Work in pregnancy and birth weight for gestational age

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ABSTRACT In a recent report on prematurity and work in pregnancy based on the Montreal survey noteworthy increases in both preterm births (<37 weeks) and infants of low birth weight (≤ 2500 g) were found in women in certain specific occupations or whose work entailed heavy lifting, shift work, long hours, or great fatigue. Because of the large overlap between preterm births and low birth weight, the latter was further analysed with allowance for gestational age in order better to separate factors retarding fetal growth from those shortening gestation. The association of low birth weight with specific occupations, long working hours, and fatigue largely disappeared, suggesting that the effect of these factors was to shorten gestation. By contrast, the association with lifting heavy weights and with shift work persisted, suggesting that these factors retarded fetal growth as well as increasing the risk of preterm birth.

An analysis of prematurity in a large study carried out in Montreal showed associations of preterm birth (<37 weeks gestation) and low birth weight (≤ 2500 g) with certain occupations, and with lifting heavy weights, long hours of work, and shift work.¹ Because reduced gestational period is a cause of low birth weight, it was not possible to distinguish factors associated with a shortened gestation period from those associated with retarded fetal growth. A further analysis was therefore undertaken with results reported here.

Methods

As in the previous analyses of prematurity the study population included 22 761 single live births to Montreal women who had worked in similar conditions for 30 or more hours a week from conception until they left or reached the 28th week. This was reduced to 22 404 after excluding women for whom either birth weight or gestational age was unknown. Details of the study design and methods have been described previously.^{1,2}

A statistical method was adopted that allowed parallel analyses of birth weight with and without allowance for gestational age and which permitted comparison with previous analyses. The birth weight in each pregnancy was expressed as per cent of

predicted, the latter accounting for eight non-occupational factors; age, gravidity, previous spontaneous abortion, ethnic group, height, educational level, cigarette smoking, and alcohol consumption. This was achieved by using coefficients obtained from a preliminary analysis of variance of birth weight in all 22 404 working women in the study. A second prediction of birth weight, accounting also for gestational age, was calculated using regression coefficients of polynomial terms of gestational age up to the cubic entered as covariates in another analysis of variance. Table 1 shows the results of these two preliminary analyses.

The relation of birth weight and weight for age with occupational factors was examined by comparing means of the two indices—per cent predicted birth weight and weight for age—in specific groups. Tests for heterogeneity of means between groups were carried out using analyses of variance; confidence intervals for group means were calculated using standard errors derived from the within group mean sum of squares.

Results

Table 2 shows mean per cent predicted birth weight and weights for age by occupational sector. The mean per cent predicted birth weights were significantly heterogeneous ($p < 0.001$), with those in the health and the manufacturing sectors lowest. Variation of

Table 1 Association of birth weight with potentially confounding variables and gestational age

Factor	Group	Confounding variables only		Confounding variables and gestational age	
		Significance level of factor*	Difference of mean from overall mean†	Significance level of factor*	Difference of mean from overall mean*
Age of mother (y)	<20		57		72
	20-29		4		0
	≥30	p = 0.013	-14	p = 0.003	-5
Gravidity	1		-34		-49
	2		44		64
	3		79		111
	≥4	p < 0.001	85	p < 0.001	132
Previous spontaneous abortion	No		12		11
	Yes	p < 0.001	-81	p < 0.001	-76
Education of mother	Primary		-7		6
	Secondary		-12		-6
	College	p = 0.004	13	p > 0.1	6
Ethnicity	White: Anglophone		69		44
	: Francophone		-2		-3
	Black		-117		-44
Smoking	Other and unknown	p < 0.001	-57	p < 0.001	-34
	Nil		72		61
	1-19 cigs daily		-117		-90
Alcohol	≥20 cigs daily	p < 0.001	-178	p < 0.001	-162
	None		-7		-1
	1-2 drinks/week		23		6
Height of mother (cm)	≥3 drinks/week	p = 0.004	2	p > 0.1	-5
	≤157		-105		-92
	158-164		14		12
Gestational age‡	≥165	p < 0.001	92	p < 0.001	81
	Age		—	p < 0.001	-1342.4†
	Age squared		—	p < 0.001	47.3†
	Age cubed		—	p < 0.001	-0.48†

*Significance levels of F tests in analysis of variance accounting for all other factors listed.

†Differences in grams of group mean birth weight from overall mean (3289 g), adjusting for effects of other factors.

‡Gestational age entered as a covariate with linear, squared, and cubic terms; regression coefficients shown.

weight for age was not significant ($p > 0.10$). Similarly, there was significant variation between the 60 occupational groups for per cent predicted birth weight ($p = 0.01$) but not for weight for age ($p > 0.10$). Considered individually, seven of the 60 occupational groups showed deficits in mean per cent predicted birth weights, statistically significant at $p < 0.05$ (one sided test) and an eighth at $p < 0.10$. These results are shown in table 3 together with mean per cent predicted weights for age, only two of which showed significant deficits at $p < 0.05$ and three others at $p < 0.10$.

Table 4 shows per cent predicted birth weight and weight for age for work requirements that were significantly associated with low birth weight or preterm birth in our previous analyses. Allowance for possible confounding by undefined selective factors related to occupational sector (not used in the calculation of expected birth weight) was made by entering sector as well as the factor of interest in the analysis of variance. In table 4 the adjusted means are shown. Lifting heavy weights more than 15 times a day and changing shift work were both significantly associated with low birth weight before and after accounting for

gestational age. Women working for long hours (46 or more a week) also had lower weight babies than predicted, but this only approached significance when no allowance was made for gestational age.

The fatigue index constructed previously to resemble as closely as possible that used by Mamelle and colleagues³ was significantly associated with birth weight ($p = 0.03$) but not with weight for age ($p > 0.10$).

Table 2 Mean per cent predicted birth weight and birth weight for age by occupational sector

Sector	No of pregnancies	Per cent predicted birth weight (90% CI)	Per cent predicted weight for age (90% CI)
Managerial	4190	100.8 (100.4-101.2)	100.4 (100.0-100.8)
Health	2767	99.4** (98.9-99.9)	99.6* (99.1-100.1)
Clerical	9814	100.1 (99.8-100.4)	100.0 (99.7-100.3)
Sales	1190	100.3 (99.5-101.1)	100.4 (99.6-101.2)
Services	1692	99.8 (99.1-100.5)	100.4 (99.8-101.0)
Manufacture	2706	99.1*** (98.6-99.6)	99.7 (99.2-100.2)
Total	22404	100.0	100.0

Significance levels of difference from 100 (one sided tests) indicated according to the key: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3 Mean per cent predicted birth weight and birth weight for age for occupations showing significant deficits (out of 60 groups)

Occupation†	No of pregnancies	Per cent predicted birth weight (90% CI)	Per cent predicted birth weight for age (90% CI)
Health sector:			
Nurses (3131-excluding psychiatric and operating room)	896	98.8** (97.9-99.7)	98.9** (98.0-99.7)
Clerical sector:			
Clerical workers, not otherwise classified (4199)	378	98.4** (97.0-99.7)	98.8* (97.5-100.2)
Services sector:			
Food & beverage service (6123, 6125)	534	98.8** (97.6-99.9)	100.6 (99.5-101.7)
Child care workers (6147)	109	96.7** (94.1-99.3)	97.4** (94.9-99.9)
Manufacturing sector (8110-8599, 9310-9519):			
Food and drink (10-12)	141	97.4** (95.2-99.7)	98.2* (96.0-100.4)
Rubber and plastic (15-16)	69	96.6** (93.4-99.9)	98.5 (95.4-101.6)
Textiles (18-19)	174	98.2* (96.2-100.3)	98.2* (96.2-100.2)
Metal, electrical (29-39)	430	96.8*** (95.4-98.0)	99.8 (98.6-101.1)

*p < 0.1; **p < 0.05; ***p < 0.01. †Four digit Standard Occupational Classification (Ottawa, Statistics Canada 1980) and for the manufacturing sector Standard Industrial Classification (Ottawa, Statistics Canada 1980) given in parentheses.

Discussion

In the present report mean indices of birth weight are presented rather than risk of birth weight below 2500 g as in our previous report.^{1,2} Whereas this form of analysis makes maximum use of information, and allows for gestational age to be taken into account simply, results are less directly interpretable than estimates of risk. The differences between groups in mean per cent predicted birth weight for age were small (1-2%), even when statistically significant. The approximate relation of these indices to relative risks may be estimated from the observed standard deviation of per cent predicted birth weight, assuming the distributions to be normal. For example, in tables 2, 3, and 4 mean per cent predicted birth weights of 99%, 98%, and 97% would correspond to relative risks of about 1.14, 1.29, and 1.46, respectively. Interpreted in this way, the mean per cent predicted birth weights (not accounting for gestational age) in this analysis agree broadly with those for risk of low birth weight reported previously.¹ There are some differences in the specific occupations found at significantly increased

risk as would be expected from random variation in small groups.

Whereas low birth weight (not accounting for gestational age) may reflect short gestations as well as low fetal growth rate, associations of a factor with low birth weight for age is more likely to reflect the latter. To the extent that gestational age is measured imprecisely this would leave some "residual confounding" by gestational age, so that even low weight for age could in part reflect the effect of short gestation. The magnitude of this effect, however, would be small.

The pattern of association of birth weight with non-occupational confounders (table 1) changed little when gestational age was taken into account, although the magnitude of effect varied appreciably for gravidity. Except for gravidity, the same patterns of risk were apparent for preterm births in the previous analysis,¹ suggesting that several of the confounders affect both gestational age and fetal growth.

The absence of significant heterogeneity of predicted weights for age in occupational sectors and specific occupations suggest that raised risks of low birth weight were more likely to have resulted from short

Table 4 Mean per cent predicted birth weight and birth weight for age by work requirements

Work requirement†	No of pregnancies	Per cent predicted birth weight (90% CI)†	Per cent predicted birth weight for age (90% CI)†
Lifting heavy weights (≥ 15 times a day)	1071	98.8*** (98.0-99.6)	99.1** (98.3-99.9)
Long working week (≥ 46 hours)	891	99.1** (98.2-100.0)	99.5 (98.6-100.4)
Changing shift	653	98.3*** (97.3-99.3)	98.2*** (97.2-99.2)
Fatigue index:‡			
0	11913	100.2 (100.0-100.4)	100.1 (99.9-100.3)
1	6600	99.9 (99.6-100.2)	99.9 (99.6-100.2)
2	2515	99.6 (99.1-100.1)	99.8 (99.3-100.3)
3	932	99.9 (99.0-100.8)	100.8 (100.0-101.6)
4 or 5	444	99.0 (97.6-100.4)	98.8* (97.4-100.2)
(test for trend)		(p = 0.03)	(p > 0.10)

*p < 0.1; **p < 0.05; ***p < 0.01. †Means adjusted for occupational sector.

‡Number of sources of fatigue at work.¹

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gestations than retarded fetal growth.

The association of low birth weight with heavy lifting remained essentially the same after accounting for gestational age, indicating an effect on fetal growth as well as preterm birth (which was found associated with heavy lifting previously¹). Changing shift work was also associated with weight for age (and therefore with fetal growth) and with preterm birth though not significantly.¹ On the other hand, the association of low birth weight with long working hours diminished on accounting for gestational age and that with the fatigue index disappeared, suggesting that these factors (which showed clear associations with preterm births¹) mainly affect gestational age and not fetal growth rate.

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