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Pregnancy outcomes among daycare employees in Finland

by Anita Riipinen, MD,¹ Markku Sallmén, PhD,¹ Helena Taskinen, MD, PhD,^{1,2} Aki Koskinen, MSc,³ Marja-Liisa Lindbohm, PhD¹

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Objective The aim of this study was to investigate whether working as a daycare employee increases the risk of perinatal death, pre-term birth, low birth weight, smallness for gestational age, or congenital malformations.

Methods We conducted a register-based cohort study among daycare employees and women from various occupations of healthcare (reference group). Study subjects were identified from the files of Finnish trade unions and the National Authority for Medicolegal Affairs. Pregnancy outcomes, antenatal occupation, and working status were obtained by linkage to national registers. The final data consisted of 13 299 and 12 182 singleton births in the study and reference groups, respectively. We analyzed pregnancy outcome data using generalized estimating equations and linear regression.

Results The occurrences of pre-term birth [odds ratio (OR) 0.91, 95% confidence interval (95% CI) 0.79–1.06], perinatal death (OR 0.91, 95% CI 0.62–1.34), smallness for gestational age (OR 1.01, 95% CI 0.91–1.12), and congenital malformation (OR 1.10, 95% CI 0.92–1.32) were similar among the children of the daycare employees and the reference group. The adjusted mean birth weight of the children of the daycare employees was slightly higher (14 g, 95% CI -1–29) than that of the reference group, but the difference was attenuated to 6 g in the subset of the first births.

Conclusion Daycare employees were not, in general, at an increased risk of an adverse pregnancy outcome. However, efforts should nevertheless be made to prevent their exposure to harmful viruses and heavy physical load during pregnancy.

Key terms birth weight; congenital malformation; perinatal death; pre-term birth; smallness for gestational age; SGA.

In Finland, daycare work is a common occupation – approximately 6% of employed women work as a children's nurse or nursery school teacher. Daycare employees may be exposed to some potential reproductive health hazards, such as various infections, heavy lifting, stress, noise, and physically demanding postures (1–5). The cytomegalo and varicella-zoster viruses (CMV and VZV), rubella and influenza can lead to congenital malformation (6, 7), while the human parvovirus B19 (B19V) infection can cause fetal death (8–10). The effects of maternal fever on the fetus are not well understood, but some studies have suggested an increase in defects of the central nervous and cardiac systems and congenital renal anomalies (6, 11–14).

Pronounced physical exertion may influence intra-abdominal pressure, uterine blood flow, hormonal balance, and nutritional status, all of which are important determinants of embryonic and fetal development and survival (15). Heavy lifting has been associated with an increased risk of spontaneous abortion (16, 17), pre-term delivery (18–20) and low birth weight (18, 21) in some, but not all studies. In addition, high psychological job demands have been reported to increase the risk of small size for gestational age (22), low birth weight (23, 24) and pre-term delivery (25).

The Canadian population-based studies of McDonald et al (16, 26, 27) examined pregnancy outcomes in 60 different occupations and observed an elevated risk

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of congenital defects among daycare employees compared to the general population. Using the same data, Armstrong et al (21) found lowered birth weight and retardation in fetal growth among the offspring of the daycare employees. To our knowledge, only one previous study has focused on daycare work and pregnancy outcome (28). In this small Swedish study, the frequency of miscarriage was found to be higher in pregnancies during employment at daycare centers than those during other types of work.

In spite of the many potential risk factors for an adverse pregnancy outcome among daycare employees, data on the reproductive health of this occupational group is sparse. The objective of our study was, therefore, to investigate whether children of daycare employees are at an increased risk of pre-term birth, perinatal death, low birth weight, smallness for gestational age (SGA) or congenital malformation. This study is a part of a larger research project focusing on the reproductive outcomes of daycare employees and the effects of human parvovirus infections on fetuses during pregnancy.

Methods

Data sources and study population

We conducted a register-based cohort study on reproductive health among daycare employees (children's nurses and nursery school teachers) in Finland during 1991–2004 (figure 1). The reference group was chosen

from women working in healthcare with similar socioeconomic status but either little or no occupational contact with children. The selected occupations were physiotherapists, dispensers, opticians, masseuses, rehabilitation nurses, and dental nurses/hygienists. Nursery school teachers were identified from the files of two trade unions (ie, the Trade Union of Education and the Union of Professional Social Workers). We identified women employed in other occupations from the register of the National Authority for Medicolegal Affairs. The source population consisted of 60 926 women born in 1946 or later.

The coverage of our data on dental, rehabilitation and children's nurses gradually dropped in the middle of the study period. After an educational reform in August 1995, the titles of these occupations were included in the new, non-specific title of "practical nurse". Women qualified in these three occupations after this time could not be identified from the register and, thus, were not included in our data.

Pregnancy outcomes

Information on births in 1991–2004 was obtained from the Finnish Medical Birth Register, which contains data on all mothers (ie, age, previous deliveries, smoking, socioeconomic status, and occupation), live births, and perinatal deaths (ie, gestational age, birth weight, and gender) in Finland, from 1987 onwards. Altogether, 49 501 children were born to 26 934 women in the source population. We restricted our study to singleton

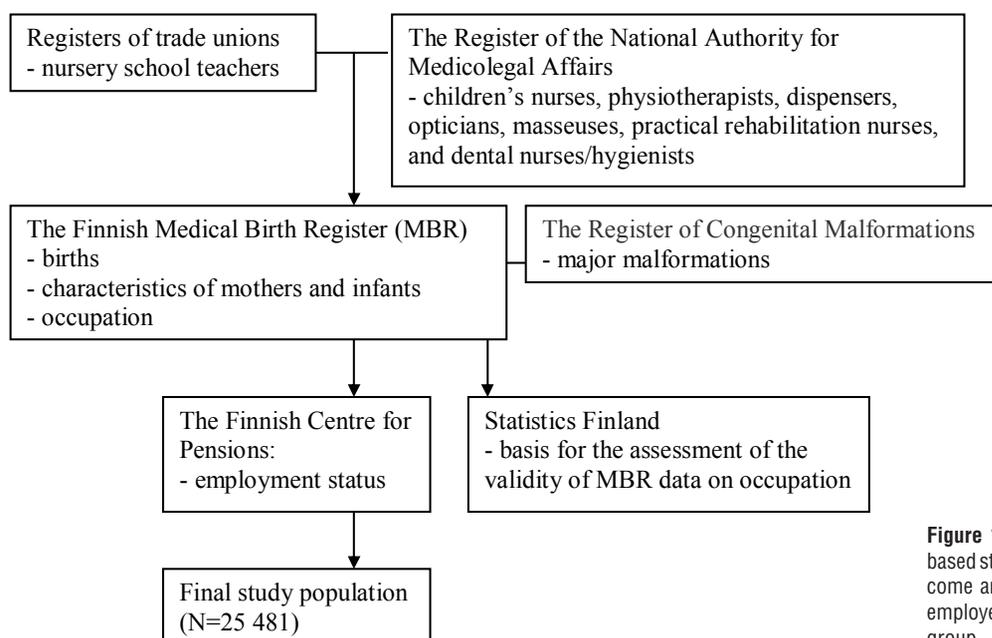


Figure 1. Design of register-based study on pregnancy outcome among Finnish daycare employees and the reference group.

births, among mothers who were ≥ 20 years old at the beginning of their pregnancy (figure 2).

Information on congenital malformations was obtained from the Register of Congenital Malformations maintained by the National Institute for Health and Welfare from 1963 onwards. Congenital malformations were registered according to ICD-9 (the International Classification of Diseases) codes 740–759. We studied major congenital malformations excluding luxation of hips, retention of the testis, and some other minor congenital malformations. Finally, we included 617 fetuses with congenital malformation. Moreover, we separately

studied chromosomal defects, and the non-chromosomal malformations of the cardiovascular, nervous, urinary, and musculoskeletal systems.

The outcome variables included pre-term birth, perinatal death, birth weight, SGA, and congenital malformations. Pre-term birth was defined as birth before the 37th week of gestation. SGA was defined as below the gender-specific 10th percentile birth weight for gestational age in the reference population. Due to the small number of infants born before gestational week 35, SGA could only be determined for ≥ 35 gestational-week-old infants. The analysis of birth weight was restricted to term births (≥ 37

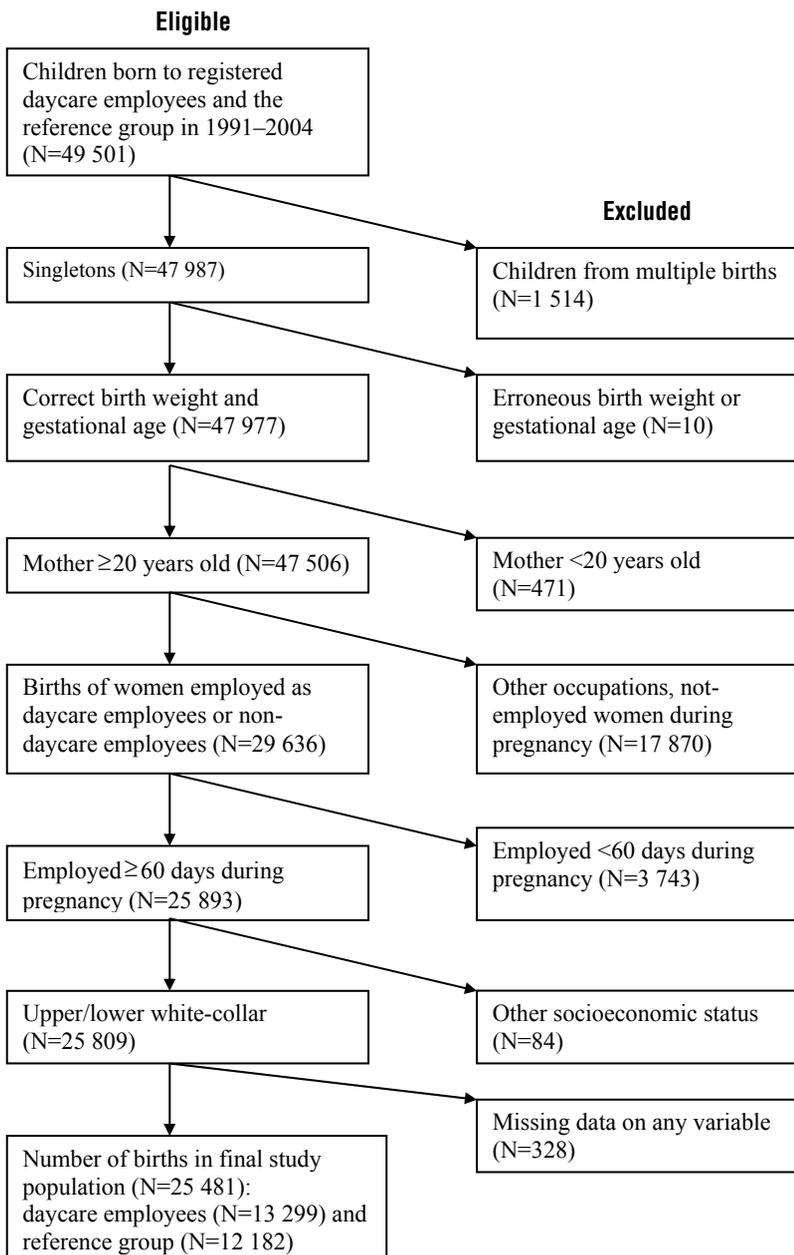


Figure 2. Flow diagram of eligibility criteria and exclusions of pregnancies in a study among Finnish daycare employees and the reference group.

gestational weeks) as suggested by Wilcox (29). Perinatal death was defined as stillbirth or neonatal death during the first week of life. Stillbirth was defined as intrauterine fetal death having occurred at the gestational age of ≥ 22 weeks or having a birth weight of ≥ 500 g.

Occupation and working status

Our source population consisted of women who were either persons qualified for selected occupations in the healthcare sector or members of the trade unions of nursery school teachers. We used information from two different registers to define the employment status and occupation of the women during pregnancy. First, we obtained the information on occupation provided by the mother to the Finnish Medical Birth Register. Secondly, we defined the employment status of mothers from the nationwide employment register of the Finnish Centre for Pensions, where all salaried employments are registered. We restricted our study to mothers in daycare or reference occupations with ≥ 60 registered employment days during the first 22 gestational weeks (figure 2). We used a 60-day limit, because holidays (typically 4–5 weeks) and sick leaves cannot be distinguished from registered information on employment. We took into account only employment during the first 22 gestational weeks to cover the minimum length of gestation for births and stillbirths.

We examined the validity of the information on occupation from the Medical Birth Register by comparing it with data obtained from Statistics Finland at two cross-sections of time, namely the last weeks of 1995 and 2000. The occupations of women whose pregnancy had started within a year (9 months before or 3 months later) from the two cross-sections of time agreed with those of Statistics Finland in 87% and 82% of the subjects, respectively (on average 85%). The proportion was slightly lower among the daycare employees (83%) than the reference group (87%). Notably, about 7% of the subjects (ie, almost half of the mismatched pairs) could not be found from the files of Statistics Finland. This is partly due to the short reference period of the last week of the year; women may have worked some time during their pregnancy, but not during this short reference period. Another reason for the difference is that childcare leaves are indistinguishable from the registered employment information. Thus, the validity of information on occupation from the Medical Birth Register is likely to be better than what could be reasoned solely on the basis of this comparison. All in all, we considered the Register's information on the mother's occupation reliable, and we thus used it as the source of occupation for all the pregnancies.

After the restrictions made in the study population and the exclusion of births with erroneous or missing

data (figure 2), the final study population consisted of 13 299 and 12 182 births in the study and the reference groups, respectively. The Coordinating Ethical Committee of the Hospital District of Helsinki and Uusimaa approved this study. We obtained permission to use the Medical Birth Register and the Register of Congenital Malformation from the Ministry of Social Affairs and Health. Permission for the use of the registers of the Finnish Centre for Pensions and Statistics Finland was obtained from the organizations directly.

Statistical methods

We analyzed pre-term birth, perinatal death, SGA, and congenital malformations using generalized estimating equations, which provided odds ratios (OR) as the measures of effects. Birth weight was analyzed by linear regression. Maternal age at the beginning of pregnancy, smoking, socioeconomic status, previous deliveries, gender (not in SGA analyses), and the calendar period of the child's birth were included in all the multivariable models as potential confounders. Data on birth weight were also adjusted for gestational age. To account for the potential role of gestational age at birth as an intermediate variable, we repeated the analyses without adjustment. Hospital district was included in the analyses of congenital malformations. The models used accounted for dependence between births by the same woman. We carried out the statistical analyses using the statistical software package SAS (version 9.1, SAS Institute Inc, Cary, NC, USA), procedure GENMOD for the generalized estimating equations and procedure MIXED for regression.

We conducted a series of sensitivity analyses to account for potential internal validity problems in our data. We began by separately analyzing the first births because, in Finland, mothers of <3-year-old children have the right to childcare leave, which is indistinguishable from the registered employment information. This analysis also guards against the potential effects of infections through one's own children. In addition, the analysis of the subset of primiparous women has been recommended in general (30). Second, we repeated the main analysis after excluding physiotherapists and masseuses, on the one hand, and dental nurses/hygienists on the other. The exposure of dental workers to mercury and nitrous oxide and the exposure of physiotherapists to short waves, microwaves, and ultrasound have been associated with adverse reproductive effects in some, although not all studies (31, 32). Moreover, physiotherapists and masseuses are exposed to physical exertion. Third, we analyzed the data by calendar period because, after the educational reform in August 1995, the proportion of daycare workers dropped from 55% to 48% between 1991–1997 and 1998–2004.

Results

Daycare employees had a higher number of previous deliveries, were more likely to be upper-class, white-collar workers, and had given birth more often during the earlier calendar period than those in the reference group (table 1). There were little or no differences in the mother's age, smoking habits, or gender of the child between the two groups.

We found no consistent pattern in associations of daycare work with pre-term birth, perinatal death or SGA (table 2). All the OR were ≈ 1 . Results of analyses of the first births, two calendar periods and subsets, excluding selected occupations, were very similar to those of the main analyses. During the B19V epidemic year of 1993, we found seven perinatal deaths among the daycare employees and five in the reference group. However, the numbers were too small for a meaningful analysis.

The mean birth weight of the children of daycare employees (3640 g) was slightly higher than that of the children born to the reference group (3612 g), but the adjusted mean difference in birth weight was small (14 g, 95% CI -1–29) (table 3). The difference in adjusted mean birth weight was reduced to 6 g (95% CI -12–25) in the subset of first births. The results did not change essentially in the analyses without adjustment for gestational age (mean difference in all births 15g, 95% CI -1–31). The mean birth weight was, as expected, lower among the children of smoking versus non-smoking women (3517 versus 3629 g), primiparous compared to multiparous women (3525 versus 3730 g), and among girls (3554 g) compared to boys (3695 g).

As shown in table 4, the prevalence of congenital malformations did not differ remarkably between the children of the daycare employees (2.5%) and those of the reference group (2.3%). The adjusted OR was 1.10 (95% CI 0.92–1.32). However, a slightly increased risk of congenital malformations (OR 1.25, 95% CI 0.96–1.61) was found among infants of daycare employees born in the latter calendar period.

We found no essential differences in the occurrence of congenital malformations of chromosomal, cardiovascular, nervous, or musculoskeletal systems between the study and the reference groups. A slightly increased risk was noted for cardiovascular (OR 1.21, 95% CI 0.89–1.63) and urinary malformations (OR 1.30, 95% CI 0.81–2.09), but the confidence intervals of the estimates were wide. Notably, the daycare employees' children had an excess of urinary malformations (OR 2.11; 95% CI 1.09–4.09) during the latter study period, and a deficit (OR 0.66; 96% CI 0.38–1.18) during the former period. The test for interaction between period and work at

daycare was statistically significant (adjusted P-value 0.0069). There were no corresponding interactions in all major or cardiovascular malformations (adjusted P-values 0.24 and 0.64, respectively).

Discussion

We found little or no difference in the occurrence of pre-term birth, perinatal death, SGA, and congenital malformation between the children of the daycare employees and those of the reference group. The occurrence of pre-

Table 1. Characteristics of births of daycare employees and those in the reference group.

Characteristic	Daycare employees (total 13 299 births)		Reference group (total 12 182 births)	
	N	%	N	%
Characteristics of mothers				
Mother's age				
20–24 years	1108	8.3	947	7.8
25–29 years	5415	40.7	4906	40.3
30–34 years	4815	36.2	4494	36.9
35–48 years	1961	14.7	1835	15.1
Previous deliveries				
0	4890	36.8	5023	41.2
1	4732	35.6	4406	36.2
≥ 2	3677	27.7	2753	22.6
Smoking				
Yes	478	3.6	422	3.5
No	12 549	94.4	11 549	94.8
Missing	272	2.1	211	1.7
Maternal occupation				
Daycare employees				
Children's nurse	4629	34.8	–	–
Nursery school teacher	8670	65.2	–	–
Reference group				
Physiotherapists	–	–	4184	34.3
Masseuse	–	–	344	2.8
Rehabilitation nurse	–	–	1289	10.6
Dispenser	–	–	3041	25.0
Optician	–	–	515	4.2
Dental nurse/hygienist	–	–	2809	23.1
Socioeconomic status				
Upper white-collar	8658	65.1	3038	24.9
Lower white-collar	4641	34.9	9144	75.1
Characteristics of child				
Year of birth				
1991–1997	8609	64.7	7114	58.4
1998–2004	4690	35.3	5068	41.6
Gender				
Girl	6556	49.3	5918	48.6
Boy	6743	50.7	6264	51.4

Table 2. Odds ratios (OR) of pre-term birth, perinatal death, and smallness for gestational age among children of daycare employees and the reference group. (95% CI=95% confidence interval)

Studied births and outcomes	Daycare employees		Reference group		Crude OR	Adjusted OR	95% CI
	N	%	N	%			
Pre-term birth^a							
All births	531	4.0	547	4.5	0.88	0.91	0.79–1.06
First birth	251	5.1	288	5.7	0.87	0.93	0.76–1.14
Year of birth 1991–1997	333	3.4	307	4.3	0.85	0.95	0.79–1.15
Year of birth 1998–2004	198	4.2	240	4.7	0.79	0.87	0.70–1.08
Physiotherapists and masseuses excluded	531	4.0	310	4.8	0.78	0.86	0.73–1.00
Dental nurses/hygienists excluded	531	4.0	417	4.5	0.82	0.94	0.81–1.09
Perinatal death^a							
All births	72	0.5	64	0.5	1.03	0.91	0.62–1.34
First birth	30	0.6	26	0.5	1.18	0.99	0.53–1.82
Year of birth 1991–1997	48	0.6	43	0.6	0.92	0.82	0.52–1.30
Year of birth 1998–2004	24	0.5	21	0.4	1.24	1.14	0.59–2.23
Physiotherapists and masseuses excluded	72	0.5	38	0.6	0.91	0.88	0.58–1.32
Dental nurses/hygienists excluded	72	0.5	45	0.5	1.13	0.97	0.64–1.47
Smallness for gestational age^b							
All births	1229	9.4	1178	9.8	0.95	1.01	0.91–1.12
First birth	686	14.3	684	13.9	1.03	1.04	0.91–1.18
Year of birth 1991–1997	804	9.5	665	9.5	1.00	1.06	0.93–1.20
Year of birth 1998–2004	425	9.2	513	10.3	0.89	0.94	0.80–1.11
Physiotherapists and masseuses excluded	1229	9.4	626	9.9	0.94	1.01	0.90–1.13
Dental nurses/hygienists excluded	1229	9.4	916	9.9	0.94	1.00	0.90–1.11

^a Adjusted for mother's age, smoking, socioeconomic status, previous deliveries, gender and calendar period of child's birth.

^b Adjusted for mother's age, smoking, socioeconomic status, previous deliveries and calendar period of child's birth.

term birth, perinatal death and congenital malformation was at the same level in our data as among all Finnish newborns (33). The children of the daycare employees had a slightly higher mean birth weight than those of the reference group, but when we restricted analysis to the first births, the difference almost disappeared.

Sensitivity analysis

We conducted three sets of sensitivity analyses – we restricted our data according to parity, occupation, and the year of the child's birth. In all subset analyses, the only noteworthy observation was a slightly increased

Table 3. Mean birth weight among infants (≥ 37 gestational weeks) born to daycare employees and those in the reference group. Adjusted for mother's age, gestational age, smoking, socioeconomic status, previous deliveries, calendar period of child's birth and gender. (95% CI=95% confidence interval)

Studied births	Daycare employees		Reference group		Mean difference in birth weight (g)		
	N	Mean birth weight (g)	N	Mean birth weight (g)	Crude	Adjusted	95% CI
All births	12 766	3640	11 635	3612	+28	+14	-1–29
First birth	4638	3532	4735	3515	+17	+6	-12–25

Table 4. Odds ratios (OR) of malformations and selected major malformations among infants born to daycare employees and those in the reference group. (95% CI=95% confidence interval)

Studied births and malformations	Daycare employees		Reference group		Crude OR	Adjusted ^a OR	95% CI
	N	%	N	%			
All major malformations							
All births	336	2.5	281	2.3	1.10	1.10	0.92–1.32
First birth	122	2.5	119	2.4	1.05	1.01	0.76–1.34
Year of birth 1991–1997	183	2.1	148	2.1	1.02	0.98	0.77–1.26
Year of birth 1998–2004	153	3.3	133	2.6	1.25	1.25	0.96–1.61
Physiotherapists and masseuses excluded	336	2.5	163	2.5	0.99	1.03	0.84–1.26
Dental nurses/hygienists excluded	336	2.5	204	2.2	1.17	1.16	0.96–1.41
Selected major malformations							
Chromosomal	23	0.2	18	0.2	1.17	0.81	0.42–1.57
Cardiovascular ^b	119	0.9	96	0.8	1.14	1.21	0.89–1.63
Nervous system ^b	14	0.1	14	0.1	0.92	1.01 ^c	0.46–2.24
Urinary system ^b	48	0.4	39	0.3	1.13	1.30	0.81–2.09
Musculoskeletal system ^b	57	0.4	56	0.5	0.93	0.89	0.58–1.34

^a Adjusted for mother's age, smoking, socioeconomic status, previous deliveries, gender, calendar period of birth of the child and hospital district.

^b Chromosomal malformations were excluded.

^c Adjusted for mother's age, socioeconomic status, previous deliveries and hospital district.

risk of congenital malformations among infants of daycare employees born in the latter calendar period. In particular, we found an unexpected interaction between study period and occupation in the risk of urinary system malformations.

There were simultaneously two separate developments that might have contributed to our findings of all major malformations: a decrease in our data's coverage of some occupations and an increase in its coverage of registered malformations. However, we consider it unlikely that these trends alone could have caused such a notable difference in the observed association with malformations of the urinary system.

The poorer coverage of the Register of Congenital Malformations in former study years is most likely non-differential as regards the compared groups. We have no obvious explanation for the findings by calendar period, and cannot exclude a chance effect. Significant associations might be found in subgroups due to multiple comparisons; this has nothing to do with causality (34).

Comparison with other studies

Our findings on perinatal death, pre-term birth, and SGA are in line with the results of earlier Canadian studies (16, 26, 27). Contrary to these and other results (21, 26), we did not observe an increased risk of major malformations or low birth weight among the children of the daycare employees. However, in the Canadian studies, the number of pregnancies of the childcare workers was small and all working women were used as a reference group. Our nationwide, register-based study included over 13 000 singleton births of daycare employees; the comparably sized reference group consisted of women from corresponding socioeconomic groups.

Strengths of the study

The main strengths of our study were the access we gained to large and nationwide data on births over 14 years, the adjustment of many important confounders in the analyses, and the possibility to verify maternal employment and occupation using information on different registers. The Medical Birth Register covers almost 100% of births, and information on birth outcomes is reliable (35). Reassuringly, our results of the effects of parity, gender, and smoking on birth weight were consistent with expectations, implying a good quality of the Register's data.

Our study focused on women who were either qualified for the selected occupations or members of selected trade unions. We also checked mothers' employment during pregnancy using the employment register of the Finnish Centre for Pensions. We only included mothers with ≥ 60 days of employment during the first 22 weeks of gestation. Moreover, the comparability between data from the Medical Birth Register and Statistics Finland on mothers' occupation was good: 83% of the occupations were convergent among the daycare employees and 87% among the reference group.

We assessed the impact of potential misclassification of occupation on our risk estimates using two strategies. First, we compared the findings among all births and first births to address the potential misclassification caused by unrecognized childcare leaves. We did not see much difference in the findings between the two groups, which indicates that this problem had only a minor impact on our

study. Secondly, we addressed the potential occupational misclassification in general using relatively simple calculations for two outcomes (ie, SGA and congenital malformations). Based on the above-mentioned comparison of registered data, we assumed that 17% of the daycare employees had been misclassified (including women on childcare leave). We assumed that the misclassified women would have had a true OR close to that of the reference women (range 0.8–1.2). Our calculations indicate that the impact of misclassification of occupation on our findings was minor (estimated bias at most 0.06 in any direction). All in all, we consider our results valid.

Confounding factors

We adjusted for many potential confounding factors – maternal age, smoking, socioeconomic status, previous deliveries, gender, calendar period of the child's birth, gestational age (in analysis of birth weight), and hospital district (in analysis of congenital malformations), but we had no information on the mothers' body mass index, diseases, use of alcohol, and marital status, which left room for residual confounding. A mother's body mass index, diabetes, and hypertension may affect birth weight. Being unmarried has been associated with higher perinatal mortality (36, 37). However, the population studied was relatively homogeneous (ie, all the mothers worked in the social and healthcare sector) and adjustment of socioeconomic status may have partly reduced the potential for the confounding of these factors. Smoking was also similar (3.6% and 3.5%) in the compared groups, and we consider it unlikely that there is any remarkable difference in the consumption of alcohol.

Role of occupational factors

We found no essential differences in the risk of perinatal death or congenital malformations between the study and the reference group. These results do not necessarily contradict the observations on the increased risk of various virus infections faced by daycare workers (38–42) that can lead to fetal death (B19V) (8–10), or congenital malformations (CMV, VZV, influenza) (6, 7). The prevalence of seronegative daycare employees has been around 50% for CMV, 40% for B19V, and <5% for VZV (38–42). The annual seroconversion rate has ranged from 1–13% for B19V during non-epidemic and epidemic time (41, 43), and 11–20% for CMV (38, 39). Thus, viral infections and particularly adverse pregnancy outcomes attributed to infections are very rare events making it difficult to observe excess risks at population level. This also holds true for the B19V epidemic in 1993. Exposure to other reproductive hazards (heavy lifting, noise, psychosocial strain) may also be infrequent and/or minor in daycare work. Lack

of individual data on viral infections and these other risk factors limited the possibility to observe potential excess risks.

Concluding remarks

Our study, which is the largest to date concerning pregnancy outcomes of daycare employees, indicated that daycare employees are not, in general, at an increased risk of adverse pregnancy outcomes such as pre-term birth, perinatal death, SGA, or congenital malformations. Although the result is reassuring, it should be noted that daycare employees can occasionally be exposed to some harmful viruses or heavy physical workload during pregnancy, in which case the women should be effectively protected.

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