

## Office employment, work with video display terminals, and course of pregnancy

### Reference mothers' experience from a Finnish case-referent study of birth defects

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NURMINEN T, KURPPA K. Office employment, work with video display terminals, and course of pregnancy: Reference mothers' experience from a Finnish case-referent study of birth defects. *Scand J Work Environ Health* 14 (1988) 293–298. In an examination of the possible harmful effects of work in an office environment and the use of a video display terminal (VDT) on the course of pregnancy, the experience of 1 475 reference mothers from a Finnish case-referent study of birth defects was analyzed. The study was based on the national Register of Congenital Malformations, whose data were supplemented with special interviews on mothers' work conditions. The group which worked in an office environment consisted of 239 women, of whom 60 had worked with video display terminals; 805 mothers had not worked in an office. Only mothers who had worked during most of their pregnancy and who had a singleton birth were included; hence 431 women were excluded from the analysis. The information on threatened abortion, length of gestation, birthweight, placental weight, and maternal blood pressure was analyzed. Office work involved no elevated risk of threatened abortion when compared with nonoffice work, and among the VDT users the proportion with symptoms related to an impending early termination of pregnancy was similar to that of other office workers. No unfavorable effects on the length of gestation were observed between the compared groups, and there were no differences in the birthweight of the babies when adjustment was made for gestational age or the other aspects under consideration. Thus the results did not suggest that office employment or work with video display terminals would be harmful for pregnancy.

**Key terms:** birthweight, length of gestation, maternal blood pressure, placental weight, threatened abortion.

Concerns about work-related reproductive problems have spread to the office environment largely due to the publicity given to the fear that work with a video display terminal (VDT) might result in birth defects and spontaneous abortions. Although it appears that the anxiety concerning the use of such terminals is unfounded when the evidence from published studies is considered (see references 2, 3, 4, 6, 10, 20), much uncertainty still prevails among office personnel. Spontaneous abortions among employees in an airline office have been linked to heavy mental work load (14). In view of the large number of women in office work and the widespread anxiety in many countries, even descriptive results from systematic studies are probably of much social value today.

We have previously published results from a case-referent study of the effect of VDT work during pregnancy on the risk of congenital defects (8), and some preliminary data on office employment, the use of video display terminals, and the reference mothers' pregnancy outcomes (9). In the present study, we have analyzed the available reference mothers' experience more extensively. Specifically, we have studied the occurrence of threatened abortion, length of gestation,

birthweight, placental weight, and changes in the mother's blood pressure during the pregnancies of a group of women who had done office work with or without video display terminals during their pregnancies and of a group of nonoffice workers.

### Subjects and methods

The primary data was obtained from 1 475 time- and area-matched case-referent pairs from a Finnish nationwide study on occupational exposures and congenital malformations (7). We obtained the basic information about the case mothers and their referents from the Finnish Register of Congenital Malformations. The pairs of mothers were interviewed by means of standard procedures of the Register about the particulars of previous pregnancies, diseases, consumption of drugs and alcohol, smoking habits, etc (16, 17). The Register data were supplemented with interviews on the mothers' work conditions and various exposures related to occupational or leisure-time activities, and the interviews were carried out by two trained persons from the Finnish Institute of Occupational Health (5); 96 % of the mothers participated.

The rules of the Register stated that for each mother a matched reference mother was to be selected whose delivery immediately preceded that of the case mother in the same maternity welfare district (16). However, no stillbirths or malformations were to be included in

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the reference series. Thus all women whose pregnancy ended in a delivery of a child not stillborn or malformed in the data collection period of the primary study between 1976 and 1982 were candidates for the reference series. The actual referents can be considered to represent a random sample from these "noncase" mothers stratified by year of birth and maternity welfare district. The 1 475 reference mothers' pregnancies formed the base of the present study. Table 1 shows the accumulation of the study pregnancies by year of birth.

There were no specific questions about VDT work in the questionnaire of the exposure interview. Therefore we used occupational titles to distinguish mothers in office work with potential VDT exposure. Among the 1 475 mothers there were 255 women with occupational titles indicating potential VDT use (table 2). An industrial hygienist and two experts in occupational medicine assessed the VDT exposures of these mothers using descriptions of the mother's ordinary workday, which had been recorded in detail during the interview.

**Table 1.** Studied pregnancies by the year of birth and types of congenital malformation included in the primary paired series.

| Year of birth     | N   | %    | Types of congenital malformation                                                           |
|-------------------|-----|------|--------------------------------------------------------------------------------------------|
| 1976 <sup>a</sup> | 49  | 3.3  | Central nervous system defects                                                             |
| 1977              | 76  | 5.2  | Central nervous system defects                                                             |
| 1978              | 148 | 10.0 | Central nervous system defects, orofacial clefts                                           |
| 1979              | 198 | 13.4 | Central nervous system defects, orofacial clefts                                           |
| 1980              | 374 | 25.4 | Central nervous system defects, orofacial clefts, skeletal defects, cardiovascular defects |
| 1981              | 349 | 23.7 | Central nervous system defects, orofacial clefts, skeletal defects, cardiovascular defects |
| 1982              | 281 | 19.0 | Central nervous system defects, orofacial clefts, skeletal defects                         |

<sup>a</sup> Data collection started in June 1976.

**Table 2.** Mothers by occupational titles representing office work and potential exposure to video display terminals.

| Code <sup>a</sup> | Occupation                                                                                  | N                |
|-------------------|---------------------------------------------------------------------------------------------|------------------|
| 084               | Journalists, editors, advertising copywriters                                               | 2                |
| 096, 14           | Automated data-processing directors, analysts, programmers, computer and keyboard operators | 13               |
| 12                | Clerical workers, including bookkeepers and bank, post office, and other office cashiers    | 36               |
| 13                | Secretaries and typists                                                                     | 32               |
| 15                | Office clerical workers, including office, bank, insurance, and travel agency clerks        | 172              |
| Total             |                                                                                             | 255 <sup>b</sup> |

<sup>a</sup> Classification of occupations, Central Statistical Office of Finland, Handbook no 14, 1981.

<sup>b</sup> Of these mothers 239 had worked during most of their pregnancy and had had a singleton birth.

In all, 64 mothers were assessed as exposed. VDT use was explicitly mentioned in the work description of 43 mothers. VDT work, though not actually mentioned in the description, was deemed obvious for 18 mothers. For three mothers such work was considered probable. Exposure time was categorized as follows: an average of 4 h or more per workday (33 mothers), less than 4 h but at least 1 h per workday (10 mothers), or less than 1 h per workday (21 mothers). The exposure of four mothers had taken place only after the first trimester of pregnancy.

Of the 255 mothers with potential VDT exposure, 242 had worked during most of their pregnancy. The thirteen mothers who had worked only temporarily were excluded from the analysis. Of these, seven had stopped working because their employment had terminated, one had left for maternity leave, one for sick leave (because of hypertension), and four had other reasons or the reason was missing. Two of the excluded mothers had worked with video display terminals. Three of the 242 working mothers had twin births and were also excluded. After the exclusions, the final group with office work consisted of 239 mothers. Of these, 60 had used video display terminals, and 179 were not VDT users.

Of the remaining 1 220 interview forms belonging to mothers not potentially VDT-exposed, we selected a random sample of 50 for inspection. None of the mothers in this sample appeared to have used video display terminals. In all, 270 mothers had not worked during their pregnancy, and 135 had worked only temporarily. Of the latter group 67 had stopped working because their employment had terminated, 11 had left for maternity leave, 21 had been given sick leave (seven because of threatened abortion and one due to hypertension), and the remaining 36 had other reasons or the reason was missing. These mothers were not included in the final analysis. A total of 815 mothers had been in nonoffice work during most of their pregnancy. However nine of these mothers had given birth to twins, and in the case of one woman information on the number of fetuses was missing. These 10 women were also excluded from the study. Thus the final group in nonoffice work consisted of 805 mothers.

We obtained information pertaining to the outcome of the pregnancies under study through the Register, from the standard questionnaire, and from the antenatal record of the maternity health care center. The question of whether the mother had had a threatened abortion during her pregnancy was asked in the Register interview by a midwife. The mother was also asked to specify if she had had vaginal bleeding or lower abdominal pain, or both, and when these symptoms had occurred. For 75 % of the mothers who had had bleeding with or without pain during pregnancy, the symptoms had occurred in the first trimester. For 71 % of the mothers who had had only lower abdominal pain during pregnancy, the symptoms had occurred in the third trimester. The duration of gestation was calcu-

lated from the first day of the last normal menstrual period and was expressed in completed days. An increase of at least 20 mm Hg (3 kPa) in the mean arterial blood pressure between the mother's first visit to the maternity health care center and her last visit before delivery was considered to indicate pregnancy-induced hypertension (1). The mean arterial blood pressure was calculated as one-third of the pulse pressure plus the diastolic pressure (ie, one-third of the systolic pressure plus two-thirds of the diastolic pressure).

Estimates and confidence limits were calculated for the rate ratios according to the Miettinen-Nurminen chi-square function procedure for unstratified and stratified data (13). The means were compared with the t-test, and the medians with the Wilcoxon test. Power calculations for single  $2 \times 2$  tables were carried out with methods derived by Miettinen (11, 15) with a significance level of  $\alpha = 0.025$  and a one-sided test.

For threatened abortion, we used adjusted odds ratio estimates from logistic regression analyses as the estimates of the rate ratios because the outcome was rare. In the comparisons, we controlled for the potential confounding effects of age, outcome of previous pregnancies, history of menstrual irregularity, alcohol consumption, smoking, and intake of drugs.

We derived the differences between the groups with respect to the mean length of gestation for term pregnancies from regression procedures after excluding preterm births (length of gestation less than 259 d) and prolonged pregnancies (gestation 294 d or longer). To adjust for confounding, we used the same variables as for threatened abortion.

## Results

Of the 239 mothers who had done office work, 8.4 % had had symptoms of threatened abortion (bleeding with or without lower abdominal pain) during pregnancy as against 9.8 % of the 805 mothers in nonoffice work. The crude rate ratio was 0.8 with a 95 % confidence interval (95 % CI) of 0.5–1.3, and the adjusted rate ratio derived from the logistic regression analysis was 0.8 (95 % CI 0.5–1.4). Thirteen percent of the mothers in office work and 10.9 % of the mothers in nonoffice work had had only lower abdominal pain during their pregnancy. The crude rate ratio was 1.2 (95 % CI 0.8–1.7), and the adjusted rate ratio was 1.3 (95 % CI 0.8–2.0).

Twenty percent of the 60 mothers who had worked with video display terminals had had either bleeding or pain or both during pregnancy as against 21.8 % of the 179 mothers in office work who had not used such terminals. The unadjusted rate ratio was 0.9 with a 95 % confidence interval of 0.5–1.6. The power to detect a twofold risk was 89 %. Controlling for the effects of the mothers' previous pregnancies did not essentially change the estimates (table 3), nor did they vary upon control for other possible confounders.

**Table 3.** Bleeding and lower abdominal pain during pregnancy, work with a video display terminal (VDT), and the outcome of previous pregnancies of mothers employed in office work.

| Outcome of previous pregnancies                          | Number of mothers | Bleeding and/or pain |      | Rate ratio       |
|----------------------------------------------------------|-------------------|----------------------|------|------------------|
|                                                          |                   | N                    | %    |                  |
| No previous pregnancy                                    |                   |                      |      |                  |
| VDT work                                                 | 22                | 2                    | 9.1  | 1.2              |
| No VDT work                                              | 76                | 6                    | 7.9  |                  |
| Previous deliveries without an adverse pregnancy outcome |                   |                      |      |                  |
| VDT work                                                 | 25                | 6                    | 24.0 | 0.9              |
| No VDT work                                              | 54                | 14                   | 25.9 |                  |
| Previous adverse pregnancy outcome <sup>a</sup>          |                   |                      |      |                  |
| VDT work                                                 | 13                | 4                    | 30.8 | 0.8              |
| No VDT work                                              | 49                | 19                   | 38.8 |                  |
| Total                                                    |                   |                      |      |                  |
| VDT work                                                 | 60                |                      |      | 0.9 <sup>b</sup> |
| No VDT work                                              | 179               |                      |      |                  |

<sup>a</sup> Previous induced abortion, miscarriage, preterm delivery, malformed child, or stillbirth.

<sup>b</sup> 95 % confidence interval = 0.5–1.5.

The mothers in office and nonoffice work had similar proportions of preterm, term, and prolonged pregnancies (table 4). The mean duration of the term pregnancies was 280 (SD 7) d for both groups, and the adjusted difference in the means between these groups was 0.4 [standard error (SE) 0.6] d. The mean length of the term pregnancies of the mothers in VDT work was 282 (SD 6) d. The adjusted difference in the means between the VDT and non-VDT users in office work was 2.9 (SE 1.2) d.

The occurrence of preterm birth was 3.0 % among the mothers in office work and 2.5 % among those in nonoffice work (rate ratio 1.2, 95 % CI 0.5–2.7) (table 4). The power to detect a twofold risk was 50 %.

There were no statistically significant differences in the birthweight of the babies born to mothers in the study groups when adjustment was made for gestational age (tables 4 and 5). In all, 21.5 % of the mothers in office work had babies with a birthweight smaller than the lower quartile birthweight of the babies born to mothers in nonoffice work in the same gestational age group (table 4). For mothers in VDT work the corresponding proportion of small babies was 25.4 % when their babies' birthweights were compared with those of the babies born to mothers who worked in an office environment but did not use video display terminals (table 5). The power to detect a twofold risk of the VDT users giving birth to a small baby was 92 %.

On the average, the placental weights did not differ between the groups, the mean placental weight being 613 (SD 122) g for the mothers in VDT work, 619 (SD 122) g for the non-VDT users in office work, and 614 (SD 128) g for the mothers in nonoffice work.

**Table 4.** Birthweight by gestational age of the babies born to mothers in office and nonoffice work.

| Gestational age | Babies         |      | Birthweight (g) |                | Small babies <sup>a</sup> |      |
|-----------------|----------------|------|-----------------|----------------|---------------------------|------|
|                 | N <sup>b</sup> | %    | Median          | Lower quartile | N                         | %    |
| <37 weeks       |                |      |                 |                |                           |      |
| Office work     | 7              | 3.0  | 2 700           | 2 440          | —                         | —    |
| Nonoffice work  | 20             | 2.5  | 2 465           | 1 440          | 5                         | 25.0 |
| 37–39 weeks     |                |      |                 |                |                           |      |
| Office work     | 89             | 37.5 | 3 430           | 3 180          | 17                        | 19.1 |
| Nonoffice work  | 323            | 40.9 | 3 400           | 3 130          | 80                        | 24.8 |
| 40–41 weeks     |                |      |                 |                |                           |      |
| Office work     | 124            | 52.3 | 3 700           | 3 400          | 28                        | 22.6 |
| Nonoffice work  | 393            | 49.8 | 3 660           | 3 400          | 92                        | 23.4 |
| ≥42 weeks       |                |      |                 |                |                           |      |
| Office work     | 17             | 7.2  | 3 750           | 3 390          | 6                         | 35.3 |
| Nonoffice work  | 54             | 6.8  | 3 760           | 3 430          | 13                        | 24.1 |
| Total           |                |      |                 |                |                           |      |
| Office work     | 237            | 100  | 3 560           | 3 250          | 51                        | 21.5 |
| Nonoffice work  | 790            | 100  | 3 540           | 3 270          | 190                       | 24.1 |

<sup>a</sup> Smaller than the lower quartile birthweight of the babies born to mothers in nonoffice work in the same gestational age group.

<sup>b</sup> There were two mothers in office work and 15 mothers in nonoffice work with missing data on the length of gestation.

**Table 5.** Birthweight by gestational age of the babies born to mothers in office work with and without a video display terminal (VDT).

| Gestational age | Babies         |      | Birthweight (g) |                | Small babies <sup>a</sup> |      |
|-----------------|----------------|------|-----------------|----------------|---------------------------|------|
|                 | N <sup>b</sup> | %    | Median          | Lower quartile | N                         | %    |
| <37 weeks       |                |      |                 |                |                           |      |
| VDT work        | 3              | 5.1  | 2 440           | 1 920          | 2                         | 66.7 |
| No VDT work     | 4              | 2.2  | 2 710           | 2 695          | 1                         | 25.0 |
| 37–39 weeks     |                |      |                 |                |                           |      |
| VDT work        | 15             | 25.4 | 3 620           | 3 090          | 4                         | 26.7 |
| No VDT work     | 74             | 41.6 | 3 385           | 3 180          | 18                        | 24.3 |
| 40–41 weeks     |                |      |                 |                |                           |      |
| VDT work        | 34             | 57.6 | 3 750           | 3 420          | 7                         | 20.6 |
| No VDT work     | 90             | 50.6 | 3 595           | 3 400          | 21                        | 23.3 |
| ≥42 weeks       |                |      |                 |                |                           |      |
| VDT work        | 7              | 11.9 | 3 570           | 3 350          | 2                         | 28.6 |
| No VDT work     | 10             | 5.6  | 3 800           | 3 390          | 2                         | 20.0 |
| Total           |                |      |                 |                |                           |      |
| VDT work        | 59             | 100  | 3 720           | 3 320          | 15                        | 25.4 |
| No VDT work     | 178            | 100  | 3 530           | 3 230          | 42                        | 23.6 |

<sup>a</sup> Smaller than the lower quartile birthweight of the babies born to mothers with no VDT work in the same gestational age group. Infants with a birthweight below the 10th, the 5th, or the 2.5th percentiles are considered small for their gestational age. The group in office work was too small for these criteria.

<sup>b</sup> There was one mother in VDT work and one mother in non-VDT work with missing data on the length of gestation.

The changes in maternal blood pressure during pregnancy were similar in the study groups. For systolic blood pressure the median of all three groups was 120 mm Hg (16 kPa) for both the first visit to the maternity health care center and the last visit before delivery. The median diastolic blood pressure was 70 mm Hg (9 kPa) for all three groups on the first visit and 75 mm Hg (10 kPa) for the VDT users and 80 mm Hg

(11 kPa) for the two other groups on the last visit. The mean blood pressure of 8.3 % of the mothers in VDT work, 5.0 % of the non-VDT users in office work, and 8.2 % of the mothers in nonoffice work increased during pregnancy to a level suggesting hypertension. The power to detect a twofold greater risk of hypertension among the mothers in office work than among the mothers in nonoffice work was 93 %, whereas the cor-

responding power of detection between mothers with and those without VDT work in an office environment was 31 %.

## Discussion

It can be considered unconventional to form the base population of a study from subjects that have primarily been chosen as referents for cases in another study. We became interested in making use of the reference mothers' experience because both relevant information on the course of their pregnancy and the associated exposure data were readily available. Our reference subjects represented "noncases" of malformations and stillbirths, and there was no indication that the midwives who selected the referents would have used any other criteria for exclusion. The reference information corresponded well with data provided by other Finnish studies (18, 19). In fact, if the midwives would have chosen children healthier in other respects, then the reference series would have shown diluted absolute rates of occurrence of, eg, preterm birth or babies with low birthweights. However, because the midwives hardly even knew the mothers' exposures during pregnancy, any differential selectivity according to exposure was improbable. Therefore, the relative risk estimates can be considered to be unbiased. (See reference 12, p 68.)

Nevertheless, inefficiency can be considerable when rare outcomes are studied and a small-sized reference series is used, as was the case in our original study with one-to-one matching. For example, our data did not allow us to study the occurrence of babies with very low birthweights (tables 4 and 5). In addition the VDT group was so small that it would have been difficult to detect minor differences in the rates of possible complications.

In our data, the symptoms inquired about in connection with the question concerning threatened abortion in the interview seemed to relate to two different phenomena. Bleeding with or without lower abdominal pain had mostly occurred during early pregnancy and thus was probably a manifestation of threatened abortion. Lower abdominal pain only had mainly occurred late in pregnancy, but its relation to threatened preterm labor is apparently less clear. We found no difference in the risk of threatened abortion between the mothers in office and nonoffice work. For VDT work the proportion of mothers with symptoms was similar to that of mothers in other office work, but the VDT group was too small for us to study these symptoms separately.

The duration of pregnancy did not differ between the mothers in office and nonoffice work, but the term pregnancies of mothers in VDT work were slightly longer than those of the mothers with non-VDT office work. However the data were too limited to permit a proper statistical evaluation of the occurrence of pre-

term delivery. The birthweights of the babies in the three groups were similar when adjustment was made for gestational age, but it was not possible to study the occurrence of premature babies (birthweight less than 2500 g) because their number was too small.

The systolic and diastolic blood pressures during pregnancy were equal in the compared groups, and the proportions of women with changes in blood pressure suggesting pregnancy-induced hypertension were similar.

A working group appointed by the World Health Organization to evaluate the effect of video display terminals on workers' health concluded that the studies it examined provided no evidence of adverse effects of video display terminals on pregnancy (20). Neither have the studies published after the appearance of this evaluation supported the suggestion that VDT use might increase the risk of congenital defects or spontaneous abortion (3, 4, 10). The analysis of our data also produced no indication of work-related reproductive problems in office environments in general or in VDT work in particular.

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