

# Mortality among female industrial workers in Iceland

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**Abstract.** *Aims:* The aim was to describe the mortality pattern among unskilled female industrial workers with the hypothesis that they were disadvantaged compared to other women and that smoking-related causes of death were in excess among them. *Methods:* The study group comprised 13,349 women who had contributed at any time to a pension fund for unskilled industrial workers in Reykjavik during the time period 1970–1995. The follow-up was from 1975 to 1995. The death rate of the study group was compared to that of women in the general population during the time period 1981–1995. The study group was studied with regard to selected causes of death, by age at first entrance into the pension fund, different lag-time, and by employment-time. *Results:* Results showed an excess of external causes but a deficit of most other causes of death, among those smoking related diseases. The high mortality by external causes was consistent in all the analyses. Standardised mortality ratio (SMR) for external causes in the total group was 1.79 (95% CI 1.45–2.19), for lung cancer 1.04 (95% CI 0.80–1.34) and for ischemic heart disease 0.77 (95% CI 0.65–0.91). Mortality was highest among those who started to pay in the pension fund at younger ages. *Conclusions:* The notable excess of external causes in the group needs further exploration. The results did not confirm the hypothesis that smoking-related causes of death were in excess in the group. Methodological problems related to studies on women workers are discussed.

Keywords: Mortality, women, female industrial workers, social groups

## 1. Introduction

### 1.1. Background

Research shows that morbidity and mortality varies by social groups and that people in the low social strata experience poorer health and shorter life expectancy than others [7,19]. Research also demonstrates that inequalities in health are large, widespread, and remarkably persistent [5]. The consistent and robust links between socio-economic status and health suggest that scientists of different disciplines must continue to search for an explanation [5]. Work, education, and economic status are the most widely used variables for

measuring social inequalities in health [19]. The social difference in mortality has been less evident among women than among men, especially if occupation is used as a proxy for social group [4,12,19].

How to measure inequality in health is a complicated question and one that is open for debate, especially inequality pertaining to women [4,18,19,21,28]. Women's participation in the labour market has changed significantly over the last several decades [8], making the debate concerning equality in health even more complex. In Iceland, 34% of women 15 years of age or older were active in the labour market in 1960 [17], whereas this proportion had increased to 77% in 1996 [24] and to 78.9% in 2001 [25].

Earlier mortality studies among female manual workers [9] and nurses in Iceland [10] showed a lower than expected death rate as compared to other Ice-

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landic women. A study of cancer incidence in the present study group showed a moderate excess of lung cancer (SMR 1.38; 95% CI 1.08–1.75) and of corpus uteri (SMR 1.67; 95% CI 1.19–2.28), but only when ten years lag-time was applied [11]. A survey of Icelandic women aged 18–69 years, conducted between 1986–1988 by the Committee for Tobacco Use Prevention, found that 24% of college or university graduates smoked daily, compared with 38% of women with less education [22]. One would assume that most female industrial workers fall into the latter group.

### 1.2. Aims

The aims of this study were: a) to describe the mortality pattern of unskilled female workers; b) to test the hypothesis that women in a low social stratum were at a disadvantage compared to other women and that smoking related causes of death were in excess among them.

## 2. Methods

The study group comprised 13,349 women who contributed to a pension fund for unskilled industrial workers in the capital area in Iceland at any time between 1970 and 1995. The Association of Industrial Workers in the capital area is an association of unskilled labourers in various industries, such as textiles, chemicals, foodprocessing, metals, packaging, and the photo industry. In this study, it was assumed that a woman who worked at any point as an unskilled industrial worker belonged to low social stratum. Information on the cause of death for women who died between 1970 and 1975 was not available. However, to improve statistical power, women who contributed to the fund between 1970 and 1975 were included in the study, even though follow-up did not start until 1975. New members entered the study group during the follow-up period but no women were excluded, unless they died. The fate of all members was followed whether they continued to participate in the fund or not.

Icelandic law obliges all wage earners to pay 4% of their salary to their respective union's pension fund. The first year a woman was listed on the fund's membership rolls determined her first year in the study. Through the individual's personal identification number, the study population was record-linked with the National Register; the Register of Deceased and the Register of Cause of Death, all kept at Statistics Ice-

land, the Office for National Statistics. Vital status was ascertained for everyone in the study group. Information on cause of death of eight persons, who died abroad, was either obtained directly from their death certificates or no death certificate was found. In that case, the cause of death was classified as unknown.

Person-years for each woman were counted from January 1, 1975 to December 31, 1995 or her date of death, whichever came first. Person-years are a measurement combining persons and time, used as denominator in person-years incidence and mortality rates. With this approach, each woman contributes only as many years of observation to the population at risk as she is actually observed. Standardized mortality ratios (SMRs) were calculated by computing the ratio of the standardized rates of the study group and of the mean general female population in Iceland within 10-year age categories for the period 1981–1995. The 95% confidence intervals (95% CI) were calculated assuming approximate log-normal distribution [6,14].

The death rate in the study group was analysed with regard to selected causes of death and then subsequently by age at first entrance into the pension fund, by different lag-time, (i.e. data was reanalysed after allowing for various time periods before the start of follow-up) and by length of employment-time. Employment-time was set as the time span between the first and last year each woman contributed to the fund, regardless if she had contributed continuously or sporadic. Any payment to the pension fund during a particular calendar year was considered a whole year of employment. The study was done with permission of the Data Protection Commission in Iceland.

## 3. Results

In the entire study group, there was a deficit of all causes combined and that accounted also for most of the selected causes of death, with the exception of SMR for external causes, which was 1.79 (95% CI 1.45–2.19). SMR for lung cancer was 1.04 (95% CI 0.80–1.34) and SMR for ischemic heart disease was 0.77 (95% CI 0.65–0.91) (Table 1). When a woman's age upon entrance into the pension fund was considered, the SMRs were highest in the group that started at 20–29 years of age; SMR for all causes was 1.38 (95% CI 1.01–1.85) (Table 2), lowest among those who started 40 years of age or older; SMR for all causes 0.66 (95% CI 0.60–0.71). Using different lag-times revealed that the SMR for external causes tapered down from

Table 1

Observed (Obs) and expected (Exp) numbers of deaths, standardised mortality ratio (SMR) and 95% confidence intervals (CI) among 13 349 female industrial workers (person-years 212.713), follow-up time 1975–1995. No lag-time applied

| Causes of death (ICD 9th)             | Obs | Exp    | SMR  | CI lower | CI upper |
|---------------------------------------|-----|--------|------|----------|----------|
| All deaths (010–E978)*                | 719 | 994.92 | 0.72 | 0.67     | 0.78     |
| All cancers (140–203)                 | 245 | 291.51 | 0.84 | 0.74     | 0.95     |
| – ca of digestive tract (151–154)     | 42  | 43.32  | 0.97 | 0.70     | 1.31     |
| – ca of trachea, bronchus, lung (162) | 60  | 57.50  | 1.04 | 0.80     | 1.34     |
| – ca of breast (174–175)              | 41  | 59.34  | 0.69 | 0.50     | 0.94     |
| – ca of other female organs (179–184) | 30  | 36.11  | 0.83 | 0.56     | 1.19     |
| – ca of blood and lymphs (200–208)    | 19  | 18.56  | 1.02 | 0.62     | 1.60     |
| Other cancers                         | 53  | 76.68  | 0.69 | 0.52     | 0.90     |
| Ischemic heart disease (410–414)      | 146 | 188.58 | 0.77 | 0.65     | 0.91     |
| Cerebrovascular diseases (430–438)    | 54  | 88.97  | 0.61 | 0.46     | 0.79     |
| Respiratory diseases (460–519)        | 63  | 105.94 | 0.59 | 0.46     | 0.76     |
| Accidents and suicides (E800–E978)    | 94  | 52.49  | 1.79 | 1.45     | 2.19     |
| Other causes of death                 | 117 | 267.44 | 0.44 | 0.36     | 0.52     |

Table 2

Standardised mortality ratios (SMR) and 95% confidence intervals (CI) among female industrial workers, follow-up time 1975–1995 by age at first entrance in the pension fund. No lag-time applied

| Causes of death (ICD 9th)             | SMR (95% CI)                                   |   |   |  |
|---------------------------------------|--|---|---|--|
|                                       | < 20 yrs; N = 5715<br>person years<br>= 88 445 | 20–29 yrs; N=3324<br>person years<br>= 50 021 | 30–39 yrs; N=1348<br>person years<br>= 22 696 | 40 yrs >; N=2962<br>person years<br>= 51 551 |
| All deaths (010–E978)                 | 1.18 (0.86–1.58)                               | 1.38 (1.01–1.85)                              | 1.10 (0.82–1.44)                              | 0.66 (0.60–0.71)                             |
| All cancers (140–203)                 | 0.95 (0.47–1.70)                               | 1.11 (0.64–1.81)                              | 0.98 (0.64–1.44)                              | 0.80 (0.69–0.93)                             |
| – ca of digestive tract (151–154)     | 2.83 (0.57–8.27)                               | 1.74 (0.20–6.30)                              | 1.98 (0.64–4.61)                              | 0.86 (0.59–1.20)                             |
| – ca of trachea, bronchus, lung (162) | 0.95 (0.01–5.26)                               | 2.21 (0.71–5.16)                              | 1.06 (0.39–2.31)                              | 1.03 (0.76–1.36)                             |
| – ca of breast (174–175)              | 0.78 (0.09–2.80)                               | 0.93 (0.25–2.39)                              | 1.03 (0.44–2.03)                              | 0.56 (0.36–0.82)                             |
| – ca of other female organs (179–184) | 0.54 (0.01–2.98)                               | 1.63 (0.33–4.76)                              | 0.96 (0.19–2.82)                              | 0.82 (0.52–1.22)                             |
| – ca of blood and lymphs (200–208)    | 1.07 (0.12–3.87)                               | 1.38 (0.16–4.99)                              | 0.67 (0.01–3.72)                              | 1.02 (0.56–1.71)                             |
| Other cancers                         | 0.63 (0.07–2.27)                               | –   | 0.50 (0.10–1.48)                              | 0.72 (0.52–0.96)                             |
| Ischemic heart disease (410–414)      | 1.57 (0.02–8.75)                               | –   | 1.10 (0.30–2.82)                              | 0.76 (0.64–0.90)                             |
| Cerebrovascular diseases (430–438)    | –  | 1.40 (0.16–5.07)                              | 0.40 (0.01–2.24)                              | 0.61 (0.45–0.80)                             |
| Respiratory diseases (460–519)        | –  | 1.79 (0.02–9.94)                              | 1.53 (0.17–5.54)                              | 0.58 (0.44–0.75)                             |
| Accidents and suicides (E800–E978)    | 1.87 (1.22–2.74)                               | 1.76 (0.98–2.90)                              | 1.97 (0.98–3.52)                              | 1.72 (1.24–2.32)                             |
| Other causes of death                 | 0.65 (0.24–1.42)                               | 1.63 (0.81–2.91)                              | 1.02 (0.44–2.01)                              | 0.38 (0.30–0.46)                             |

the 1.79, when no lag-time was applied, to 1.00 (95% CI 0.74–1.32) with ten years lag-time (Table 3). The two groups with employment-time less than five years had higher SMRs for external causes than others, 2.45 (CI 1.74–3.35), 2.09 (CI 1.45–2.92), and 1.03 (95% CI 0.64–1.58), respectively (Table 4). To further detail the increase in SMRs from external causes, they were classified as traffic accidents, other accidents, and suicides and subsequently divided into age groups. The hypothesis was tested that the distribution between these causes of death was the same among the industrial workers as among Icelandic women in general. The results did not provide evidence to reject that hypothesis ( $\chi^2 = 0.1165$  df 4  $p = ns$ ).

#### 4. Discussion

Compared to the general female population in Iceland, the study group of unskilled, female industrial workers consistently had an excess of deaths by external causes but a deficit of most other causes of deaths. Smoking-related causes of death were not in excess, although deaths from lung cancer were relatively elevated. The present study suggests that occupation can be used to identify groups of women that might need special public health measures. However, to use occupation for this purpose has its limitations.

Comparing an occupational group with the general population, which includes the study population itself, introduces a bias towards the null and concerns both men and women [3,20]. This inclusion diminishes the possibility to reveal difference between the study group

Table 3  
Standardised mortality ratios (SMR) and 95% confidence intervals (CI) among female industrial workers, follow-up time 1975–1995, by different lag-time

| Causes of death (ICD 9th)             | SMR (95% CI)                                  |  |   |
|---------------------------------------|---|--|---|
|                                       | 5 years;<br>N=12529 person<br>years = 210 229 | 10 years;<br>N=10546 person<br>years = 195 611 | 15 years;<br>N=7705 person<br>years = 161 599 |
| All deaths (010–E978)                 | 0.67 (0.62–0.72)                              | 0.56 (0.52–0.61)                               | 0.42 (0.38–0.46)                              |
| All cancers (140–203)                 | 0.79 (0.70–0.90)                              | 0.69 (0.60–0.80)                               | 0.49 (0.40–0.58)                              |
| – ca of digestive tract (151–154)     | 0.95 (0.68–1.29)                              | 0.82 (0.57–1.15)                               | 0.65 (0.41–0.96)                              |
| – ca of trachea, bronchus, lung (162) | 0.93 (0.70–1.21)                              | 0.80 (0.58–1.08)                               | 0.51 (0.33–0.76)                              |
| – ca of breast (174–175)              | 0.68 (0.49–0.93)                              | 0.64 (0.45–0.88)                               | 0.44 (0.28–0.67)                              |
| – ca of female organs (179–184)       | 0.78 (0.52–1.13)                              | 0.61 (0.38–0.94)                               | 0.53 (0.30–0.86)                              |
| – ca of blood and lymphs (200–208)    | 0.92 (0.54–1.48)                              | 0.79 (0.43–1.33)                               | 0.51 (0.22–1.01)                              |
| Other cancers                         | 0.67 (0.50–0.88)                              | 0.59 (0.43–0.79)                               | 0.38 (0.25–0.57)                              |
| Ischemic heart disease (410–114)      | 0.75 (0.63–0.89)                              | 0.63 (0.52–0.75)                               | 0.49 (0.39–0.60)                              |
| Cerebrovascular diseases (430–438)    | 0.53 (0.39–0.71)                              | 0.44 (0.31–0.61)                               | 0.37 (0.25–0.53)                              |
| Respiratory diseases (460–519)        | 0.60 (0.46–0.76)                              | 0.54 (0.40–0.70)                               | 0.44 (0.32–0.60)                              |
| Accidents and suicides (E800–E978)    | 1.39 (1.08–1.74)                              | 1.00 (0.74–1.32)                               | 0.65 (0.43–0.94)                              |
| Other causes of death                 | 0.41 (0.34–0.50)                              | 0.35 (0.28–0.43)                               | 0.26 (0.20–0.34)                              |

Table 4  
Standardised mortality ratios (SMR) and 95% confidence intervals (CI) among 13 349 female industrial workers follow-up time 1975–1995 for employment-time. No lag-time applied

| Causes of death (ICD 9th)             | SMR (95% CI)                                 |   |   |
|---------------------------------------|--|---|---|
|                                       | < 1 year;<br>N=5169 person<br>years = 76 136 | 1–4 years;<br>N=4665 person<br>years = 69 832 | 5 years or more;<br>N=3515 person<br>years = 66 745 |
| All deaths (010–E978)                 | 0.97 (0.84–1.12)                             | 0.77 (0.68–0.88)                              | 0.60 (0.53–0.67)                                    |
| All cancers (140–203)                 | 0.96 (0.74–1.24)                             | 0.72 (0.54–0.93)                              | 0.86 (0.71–1.02)                                    |
| – ca of digestive tract (151–154)     | 1.02 (0.47–1.94)                             | 0.91 (0.45–1.63)                              | 0.98 (0.61–1.49)                                    |
| – ca of trachea, bronchus, lung (162) | 1.61 (0.98–2.48)                             | 0.96 (0.54–1.58)                              | 0.85 (0.55–1.25)                                    |
| – ca of breast (174–175)              | 0.57 (0.25–1.13)                             | 0.73 (0.38–1.27)                              | 0.73 (0.45–1.11)                                    |
| – ca of female organs (179–184)       | 0.62 (0.20–1.44)                             | 0.90 (0.41–1.71)                              | 0.89 (0.51–1.44)                                    |
| – ca of blood and lymphs (200–208)    | 0.68 (0.14–1.98)                             | 1.13 (0.41–2.45)                              | 1.14 (0.54–2.09)                                    |
| Other cancers                         | 1.03 (0.60–1.64)                             | 0.23 (0.08–0.54)                              | 0.80 (0.54–1.14)                                    |
| Ischemic heart disease (410–114)      | 0.95 (0.65–1.34)                             | 0.94 (0.70–1.24)                              | 0.62 (0.48–0.80)                                    |
| Cerebrovascular diseases (430–438)    | 0.92 (0.51–1.52)                             | 0.46 (0.24–0.80)                              | 0.58 (0.38–0.84)                                    |
| Respiratory diseases (460–519)        | 0.87 (0.50–1.41)                             | 0.80 (0.52–1.18)                              | 0.39 (0.24–0.59)                                    |
| Accidents and suicides (E800–E978)    | 2.45 (1.74–3.35)                             | 2.09 (1.45–2.92)                              | 1.03 (0.64–1.58)                                    |
| Other causes of death                 | 0.59 (0.39–0.84)                             | 0.54 (0.39–0.72)                              | 0.33 (0.24–0.44)                                    |

and the reference population. Distribution of potential confounders is not controlled for.

The positive outcome, regarding all causes combined, for working people has been seen in studies on other female blue-collar workers [9] and nurses in Iceland [10] and among female industrial workers in other countries [1,2,26]. These findings indicate a strong healthy-worker effect (HWE). The SMRs were lowest among those who started in the pension fund 40 years of age or older. This could be expected as the combined self-selection of workers, together with selection by the employer is considered to be the most important source of the HWE [3]. Being fit to do physical work at this age and being accepted on the job market suggests a worker is in good health. In the present study, mortality was lowest when 15 years lag-time was applied. This

challenges the assertion that HWE is strongest at the beginning of employment [15]. However, this is not always the case [3]. Allowing time to elapse before computing of person-years starts is done to reduce HWE in studies that examine the effect of some defined exposure on the incidence of diseases. However, it is not likely to apply to external causes. In the present study, the “exposure” was to have belonged to a low social stratum, an exposure that is not bound to have the same expected dose-response relationship as other kinds of exposures might have, and is most likely complex in nature.

One weakness of this study is that the marital status of the study group members and the socio-economic status of their husbands or families is unknown. This information has been found to be important in stud-

ies on inequalities in health among women [4,7,23,27]. Another weakness was that no previous or subsequent work history was available. Thus, there was no information on the social status of these women before or after their contribution to the pension fund.

The strength of the study is that information on occupation is from a reliable source, i.e. the pension fund, and it does not depend on the women's own answers at census or information on occupation provided on death certificates. Information on women's usual occupation is often lacking on the death certificate.

Furthermore, no woman was lost during follow-up, a problem that often hampers studies of women workers because of frequent name changes [1]. Icelandic women do not change their names at marriage, a fact that helps in this context. The vital status of all participants was confirmed and information on the cause of death of nearly all the deceased was obtained.

Interpreting the present findings or using methods primarily oriented towards occupational health studies might hide the important public health findings here, i.e. women entering a pension fund for unskilled workers have increased risk for dying from external causes for up to 10 years after the first entrance. These findings have implications for occupational health services in particular and the health care systems in general. Both systems should follow both women and men closely in order to monitor and address mental and behavioural disturbances associated with behaviour liable to result in a violent death.

At this stage, the relatively high number of deaths by external causes in this group of women cannot be explained. In mortality studies of two other groups of working women in Iceland [9,10], there was a small indication of the same in some subgroups. On the other hand external causes were not in excess among American industrial women [1,2,26].

Unskilled workers in Iceland are more likely to receive psychotropic medication [13] compared to others in the workforce. An employee's use of psychotropic medications is a potential indicator of poorer mental health that could be a risk factor for violent death.

This study did not confirm the hypothesis that smoking-related causes of death were in excess, reflecting social disadvantage. However, lung cancer was proportionally elevated. As the follow-up time was relatively short, the long-term effects of smoking may become clearer at a later time. These effects could include ischemic heart disease, which presents itself later in life among women than among men [16]. The finding that the SMRs were highest in the group that

started contributing to the fund at 20–29 years of age is interesting since this age often marks the beginning of the career path in people's life. It suggests that these women represent a social group that is disadvantaged in terms of health. On the other hand, the group that contributes to a pension fund for unskilled workers before 20 years of age might include school-girls who work during their three months long summer vacation, as is the custom in Iceland, without belonging to the social group of unskilled workers later in life.

## 5. Conclusions

The notable excess of external causes of death in the group requires further research. In addition, the occupational health services system and the general health care system should address these findings. The study suggests that women's own occupation can be used to identify groups that need special public health measures.

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