregnancy. Br J Ind Med 45: 56–62 (1988).
7. Mamelle, N., and Munoz, F.: Occupational working conditions and preterm birth: a reliable scoring system. Am J Epidemiol 126: 150–152 (1987).
8. Nurminen, T., Lusa, S., Ilmarien, J., and Kurppa, K.: Physical work load, fetal development and course of pregnancy. Scand J Work Environ Health 15: 404–414 (1989).
9. Ramirez, G., et al.: Occupational physical activity and other risk factors for preterm birth among U.S. army primigravidas. Am J Public Health 80: 728–729 (1990).
10. Saurel-Cubizolles, M. J., and Kaminski, M.: Pregnant women's working conditions and their changes during pregnancy: a national study in France. Br J Indust Med 44: 236–243 (1987).
11. Saurel-Cubizolles, M. J., et al.: Pregnancy and its outcome among hospital personnel according to occupation and working conditions. J Epidemiol Community Health 39: 129–134 (1985).
12. Teitelman, A. M., Welch, L.S., Hellenbrand, K.G., and Bracken, M.B.: Effect of maternal work activity on preterm birth and low birth weight. Am J Epidemiol 131: 104–113 (1990).
13. Saurel-Cubizolles, M. J., Subtil, D., and Kaminski, M.: Is preterm delivery still related to physical working conditions in pregnancy? J Epidemiol Community Health 45: 29–34 (1991).
14. Ahlborg, G., Jr., Bodin, L., and Hogstedt, C.: Heavy lifting during pregnancy—a hazard to the fetus? A prospective study. Int J Epidemiol 19: 90–97 (1990).
15. Berkowitz, G. S., Kelsey, J. L., Holford, T. R., and Berkowitz, R. L.: Physical activity and the risk of spontaneous preterm delivery. J Reprod Med 28: 581–588 (1983).
16. Brandt, L. P. A., and Nielsen, C. V.: Job stress and adverse outcome of pregnancy: a causal link or recall bias? Am J Epidemiol 135: 302–311 (1992).
17. Grunebaum, A., Minkoff, H., and Blake, D.: Pregnancy among obstetricians: a comparison of births before, during, and after residency. Am J Obstet Gynecol 157: 79–83 (1987).
18. Hartikainen-Sorri, A. L., and Sorri, M.: Occupational and socio-medical factors in preterm birth. Obstet Gynecol 74: 13–16 (1989).
19. Klebanoff, M. A., Shiono, P. H., and Rhoads, G. G.: Outcomes of pregnancy in a national sample of resident physicians. N Engl J Med 323: 1040–1045, Oct. 11, 1990.
20. Klebanoff, M. A., Shiono, P. H., and Carey, J. C.: The effect of physical activity during pregnancy on preterm delivery and birth weight. Am J Obstet Gynecol 163: 1450–1456 (1990).
21. Magann, E. F., and Nolan, T. E.: Pregnancy outcome in an active-duty population. Obstet Gynecol 78: 391–393 (1991).
22. Miller, N. H., Katz, V. L., and Cefalo, R. C.: Pregnancies among physicians: a historical cohort study. J Reprod Med 34: 790–796 (1989).
23. Peoples-Sheps, M. D., et al.: Characteristics of maternal employment during pregnancy: effects on low birthweight. Am J Public Health 81: 1007–1012 (1991).
24. Culpepper, L., and Thompson, J. E.: Work during pregnancy. *In* New perspectives in prenatal care, edited by I. R. Merkatz and J.E. Thompson. Elsevier, New York, 1990, pp. 211–234.
25. Joffe, M.: Biases in research on reproduction and women's work. Int J Epidemiol 14: 118–123 (1985).
26. Bergsjo, P., et al.: Preliminary results from the collaborative Alabama and Scandinavian study of successive small-for-gestational age births. Report from a symposium in Trondheim, Norway, June 9, 1988. Acta Obstet Gynecol Scand 68: 19–25 (1989).
27. Wirtschafter, D. D., et al.: A county-wide obstetrical automated medical record system. J Med Syst 6: 277–290 (1982).
28. SAS user's guide. SAS Institute, Cary, NC, 1988.
29. McCormick, M. C., et al.: Factors associated with smoking in low-income pregnant women: relationship to birth weight, stressful life events, social support, health behaviors and mental distress. J Clin Epidemiol 43: 441–448 (1990).
30. Wen, S. W., et al.: Intrauterine growth retardation and preterm delivery: prenatal risk factors in an indigent population. Am J Obstet Gynecol 162: 213–218 (1990).
31. U.S. Department of Labor, Bureau of Labor Statistics: Table 22: Employed civilians by detailed occupation, sex, race, and Hispanic origin. Employment and Earnings 39: 185–190 (1992).
32. Barnes, D. L., Adair, L. S., and Popkin, B. M.: Women's physical activity and pregnancy outcome: a longitudinal analysis from the Philippines. Int J Epidemiol 20: 162–172 (1991).
33. Chamberlain, G. V.: Work in pregnancy. Am J Industr Med 23: 559–575 (1993).
34. Colie, C. F.: Preterm labor and delivery in working women. Semin Perinatol 17: 37–44 (1993).
35. Savitz, D. A., Blackmore, C. A., and Thorp, J. M.: Epidemiologic characteristics of preterm delivery: etiologic heterogeneity. Am J Obstet Gynecol 164: 467–471 (1991).
36. Rowley, D., and Tosteson, H., editors.: Racial differences in preterm delivery: developing a new research paradigm. Am J Prev Med 9 (supp): 1–123 (1993).
37. McLean, D. E., Hatfield-Timajchy, K., Wingo, P. A., and Floyd, R. L.: Psychosocial measurement: implications for the study of preterm delivery in black women. *In* Racial differences in preterm delivery: developing a new research paradigm, edited by D. Rowley and H. Tosteson. Am J Prev Med 9 (supp): 39–81 (1993).