Maternal Occupation and Risk for Low Birth Weight Delivery: Assessment Using State Birth Registry Data

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Objective: *To determine the effects of employment on low birth weight (LBW) in a service-based economy, we evaluated the association of LBW delivery with occupational data collected in a state birth registry.* ***Methods:*** *Occupational data in the 2000 Connecticut birth registry were coded for 41,009 singleton births. Associations between employment and LBW delivery were analyzed using logistic regression controlling for covariates in the registry data set.* ***Results:*** *Evidence for improved LBW outcomes in working mothers did not persist when adjusted for maternal covariates. Among working mothers, elevated risk of LBW was seen in textile, food service, personal appearance, material dispatching or distributing, and retail sales workers.* ***Conclusions:*** *Improved overall birth outcomes seen in working mothers may arise from favorable demographic and health attributes. Higher LBW risk was seen in several types of service sector jobs and in textile work.* (J Occup Environ Med. *2008;50:306–315*)

The increased proportion of women in the workforce over the last half-century has resulted in a parallel increase in women who continue to work while pregnant, and who work longer during pregnancy. US Census Bureau reports in the past decade indicate that two thirds of first-time pregnant women continued working during the pregnancy, with 53% continuing into the last month of pregnancy.[1,2] A variety of factors ranging from personal preference to economic necessity play a role in this increase. Occupational hazards in pregnancy have long been acknowledged, but remain difficult to ascertain and quantify.[3–5] Most studies report improved pregnancy outcomes (increased birth weight and reduced preterm births) in working pregnant women when contrasted with their nonworking counterparts.[6–9] Reasons for this finding are likely diverse and multifactorial; it may arise partly as a consequence of the "healthy worker effect" or from improved risk profiles, including later age at first delivery and higher educational level, on the part of working women,[10] and partly from the real social and economic benefits that accrue to the employed, including insurance, financial stability, and social interaction. Factors that are associated both with employment and outcome, and may affect estimation of the effect of work on pregnancy outcomes include an increase in risk at extremes of maternal age,[11] differences in educational level,[8,10,12–14] differences in prenatal

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care,[8,15,16] and differential smoking rates[14,17,18] Despite evidence of overall improved birth outcomes in working women, there still remains evidence of differential effects of work particularly in birth weight, within working populations, that may be attributable to exposures or other facets of the job, although results are not consistent across studies.[14,19–21]

Dual sets of forces have played a role in women's employment over the past quarter-century. Increased participation in more physically demanding and socially challenging occupations has arisen through reduction of employment barriers for women. At the same time, broad economic trends have favored a general shift into employment in the service sector over older manufacturing jobs. Although employment in some areas of a service economy may reduce exposure to traditional industrial hazards, such as chemical toxicants and dusts, work in many service occupations still entails potential risks, including increased physical demands, in addition to the biological and physical hazards present in such fields as health care.[4,5,22–24] Characteristics of work organization may be also changing, as industrial and manufacturing jobs are replaced or supplanted by growing service-sector employment. The expanded use of computers has spawned newer occupations, such as information technology and software design, and altered older jobs, such as those involving data entry and customer service. Other service occupations have become deskilled in ways analogous to manufacturing assembly line work. Psychosocial and work organizational factors, such as the disparity between psychological work demands and the degree of worker control in meeting them, are also drawing interest as a contributor to adverse pregnancy outcomes in working women.[25–27]These changes in work that are contingent on changes in the overall economy suggest that associations between work and possible health effects, including pregnancy outcomes, are not static, but may change or vary with broader work trends or changes in job characteristics.

The study described here was designed to evaluate the association of low birth weight (LBW) delivery with occupational data collected for a state birth registry. In using a large, unselected registry population, particularly from a state with a diverse economic profile, we hoped to determine whether associations between birth weight and employment might be changing. Specifically, we hypothesized that a) previously observed differences in birth weight between working and nonworking mothers would persist in a newer economic climate, and b) that the occupational profile of risk for LBW may be changing in the face of a shift into service-based jobs.

Methods

Data Set

Records of all live births to Connecticut residents are reported to the Connecticut Department of Public Health (CT DPH) where they are compiled and maintained. Data fields included in the Connecticut birth registry include infant birth weight, date of last menstrual period and gestational age, maternal age, race, ethnicity, occupation and industry, maternal tobacco use during pregnancy (yes or no), the month prenatal care was initiated and the number of prenatal visits, maternal education (years, up to 17), and history of previous live birth and stillbirth. Data from the birth registry for the calendar year 2000 were obtained from the CT DPH as a text file after being stripped of maternal and infant personal identifiers and converted into an SPSS data file (SPSS Inc., Chicago, IL, Version 13.0) for analysis.

Validation Pilot

Concurrent with this analysis, a small pilot mail survey was sent in 2003 to 700 mothers listed in the birth registry as recently having given birth, and for whom an entry was made in the occupation field in the registry data. This survey inquired as to the mother's occupation and industry while pregnant, and the time of leaving work relative to gestational age or delivery. A second mailing was made 4 weeks after the first to those not completing it after the first mailing. Survey responses for occupation and industry were compared with those listed in the birth registry for respondents.

Variable Creation

Coding of maternal occupation and industry was performed using procedures and algorithms for standardized occupation and industry coding developed by the National Institute for Occupational Safety and Health (NIOSH) and the National Center for Health Statistics.[28,29] Occupation and industry were coded to three digits using the Bureau of the Census classification framework for the 2000 Census and aggregated into minor and major occupational groups using crosswalks and guidance documents from the 2000 Census classification and the 2000 Standard Occupational Classification (SOC) System of the Bureau of Labor Statistics.[28] Four other categories for mothers without an occupation listed were developed: Homemaker (including those listed as homemaker, housewife, or stay-at-home mother); Student (if specifically listed as such); No occupation (specifically listed as Unemployed or None); and Unknown (which included both a specific listing of "unknown" or a blank entry in the data set). The age distribution of the birth data set as a whole was used as a base for age-adjustment of birth weights and rates. Rates for term- and all-LBW were calculated for those in SOC minor occupational groups with 50 deliveries or more in 2000.

Additional variables obtainable from the birth data set were abstracted and coded for use as covariates in regression models. Gestational age was coded as weeks prior to term (37 weeks) delivery. Maternal age demonstrated an association with LBW at both extremes of age, consistent with previous literature.[11] Indicator variables contrasting maternal age less than 20 years and greater than 37 years with those aged 20 to 37 (referent group) were used to analyze age effects in logistic regression. Educational level was categorized as college graduate (16 or more years education), high school graduate (12 to 15 years), or non-high-school graduate (<12 years). Indicator variables for race and ethnicity contrasted White non-Hispanics with Black and Hispanic mothers. Delivery of a previous live-born child was associated in the overall data set with reduced risks of LBW and prematurity; a Yes or No variable was used to code for previous delivery. Similarly an indicator variable was used to code trimester in which prenatal care was initiated. Previous preterm delivery, an important predictor of subsequent preterm delivery, was not available in this data set and hence was not incorporated into analyses.

Analytic Strategy

Analyses were performed using SPSS v 13, and examined outcomes for singleton deliveries only, to exclude the effects of multiple gestation on LBW. LBW (defined as birth weight less than 2500 g), and term LBW (less than 2500 g at 37 weeks gestation or greater, which eliminates the effect of prematurity on estimates of LBW and growth retardation) were used as dichotomous outcome measures in multivariate analyses. Age adjustment of birth weight between groups was performed using analysis of covariance; age-adjusted rates for LBW and preterm delivery were calculated by direct standardization using 5-year age strata in the overall birth data set. Logistic regression was used to estimate the odds of all LBW and term LBW for working versus nonworking mothers, adjusting for covariates obtained from the data set; variables that resulted in a 5% or greater change in the effect estimate for the outcome contrasting working or nonworking mothers were included in the multivariate model. Odds ratios for specific occupations (broad occupational category and SOC minor occupational code) were calculated while controlling for gestational age and covariates from the overall multivariate model. Secretaries (SOC minor occupational code 43.6) were used as referents in logistic regression analyses. These represent a subset of clerical workers used as a referent or comparison group in similar studies of occupation and LBW, and have been chosen in previous studies because their work does not entail known chemical or physical hazards nor strenuous physical activity.[21] Consistent with previous studies, secretaries in this data set had an overall LBW rate (47.5 per 1000 births) close to the mean for working mothers with singleton deliveries, which supports their use as referent category. The 95% confidence intervals (CIs) were calculated for estimates of effect. Approval for this study was obtained from the Institutional Review Board of the University of Connecticut Health Center and the Human Investigations Committee of the CT DPH.

Results

Pilot Validation Survey

A total of 194 mothers (27.7%) responded to the mail survey requesting information on occupation while pregnant. Of these respondents, 161 of 162 (99.4%) who were listed in the birth registry as having an occupation noted that they worked during pregnancy; of 32 listed as not working, 18 (56.3%) indicated that they did have a job during pregnancy. One hundred fifty-one (77.8%) of respondents indicated working full time into the pregnancy; another 22 (11.3%) worked part time. The positive predictive value of the birth registry listing for specific occupation using the job listed on the questionnaire as a "definitive standard" was 93.8% for those listed in the birth data set as working, whereas the negative predictive value for a registry listing as nonworking was 56.3%. Of those who indicated that they were working during pregnancy, 163 (91.1%) worked beyond the start of the seventh month of gestation, whereas 140 (78.2%) worked either until the last month of gestation or the time of delivery.

Full Data Set Analyses

Maternal characteristics and birth outcomes for singleton deliveries recorded in the 2000 birth registry are shown in Table 1, categorized by employment status in the maternal occupation field of the data set. Mothers listed in the birth registry as working were slightly older, had a higher mean educational level, smoked and drank alcohol less during the pregnancy, and were more likely to have initiated prenatal care in the first trimester than those without an occupation listed. Births to mothers with an occupation listed in the data set weighed 46 g more than those without a maternal occupation (3392 g in those working vs 3346 g for all nonworking). Rates of LBW, at term, and premature delivery were also lower in those listed as working. Adjustment for the differing age distributions between mothers in working and nonworking categories reduces the birth weight differential as well as observed differences in rates of LBW and premature delivery, although elevations persist in those classified as "unemployed" or unknown (bottom, Table 1).

Table 2 shows univariate and full multivariate model effect estimates for all- and term-LBW delivery for maternal covariates derived from the birth registry data. The small increased risk for term LBW (1.12) and all LBW (1.21) in nonworking mothers seen on univariate analysis (initial columns) does not persist after adjustment for all covariates in the multivariate model (for all LBW, adjusted OR (aOR) 1.07; 95% CI =

TABLE 1

Maternal Demographic Characteristics, Low Birth Weight, and Premature Delivery Cases; Subjects With a Singleton Delivery by Listing in the Occupation Field of the Birth Dataset. Connecticut Births, 2000

	Working	Homemaker	Student	Unemployed or None	Unknown	Total*
Singleton deliveries	26,408	7,231	1,067	947	5,356	41,009
Maternal age (mean, yr)	30.0	30.3	21.6	26.2	25.5	29.2
<20 yr: *n* (%)	1,009 (3.8)	275 (3.8)	535 (50.1)	208 (22.0)	1,231 (23.0)	3,258 (7.9)
20–37 yr	23,230 (88.0)	6,247 (86.4)	518 (48.5)	675 (71.3)	3,895 (72.7)	34,565 (84.3)
>37 yr	2,169 (8.2)	709 (9.8)	14 (1.3)	64 (6.8)	230 (4.3)	3,186 (7.8)
Maternal education (mean, yr)	14.2	13.7	12.7	12.2	12.2	13.8
Non-high school graduate (<12 yr): *n* (%)	1,394 (5.3)	770 (10.6)	374 (35.1)	290 (30.6)	1,549 (28.9)	4,377 (10.7)
High school grad/some college (12–15 yr)	13,281 (50.3)	3,570 (49.4)	421 (39.5)	476 (50.3)	2,586 (48.3)	20,334 (49.6)
College graduate and above (<15 yr)	11,326 (42.9)	2,769 (38.3)	252 (23.6)	172 (18.2)	830 (15.5)	15,349 (37.4)
Unknown	407 (1.5)	121 (1.7)	21 (2.0)	9 (1.0)	391 (7.3)	949 (2.3)
First delivery (%)	44.4	18.3	70.7	36.6	40.3	39.8
Prenatal care in 1st trimester: *n* (%)	23,612 (89.4)	6,156 (85.1)	812 (76.1)	693 (73.2)	4,144 (77.4)	35,417 (86.4)
2nd trimester	1,734 (6.6)	682 (9.4)	163 (15.3)	156 (16.5)	762 (14.2)	3,497 (8.5)
3rd trimester	272 (1.0)	156 (2.2)	40 (3.7)	34 (3.6)	146 (2.7)	648 (1.6)
Unknown	790 (3.0)	237 (3.3)	52 (4.9)	64 (6.7)	304 (5.7)	1,447 (3.5)
Tobacco use in pregnancy (%)	6.9	6.6	7.5	18.1	12.9	7.9
Alcohol use in pregnancy (%)	0.6	0.4	0.6	1.1	1.1	0.6
White non-Hispanic (%)	71.3	68.4	41.4	56.2	38.2	65.3
Black (%)	11.1	4.7	20.9	11.3	20.3	11.4
Hispanic (%)	10.5	17.8	27.3	25.6	31.1	15.3
Birth outcomes						
Mean birth weight (g)	3,392	3,428	3,269	3,336	3,258	3,376
Low birth weight: *n* (% all births)	1,441 (5.5)	345 (4.8)	75 (7.0)	60 (6.3)	474 (8.8)	2,395 (5.8)
Term low birth weight: *n* (% term births)	479 (2.0)	140 (2.1)	28 (2.9)	24 (2.8)	159 (3.4)	830 (2.2)
Preterm delivery: *n* (% all births)	2,195 (8.3)	568 (7.9)	103 (9.7)	84 (8.9)	575 (10.7)	3,525 (8.6)
Age adjusted						
Birth weight (g)	3,384	3,418	3,334	3,361	3,288	–
Low birth weight (% all births)	5.6	5.0	4.4	6.0	8.5	–
Term low birth weight (% term births)	2.1	2.2	1.1	2.4	3.2	–
Preterm delivery (% all births)	8.4	8.2	8.4	8.8	10.5	–

*Forty-five subjects were excluded for insufficient information by which occupation could be coded, or because they were listed as "retired."

0.94 to 1.22). Estimates of risk for LBW for factors derived from the data set were of consistent magnitude and direction with other studies; strong effects are seen in particular for smoking in pregnancy. Risk also varied markedly with reported race or ethnicity, with an 80% increase for all LBW in Black mothers over non-Hispanic Whites, and an over 2-fold increase in term LBW. Persistent, although less marked elevations were also seen for Hispanic mothers. The effect of maternal education was even more pronounced when analysis was limited to mothers ≥25 years old who would presumably have completed their education, thereby attempting to control for confounding of educational level by age. In this subset of mothers, using those with ≥16 years education (college graduates) as referent, the risk of term LBW (aOR) was 1.56 (95% CI = 1.25 to 1.96) for those completing high school or with some college level education, and 2.69 (95% CI = 1.82 to 3.97) for those ≥25 not completing high school (results not shown). The nonsignificant adjusted risk estimates for working versus nonworking mothers were not affected by excluding births to younger mothers.

Unadjusted rates for all- and term-LBW by occupation (using three-digit 2000 SOC Codes for minor occupational group) with 95% CIs for all-LBW rates, are shown in Table 3. The overall or mean rates (shown in the body of Table 3 to facilitate comparisons) were 54.6 and 19.9 per 1000 live births, respectively. Rates for nonworking groups are also included (in italics) for com-

TABLE 2

Odds Ratios for All- and Term-Low Birth Weight Delivery by Working Status and Maternal Characteristics. Connecticut Births, 2000

	All Low Birth Weight			Term Low Birth Weight		
		Multivariate Model			Multivariate Model	
	Univariate OR	OR	95% CI	Univariate OR	OR	95% CI
Not working	1.21	1.07	0.94–1.22	1.34	1.15	0.97–1.36
Gestational age (weeks prior to term)	2.71	2.70	2.59–2.81	—	—	—
Maternal age (yr)						
20–37	Referent			Referent		
<20	1.78	0.87	0.70–1.07	2.03	0.84	0.65–1.10
>37	1.32	1.58	1.29–1.93	1.10	1.61	1.21–2.14
Previous birth	0.68	0.53	0.47–0.60	0.61	0.53	0.45–0.63
Tobacco use in pregnancy	2.50	2.42	2.05–2.85	3.05	2.74	2.23–3.36
Alcohol use in pregnancy	3.04	—	—	3.29	—	—
Prenatal care began after 1st trimester	1.64	1.18	0.99–1.40	2.05	1.47	1.20–1.81
Race/ethnicity						
White non-Hispanic	Referent	—	—	Referent	—	—
Black	2.53	1.82	1.55–2.14	2.59	2.46	2.01–3.02
Hispanic	1.72	1.31	1.11–1.55	1.89	1.63	1.31–2.02
Education						
College graduate or more (≥16 yr)	Referent		—	Referent		—
High school graduate/some college (12–15 yr)	1.62	1.24	1.07–1.43	1.80	1.50	1.22–1.84
Non-high school graduate (<12 yr)	2.57	1.40	1.12–1.76	3.15	1.91	1.42–2.57

Multivariate model: adjusted odds ratios using logistic regression with variables that resulted in a 5% or greater change in the effect estimate contrasting working and non-working mothers as the criterion for inclusion.

OR indicates odds ratio; 95% CI, 95% confidence interval.

parison. Elevated rates are seen in several areas of service-sector work, particularly in the food and beverage service industry, personal appearance, retail sales, and health care support occupations. Other service sector jobs with increased rates for LBW were material distributing work (predominately postal and courier service workers) and building cleaning. Among women with traditional manufacturing jobs, only textile workers and assemblers or fabricators had more than 50 births noted in the data set and could be included in this table; both had rates of all LBW that were elevated above the overall rate, and in the case of textile workers, a higher rate of term LBW as well.

Occupations with elevated risk for all- or term-LBW delivery after adjustment for covariates in logistic regression analysis, using secretaries as a referent group, are shown in Table 4. Increased odds ratios were seen in several service occupations including food service workers, personal appearance, material distributing, and retail sales work, though in most cases associations are higher for term LBW. Textile work was the only manufacturing job for which significantly higher risk for LBW was seen. Odds ratios were only modestly attenuated by control for relevant covariates, and in some cases were mildly increased after adjustment, suggesting that factors related to work may have a persisting effect after confounders of this relationship are taken into account. Logistic regression analyses of occupations with rates of LBW below the mean value showed no reduced risks for LBW that were statistically significant after adjustment.

Discussion

In contrast to data on other factors which may predict or contribute to adverse birth outcomes, occupational information is not collected in the birth data files of the National Center for Health Statistics, and therefore investigations must use individual state registry files or other survey data. Previous studies on the utility of state birth registry data as a source of exposure data for occupational risks have focused on their utility in prediction of congenital defects.[30,31] These two studies found concordance of 71% and 72%, respectively between reported and recorded maternal occupation, and suggested that the use of these datasets in screening were likely to miss all but the very strongest associations of malformations with occupation. A more recent study from Indiana found excellent agreement between medical records and birth certificate data for demographic variables, including maternal age, educational attainment, initiation of prenatal care, and previous live births (κ statistics all between 0.79 and 0.99) suggesting that demographic variables used as covariates in analyses may be reasonably accurate.[32] Occupation was, however, not addressed in the Indiana study, limiting the opportunity to compare the accuracy of this data field with our

TABLE 3

Rates of Low Birth Weight Delivery by SOC Minor Occupational Group, and for Nonemployed Mothers by Category. Connecticut Births, 2000

Occupation (SOC Minor Occupational Group Code)	Total Births	LBW Births	Term LBW Births	All LBW: Rate/1000 Births (95% CI)	Term LBW: Rate/1000 Term Births
Other food preparation and serving workers (35.9)	90	13	5	144.4 (71.8–217.1)	64.9
Communications equipment operators (43.2)	53	7	2	132.1 (40.9–223.2)	43.5
Textile, apparel, and finishing workers (51.6)	78	9	2	115.4 (44.5–186.3)	30.0
Unknown, or no entry	*5,356*	*474*	*159*	*88.5* (80.9–96.1)	*33.6*
Material recording, scheduling, dispatching, distributing workers (43.5)	334	28	13	83.8 (54.1–113.6)	43.5
Personal appearance workers (39.5)	516	43	13	83.3 (59.5–107.2)	28.2
Retail sales workers (41.2)	1,438	114	42	79.3 (65.3–93.2)	33.1
Food and beverage serving workers (35.3)	640	50	17	78.1 (57.3–98.9)	29.8
Material moving workers (53.7)	104	8	3	76.9 (25.7–128.1)	31.6
Nursing and home health aides (31.1)	1,119	86	34	76.9 (61.2–92.5)	34.4
Other sales and related workers (41.9)	177	13	3	73.4 (35.0–111.9)	18.9
Assemblers & fabricators (51.2)	207	15	3	72.5 (37.1–107.8)	16.8
Student	*1,067*	*75*	*28*	*70.3* (55.0–85.6)	*29.2*
Other personal care and service workers (39.9)	629	43	13	68.4 (48.6–88.1)	23.0
Building cleaning and pest control workers (37.2)	264	18	8	68.2 (37.8–98.6)	33.3
Other education/training occupations (25.9)	265	18	4	67.9 (37.6–98.2)	16.7
Other production occupations (51.9)	397	26	7	65.5 (41.2–89.8)	20.0
Unemployed/none	*947*	*60*	*24*	*63.4* (47.8–78.9)	*28.1*
Other healthcare support occupations (31.9)	488	30	14	61.5 (40.2–82.8)	31.5
Information and record clerks (43.4)	1,231	73	28	59.3 (46.1–72.5)	25.1
Health technologists and technicians (29.2)	636	37	14	58.2 (40.0–76.4)	24.5
Supervisors of food prep and serving workers (35.1)	174	10	5	57.5 (22.9–92.1)	32.7
Total	*26,408*	*1,441*	*479*	*54.6 (51.8–57.3)*	*19.9*
Financial specialists (13.2)	958	52	19	54.3 (39.9–68.6)	21.6
Religious workers (21.2)	662	35	9	52.9 (35.8–69.9)	15.0
Supervisors of sales workers (41.1)	580	30	9	51.7 (33.7–69.7)	17.2
Financial clerks (43.2)	818	42	15	51.3 (36.2–66.5)	20.2
Art and design workers (27.1)	335	17	7	50.7 (27.2–74.2)	22.0
Other office administrative support workers (43.9)	847	42	12	49.6 (35.0–64.2)	15.5
Homemaker	*7,231*	*345*	*140*	*47.7* (42.8–52.6)	*21.1*
Secretaries and administrative assistants (43.6)	1,263	60	15	47.5 (35.8–59.2)	13.1
Other management occupations (11.9)	1,250	59	20	47.2 (35.4–59.0)	17.4
Supervisors of administrators (43.1)	452	21	9	46.5 (27.1–65.9)	21.7
Business operations specialists (13.1)	1,015	47	15	46.3 (33.4–59.2)	16.0
Sales representatives, services (41.3)	596	27	7	45.3 (28.6–62.0)	12.7
Postsecondary teachers (25.1)	133	6	2	45.1 (9.8–80.4)	16.0
Top executives (11.1)	333	15	6	45.0 (22.8–67.3)	19.4
Computer specialists (15.1)	629	28	7	44.5 (28.4–60.6)	12.0
Social scientists and related workers (19.3)	162	7	2	43.2 (11.9–74.5)	13.2
Operations specialties managers (11.3)	630	27	7	42.9 (27.0–58.7)	12.0
Legal support workers (23.2)	258	11	4	42.6 (18.0–67.3)	17.0
Health diagnosing and treating practitioners (29.1)	1,927	79	21	41.0 (32.1–49.8)	11.9
Mathematical science occupations (15.2)	51	2	0	39.2 (0–92.5)	0

(*Continued*)

TABLE 3
Continued

Occupation (SOC Minor Occupational Group Code)	Total Births	LBW Births	Term LBW Births	All LBW: Rate/1000 Births (95% CI)	Term LBW: Rate/1000 Term Births
Entertainment attendants and related workers (39.3)	104	4	1	38.5 (1.5–75.4)	10.8
Media and communication workers (27.3)	194	7	2	36.1 (9.8–62.3)	11.0
Sales reps, wholesale, and manufacturing (41.4)	196	7		35.7 (9.7–61.7)	
Primary, secondary, and special education teachers (25.2)	1,641	58	24	35.3 (26.4–44.3)	15.7
Physical scientists (19.2)	65	2	0	30.8 (0–72.8)	0.0
Advertising, marketing, promotions, public relations, sales workers (11.2)	424	13	1	30.7 (14.3–47.1)	2.5
Supervisors of personal care and service workers (39.2)	72	2		27.8 (0–65.7)	
Other teachers and instructors (25.3)	183	5	1	27.3 (3.7–50.9)	5.8
Lawyers and judges (23.1)	299	8	2	26.8 (8.5–45.0)	7.3
Entertainment and performers, sports, and related workers (27.2)	87	2	0	23.0 (0–54.5)	0.0

TABLE 4
Crude and Adjusted Odds Ratios for Low Birth Weight and Term LBW by Occupation Census Code Grouping (SOC Minor Occupational Group) Using Secretaries (43.6) as Referent. Connecticut Births, 2000

	All Low Birth Weight			Term Low Birth Weight		
		Adjusted			Adjusted	
Occupation (SOC Minor Occupation Code)	OR[a]	OR	95% CI	OR*	OR	95% CI
Other food preparation and serving workers (35.9)	4.28	4.67	1.73–12.63	7.27	6.34	1.79–22.41
Textile workers (51.6)	4.04	3.71	1.08–12.81	4.25	†	—
Communications equipment operators (43.2)	3.60	3.46	0.96–12.45	3.02	†	—
Personal appearance workers (39.5)	2.18	2.45	1.32–4.55	2.94	2.97	1.26–6.98
Material recording, scheduling, dispatching, and distributing workers (43.5)	1.81	1.81	0.90–3.64	4.22	4.42	1.83–10.64
Other personal care and service workers (39.9)	1.60	1.69	0.96–2.97	2.21	2.23	0.97–5.13
Retail sales workers (41.2)	1.48	1.43	0.88–2.32	2.91	2.51	1.19–5.26

*Initial odds ratios represent comparison with secretaries, adjusted for gestational age for all-LBW cases. Adjusted OR's are logistic regression results incorporating maternal age, tobacco use, maternal educational level, and maternal race/ethnicity, in addition to gestational age for all-LBW.

†Insufficient numbers of term LBW cases were noted in these occupations to yield statistically stable results on adjustment.

own. Difficulties in ascertaining occupation through surveys using vital records as a base, and the problems of substantial nonresponse, have been well described,[33] and comparison with other data sources may be necessary. The 2000 Connecticut birth data set listed 72% of mothers as having an occupation, which is slightly greater than the figure for first-time mothers who worked during pregnancy (67.2%) provided by the Census Bureau for the period 1996 to 2000.[2] This comparison suggests that our results may not be affected by substantial under-reporting of occupation. Our pilot survey did not ascertain the accuracy of reporting for those without an entry for occupation in the data set. Nevertheless, more individuals who were listed in the data set as nonworking reported that they did work during pregnancy, whereas concordance between those listed as working and their self-reports was much greater. This could indicate, by contrast, that reporting of employment status may be underestimated. Taking these comparisons into account, the possibility of misclassification bias in ascertainment of maternal occupation through the registry cannot be excluded, in particular if recording of occupation may be influenced by a poor outcome, such as maternal illness that necessitated removal from work or a medical decision to deliver prior to term.[21,34]

The unadjusted results for pregnancy outcomes noted here are consistent with a body of literature that shows an overall beneficial effect of maternal employment on birth weight and outcomes, including intrauterine growth retardation and prematurity.[6–9,35,36] Statistical adjustment, however, indicates that the improved outcomes seen in working mothers may be at least in part the result of a favorable demographic profile and better health attributes when compared to their nonworking counterparts. Adjustment of mean birth weight and LBW or preterm delivery rates for age, as well as multivariate analysis using sociodemographic predictors of adverse outcomes, attenuates the influence of occupation on birth outcomes, suggesting that positive attributes related to working, such as age, education, and access to prenatal care could be a pathway through which improved birth outcomes in working populations are manifested (although evidence of risk still persists in some occupations). This finding differs from that noted by Poerksen and Petitti,[8] who found that work was a stronger predictor of improved birth outcomes than were most other socioeconomic variables. The discrepancy in findings may be a consequence of differences in the populations studied, with the earlier study concentrating on poor women in Alameda County, California, for whom working may represent a more important source for such attributes as social support, provision of necessities, and access to health care than it does in our unselected population. Our analysis also assumes that the lack of an entry in the data field for occupation indicates a nonworking mother. Although the characteristics of these individuals with missing occupational data is much closer to those listed as either students or as unemployed than to working mothers (lower age and educational levels, higher smoking rates), the possibility that misclassification of occupational status has occurred should still be considered, as noted above. Other findings not heretofore observed were the improved outcomes seen in those specifically listed as homemaker or housewife. Similar to working mothers, this group has a favorable health and demographic profile (older age, higher education, less tobacco and alcohol use) which may be relevant to better outcomes. In addition, this category may also represent a surrogate for the availability of resources that contribute to improved outcomes, such as a higher family income level or availability of health insurance through a partner. Although we can only speculate on reasons for this finding, it may suggest avenues for further investigation of protective factors.

Within the working population, there is consistency with other studies in finding differential birth outcomes according to occupation. Previous studies of birth weight and occupation have found increased risks in manufacturing, industrial work, and other manual trades.[14,19,21,37] In particular, our study corroborates the elevated risk for LBW delivery seen in textile workers in several of these previous studies. Textile work may have several associated potential reproductive hazards, including endotoxin exposures and heavy manual work, although the mechanisms for adverse birth outcomes in this industry are still unclear. In addition, we note increased risks in several service-based occupations, in particular in food services, personal appearance (beauticians, cosmetologists, and nail salon workers), retail sales workers, and material recording, scheduling, dispatching, and distributing workers (this includes workers with mail and courier services as well as telephone dispatchers, warehouse clerks and shippers). Elevated risks for adverse pregnancy outcome in several of these occupations were previously described, principally in food services,[21] although increased risks in the broader range of service sector jobs seen here have not been noted in previous studies. One possibility for this difference is that some occupations with adverse outcomes in this study were subsumed into the broader categories used to classify occupations in earlier studies.[9,21,38] This strategy may aid in providing adequate numbers and hence improved statistical power to detect potential effects of occupation; in particular when classification systems are based on exposures or work processes common to particular occupational groups.[38] They may also, however, obscure differences in exposure or risk within broader occupational classifications if job tasks or other attributes differ between jobs within a class.[22,39] A common thread among the service-sector jobs found to be at higher risk in our study is their similarity in psychosocial attributes, principally low control over work, which is often coupled with high psychological and physical demands,[40–42] although other factors such as lower income levels and educational requirements in these jobs may also be contributory. This suggests that strategies that use task-based evaluations to impute potential job hazards such as low decision latitude and physical strain may be useful in categorizing occupational groups.[22,27]

Limitations are inherent in the use of a large administrative data set to answer research questions such as those posed here. A principal limitation, discussed earlier, is the reliability of data on maternal occupation, including both the accuracy of job title reporting, and the lack of information on work span during pregnancy. A related problem is the limited information available on covariates and potential confounders in the data set. Some important predictors of adverse outcomes are collected by the birth registry, including maternal age, educational level, prior deliveries, and tobacco use during pregnancy. Nevertheless, the practicability of collecting additional data for administrative purposes limits the variables available for analysis. Thus strong predictors of LBW and prematurity, such as a previous occurrence of a preterm delivery, as well as other potentially important factors such as income and insurance coverage, are not available in the data. The coding of other available fields, such as smoking during pregnancy (limited to a yes or no answer) and education (truncated at 17 years) may reduce precision in testing hypothesized contributors to LBW. Nevertheless, despite these limitations, the magnitude and direction of risks attributable to covariates derived from these data are consistent with those from other studies. For example, the adjusted coefficients obtained for tobacco use and LBW from these data show at least a doubling of risk or greater, equivalent to findings in other studies that assessed smoking and its contribution to LBW.[17,18,43] These analyses also replicate the consistent findings of LBW differentials by race and ethnicity, with adverse outcomes seen particularly in blacks over non-Hispanic Whites,[13,44–47] the causes of which remain undetermined but an important priority for public health research. Finally, the extent to which other socioeconomic variables, such as income and prior educational achievement can be disentangled from occupational characteristics cannot be fully assessed by use of this data set alone. Education in particular may represent an effect modifier instead of a confounder, affecting the causal pathway that links workplace attributes, such as physical and psychosocial stressors, with poor pregnancy outcomes. Some investigators[12] have found better predictive effects of education for birth outcomes than occupational characteristics, whereas others find attenuation of the effect of psychosocial work exposures by educational level, suggesting a mediating effect.[27] The role of contextual effects, which view risk as a combination of individual-level and group or aggregate socioeconomic factors,[48,49] and of joint or interactive effects between socioeconomic indicators that vary among racial or ethnic subgroups[13,50] represent another set of challenges to consider when attempting to ascertain the role of work in general, and occupation more specifically, in the etiology of adverse pregnancy outcomes.

In summary, this study, using a large state birth data set, suggests that findings of overall improved birth outcomes in working populations may be, in part, a consequence of differing demographic and risk profile characteristics between working and nonworking mothers. These data are, however, consistent in demonstrating differential outcomes within the set of working mothers. Associations of occupation with LBW and term LBW are seen in several service sector jobs, including food services, personal appearance, retail sales, and shipping, as well as in textile work. Associations of these occupations, particularly with term LBW, persist when adjusted for relevant covariates that could be obtained from the data set. Estimations of risk from this study may be limited by the cross-sectional nature of the data, the small number of covariates that could be used in analysis of outcomes, and problems inherent in determining the duration and scope of maternal work during pregnancy. Investigation that more precisely ascertains maternal work, including the time span of work during pregnancy, as well as accounting for other covariates that affect the association between maternal work and LBW delivery, would be important to confirm the results presented here. Additionally, these finding indicate the importance of continuing research that accounts for the complexity of interactions between demographic and socioeconomic factors and occupational characteristics in the genesis of adverse pregnancy outcomes.

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References

1. Smith K, Downs B, O'Connell M. *Maternity Leave and Employment Patterns: 1961–1995. Current Population Reports.* Washington, DC: US Census Bureau; 2001:70–79.
2. Johnson JO, Downs B, U.S. Census Bureau. *Maternity Leave and Employment Patterns of First-Time Mothers: 1961–2000.* Washington, DC: U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau; 2005.
3. Ahlborg G Jr, Hemminki K. Reproductive effects of chemical exposures in health professions. *J Occup Environ Med.* 1995;37:957–961.
4. Paul M. Occupational reproductive hazards. *Lancet.* 1997;349:1385–1388.
5. Lindbohm ML. Women's reproductive health: some recent developments in occupational epidemiology. *Am J Ind Med.* 1999;36:18–24.
6. Murphy JF, Dauncey M, Newcombe R, Garcia J, Elbourne D. Employment in pregnancy: prevalence, maternal characteristics, perinatal outcome. *Lancet.* 1984;1:1163–1166.
7. Saurel-Cubizolles MJ, Zeitlin J, Lelong N, Papiernik E, Di Renzo GC, Breart G. Employment, working conditions, and preterm birth: results from the Europop case-control survey. *J Epidemiol Community Health.* 2004;58:395–401.
8. Poerksen A, Petitti DB. Employment and low birth weight in black women. *Soc Sci Med.* 1991;33:1281–1286.
9. Chia SE, Lee J, Chia KS, Chan OY. Low birth weight in relation to parental occupations—a population-based registry in Singapore (1994–1998). *Neurotoxicol Teratol.* 2004;26:285–290.
10. Savitz DA, Whelan EA, Rowland AS, Kleckner RC. Maternal employment and reproductive risk factors. *Am J Epidemiol.* 1990;132:933–945.
11. Shmueli A, Cullen MR. Birth weight, maternal age, and education: new observations from Connecticut and Virginia. *Yale J Biol Med.* 1999;72:245–258.
12. Parker JD, Schoendorf KC, Kiely JL. Associations between measures of socioeconomic status and low birth weight, small for gestational age, and premature delivery in the United States. *Ann Epidemiol.* 1994;4:271–278.
13. Savitz DA, Kaufman JS, Dole N, Siega-Riz AM, Thorp JM Jr, Kaczor DT. Poverty,

education, race, and pregnancy outcome. *Ethn Dis*. 2004;14:322–329.
14. Virji SK, Talbott EO. The relationship between occupational classification and low birth weight in a national sample of white married mothers. *Int Arch Occup Environ Health*. 1990;62:351–356.
15. O'Campo P, Xue X, Wang MC, Caughy M. Neighborhood risk factors for low birth weight in Baltimore: a multilevel analysis. *Am J Public Health*. 1997;87:1113–1118.
16. Savitz DA, Dole N, Kaczor D, et al. Probability samples of area births versus clinic populations for reproductive epidemiology studies. *Paediatr Perinat Epidemiol*. 2005;19:315–322.
17. Lieberman E, Gremy I, Lang JM, Cohen AP. Low birth weight at term and the timing of fetal exposure to maternal smoking. *Am J Public Health*. 1994;84:1127–1131.
18. Steyn K, de Wet T, Saloojee Y, Nel H, Yach D. The influence of maternal cigarette smoking, snuff use and passive smoking on pregnancy outcomes: the birth to ten study. *Paediatr Perinat Epidemiol*. 2006;20:90–99.
19. McDonald AD, McDonald JC, Armstrong B, et al. Occupation and pregnancy outcome. *Br J Ind Med*. 1987;44:521–526.
20. Sanjose S, Roman E, Beral V. Low birth weight and preterm delivery, Scotland, 1981–84: effect of parents' occupation. *Lancet*. 1991;338:428–431.
21. Savitz DA, Olshan AF, Gallagher K. Maternal occupation and pregnancy outcome. *Epidemiology*. 1996;7:269–274.
22. MacDonald LA, Karasek RA, Punnett L, Scharf T. Covariation between workplace physical and psychosocial stressors: evidence and implications for occupational health research and prevention. *Ergonomics*. 2001;44:696–718.
23. Mozurkewich EL, Luke B, Avni M, Wolf FM. Working conditions and adverse pregnancy outcome: a meta-analysis. *Obstet Gynecol*. 2000;95:623–635.
24. McDiarmid MA. Chemical hazards in health care: high hazard, high risk, but low protection. *Ann N Y Acad Sci*. 2006;1076:601–606.
25. Hogue C, Hoffman S, Hatch MC. Stress and preterm delivery: a conceptual framework. *Paediatr Perinat Epidemiol*. 2001;15(suppl 2):30–40.
26. Brett KM, Strogatz DS, Savitz DA. Employment, job strain, and preterm delivery among women in North Carolina. *Am J Public Health*. 1997;87:199–204.
27. Meyer JD, Warren N, Reisine S. Job control, substantive complexity, and risk for low birth weight and preterm delivery: an analysis from a state birth registry. *Am J Ind Med*. 2007;50:664–675.
28. Division of Vital Statistics. National Center for Health Statistics. *Instruction Manual Part 19a: Industry and Occupation Coding for Death Certificates*. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics; 2003.
29. Division of Vital Statistics. National Center for Health Statistics. *Instruction Manual Part 19b: Alphabetical Index of Industries and Occupations*. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control & Prevention, National Center for Health Statistics; 2003.
30. Shaw GM, Malcoe LH, Croen LA, Smith DF. An assessment of error in parental occupation from the birth certificate. *Am J Epidemiol*. 1990;131:1072–1079.
31. Marshall EG, Gensburg LJ, Roth GB, Davidson GK, Dlugosz LJ. Comparison of mother's occupation and industry from the birth certificate and a self-administered questionnaire. *J Occup Med*. 1992;34:1090–1096.
32. Zollinger TW, Przybylski MJ, Gamache RE. Reliability of Indiana birth certificate data compared to medical records. *Ann Epidemiol*. 2006;16:1–10.
33. Gilboa SM, Mendola P, Olshan AF, et al. Characteristics that predict locating and interviewing mothers identified by a state birth defects registry and vital records. *Birth Defects Res A Clin Mol Teratol*. 2006;76:60–65.
34. Savitz DA, Hertz-Picciotto I, Poole C, Olshan AF. Epidemiologic measures of the course and outcome of pregnancy. *Epidemiol Rev*. 2002;24:91–101.
35. Oths KS, Dunn LL, Palmer NS. A prospective study of psychosocial job strain and birth outcomes. *Epidemiology*. 2001;12:744–746.
36. Saurel-Cubizolles MJ, Kaminski M. Work in pregnancy: its evolving relationship with perinatal outcome (a review). *Soc Sci Med*. 1986;22:431–442.
37. de Sanjose S, Roman E. Low birth weight, preterm, and small for gestational age babies in Scotland, 1981–1984. *J Epidemiol Community Health*. 1991;45:207–210.
38. Schnitzer PG, Teschke K, Olshan AF. A classification scheme for aggregating U.S. census occupation and industry codes. *Am J Ind Med*. 1995;28:185–191.
39. Schwartz JE, Pieper CF, Karasek RA. A procedure for linking psychosocial job characteristics data to health surveys. *Am J Public Health*. 1988;78:904–909.
40. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol*. 1998;3:322–355.
41. Muntaner C, Eaton WW, Garrison R. Dimensions of the psychosocial work environment in a sample of the United-States metropolitan population. *Work Stress*. 1993;7:351–363.
42. Hadden W, Kravetz N, Muntaner C. The dimensions of work organization using the O*NET. *Soc Sci Res*. 2004;58:1869–1887.
43. Horta BL, Victora CG, Menezes AM, Halpern R, Barros FC. Low birthweight, preterm births and intrauterine growth retardation in relation to maternal smoking. *Paediatr Perinat Epidemiol*. 1997;11:140–151.
44. Kleinman JC, Kessel SS. Racial differences in low birth weight. Trends and risk factors. *New Eng J Med*. 1987;317:749–753.
45. McGrady GA, Sung JF, Rowley DL, Hogue CJ. Preterm delivery and low birth weight among first-born infants of black and white college graduates. *Am J Epidemiol*. 1992;136:266–276.
46. Sung JF, McGrady GA, Rowley DL, Hogue CJ, Alema-Mensah E, Lypson ML. Interactive effect of race and marital status in low birth weight. *Ethn Dis*. 1993;3:129–136.
47. Collins JW Jr, Butler AG. Racial differences in the prevalence of small-for-dates infants among college-educated women. *Epidemiology*. 1997;8:315–317.
48. Krieger N, Chen JT, Waterman PD, Soobader MJ, Subramanian SV, Carson R. Choosing area based socioeconomic measures to monitor social inequalities in low birth weight and childhood lead poisoning: the Public Health Disparities Geocoding Project (US). *J Epidemiol Community Health*. 2003;57:186–199.
49. Subramanian SV, Chen JT, Rehkopf DH, Waterman PD, Krieger N. Comparing individual- and area-based socioeconomic measures for the surveillance of health disparities: a multilevel analysis of Massachusetts births, 1989–1991. *Am J Epidemiol*. 2006;164:823–834.
50. Kaufman JS, Cooper RS, McGee DL. Socioeconomic status and health in blacks and whites: the problem of residual confounding and the resiliency of race. *Epidemiology*. 1997;8:621–628.