

Final Progress Report: Textile Industry Exposures and Breast Cancer in Women

Grant Number: 1 R01 OH008149

Project Title: Textile Industry Exposures and Breast Cancer in Women

Principal Investigator: Checkoway, Harvey, PhD
University of Washington
Box 357234
Department of Environmental and Occupational Health Sciences
Health Sciences F-561F
Seattle, WA 98195-7234
Tel: 206-543-2052
Fax: 206-685-3990
checko@u.washington.edu

Co-investigators: David B. Thomas, MD, DrPH
Michael G. Yost, PhD
Janice E. Camp, MS
Wenjin Li, MD, PhC

Institution: Fred Hutchinson Cancer Research Center
1100 Fairview Avenue North
PO Box 19024, J6-500
Seattle, WA 98109
gmail@Fhcr.org

Project Period: 07/01/2004 – 06/30/2007 (Extended to December 31, 2008)

Project Director & Sponsor: Centers for Disease Control and Prevention,
National Institute for Occupational Safety and Health

Report Date: December 1, 2009

Table of Contents

LIST OF TERMS AND ABBREVIATION

LIST OF TERMS AND ABBREVIATIONS	3
---------------------------------------	---

ABSTRACT

ABSTRACT	4
----------------	---

SECTION 1

HIGHLIGHTS/SIGNIFICANT FINDINGS	5
TRANSLATION OF FINDINGS	5
OUTCOMES/RELEVANCE/IMPACT	5

SECTION 2

BACKGROUND	7
SPECIFIC AIMS	7
METHODS	8
RESULTS	11
DISCUSSION	14
PUBLICATIONS	16
INCLUSION OF GENDER AND MINORITY STUDY SUBJECTS	17

List of Terms and Abbreviations

EMF	Electromagnetic fields
MF	Magnetic fields
STIB	Shanghai Textile Industrial Bureau
JEM	Job-exposure matrix
HR	Hazard ratio
CI	Confidence interval
RCM	Rate of change
RCMS	Standardized rate of change

ABSTRACT

Background: The etiology of female breast cancer remains poorly understood. Some evidence suggests exposure to extremely low electromagnetic fields (EMF) and light at night, from working night and/or rotating shifts, may increase risk. Suppression of melatonin by EMF and light at night is a credible underlying mechanism that is supported by experimental and epidemiologic research. The objective of this research project was to test the hypothesis that EMF and rotating shift work are risk factors for breast cancer among women textile workers in Shanghai.

Methods: A total of 1707 incident breast cancer cases diagnosed between 1989 and 2000 were identified in the cohort. The comparison group compared of 3155 women randomly selected, age stratified from the whole cohort, supplemented by 1685 controls enrolled in the previous case-control studies of the cohort to make a total of 4840 woman in the comparison group. A quantitative job- exposure matrix (JEM) for the MF exposure was developed based on 1155 personal measurements of magnetic field exposure for 146 jobs that were grouped based on similar tasks defined from factory information collected in Shanghai textile industry for a previous study. Multiple exposure indices including arithmetic and geometric means, rate of change (RCM) and standardized RCM (RCMS) were calculated for each job. Detailed historical shiftwork practices were collected from 502 Shanghai textile factories. The EMF JEM and shiftwork information was linked to the work history records of women to calculate cumulative exposures. The cumulative exposures with 0, 5, 10, 15, or 20 years of lag time were categorized into quartiles to estimate hazard ratios and 95% confidence intervals with risk of breast cancer using a case-cohort design.

Results: Cumulative exposures to MF and night shifts did not show any effect on risk of breast cancer in our initial analyses. All analyses were adjusted for the established risk factor for breast cancer. There was no dose-response trend observed.

Conclusions: Our current results suggest that they are not associations between the workplace exposures to MF and shiftwork and the risk of breast cancer. We are further analyzing our data by controlling for other confounding factors, such as physical activity, and by categorizing EMF exposures according to the defined time windows of exposure prior to diagnosis or reference date.

SECTION 1

Highlights/Significant Findings

There is no evidence according to our current results suggesting any associations between the workplace exposures to MF or shiftwork and the risk of breast cancer. We are further analyzing our data by controlling for other confounding factors, such as physical activity, and by categorizing EMF exposures according to the defined time windows of exposure prior to diagnosis or reference date.

A quantitative job/exposure matrix that characterizes historical EMF exposures by process and job in the Shanghai textile industry was developed based on 1155 personal measurements collected in selected factories of Shanghai textile industry. A wide range of magnetic field exposures was observed. The levels of exposure at 3 mG or higher were observed for 41 of 146 (28%) well defined major process/work type positions sampled. Operators in cutting/sewing process have highest magnetic exposure (8.47 mG). Other jobs with the high levels of exposure were special skilled personnel in fiber processing, operators of printing and spinning. Quality control testers in several manufacturing processes also demonstrated highest levels of magnetic exposure.

Historical shiftwork profiles were collected for 502 Shanghai textile factories where the cases and women in the comparison group worked. Of those, 402 factories had jobs assigned on shiftwork schedules. The nature of shiftwork in each factory is characterized by: specific jobs assigned to shiftwork, rotation cycle, daily rotation schedule (start time and end time of each shift), and changes of shift policy over time. The most common rotation cycles were 2-day or 6-day cycles. There was no job assigned to graveyard shift only.

Translation of Findings

The findings from this study are not final, as further analyses are ongoing. Nonetheless, our findings to date are unlikely to change dramatically. We can therefore offer some provisional conclusions and recommendations. Evidence from prior epidemiological studies of occupational EMF exposure and shiftwork in relation to breast cancer risk has been inconsistent. Our study is one of the largest, most comprehensive investigations conducted to date. We have not observed evidence that either EMF or shiftwork influences breast cancer risk. This is not to say that these workplace factors could not play a role in breast cancer etiology, but rather that our study offers some reassurance that there are unlikely to be large breast cancer hazards associated with these exposures. There may, however, be other health-related reasons to modify workplace exposures to these factors, such as the potential for other sequelae from circadian rhythm disturbances, such as sleep disorders or injuries.

Outcomes/Relevance/Impact

There continues to be controversy regarding the potential effects of EMF and shiftwork as possible causes of breast cancer. Our findings thus far do not indicate that either exposure is etiologically important in the cohort of Chinese women we studied. If these findings persist on

further analyses, which are in progress, the results should offer some reassurance that workplace exposures to EMF or shiftwork do not need to be modified because of concerns about breast cancer. The caveat to that conclusion is that our findings may not necessarily be generalizable to other worker groups in different countries.

SECTION 2

Background

Breast cancer is the most frequent non-skin cancer among women, and incidence is increasing worldwide (1). Although intensive research has been made to improve the understanding of the biology of breast cancer, the etiology of breast cancer remains poorly explained. The etiologic contributions of occupational risk factors have not been adequately studied, especially in view of the large numbers of women in the workforce worldwide with potentially hazardous exposures. The textile industry employs millions of women workers worldwide, and a large portion of those women are employed in China. We undertook this study with objectives to test associations between breast cancer risks and two very widespread occupational exposures, electromagnetic fields and shiftwork, for which a shared biological mechanism of melatonin suppression is hypothesized, within a well-defined cohort of 267,400 women textile workers in Shanghai Textile Industrial Bureau (STIB).

Specific Aims

The specific aims of this study are:

1. Develop a quantitative job/exposure matrix (JEM) that characterizes historical magnetic field (MF) exposures by factory, process, and job within the various sectors of the Shanghai textile industry: cotton, wool, synthetic fibers, silk, bleaching and dyeing, garment assembly, and machine assembly and repair.
2. Construct cumulative MF exposures for 1707 breast cancer cases and 4840 comparison women by linking the JEM with detailed work history records that have already been collected;
3. Collect data on past shiftwork for textile industry jobs held by breast cancer cases and subcohort women, and construct cumulative exposure indices of shiftwork;
4. Develop a JEM for occupational physical activity that will enable classification of jobs into ordinal categories of physical exertion. Occupational physical activity will be regarded primarily as a potential confounder of observed associations of breast cancer risk with EMF exposure and shiftwork;
5. Estimate separate dose-response relations for breast cancer in relation to a) MF exposure, b) shiftwork, and c) physical activity for: the entire work career, and specific time windows defined in relation to breast cancer diagnosis; these analyses will control for potential confounding by age, cigarette smoking, and alcohol use.
6. Estimate potential confounding of the associations observed in Aim 5 by use of oral contraceptives, reproductive history (number of pregnancies, age at first pregnancy), and dietary factors by performing separate analyses on subsets of subjects for whom the data on these covariates are available.

Methods

Study population

This study of breast cancer and two occupational exposures: MF and shiftwork is an extension of a series of case-cohort studies of textile industry exposures to dusts, chemicals and other physical agents in relation to risks of various cancers (2-4). Briefly, the previous studies were based on a cohort of 267,400 workers from 503 textile factories in STIB who were recruited in 1989-1991 for a randomized trial of breast self examination (5, 6). The STIB provided health care for all workers through a health station maintained in each factory. All cancers diagnosed from 1989 to 1998 were reported by clinic workers to a cancer and death registry operated by the STIB Station for the Prevention and Treatment of Cancer. Cancer diagnoses were confirmed by computer matching with records from the Shanghai Cancer Registry and by medical record review. A subcohort of 3155 women, randomly selected from the entire cohort, stratified on year of birth using 5 year interval groupings, supplemented by 1685 controls participated in the previous case-control studies in the cohort compared of the comparison group (4840 in total).

Exposure Assessment: MF

A Job Exposure Matrix (JEM) for various exposures to chemicals and dusts in the textile industry was developed in our previous studies and informed the development of the current MF JEM and shiftwork reconstruction (7). Briefly, six STIB industrial hygienists were trained to collect information from each factory on factory characteristics, including types of workshops, specific processes, and exposures to specific dust, chemical, and physical agent. On the basis of this information, a team of occupational exposure assessment experts in Seattle, including three industrial hygienists and three occupational epidemiologists, constructed the JEM in three dimensions: industrial sector, textile process, and chemical or physical agent.

Information on all textile industry jobs that were held by each study subject since the date of their first employment in the STIB was collected by trained field workers through review of factory personnel records (80%), interviews of factory supervisors (11%), and in-person interviews of women or their relatives (8%). For each job that a woman held, the field workers recorded the dates of employment, workshop, and description of the job tasks. The occupational study team classified the work activities across all factories into 17 categories of major textile manufacturing processes and 12 categories of work types (Table 1). The basic structure of the JEM was organized around these two dimensional matrix.

Table 1. Jobs in the Shanghai Textile Industrial Bureau grouped into 17 major processes and 12 work types according to the similarity of task.

Major Process Groupings	N*	Work Type Groupings	N*
01-Warehouse	39	01-Operator of production equipment	165
02-Material handling	68	02-Non-mechanical laborer	129
03-Fiber processing	79	03-Special-skilled personnel (e.g., technician)	110
04-Spinning	98	04-Floor supervisor	91
05-Scouring/bleaching	36	05-Tester	121
06-Dyeing	57	06-Administrative staff	101
07-Textile finishing	48	07-Machine maintenance technician	81
08-Weaving/knitting/fabric manufacturing	77	08-Factory maintenance staff	54
09-Printing	39	09-Custodial staff	77
10-Cutting/sewing	89	10-Medical personnel	11
11-Finishing/packaging	56	11-Education personnel	66
12-Testing/quality control	50	12-Support services	124
13-Maintenance	65		
14-Administration/general affairs	133		
15-Non-production (e.g., supply, sales, and cafeteria)	92		
16-Machine manufacturing/metal working	86		
17-Non-metal parts manufacturing (e.g., paper roll or rubber manufacturing)	18		

* The number of samples collected.

In order to quantify MF exposure, sampling was conducted for the major process/work type positions in the two dimensional matrix in which breast cancer cases and cohort women had ever worked, resulting in a measurement need for a total of 157 major process/work type positions. Exposure data for each position were obtained from women who were currently working in those jobs in STIB factories between December 2004 and December 2006. Because of possible variations in job tasks, and the heterogeneity of the work environment within the same job category across the textile industry, attempts were made to collect at least eight measurements from at least two factories for each major process/work type position.

On the day of sample collection, eligible workers in specified positions were identified by workshop managers according to their job descriptions. The workers were then asked to give their oral consent to participate. Magnetic field was measured using the EMDEX II meters calibrated by the manufacturer at 50 Hz (manufactured by EnerTech Consultants, Campbell, CA). The meters were set to record the magnetic field in broadband (40 – 800 Hz) and harmonic (100 – 800 Hz) frequencies at a rate of every ten seconds. All measurements were obtained for 4 to 6 hours of monitoring with the meter positioned at the workers' waists. Six local industrial hygienists distributed the EMDEX II meters to the workers right before they started their typical working shift in the participating factories. Sampling was discontinued at the beginning of lunch breaks, and re-started at the end of breaks. The industrial hygienists retrieved the meters at the end of the sampling period and downloaded the data into a PC laptop computer using EMCALC

2000 software, which is a communications and analysis software designed specifically for EMDEX II meters (manufactured by EnerTech Consultants, California). The EMCALC 2000 allows the data records to be annotated with time-diary information. The industrial hygienists also recorded the job tasks that the workers performed and the types of machines involved in those tasks. The calibrations of the meters were checked each month with a two-coil calibration system.

Exposure assessment: shiftwork

Shiftwork profile was collected for each of the 502 factories where cases and subcohort women worked through interview of factory leaders and production managers. The information included: specific jobs assigned to shiftwork, rotation cycles (2-day, 6-day), daily rotation schedule (morning, evening, nighttime shift), start and end times of each shift, and changes in shiftwork policy over time. Working at nighttime shift was defined as starting before 12 a.m. and ending after 6 a.m.

Statistical Analysis

The JEM for occupational MF exposures was constructed based on the personal measurements. Exposure metrics for the JEM were selected based on common use in previous epidemiological studies and hypothesized biological mechanisms of development of disease and included the broadband resultant time-weighted average (TWA), geometric means, rate of change (RCM), and standardized rate of change (RCMS) (8, 9). Averages for these metrics were calculated for each major process/work type position. To demarcate high and low levels of exposure, we used the criterion defined by Forssèn et al. in developing their job-exposure matrix of MF for female occupations in Sweden (10). The criterion was based on the individual estimate of TWA, Occupations with a median of 2.4 mG TWA or more and the 1st quartile higher than 1.7 mG were defined as highly exposed; occupations as having low exposure if the 3rd quartile of the TWA estimates was lower than 1.7 mG with a median 1.0 mG or less (10).

The primary goals of the analysis were to estimate dose-response relations for EMF and shiftwork in relation to risk of breast cancer, while controlling for potentially confounding factors. Cases and subcohort women were first compared for demographic characteristics, reproductive and other confounding factors collected in the previous studies for their compatibility. The MF JEM and shiftwork history data were linked to work history data of cases and subcohort women to compute cumulative exposures to these two factors in their entire work history in STIB. Cox proportional hazards modeling adapted for the case-cohort design was used to estimate hazard ratios for breast cancer in relation to MF and shiftwork exposures. Cumulative exposure to MF for each woman was calculated as intensity (mG) x duration of exposure (years); cumulative exposure to nighttime shift was calculated as numbers of nights worked on nighttime shift per year x duration of employment (years). Both cumulative exposures were categorized into quartiles to estimate hazards ratios. All analyses were conducted using SAS version 9.0 (SAS institute, Inc., Cary, NC).

Ethics approval

This study was approved by the Institutional Review Boards of Fred Hutchinson Cancer Research Center, the University of Washington, and Zhong Shan Hospital; in accordance with an assurance filed with the Office for Human Research Protections (OHRP) of the U. S. Department of Health and Human Services.

Results

Personal measurements of MF exposure were collected from 1155 current workers working in 146 major process/work type positions in 56 factories. The number of samples collected for each major process/work type position varied from 2 to 21, with an average of 7.7 samples. The number of factories from which the samples were collected in each position ranged from 1 to 7, with an average of 2.9 factories. Among individual samples, the arithmetic mean of TWA of overall measured samples was 2.54 mG, ranging from 0.06 to 34.98 mG. When summarized into major process/work type positions, the MF exposure levels range from 8.47 mG (Operators in cutting/sewing process) to 0.43 mG (Operator in Warehouse). The exposure levels that reach 3 mG or higher were observed for 41 (28%) sampled positions. Other jobs with the high levels of exposure were special skilled personnel in fiber processing (6.36 mG), operators of printing and spinning. Quality control testers in several manufacturing processes also demonstrated highest levels of magnetic exposure. When using the criterion defined by Forssèn et al. to identify high exposure positions, Machine Operator in Spinning was excluded from the high exposure groups.

Shiftwork profile was collected for 502 Shanghai textile factories where the cases and subcohort women worked. Of those, 402 factories had jobs assigned on shiftwork schedules. The most common rotation cycles were 2-day or 6-day cycle. There was no job assigned to graveyard shift only.

Among the demographic characteristics, productive risk factors, and some lifestyle factors compared between cases and the subcohort women, age, number of live births, and age at first live birth were significantly associated with risk of breast cancer, therefore, included in the following case-cohort analyses as confounding factors.

Hazard ratios and their 95% confidence intervals for cumulative exposures to MF and nighttime shift with 0, 5, 10, and 20 years of lag time are listed in Table 2 and 3 respectively. Overall, long term exposures to MF or nighttime shift were not associated with the risk of breast cancer.

Table 2. Adjusted HRs and their 95% CIs for breast cancer in relation to long term exposure to MF

MF exposure	HR ^a	95% CI	HR ^b	95% CI
Broadband resultant (mG x year)				
<i>Continuous</i>	<i>1.014</i>	<i>(0.977, 1.052)</i>	<i>1.000</i>	<i>(0.999, 1.001)</i>
Quartiles				
<=30.4	1.0	(ref)	1.0	(ref)
30.4-47.9	1.03	(0.87, 1.21)	1.02	(0.87, 1.20)
47.9-88.6	1.18	(1.01, 1.39)	1.17	(1.00, 1.37)
>88.6	0.97	(0.82, 1.15)	0.99	(0.83, 1.17)
5 years of lag time				
<i>Continuous</i>	<i>1.000</i>	<i>(0.998, 1.001)</i>	<i>1.000</i>	<i>(0.999, 1.001)</i>
Quartiles				
<=30.4	1.0	(ref)	1.0	(ref)
30.4-47.9	0.94	(0.81, 1.10)	0.94	(0.80, 1.11)
47.9-88.6	1.12	(0.96, 1.30)	1.11	(0.95, 1.29)
>88.6	0.91	(0.77, 1.08)	0.93	(0.78, 1.10)
10 years of lag time				
<i>Continuous</i>	<i>1.000</i>	<i>(0.998, 1.001)</i>	<i>1.000</i>	<i>(0.999, 1.001)</i>
Quartiles				
<=30.4	1.0	(ref)	1.0	(ref)
30.4-47.9	0.94	(0.81, 1.10)	0.94	(0.80, 1.11)
47.9-88.6	1.12	(0.96, 1.30)	1.11	(0.95, 1.29)
>88.6	0.91	(0.77, 1.08)	0.93	(0.78, 1.10)
15 years of lag time				
<i>Continuous</i>	<i>1.000</i>	<i>(0.998, 1.001)</i>	<i>1.000</i>	<i>(0.999, 1.002)</i>
Quartiles				
<=30.4	1.0	(ref)	1.0	(ref)
30.4-47.9	0.93	(0.79, 1.09)	0.94	(0.80, 1.10)
47.9-88.6	0.97	(0.82, 1.14)	0.98	(0.83, 1.15)
>88.6	0.95	(0.79, 1.15)	0.98	(0.81, 1.19)
20 years of lag time				
<i>Continuous</i>	<i>1.000</i>	<i>(0.998, 1.001)</i>	<i>1.000</i>	<i>(0.998, 1.002)</i>
Quartiles				
<=30.4	1.0	(ref)	1.0	(ref)
30.4-47.9	0.94	(0.80, 1.10)	0.95	(0.81, 1.11)
47.9-88.6	0.94	(0.78, 1.13)	0.95	(0.79, 1.14)
>88.6	0.98	(0.80, 1.20)	1.02	(0.83, 1.26)

^a adjusted for age only

^b adjusted for age, number of live births and age at 1st live birth.

Table 3. Adjusted HRs and their 95% CIs for breast cancer in relation to long term working on nighttime shift (nights per year x number of years) in relation to the risk of breast cancer

variable	HR ^a	95% CI	HR ^b	95% CI
Worked on nighttime shifts (nights)				
no lag time				
less than 90 (1 yr)	1.00	(ref)	1.00	(ref)
90 - < 1518	0.96	(0.81, 1.12)	0.96	(0.82, 1.13)
1518 - < 2246	0.97	(0.82, 1.15)	1.01	(0.85, 1.19)
2246 - < 3132	0.90	(0.76, 1.07)	0.94	(0.79, 1.12)
3132 or more	0.91	(0.75, 1.09)	0.94	(0.77, 1.14)
5 years of lag time				
less than 90 (1 yr)	1.00	(ref)	1.00	(ref)
90 - < 1518	0.97	(0.83, 1.13)	0.97	(0.83, 1.14)
1518 - < 2246	0.96	(0.81, 1.14)	1.00	(0.84, 1.19)
2246 - < 3132	0.91	(0.76, 1.09)	0.96	(0.80, 1.15)
3132 or more	0.91	(0.75, 1.10)	0.95	(0.78, 1.16)
10 years of lag time				
less than 90 (1 yr)	1.00	(ref)	1.00	(ref)
90 - < 1518	0.98	(0.85, 1.14)	0.98	(0.85, 1.14)
1518 - < 2246	0.95	(0.80, 1.14)	0.99	(0.83, 1.19)
2246 - < 3132	0.90	(0.74, 1.10)	0.95	(0.77, 1.16)
3132 or more	0.92	(0.75, 1.12)	0.96	(0.79, 1.18)
15 years of lag time				
less than 90 (1 yr)	1.00	(ref)	1.00	(ref)
90 - < 1518	1.14	(0.89, 1.17)	1.02	(0.89, 1.17)
1518 - < 2246	1.19	(0.75, 1.10)	0.93	(0.77, 1.13)
2246 - < 3132	1.16	(0.76, 1.17)	0.97	(0.79, 1.19)
3132 or more	1.18	(0.79, 1.20)	0.97	(0.80, 1.18)
20 years of lag time				
less than 90 (1 yr)	1.00	(ref)	1.00	(ref)
90 - < 1518	1.01	(0.88, 1.17)	1.04	(0.90, 1.19)
1518 - < 2246	1.02	(0.83, 1.25)	1.06	(0.86, 1.31)
2246 - < 3132	0.95	(0.76, 1.19)	0.99	(0.79, 1.24)
3132 or more	1.00	(0.79, 1.26)	1.07	(0.84, 1.36)

^a adjusted for age only

^b adjusted for age, number of live births and age st 1st live birth.

Discussion

Our current results investigating the workplace exposures to MF and shiftwork on risk of breast cancer suggest that there are no evident associations between these two exposures and risk of breast cancer. We are further analyzing our data by controlling for other confounding factors, such as physical activity, and by categorizing EMF and shiftwork exposures according to the defined time windows of exposure prior to diagnosis or reference date.

In this study, we characterized magnetic field exposures for a wide variety of jobs in the Shanghai Textile Industry, and identified some jobs in the industry with high magnetic field exposure. We confirmed that operators of sewing machines experience high magnetic field exposures. Quality control testers in a number of production lines also had elevated exposures.

Production machines in the workshops where the measurements were collected were manufactured from the 1970s to 2000s. New and old machines were often installed in close proximity to each other in the same workshop and were operated simultaneously. Our study as well as other published study demonstrated that higher magnetic field exposures are inversely correlated with the age of equipment (11). Therefore, it is reasonable to assume that our contemporary measurements of magnetic exposures will likely have underestimated the historical exposures due to the installation of more efficient motors and transformers, and equipment upgrades that occurred in the workshops over time. Thus, exposure misclassification may have biased our findings toward observing no associations, but the extent of such bias is probably not strong.

The majority of manufacturing factories in Shanghai Textile Industry operated rotation shifts. Machine operators and workers who worked on the production floor were mandated working on the rotation shifts whereas staff in administration and support services often worked on day only schedule.

Some limitations to exposure assessment in this study should be mentioned. First, a magnetic field sampling was conducted in 56 out of 503 textile factories. Some factories were selected based on availability, and thus were not a random sample of all factories. From the factories available for measurements, we randomly selected factories for the initial sample collection. If the selected factories were not available, or did not have enough workers for sampling, our local research team tried to select other factories that were representative of the type of factories operated by the STIB. When the characteristics of the factories where the samples were collected were compared to those of all factories in the study, the sampled factories demonstrated a good representation of all study factories with respect to product activities, factory age, and factory size. The STIB determined which mills produced specific products, and standardized production processes such that they were similar across factories with similar productions. We obtained magnetic field measurements from the same process-work type positions in at least two such factories. Therefore, we do not expect factory selection bias to be appreciable.

This study has several noteworthy strengths. The job categories used in this study were carefully constructed from the detailed process information collected from 503 STIB factories. This unique setting provided an excellent opportunity to characterize magnetic field exposure for a

wide range of textile jobs from operators of various production machines to positions in support service. The magnetic field JEM developed in our study was constructed using more than one thousand direct measurements which is a vast improvement on assessment methods used in the majority of studies where exposures were inferred from indirect data sources (e.g., census information, subjects' self-report, and job titles).

The analysis for this study is close to completion. The constructed MF JEM and shiftwork data are being used to investigate their associations with other health outcomes.

References

1. IARC. Non-ionizing radiation, Part 1: static and extremely low-frequency (ELF) electric and magnetic fields. IARC Monogr Eval Carcinog Risks Hum 2002;80:1-395.
2. Astrakianakis G, Seixas NS, Ray R, Camp JE, Gao DL, Feng Z, et al. Lung cancer risk among female textile workers exposed to endotoxin. J Natl Cancer Inst 2007;99(5):357-64.
3. Ray RM, Gao DL, Li W, Wernli KJ, Astrakianakis G, Seixas NS, et al. Occupational exposures and breast cancer among women textile workers in Shanghai. Epidemiology 2007;18(3):383-92.
4. Li W, Ray RM, Gao DL, Fitzgibbons ED, Seixas NS, Camp JE, et al. Occupational risk factors for nasopharyngeal cancer among female textile workers in Shanghai, China. Occup Environ Med 2006;63(1):39-44.
5. Thomas DB, Gao DL, Self SG, Allison CJ, Tao Y, Mahloch J, et al. Randomized trial of breast self-examination in Shanghai: methodology and preliminary results. J Natl Cancer Inst 1997;89(5):355-65.
6. Thomas DB, Gao DL, Ray RM, Wang WW, Allison CJ, Chen FL, et al. Randomized trial of breast self-examination in Shanghai: final results. J Natl Cancer Inst 2002;94(19):1445-57.
7. Wernli KJ, Astrakianakis G, Camp JE, Ray RM, Chang CK, Li GD, et al. Development of a job exposure matrix (JEM) for the textile industry in Shanghai, China. J Occup Environ Hyg 2006;3(10):521-9.
8. Burch JB, Reif JS, Yost MG. Geomagnetic disturbances are associated with reduced nocturnal excretion of a melatonin metabolite in humans. Neurosci Lett 1999;266(3):209-12.
9. Burch JB, Reif JS, Yost MG, Keefe TJ, Pitrat CA. Nocturnal excretion of a urinary melatonin metabolite among electric utility workers. Scand J Work Environ Health 1998;24(3):183-9.
10. Forssen UM, Mezei G, Nise G, Feychting M. Occupational magnetic field exposure among women in Stockholm County, Sweden. Occup Environ Med 2004;61(7):594-602.
11. Kelsh MA, Bracken TD, Sahl JD, Shum M, Ebi KL. Occupational magnetic field exposures of garment workers: results of personal and survey measurements. Bioelectromagnetics 2003;24(5):316-26.

Publication

1. Li W, Ray RM, Gao D, Yost M, Davis S, Thomas DB, et al. Occupational magnetic field exposures in the textile industry in Shanghai, China. *Occup Environ Med* (in preparation for submission).

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Textile Industry Exposures and Breast Cancer in Women

Total Enrollment: 6620 **Protocol Number:** _____

Grant Number: 1 R01 OH008149

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race				
Ethnic Category	Females	Males	Sex/Gender Unknown or Not Reported	Total
Hispanic or Latino	0	0	0	0 **
Not Hispanic or Latino	6,620	0	0	6,620
Unknown (individuals not reporting ethnicity)	0	0	0	0
Ethnic Category: Total of All Subjects*	6,620	0	0	6,620 *
Racial Categories				
American Indian/Alaska Native	0	0	0	0
Asian	6,620	0	0	6,620
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	0	0	0
White	0	0	0	0
More Than One Race	0	0	0	0
Unknown or Not Reported	0	0	0	0
Racial Categories: Total of All Subjects*	6,620	0	0	6620 *
PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)				
Racial Categories	Females	Males	Sex/Gender Unknown or Not Reported	Total
American Indian or Alaska Native	0	0	0	0
Asian	6,620	0	0	6,620
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	0	0	0
White	0	0	0	0
More Than One Race	0	0	0	0
Unknown or Not Reported	0	0	0	0
Racial Categories: Total of Hispanics or Latinos**	6,620	0	0	6620 **

* These totals must agree.

** These totals must agree.