

MORTALITY OF FEMALE WORKERS IN THE RUBBER INDUSTRY

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ABSTRACT

Mortality experience of female production workers in a large manufacturing plant of the rubber industry was examined over a period of ten years, from 1/1/1964 through 12/31/1973. The cohort consisted of 1649 white females, 40 to 84 years of age. At the beginning of the observation, the cohort members were either active or retired, but over 99 per cent of them had at least ten years of employment service within the plant under study.

In contrast to male production workers in the same plant, females experienced less favorable mortality than the general population of the same sex. The all causes Standardized Mortality Ratio (SMR), based on the U.S. population as a standard, was 103 for the entire cohort of women. The magnitude of this SMR is provocative when the "healthy worker effect" of the employed population is considered. Among women the cause specific SMR for lung cancer is 190, indicating a statistically significant excess of deaths. For males, in the same plant, a statistically significant deficit of deaths due to lung cancer was observed. The SMR for breast cancer among the women is 41, indicating a statistically significant deficit due to this cause. Results of the preliminary analyses of possible associations of selected causes of death with work experience are discussed.

The increasing sex mortality differential, favoring females, over the past three quarters of the century is a well substantiated epidemiologic feature for the general U.S. population. To explain these differences both endogenous and exogenous hypotheses have been examined in the past and the consensus among investigators has been that for the adult population environmental factors, usually those linked to occupation, may explain the higher mortality rates among males. Historically, men have been in the work force longer than women and while employment traditionally played more of a secondary role in women's lives, it has always been of primary importance among men. Because of this tradition, most epidemiologic studies of industrial populations have dealt exclusively with mortality of male workers, resulting in a rather sparse literature concerning the mortality experience among employed women.

With the rapidly increasing number of employed women in various industries who share the work environment with men, however, there is a

pressing need to systematically study the health and mortality of female workers at least in those industries in which they comprise a reasonably large portion of the labor force. It would be important to determine, as a first step, whether the sex mortality differential as documented for the general population is maintained among employed female industrial workers as well.

Over the past several years there has been increasing concern voiced specifically about the reproductive hazards in the work environment which may affect the fetus and future generations through the exposure of either one or both parents. Despite the importance of this issue, however, studies of the general health of industrially employed women should not be relegated to a position of secondary importance.

SUBJECTS AND METHODS

The study presented in this paper describes the mortality experience of female production workers in a large manufacturing plant of the rubber industry. This is one of several epidemiological studies which are being carried out by the Occupational Health Studies Group at the University of North Carolina at Chapel Hill as part of a comprehensive occupational health research program in the rubber industry, a program sponsored jointly by the United Rubber Workers of America and four major U.S. rubber companies. Our own earlier studies^{1,5} have been confined to male production workers.

Following the same study procedures used earlier in the study of males¹ a ten-year cohort mortality study was conducted among white female production workers in the same plant. Criteria used in defining the cohort were the same, the procedures employed in the follow-up of the cohort members were identical to those used for the study of male workers, and the period of observation covered the same 10 year period from 1964 through 1973.

To qualify for membership in the cohort a woman production worker had to be 40–84 years of age as of January 1, 1964, and, as of the same date, had to be either actively employed at or retired from the plant under study. So defined, the 1964 cohort consisted of 1649 white females, who were then followed through December 31, 1973. The survivorship status at the closing date of the study is known for 96.5 per cent of the cohort members. During the ten years of observation 279 deaths have occurred for which, except for three deaths, the death certificates were obtained. Causes of death were coded according to the Eighth Revision of the International Classification of Diseases.

As of January 1, 1964, 99.7 per cent of women in this cohort had at least ten years of employment service within the plant under study. On the same date the mean age of the cohort was about 58 years, while the mean age at first employment was 30 years. The great majority of these women, 64 per cent, worked the longest time in the manufacture of industrial products, while the remainder worked longest in the manufacture of tires in the same plant under study.

The mortality experience of the cohort under study was evaluated in terms of age-standardized mortality ratios (SMR's). In the calculation of the expected

numbers of deaths, the 1968 U.S. white females' age specific death rates were used. One of the major limitations in the conduct of mortality studies of industrial populations is the lack of a comparable employed standard population which would reduce the problem of the "healthy worker effect". The general population in addition to including employed persons, consists also of those not employed and not employable, which in many instances is a consequence of impaired health. A general population therefore often has higher mortality rates than one which is employed. The expected numbers of deaths based on a general population as a standard are therefore usually higher than the observed number in the employed group leading to a relative estimate which makes it appear that the working population is protected from death. This is the "healthy worker effect". Nevertheless, in the absence of an ideal standard the usual choice of most investigators is to use rates from the general population of the country or of a smaller geographical region closer to the plant under study.

RESULTS AND DISCUSSION

The all-causes SMR for the entire cohort of white females (Table 1), is 103. Although this three per cent excess was not statistically significant, in view of the healthy worker effect, an SMR of over 100 was not expected for an employed and therefore presumably healthier population than the general population of the same age, race and sex, whose SMR is, by definition 100. Actually it has been suggested that an SMR in the range between 80–85 would be expected for an

TABLE 1
Observed deaths and standardized mortality ratios (SMR) for deaths from malignant neoplasms among female rubber workers, 1964–1973.

ICD* No. and cause of death	Observed	SMR
All causes	279	103
140–209 Malignant neoplasms:	62	102
150 Esophagus	1	175
151 Stomach	4	155
153 Large intestine	11	137
154 Rectum	4	203
156 Gallbladder	1	69
157 Pancreas	3	88
162 Trachea, bronchus and lung	9	190**
174 Breast	5	41***
180–184 Genital organs	8	84
188 Bladder	2	204
189 Other urinary organs	1	95
190–199 Other and unspecified sites	8	138
200–209 Neoplasms of lymphatic and hematopoietic tissue	5	92

* International Classification of Diseases, Eighth Revision

** p value = 0.051.

*** p value = 0.040.

industrial population which had not been exposed to work related health hazards. In the first detailed study of mortality among female employees in the U.S. rubber industry reported in 1976⁷, the overall SMR was 78 for women in a single plant of another company.

For white males in our study employed in the same plant, for the same calendar period of observation, the all-causes SMR of 94, which was statistically significantly low ($p < 0.01$), was obtained based on the 1968 U.S. male population as a standard¹.

TABLE 2
Observed deaths and standardized mortality ratios (SMR) for deaths from non-neoplastic diseases among female rubber workers, 1964-1973.

ICD* No. and cause of death	Observed	SMR
All causes	279	103
250 Diabetes mellitus	10	114
280-289 Diseases of blood and blood forming organs	1	133
320-389 Diseases of nervous system and sense organs	2	86
393-398 Chronic rheumatic heart disease	2	52
400-404 Hypertensive disease	3	77
410-413 Ischemic heart disease	105	107
410 Acute myocardial infarction	68	125**
430-438 Cerebrovascular disease	38	113
470-486 Influenza and pneumonia	5	66
490-493 Bronchitis, emphysema and asthma	3	105
500-519 Other respiratory diseases	3	196
520-577 Diseases of digestive system	11	101
571 Cirrhosis of liver	4	106
580-629 Diseases of genitourinary system	3	78
710-738 Diseases of musculoskeletal system and connective tissue	1	90
780-796 Symptoms and ill-defined conditions	2	112
800-999 Accidents, poisoning and violence	11	117
All other non-neoplastic diseases	17	112

*International Classification of Diseases, Eighth Revision

**p value = 0.063.

Results of the cause-specific standardized mortality analyses are given in Tables 1 and 2, respectively, separately for deaths due to cancer and from other causes. From these two tables the following major findings should be noted:

- (1) Breast cancer with SMR of 41; 5 observed and 12.19 expected, $p = 0.040$,
- (2) Lung cancer with SMR of 190; based on 9 observed and 4.74 expected, $p = 0.051$,
- (3) Myocardial infarction with SMR of 125; 68 observed and 54.30 expected, $p = 0.063$.

While breast cancer is the most frequent cause of death from cancer among females in the general U.S. population, this does not hold for members of the present cohort, among whom a 59 per cent deficit of deaths from this cause was noted. In the earlier mentioned study of female employees from another U.S. rubber manufacturing company⁷, a deficit, although smaller, was also reported. In a proportional mortality analysis of female employees in 17 U.S. polyvinyl chloride fabricator plants, on the other hand, a sizeable (36%) excess of deaths from breast cancer was recently reported².

Numerous non-occupational factors have, so far, been associated with the incidence of breast cancer, such as: age at first childbearing, parity, artificial menopause, and age at artificial menopause, lactation and the duration of lactation, obesity, and age at menarche, among others. We are not presently able to provide an explanation for the apparent deficit of breast cancer among rubber workers, since we do not presently have records of these and other breast cancer associated factors. Further study will be appropriate when these data become available.

For lung cancer an SMR of 190 was obtained, based on only nine deaths observed within the entire cohort of white females. Regarding lung cancer, the following inconsistent findings, from the reports of numerous investigators, are noted:

- (1) For many years the male predominance in lung cancer mortality in the U.S. has been well recognized, and in 1969 the male mortality was 4.6 times the female rate.
- (2) As a cause of cancer death, lung cancer ranked first among males and fourth among females in the U.S. in 1969.
- (3) British investigators^{3,4} observed an excess of bronchogenic carcinoma among male rubber workers, but did not study females.
- (4) American male rubber workers experienced lower than expected mortality from this disease^{5,6}.
- (5) An SMR of 100 for lung cancer deaths was reported for a cohort of 5816 women, in another rubber manufacturing plant including both salary and production workers⁷.
- (6) In the present study an excess of lung cancer deaths was observed among female workers in the same plant in which male workers experienced a deficit of deaths from lung cancer¹.

For deaths due to myocardial infarction, an SMR of 125 was found for the entire cohort of white females. As with lung cancer, numerous risk factors for myocardial infarction have been identified, but cigarette smoking remains a major risk for both diseases. In view of the latest U.S. data which indicate that a greater proportion of females now smoke, and they smoke more heavily, information on smoking histories for rubber workers would have to be obtained before occupational exposures can be implicated. For instance, if the proportion of smokers among employed females is greater than the proportion among the U.S. female general population, which is the basis for the SMR's, some

proportion of the excess lung cancer and heart disease may be explained by the smoking factor. Because of the great diversity of chemicals used in the industry, however, many of which are known or suspect carcinogens, there is also the possibility that smoking and industrial exposures work either independently or synergistically in the etiology of numerous diseases. All of these possibilities must therefore be investigated.

Prior to analytic studies at the level of the individual, however, we decided to examine our data for possible associations between cause of death and employment histories. A comparison of the general occupational characteristics of the males and females in the plant under study showed striking similarities. We then attempted to determine whether females with similar causes of death were likely to have similar employment histories. We found preliminarily that women with myocardial infarction who were retired at the onset of study in 1964 had, in fact, worked more frequently than the remainder of the cohort in three work areas: tire stock preparation, fabrication of tires and beads, and industrial products manufacturing. Similar analyses for those women who died from lung cancer did not reveal any striking differences. Further detailed examination of our data indicated that among the women with myocardial infarction anywhere on their death certificates, about 40 per cent had worked for the longest period of time in either fuel cell production or the manufacture of foam products, work areas in which the proportion of male employees, among whom we did not observe excesses of myocardial infarction or lung cancer, was quite small. While these findings are obviously not conclusive, it is this type of relationship in which we are interested for this preliminary phase of our investigation into the health of female employees. A similar pattern was not observed among the nine women who died of lung cancer.

CONCLUDING REMARKS

It should be kept in mind that this report is based on a relatively small cohort, within which only few deaths occurred, making it especially difficult to determine excesses for specific causes of death. Despite this drawback, there were observed statistically significant excesses for cancer of lung and for myocardial infarctions and these excesses should not be ignored, despite the fact that we have enumerated various limitations to our data one of which is the absence of a suitable standard of comparison for industrially employed females.

Since the comparison group is responsible for the relative magnitude of the excess, without an appropriate standard it is difficult to differentiate between real and spurious excesses. For instance, the differences in mortality findings of British and American investigators may be a function of this very problem, and unless this issue can be resolved, comparisons may not be meaningful. Perhaps this is the time and place to suggest that an international effort be made in this regard, especially in view of the historically high employment rate among females in European and many Asian countries and the dramatic increase in the number of employed women in America, which now numbers about 50 million.

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