U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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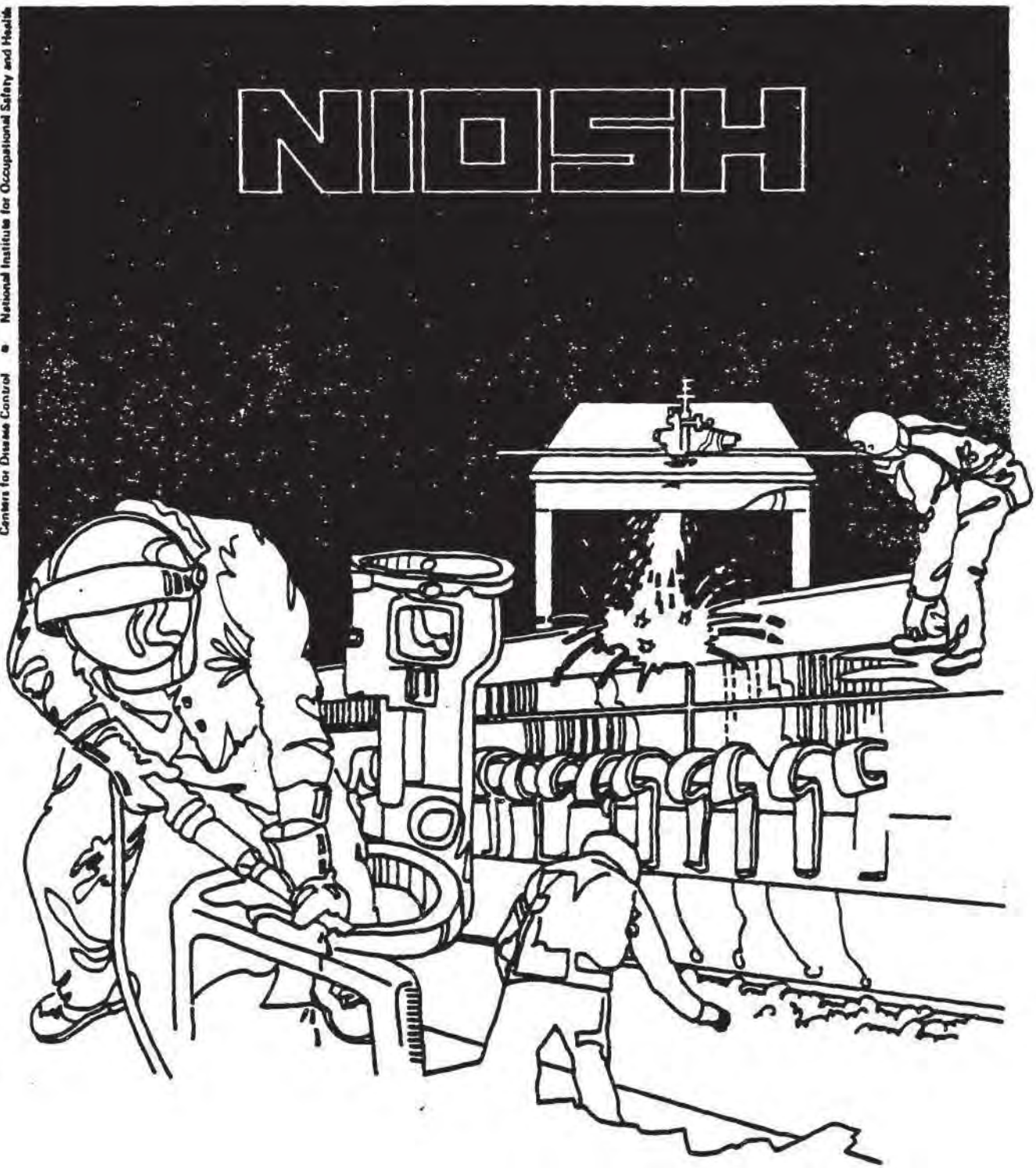
NIOSH



Health Hazard Evaluation Report

HETA 84-297-1609
GENERAL TELEPHONE COMPANY
OF MICHIGAN
ALMA, MICHIGAN

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 84-297-1609
JULY 1985
GENERAL TELEPHONE COMPANY OF MICHIGAN
ALMA, MICHIGAN

NIOSH INVESTIGATOR:
Peter D. Lichty, M.D., M.O.H.

I. SUMMARY

On April 20, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the General Telephone Company of Michigan (GTCM) to evaluate toll operators' concerns that their apparently increased number of adverse pregnancy outcomes could be linked to the use of video display terminals (VDTs). The specific request was for NIOSH to determine whether there had, in fact, been an increased number of adverse pregnancy outcomes.

A NIOSH investigator visited the office on May 8, 1984. No unusual chemical or other environmental exposures were found in the office. The work force at the time of the investigation consisted of 96 operators, mostly female, all working with VDTs to some extent. In addition, six other operators had recently transferred out of the toll operator office. Nine supervisors and one clerk also worked in the area.

To gather accurate statistics on the reproductive experience of the work force, the NIOSH investigator, via management and union officials, distributed a self-administered questionnaire to all of the current and recently transferred toll operators and supervisory personnel. These questionnaires were distributed in the office, and returned to NIOSH by an attached, franked return envelope.

Eighty-three of 112 (74%) of the questionnaires were returned, yielding 163 pregnancy histories, 162 among female employees and one (with a normal outcome) in a spouse of one of the three male respondents. The results were analyzed by describing pregnancy outcomes, and comparing pregnancy outcomes for VDT-exposed and non-VDT-exposed pregnancies. The 162 pregnancy histories reported by female employees included 29 pregnancies during employment at GTCM with VDT work (GTCM, VDT), 29 pregnancies during employment at GTCM without VDT work (GTCM, nonVDT), 97 pregnancies prior to GTCM employment without VDT work (nonGTCM, nonVDT), and 1 pregnancy prior to GTCM employment with VDT work (nonGTCM, VDT). VDT-exposed pregnancies were found to have occurred in more mothers with a history of prior miscarriages than non-VDT-exposed pregnancies.

The number of miscarriages in the groups described above were 8 out of 97 (8%) of nonGTCM-nonVDT pregnancies, 3 out of 29 (10%) of GTCM-nonVDT pregnancies, 6 out of 29 (21%) of GTCM-VDT pregnancies, and 1 out of 1 nonGTCM-VDT pregnancy. A logistic regression model including VDT exposure and the risk factors for miscarriage found that VDT use was statistically associated with miscarriage in this group of pregnancy histories. However, no association resulted if the nonGTCM-VDT pregnancy, which ended in miscarriage, was excluded.

A statistical excess of miscarriages has been identified among the VDT-exposed pregnancies reported by toll operators at this facility. Whether this excess was caused by work-related factors is unknown. Further research by NIOSH is pending, and more complete recommendations may result from that research. In the meantime, recommendations are made to improve the ergonomic design of the VDT workstations.

KEYWORDS: SIC 4811 [Telephone Communication (wire or radio)], VDT, video display terminals, miscarriages, ergonomics

II. INTRODUCTION

On April 20, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the General Telephone Company of Michigan (GTCM) to evaluate toll operators' concerns that an apparently increased number of adverse pregnancy outcomes could be linked to the use of video display terminals (VDTs) at the Alma, Michigan office. The specific request was for NIOSH to determine whether there had, in fact, been an increased number of adverse pregnancy outcomes. To determine whether these health concerns were justified and related to occupational exposures, a NIOSH investigator conducted a site visit at the Alma, Michigan office on May 8, 1984. A follow-up reproductive history survey was conducted in June 1984.

III. BACKGROUND

The Alma, Michigan office of the General Telephone Company was built in 1960, and expanded in 1974. The building contains facilities for call handling, equipment repair, and the dispatching of repair personnel. Types of calls handled by toll operator personnel include person-to-person, pay-phone, and charge-back calls (i.e. calls charged to a home phone number). The operators are located in a single office, on the third floor of the office building. This function has been performed since November 1979, at video display terminals. The terminals are manufactured by the Control Data Corporation. The workstation (table, keyboard, and monitor support) is an integral part of the VDT. The workstation does not allow for adjustment of table height, monitor height, keyboard height, or monitor angle. The distance to the monitor is adjustable. The chairs in use are also adjustable.

The ventilation for this floor is designed to provide 5 air changes per hour, and supplies air only to this floor. The air inlet is located on the side of the building on the third floor. In the past, there have been rare complaints of diesel exhaust odors when a truck has stopped on the street alongside the building.

Preplacement medical examinations are provided locally. No special provisions are made for regular visual acuity examination, or reimbursement for glasses. General health promotion information is provided on videotapes, which are viewed during slack hours during the workshift. Past injuries to employees in this area have been mostly slips and falls.

A few of the rural offices of the General Telephone Company of Michigan in the Alma area have recently closed and had their functions moved into the Alma office. This has led to transfers of operators into the Alma office. At the time of the survey, operators lived in many different small towns surrounding Alma. In Alma, the main industries are a chemical company and a plastic automotive parts manufacturer.

Prior to the NIOSH investigator's visit, two pertinent occupational health activities had been performed. The Michigan State Department of Health had conducted a survey of ionizing radiation in the Alma toll traffic office, and reportedly found that no terminal was emitting ionizing radiation above background levels. Also, the General Telephone Company of Michigan and the International Brotherhood of Electrical Workers union had each gathered lists of reproductive problems of which they were aware.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

The NIOSH investigator inspected the job site with particular attention to the presence and use of chemicals known to cause reproductive disorders.[1] None were in use on the third floor, and only small amounts of solvents were used anywhere in the building. The NIOSH investigator therefore judged that there was no opportunity for hazardous chemical exposure to the toll operators.

The health physicist from the Michigan Department of Public Health was contacted. He confirmed that no ionizing radiation was detected from any of the 51 VDTs that he measured using a Geiger-Mueller counter.

B. Medical

The previously collected lists of reproductive problems were gathered by the NIOSH investigator. In addition, reproductive history questionnaires were distributed via union and company personnel to all toll operators. The questionnaires consisted of two main parts. The first part contained demographic and overall reproductive questions such as total number of pregnancies. The second part consisted of multiple copies of a pregnancy history form (Appendix I). One form was filled out for each pregnancy. The information gathered included year of pregnancy, employment by the General Telephone Company of Michigan during the pregnancy, maternal age, pregnancy outcome, use of tobacco or alcohol during and immediately before the pregnancy, and whether the mother worked at VDTs during the six months before the pregnancy was diagnosed.

Questionnaires were distributed to employees of both sexes. For men, the questions were reworded to ask the appropriate information about their wives.

V. RESULTS

Eighty-three of 112 (74%) of the questionnaires were returned. These questionnaires yielded 163 pregnancy histories. 162 of these pregnancies were reported by female employees. There was only one spousal pregnancy, with a normal outcome, reported among the three male respondents. This pregnancy has not been included in the analysis.

The first pregnancy grouping is listed in Table 1 and illustrated in Figures 1-3. As the figures illustrate, approximately three-fourths of the pregnancies did not occur during VDT work, and about three-fifths of the pregnancies occurred before employment with GTCM.

The key comparison groups are as follows: Group A pregnancies (n=97) occurred before GTCM employment without recent VDT work; Group B pregnancies (n=29) occurred during GTCM employment without recent VDT work; and Group C pregnancies (n=29), occurred during GTCM employment with recent VDT work. Recent VDT work is defined as working at a VDT during the six months before the pregnancy. One pregnancy history that fell in Group C was not included in the outcome analysis because the questionnaire was incomplete and the outcome was unknown. One additional pregnancy was reported--it was associated with VDT work prior to working at GTCM, and does not fall into any of the groups. This pregnancy is not included in the risk factor and outcome analysis below, but was included in the logistic regression model. Tne pregnancy ended in a miscarriage.

Four major risk factors are known to be associated with miscarriages--smoking, drinking alcohol, prior history of miscarriage, and maternal age. The proportions of each group having the presence of a risk factor and the group's mean maternal age at the time of conception are shown in Figures 4-7. For alcohol use and smoking, two questions were asked: whether the mother used alcohol/tobacco during the three months before the pregnancy, and whether the mother used alcohol/tobacco during the pregnancy. As can be seen from the figures, there was a higher proportion of VDT pregnancies with the risk factors of smoking, alcohol usage, and history of miscarriage. Chi-square testing for these three factors found that only the elevated proportion of pregnancies which occurred in women with a history of miscarriage was statistically significant (chi-square=6.08, p=0.048). The mean maternal age also was slightly higher in group C, but this difference was not statistically significant (analysis of variance F=2.39, p=0.095).

The numbers, percentages, and types of pregnancy outcomes are listed in Table 2 and illustrated in Figures 8 and 9. The outcome of major interest is miscarriage (defined as a pregnancy ending spontaneously before the twentieth week of pregnancy). Figure 7 shows the number of each outcome. There were 8, 3, and 6 miscarriages in groups A, B, and C, respectively. Calculating and plotting the percent of pregnancies with each outcome yields Figure 9. Ignoring the information on risk factors, comparing Group C to the combined Groups A and B shows no statistical excess of miscarriages in Group C, the VDT-exposed group (chi-square=3.56, p=0.059).

To consider simultaneously the presence of risk factors with GTCM employment and VDT exposure, a logistic regression model was created. This model is detailed in Table 3. When variables were entered into the model in stepwise fashion, the only variable which was

significantly associated with miscarriage was VDT work. This association was present whether or not pregnancies ending in induced abortions were included in the non-miscarriage outcome classification. GTCM employment was not statistically associated with miscarriage.

VI. DISCUSSION

A study of reproductive histories among current workers is difficult because of several inherent sources of bias. These types of bias derive from who is included in the study, who is excluded from the study, and what information is returned. In addition, the results need to be interpreted in light of findings elsewhere.

The entire study is based on the information provided by respondents. Two groups of people are not included among the respondents. The first group is the current employees who did not return the questionnaire. This could be important because if women with adverse reproductive outcomes were more likely to return the questionnaire, this would lead to a false excess of the rate of adverse reproductive outcomes. A second group of nonrespondents is inherent in the study design. The women who worked at GTCM and left the workforce were not included. These past workers would represent a group of pregnancies not included in the statistics. Previous studies have shown that the miscarriage rate among women who leave work is lower than the miscarriage rate among current workers because women who do not have miscarriages usually have a healthy baby to care for, causing some of them to leave the workforce.[2] This bias tends to inflate the miscarriage rate when studying only current employees.

Another source of possible bias in the current study is its historical nature. Pregnancies that occurred a long time ago are more difficult to remember than more recent pregnancies. Women with pregnancy difficulties may remember the circumstances surrounding the pregnancy more accurately than other mothers. In this study, the median year for the different pregnancy groups was: Group A, 1963; Group B, 1977; Group C, 1982. The exact role that the differing recall intervals played in the data is unknown. It should be noted that the exact date of VDT installation was known for this office, and that the pregnancy histories were all consistent with this date with respect to their exposure information.

There has been a controversy over how best to analyze pregnancy history data. Some persons feel that the relevant analysis is the person--that the risk of miscarriage is most directly linked to the mother. Other persons feel that pregnancies can be looked at separately, taking into account the exposure circumstances of each pregnancy. This study has merged these approaches, analyzing each pregnancy and its exposures separately, but taking into account the mother's prior pregnancy

experience. Some women are known to have anatomic abnormalities that predispose to repeated miscarriages. In this study, it was impossible to get physical examination data. The greatest number of miscarriages was found in one worker who had 3 miscarriages (the usual threshold for suspicion of abnormal reproductive anatomy).

Known risk factors for miscarriage have been considered in this study. Although the proportion of workers with miscarriage risk factors was higher among VDT operators, this difference did not serve to statistically predict miscarriage as a pregnancy outcome. Working at a VDT was statistically associated with miscarriage in this group of workers after allowing statistically for control of the other risk factors.

Once a statistical association has been demonstrated, the finding needs to be compared to other similar studies. An excess of miscarriages (or other health problems) among a small group of workers is often called a "cluster". It is not possible to look at a single cluster and determine whether it represents cause and effect, or just a coincidence. There have been several other clusters of miscarriages associated with VDT use in recent years. However, because of the large number of offices using VDTs currently, even more clusters would be expected than have been investigated. Therefore, statistical analysis of a single, reported cluster is unable to allow a causal association to be demonstrated.

Our knowledge of causes of miscarriage is currently limited. None of the known physical or chemical causes of miscarriage have been demonstrated to be present in the environment as a result of VDT use. The concept of biologic plausibility insists that before reproductive problems can be attributed to VDT use, some intermediate process that is known to cause reproductive problems must be demonstrated.

Recognizing the large amount of public concern about possible reproductive effects of VDT work, NIOSH has recently designed a large study to study this subject. The study has been designed to overcome many of the sources of bias found in the current study. This study, to be conducted by NIOSH's Industrywide Studies Branch, is expected to begin in 1985.

In summary, a small number of miscarriages was statistically associated with VDT work in the Alma, Michigan office of the General Telephone Company of Michigan. Many of the necessary scientific links required to attribute this excess to VDT use are missing.

VII. RECOMMENDATIONS

1. For the reasons discussed above, no specific reproductive policy is recommended. It is premature to take special action with regard to pregnant employees. Current research should be monitored to keep aware of further scientific findings in the field. In the

meantime, attention should be directed to the other aspects of VDT work that can be improved. These previously published NIOSH recommendations were developed to address stress, fatigue, eyestrain, and musculoskeletal effects.[3]

2. The ergonomic design of the VDT workstations should be reviewed. The NIOSH recommendations are not currently being met. In this office, particular attention should be directed to providing an adjustable keyboard height, screen height, and screen position.

3. In view of several years of NIOSH experience, monitoring of radiation near VDTs is not warranted.[3,4]

4. Lighting levels should be set up at approximately 500-700 lux, depending on the visual demands of other tasks performed in the same work area.[3]

5. Direct and reflected glare should be limited through one or more of the following methods:

   a) The terminals should be properly positioned with respect to windows and overhead lighting.

   b) Screen hoods may be installed.

   c) Anti-glare filters may be installed on the VDT screen.

   d) Direct lighting fixtures may need to be recessed. Baffles may be used to cover fluorescent fixtures to prevent the luminaires from acting as a glare source, or special covers on light fixtures may be used to direct the light downward rather than allowing the light to diffuse.

   e) The current workstations have a shiny piece of plastic covering frequently used numbers directly in front of the keyboard; this source of glare should be eliminated.

6. NIOSH has recommended the following work schedules for VDT operators to prevent potential chronic effects on the visual system and musculature and prolonged psychological distress.[3] Operators under moderate visual demands and/or moderate work load, should have a 15 minute period of nonVDT work after two hours of continuous VDT work. Operators under high visual demands and/or those engaged in repetitive work tasks, should nave a 15 minute period of nonVDT work after one hour of continuous VDT work.

7. VDT workers should have a comprehensive pre-placement vision examination.[3] Individuals who become symptomatic after the initial examination should receive appropriate medical care, and a general eye examination should be repeated periodically.

VIII. REFERENCES

1. Hemminki K. Occupational Chemicals Tested for Teratogenicity. Int Arch Occup Environ Health 47:191-207, 1980.

2. Axelsson, G. Selection Bias in Studies of Spontaneous Abortion Among Occupational Groups. J Occup Med 26:525-528, 1984 .

3. National Institute for Occupational Safety and Health. Potential Health Hazards of Video Display Terminals. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) Publication No. 81-129).

4. Statement of J. Donald Millar, M.D., Director of the National Institute for Occupational Safety and Health, before the Subcommittee on Health and Safety, Committee on Educational and Labor, House of Representatives, May 15, 1984.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. GTE Service Corporation
2. General Telephone Company
3. International Brotherhood of Electrical Workers, Local 1106
4. NIOSH, Region V
5. OSHA, Region V
6. Michigan Department of Labor

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1 - Classification of Pregnancies by GTCM employment and VDT Usage

		Employment at GTCM During the Pregnancy		
		Yes	No	Totals
VDT Usage	Yes	29	1	30
	No	29	97	126
	Unknown	1	5	6
	Totals	59	103	162

Table 2 - Pregnancy Outcomes by Pregnancy Exposure Status

Pregnancy Group Definition

Group A - Pregnancy prior to GTCM employment without VDT work
Group B - Pregnancy during GTCM employment, without VDT work
Group C - Pregnancy during GTCM employment with recent VDT work.

Number (%) of Pregnancy Outcomes by Pregnancy Exposure Status

	Pregnancy Exposure Group					
	A		B		C	
Miscarriage	8	(8.3)	3	(10.3)	6	(20.7)
Induced Abortion	1	(1.0)	1	(3.5)	1	(3.5)
Stillbirth	0	(0.0)	1	(3.5)	0	(0.0)
Live birth	86	(88.7)	24	(82.8)	22	(75.9)
Twin birth	2	(2.1)	0	(0.0)	0	(0.0)
Totals	97	(100.0)	29	(100.0)	29	(100.0)

Table 3 - Summary of Variables used in the Multiple Logistic Regression Model

Independent Variables	Definition
1) Age	Age of mother (in years) at time of pregnancy
2) GTCM	1=Employed at GTCM during the pregnancy. 0=Not employed at GTCM.
3) Smoking	1=Smoked tobacco during 3 months prior to pregnancy. 0=Nonsmoker.
4) Alcohol	1=Drank alcohol during 3 months prior to pregnancy. 0=Nondrinker.
5) VDT	1=Worked at VDTs during the 6 months prior to pregnancy. 0=No VDT work.
6) History of Miscarriage	1=Pregnancy history with at least one prior miscarriage. 0=No prior miscarriages.

Dependent (outcome) Variables	Description
First Run	Miscarriage=1, all other outcomes, including induced abortion=0
Second Run	Miscarriage=1, stillbirths and livebirths=0. (Induced abortions excluded from model).*

*There is a difference of opinion whether induced abortions should be included as non-miscarriage outcomes. Because the pregnancy ending in induced abortion is at risk of miscarriage until the abortion, it can be considered among the other "at risk" pregnancies. In this case, the small number of induced abortions made no difference in the results of the analysis.

Results of First Run - Induced Abortions Included

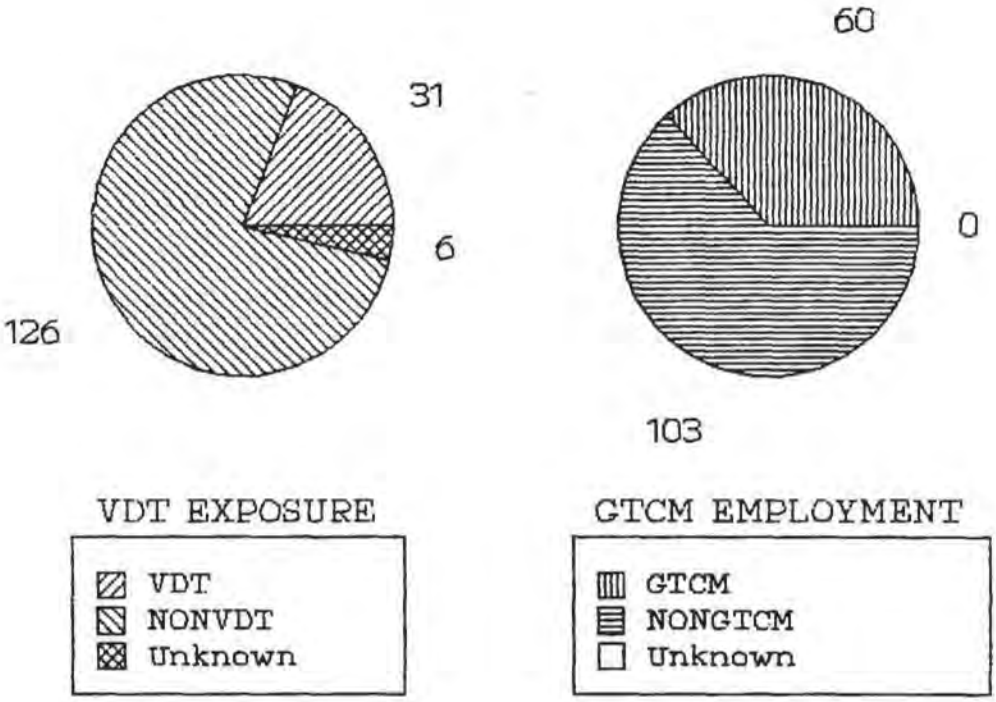
Variable	Chi-square	Probability	Correlation (r)	Beta	Std. Error
Intercept	54.85	0.0000	---	-2.34	0.316
VDT	4.61	0.0317	0.153	1.15	0.535

Results of Second Run - Induced Abortions Excluded

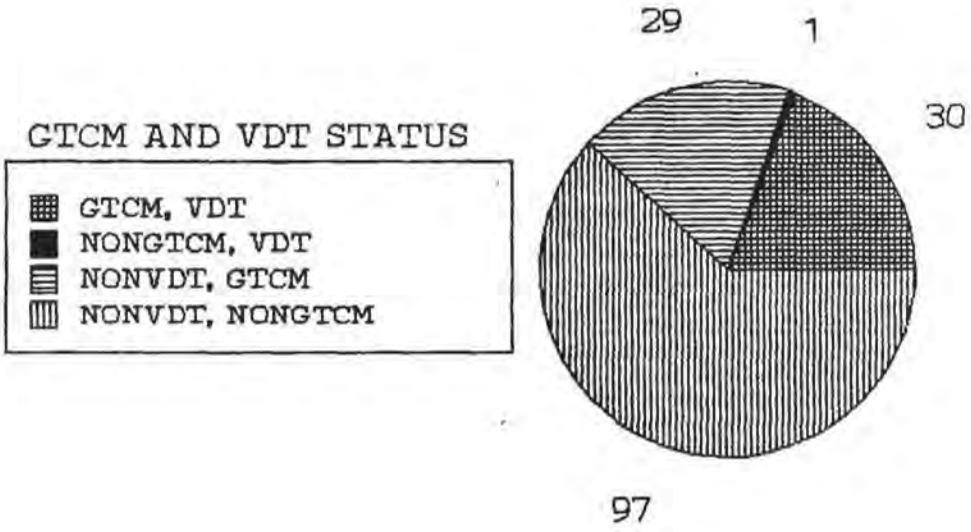
Variable	Chi-square	Probability	Correlation (r)	Beta	Std. Error
Intercept	54.40	0.0000	---	-2.33	0.316
VDT	4.87	0.0273	0.161	1.13	0.537

GTCM AND VDT "EXPOSURE" DURING PREGNANCY

FIGURES 1 - 3

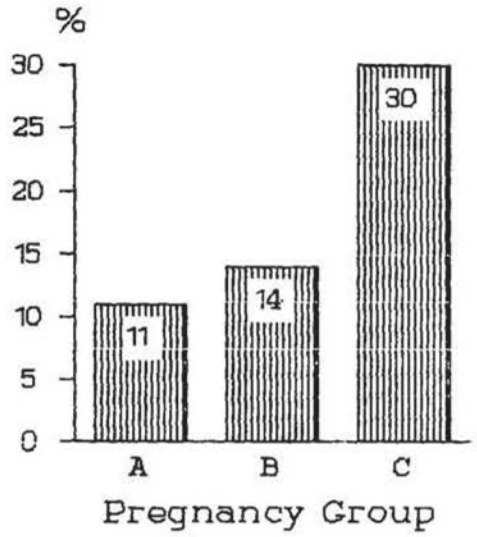


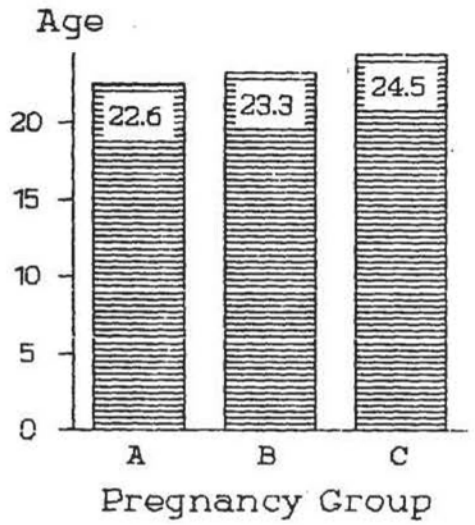
GTCM AND VDT COMBINED "EXPOSURE" STATUS



KNOWN RISK FACTORS FOR SPONTANEOUS ABORTION

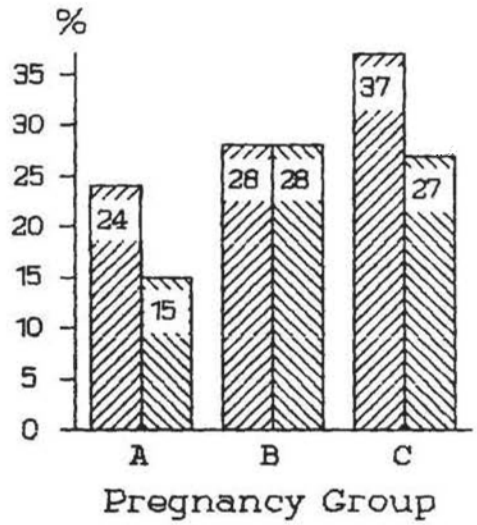
FIGURES 4 - 7

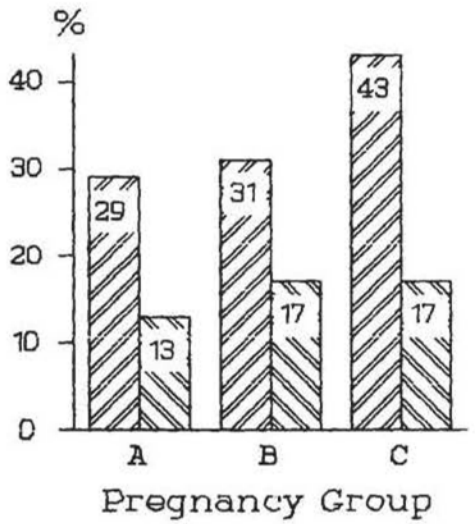




History of Spontaneous Abortion

Mean Maternal Age



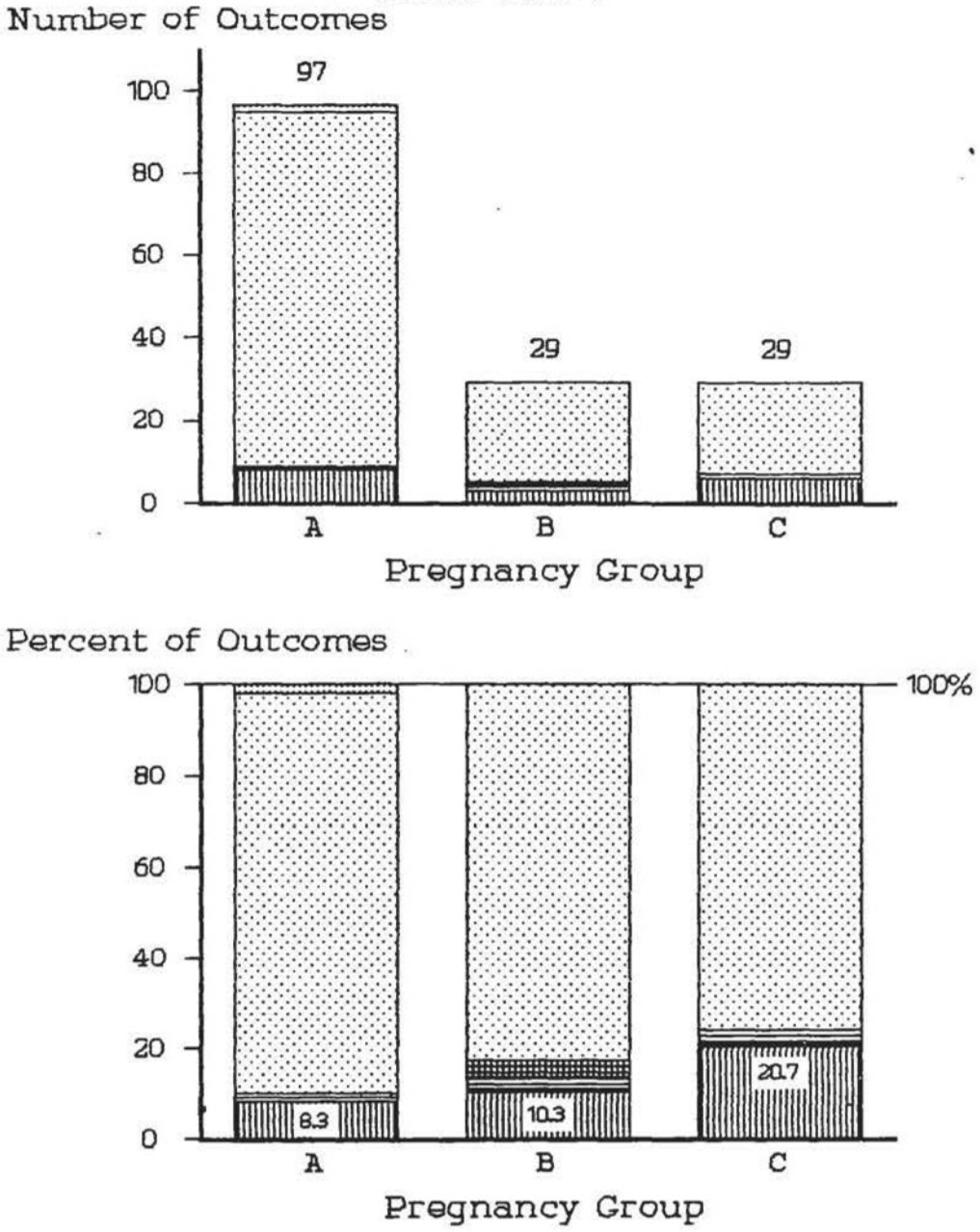


Smoked before pregnancy
Smoked during pregnancy

Alcohol before pregnancy
Alcohol during pregnancy

PREGNANCY OUTCOMES

FIGURES 8 AND 9



Pregnancy Outcome

- Miscarriages
- Induced Abortions
- Stillbirths
- Live, single births
- Twin births

Group Coding

A NONGTCM, NONVDT (n=97)
B GTCM, NONVDT (n=29)
C GTCM, VDT (n=29)

APPENDIX I

PREGNANCY HISTORY — PLEASE FILL OUT ONE PREGNANCY HISTORY FOR EACH PREGNANCY YOU HAVE FINISHED -- BEGIN WITH YOUR FIRST PREGNANCY

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|0|_|_|_| (1-4)

1. Number of this pregnancy (01 = first, 02 = second, etc.)

|_|_|_| |_|_|_| (5-6)

2. Year at beginning of pregnancy 19|_|_| |_|_|_| (7-8)

3. What was your age at beginning of pregnancy? |_|_|_| years |_|_|_| (9-10)

4. Did you work for G.T.E. in Alma, Michigan during this pregnancy?

(circle one) Yes No |_|_| (11)

5. Was this pregnancy diagnosed by a doctor?

(circle one) Yes No |_|_| (12)

6. About how many weeks were you pregnant when the pregnancy ended?

(Normal term = 40 weeks) |_|_|_| weeks |_|_|_| (13-14)

7. What was the pregnancy outcome? (circle one) |_|_|_| (15-16)

Miscarriage or spontaneous abortion (before 20 weeks)

Therapeutic (medical) abortion

Stillbirth (after 20 weeks)

Live birth

Twins or other multiple birth

8. If you had a live birth, please circle the correct description |_|_| (17)

(You may circle more than one if applicable)

Normal baby

Birth defect

please state defect(s)

_____ |_|_| (18)

Neonatal death (during the first month of age)

please state cause for death

_____ |_|_| (19)

PREGNANCY HISTORY page 2

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9. Did you smoke during the 3 months prior to this pregnancy?

   (circle one) Yes No — | | (20)

10. Did you smoke during this pregnancy?

    (circle one) Yes No — | | (21)

11. Did you have any of the following diseases during this pregnancy? (circle any that apply)

    Diabetes — Thyroid disease

    Anemia — Venereal disease

    Serious infection (pneumonia, sepsis, or amnionitis)

    Toxemia, pre-eclampsia, or eclampsia

    | | | | | | | (22-27)

12. Did you drink alcohol during the 3 months prior to this pregnancy?

    (circle one) Yes No — | | (28)

13. Did you drink alcohol during this pregnancy?

    (circle one) Yes No — | | (29)

14. Did you work at VDTs during this pregnancy?

    (circle one) Yes No — | | (30)

15. Average number of hours of VDT work per week: | | | hours — | | | (31-32)

16. Before this pregnancy, had you had any of the following events? (circle any that apply)

    Spontaneous abortion — | | (33)

    Previous infant with a birth defect

    type of defect _____ — | | | (34-35)

17. What was your husband's occupation during this pregnancy?

    _____ — | | | (36-37)

18. Please list any drugs which you took during this pregnancy, whether prescribed by a physician or not.

    _____ — | | | | | (38-41)

CARD NUMBER | | | (79-80)

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