Cancer incidence and mortality of isocyanate exposed workers from the Swedish polyurethane foam industry: updated findings 1959-98.

Mikoczy, Zoli; Welinder, Hans; Tinnerberg, Håkan; Hagmar, L

Published in:
Occupational and Environmental Medicine

2004

Link to publication

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Cancer incidence and mortality of isocyanate exposed workers from the Swedish polyurethane foam industry: updated findings 1959–98

Z Mikoczy, H Welinder, H Tinnerberg and L Hagmar

*Occ* Occup. Environ. Med. 2004;61;432-437
doi:10.1136/oem.2003.009712

Updated information and services can be found at:
http://oem.bmjournals.com/cgi/content/full/61/5/432

These include:

**References**
This article cites 8 articles, 2 of which can be accessed free at:
http://oem.bmjournals.com/cgi/content/full/61/5/432#BIBL

**Rapid responses**
You can respond to this article at:
http://oem.bmjournals.com/cgi/eletter-submit/61/5/432

**Email alerting service**
Receive free email alerts when new articles cite this article - sign up in the box at the top right corner of the article

**Topic collections**
Articles on similar topics can be found in the following collections

- Occupational Health (1027 articles)
- Cancer: lung (290 articles)

**Notes**

To order reprints of this article go to:
http://www.bmjournals.com/cgi/reprintform

To subscribe to *Occupational and Environmental Medicine* go to:
http://www.bmjournals.com/subscriptions/
Cancer incidence and mortality of isocyanate exposed workers from the Swedish polyurethane foam industry: updated findings 1959–98

Z Mikoczy, H Welinder, H Tinnerberg, L Hagmar

Aims: To assess whether cancer incidence and mortality in chronic obstructive lung diseases were increased in the Swedish polyurethane foam industry cohort, updated with 11 more years of follow up. Methods: The mortality and cancer incidence (1959–1998) experienced by a cohort of 4175 male and female employees employed for at least one year in the period 1959–87 at one of nine Swedish polyurethane foaming plants were investigated. Comparisons were based on calendar year, sex, and five-year age group specific mortality and incidence rates for Sweden. Workplaces and job tasks were categorically assessed for exposure to toluene diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI) by occupational hygienists. Results: Fewer cancer cases than expected were observed, but the lung cancer incidence was enhanced in women. Women with “apparent exposure” to TDI or MDI did not, however, have a higher lung cancer incidence than those with “no or low exposure”. Moreover, a nested case referent study did not find that polyurethane dust exposure had been more prevalent among the female lung cancer cases than among referents. No increased mortality in chronic obstructive lung diseases was observed in the cohort. Conclusions: Results support the findings from two other cohort studies of an increased lung cancer risk among female workers in the polyurethane foam manufacturing industry. Chance or confounding from smoking are not obvious explanations for the coherent findings. However, the study was not able to link isocyanate exposure employment with lung cancer risk.

Toluene diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI) are large volume industrial chemicals. The estimated yearly production in the early 1990s of TDI and MDI exceeded 2.5 million tonnes, and the production volumes have continued to grow since then. TDI is usually produced as a mixture of the 2,4- and 2,6-isomers. The main component of commercial MDI is 4,4’-MDI, but other isomers are also present in the product. The main use of these isocyanates is in the polyurethane foam manufacturing industry, but they are also used in the industrial production of coatings, adhesives, sealants, and various elastomers.

In a recent evaluation the International Agency for Research on Cancer considered that there is sufficient evidence that TDI is carcinogenic in experimental animals, and that there is limited evidence for a carcinogenic effect of MDI in animals. Inhalation of a mixture of monomeric and polymeric 4,4’-MDI increased the incidence of lung tumours in rats. Moreover, it has been reported that inhalation of freshly generated polyurethane dust generated lung tumours in rats.

Results from three cohort studies of isocyanate exposed workers in the polyurethane foam manufacturing industry have been published. In the first report from the Swedish cohort study no overall excess in cancer incidence was observed, but risk increases for rectal cancer and non Hodgkin’s lymphoma were found, when the first 10 years of follow up were ignored. A nested case-control study within the cohort did not support the tentative association between isocyanate exposure and these tumours. However, non-significant associations were shown for prostate cancer and colon cancer.

The main health concern with occupational exposure to TDI and MDI has been the risk for developing chronic airway disorders, especially bronchial asthma. It is not clearly established whether exposure to isocyanates in the polyurethane foam industry have affected the occurrence of chronic obstructive lung diseases to such an extent that it is reflected in increased mortality. In the recent update of the UK cohort there was in female, but not in male, workers a significant increasing trend of SMR for non-malignant diseases of the respiratory system with decade from hire. More detailed analyses gave, however, no support for the hypothesis that exposure to isocyanate was the causative factor. The results from the US cohort as well as the previous analysis of the Swedish cohort did not indicate any enhanced mortality in isocyanate exposed workers.

Abbreviations: DABCO, triethylenediamine; E, expected; MDI, methylene diphenyl diisocyanate; MOCA, methylenebis-o-chloroaniline; O, observed; SIR, standardised incidence ratio; SMR, standardised mortality ratio; TDI, toluene diisocyanate
Cancer incidence and mortality of workers from the Swedish polyurethane foam industry

The aim of the present study was to assess whether cancer incidence and mortality in chronic obstructive lung diseases were increased in the Swedish polyurethane foam industry cohort, updated with 11 more years of follow up.

METHODS

The plants and chemical exposure

Nine Swedish plants manufacturing polyurethane foam in which TDI or MDI had been used for producing flexible foam blocks or dead cast moulding materials were included in the study. The start of manufacture varied between 1958 and 1974. Table 1 gives the exposure periods for TDI and MDI for each plant.

The time weighted average concentrations of airborne TDI had normally been below 100 µg/m³ from 1965, when the first samples were taken, and below 20 µg/m³ at the end of the 1980s. The corresponding values for MDI were below 10 µg/m³. Much higher values (TDI up to 3 mg/m³; MDI up to 0.35 mg/m³) had, however, repeatedly been measured. Furthermore, there are reports of many accidental exposures to isocyanates due to spills and leakages. Thus, only five of the plants operated up to 1998. After 1990 TDI was used in only three of the plants. Due to its much lower vapour pressure, the use of MDI instead of TDI has led to lower emissions of isocyanates. The exposure levels have continuously reduced over the years. In a large investigation performed by our department during the years 2000–01 of the 113 monitored workers had experienced no, low, or intermittent exposure to TDI or MDI, and the classification “apparent exposure” denotes direct exposure at the foaming or moulding processes or work in the same premises. The classification “low or intermittent exposure” denotes handling of cured materials in premises situated close by those used for foaming or moulding, or only intermittent exposures. Potential exposures after 1987 had to be disregarded because several of the plants had closed down since the previous analysis of the present cohort, which did not allow a valid retrospective exposure classification for the period after 1987.

All work periods could be classified with respect to exposure to TDI or MDI for 3988 of the 4175 cohort members. Of the exposure classified workers, 1394 had constantly exposed occupations for at least one year (table 1). Information on workplace or job task was available for all but 139 of these subjects.

The start of the observation period was defined as the first calendar year when both the foaming had started and the company records were considered to be complete and valid. This varied from 1958 to 1975 for the nine plants. The median calendar year of birth for the cohort members was 1951 (range 1896–1972), the median first year of exposure was 1978 (range 1958–86), and the median follow up period was 19.2 years (range 0.3–40). The Ethics Committee of Lund University approved the study.

Exposure estimates and work tasks

Each workplace and work task in the nine plants was categorically assessed for each calendar year up to 1987 by an experienced occupational hygienist for “no exposure”, “low or intermittent exposure”, or “apparent exposure” to TDI or MDI. The classification “apparent exposure” denotes direct exposure at the foaming or moulding processes or work in the same premises. The classification “low or intermittent exposure” denotes handling of cured materials in premises situated close by those used for foaming or moulding, or only intermittent exposures. Potential exposures after 1987 had to be disregarded because several of the plants had closed down since the previous analysis of the present cohort, which did not allow a valid retrospective exposure classification for the period after 1987.

All work periods could be classified with respect to exposure to TDI or MDI for 3988 of the 4175 cohort members. Of the exposure classified workers, 1394 had constantly experienced no, low, or intermittent exposure to TDI or MDI, while 1679 had constantly experienced apparent exposure. The remaining 915 subjects had varying exposure situations during their employment periods. The exposure-response

had to be excluded. The remaining 6426 workers had been employed for at least one day from 1958 to 1987. The final cohort was restricted to those 4175 workers that had been employed for at least one year (table 1). Information on workplace or job task was available for all but 139 of these subjects.

The consistent, and up to now, unexplained risk increase for female lung cancer calls for future follow ups of employees from the polyurethane foam industry.

Table 1. TDI and MDI exposure periods for the nine polyurethane foam manufacturing plants and cohort sizes and person-years under observation for workers employed for at least one year.

<table>
<thead>
<tr>
<th>Plant</th>
<th>TDI exposure period</th>
<th>MDI exposure period</th>
<th>Cohort size</th>
<th>Person-years under observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1959–73</td>
<td>1968–98</td>
<td>262</td>
<td>6560</td>
</tr>
<tr>
<td>B</td>
<td>1969–95</td>
<td>1969–95</td>
<td>71</td>
<td>1681</td>
</tr>
<tr>
<td>C</td>
<td>1973–90</td>
<td>1982–90</td>
<td>146</td>
<td>2712</td>
</tr>
<tr>
<td>D</td>
<td>1958–98</td>
<td>Not known</td>
<td>398</td>
<td>7872</td>
</tr>
<tr>
<td>F</td>
<td>1972–92</td>
<td>1972–92</td>
<td>379</td>
<td>6632</td>
</tr>
<tr>
<td>H</td>
<td>1958–74</td>
<td>1964–98</td>
<td>1038</td>
<td>20482</td>
</tr>
<tr>
<td>I</td>
<td>1977–87</td>
<td>1966–98</td>
<td>522</td>
<td>10650</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>4175</td>
<td>83023</td>
</tr>
</tbody>
</table>

www.occenvmed.com
Table 2  Mortality 1958–99 in subjects employed for at least one year by gender

<table>
<thead>
<tr>
<th>Causes of death</th>
<th>ICD-8</th>
<th>All (n = 4175)</th>
<th>Men (n = 2639)</th>
<th>Women (n = 1536)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>E</td>
<td>SMR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Malignant tumours</td>
<td>140–209</td>
<td>100</td>
<td>106</td>
<td>0.94</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>1620–1621</td>
<td>17</td>
<td>17.1</td>
<td>0.99</td>
</tr>
<tr>
<td>Cardiovascular diseases</td>
<td>390–458</td>
<td>145</td>
<td>176</td>
<td>0.82</td>
</tr>
<tr>
<td>Respiratory diseases</td>
<td>460–519</td>
<td>14</td>
<td>20.6</td>
<td>0.68</td>
</tr>
<tr>
<td>Asthma, bronchitis, emphysema</td>
<td>490–493</td>
<td>5</td>
<td>8.13</td>
<td>0.62</td>
</tr>
<tr>
<td>Accidents, poisonings, and violence</td>
<td>800–999</td>
<td>46</td>
<td>53.4</td>
<td>0.86</td>
</tr>
<tr>
<td>All causes</td>
<td>000–999</td>
<td>337</td>
<td>403</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Table 3  Cancer incidence 1959–98 in subjects employed for at least one year by gender

<table>
<thead>
<tr>
<th>Tumour site</th>
<th>ICD-7</th>
<th>All (n = 4175)</th>
<th>Men (n = 2639)</th>
<th>Women (n = 1536)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>E</td>
<td>SIR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Colon</td>
<td>153</td>
<td>8</td>
<td>15.1</td>
<td>0.53</td>
</tr>
<tr>
<td>Rectum</td>
<td>154</td>
<td>11</td>
<td>17.7</td>
<td>0.62</td>
</tr>
<tr>
<td>Pancreas</td>
<td>157</td>
<td>3</td>
<td>6.09</td>
<td>0.48</td>
</tr>
<tr>
<td>Lung</td>
<td>1620–1621</td>
<td>18</td>
<td>19.0</td>
<td>0.95</td>
</tr>
<tr>
<td>Breast</td>
<td>170</td>
<td>23</td>
<td>30.0</td>
<td>0.77</td>
</tr>
<tr>
<td>Prostate</td>
<td>177</td>
<td>23</td>
<td>26.7</td>
<td>0.86</td>
</tr>
<tr>
<td>Urinary bladder, ureter</td>
<td>181</td>
<td>11</td>
<td>11.9</td>
<td>0.92</td>
</tr>
<tr>
<td>Melanoma</td>
<td>190</td>
<td>9</td>
<td>11.3</td>
<td>0.80</td>
</tr>
<tr>
<td>Brain and nervous system</td>
<td>193</td>
<td>15</td>
<td>10.1</td>
<td>1.49</td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>200, 202</td>
<td>6</td>
<td>8.31</td>
<td>0.72</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>204–207</td>
<td>7</td>
<td>5.61</td>
<td>1.25</td>
</tr>
<tr>
<td>All</td>
<td>140–209</td>
<td>209</td>
<td>241</td>
<td>0.87</td>
</tr>
</tbody>
</table>
Cancer incidence and mortality of workers from the Swedish polyurethane foam industry

435

As a Poisson variable, or as a normal variable if the observed

and SIRs) were calculated by treating the observed number

specific standardised mortality and incidence ratios (SMRs

the cohort contributed 83,023 person-years under risk

individual endpoints, whichever occurred first. Altogether

emigration, or a person’s 80th birthday were used as

Sweden and the Swedish Cancer Registry. Date of death,

tumours and population counts, obtained from Statistics

incidence rates for specific causes of death and malignant

group specific rates. These rates were calculated from

program using cause, calendar year, sex, and five-year age

period was calculated by means of the SYDCAP cohort

Sweden. None was lost to follow up.

Unfortunately, no dust measurements had been performed in

the plants.

There was a gender difference with respect to work tasks in

the plants. Twenty-six per cent of the female workers had

been involved in the finishing treatment of the foamed

products compared with 12% of the male workers. These

work tasks, comprising grinding, punching, sawing, and

cutting, may have resulted in polyurethane dust exposure.

Unfortunately, no dust measurements had been performed in

the plants.

Information on causes of death and tumours and risk

estimates

Information on cause of death for the period 1959–98, coded

according to the International Classification of Diseases

(ICD), 8th revision, was obtained from Statistics Sweden.

Information on malignant tumours for the period 1959–98

coded according to the ICD, 7th revision, was obtained from

the Swedish Cancer Registry. Information on vital status and
date of emigration was obtained from the Swedish population
registry. Three hundred and thirty-seven of the 4175

workers were deceased at 31 December 1998, 123 had

died of intercurrent diseases and three were still alive.

Each of the 12 female lung cancer cases, three referent

women from the cohort without cancer were randomly

selected but matched for calendar year of birth. Two

occupational hygienist (HT, HW) used available information

for each subject about plant and workplace or job task, to

crudely classify the likelihood that the subjects had been

substantially exposed to polyurethane dust. Due to lack of

exposure data, no classification could be performed for one of

the cases. Odds ratios and 95% CIs were calculated using

conditional logistic regression.

RESULTS

A total of 337 workers had died during the observation

period, which was significantly fewer than expected (SMR

0.84, 95% CI 0.75 to 0.93, table 2). No increased mortality was

observed for either malignant tumours or for chronic

obstructive lung diseases. An increased mortality in lung

cancer was observed, however, only in women (SMR 3.52,

95% CI 1.69 to 6.48).

Two hundred and nine incident cancer cases were

observed, which was fewer than expected (SIR 0.87, 95% CI

0.75 to 0.99, table 3). The lung cancer incidence was

enhanced in women (SIR 3.00, 95% CI 1.55 to 5.24), but

not in men. Seven of the 12 women with incident lung cancer

had also been registered as deceased from this disease, while

two had died of intercurrent diseases and three were still

alive.

A numerical increase in malignant neoplasms in the brain

and nervous system was observed (SIR 1.49, 95% CI 0.83 to

2.46), which did not seem to differ between men and women.

The incidences of rectal cancer, non-Hodgkin’s lymphoma, and

pancreatic cancer were not increased.

The overall cancer incidence was not increased, even when

lagging the first 20 years since start of exposure, but the SIR

was greater than 15. The term significant indicates that

the 95% CI does not include 1.00.

Nested case-referent study

For each of the 12 female lung cancer cases, three referent

women from the cohort without cancer were randomly

selected but matched for calendar year of birth. Two

occupational hygienist (HT, HW) used available information

for each subject about plant and workplace or job task, to

crudely classify the likelihood that the subjects had been

substantially exposed to polyurethane dust. Due to lack of

exposure data, no classification could be performed for one of

the cases. Odds ratios and 95% CIs were calculated using

conditional logistic regression.

Table 4 Cancer incidence 1959–98 in 4175 subjects employed for at least one year and after at least 20 years since first exposure

<table>
<thead>
<tr>
<th>Tumour site</th>
<th>ICD-7</th>
<th>O</th>
<th>E</th>
<th>SIR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colon</td>
<td>153</td>
<td>4</td>
<td>5.58</td>
<td>0.72</td>
<td>0.19 to 1.84</td>
</tr>
<tr>
<td>Rectum</td>
<td>154</td>
<td>1</td>
<td>3.48</td>
<td>0.29</td>
<td>0.01 to 1.60</td>
</tr>
<tr>
<td>Lung</td>
<td>1620–1621</td>
<td>8</td>
<td>6.74</td>
<td>1.19</td>
<td>0.51 to 2.34</td>
</tr>
<tr>
<td>Breast</td>
<td>170</td>
<td>9</td>
<td>9.69</td>
<td>0.93</td>
<td>0.42 to 1.76</td>
</tr>
<tr>
<td>Prostate</td>
<td>177</td>
<td>12</td>
<td>11.4</td>
<td>1.05</td>
<td>0.54 to 1.84</td>
</tr>
<tr>
<td>Urinary bladder, ureter</td>
<td>181</td>
<td>4</td>
<td>4.39</td>
<td>0.91</td>
<td>0.25 to 2.33</td>
</tr>
<tr>
<td>Melanoma</td>
<td>190</td>
<td>1</td>
<td>3.04</td>
<td>0.33</td>
<td>0.01 to 1.83</td>
</tr>
<tr>
<td>Brain and nervous system</td>
<td>193</td>
<td>6</td>
<td>2.45</td>
<td>2.45</td>
<td>0.90 to 5.33</td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>200, 202</td>
<td>1</td>
<td>2.89</td>
<td>0.35</td>
<td>0.01 to 1.93</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>204–207</td>
<td>2</td>
<td>1.66</td>
<td>1.20</td>
<td>0.15 to 4.35</td>
</tr>
<tr>
<td>All</td>
<td>140–209</td>
<td>80</td>
<td>80.5</td>
<td>0.99</td>
<td>0.78 to 1.23</td>
</tr>
</tbody>
</table>

Table 5 Exposure to TDI or MDI and cancer incidence in polyurethane foam industry workers with stable exposure classification over their employment period

<table>
<thead>
<tr>
<th>Tumour</th>
<th>None or constantly low exposure</th>
<th>Constantly apparent exposure [n = 1679]†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[n = 1394]*</td>
<td>[n = 1679]†</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>E</td>
</tr>
<tr>
<td>Lung cancer (women)</td>
<td>6</td>
<td>1.50</td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>6</td>
<td>1.38</td>
</tr>
<tr>
<td>All (men and women)</td>
<td>80</td>
<td>92.2</td>
</tr>
</tbody>
</table>

*582 women.
†566 women.

www.occenvmed.com
for malignant neoplasms in the brain and nervous system became somewhat higher (2.45, 95% CI 0.90 to 5.33, table 4).

There were no indications of any exposure-response associations between level or length of TDI or MDI exposure and total cancer incidence, or brain cancer or female lung cancer (table 5).

The results from the nested case referent study did not indicate that polyurethane dust exposure had been more prevalent among the female lung cancer cases than among the referents (table 6).

**DISCUSSION**

The main result of the present study was the increased lung cancer incidence in female workers in the polyurethane foam manufacturing industry, which is noteworthy because this has also been observed in the UK and the US cohorts. A significant lung cancer mortality excess (SMR 1.81, 95% CI 1.26 to 2.51) was seen in female workers in the UK cohort, and in the US cohort there was non-significantly increased lung cancer mortality among the female workers (SMR 1.73, 95% CI 0.75 to 3.41).

The reason for this consistent pattern of increased female lung cancer risk is not obvious. In both the UK study and the present study there were attempts to assess exposure-response associations with respect to estimated exposure to TDI or MDI, but no such patterns were found. In the US study there were no attempts to perform dose-response analyses. The lack of dose-response associations in the UK study and the present study might speak against a causal role for isocyanate exposure. On the other hand, the exposure levels for TDI and MDI have varied considerably both between different workplaces in the plants and within them. The information derived from the company records on the workplace and job tasks for the subject in the cohort has not always been specific, at least not in the Swedish cohort. Taken together, this has probably caused a non-differential misclassification of exposure, which will decrease the possibility to associate a risk excess with specific exposures.

Moreover, the present exposure-response analysis, based on only 11 lung cancer cases, has a low statistical power to detect more than very high risk increases associated with high exposure levels.

The manufacture of polyurethane foam involves exposure not only to isocyanates but also to a number of other chemicals, which unfortunately rarely have been monitored, such as expanding agents, lubricants, accelerators, and organic solvents. The use of these compounds has varied between the plants involved in the present study, and the exposure to isocyanates has thus been the only common chemical characteristic of the plants. In the first report of the UK study an attempt was made to assess the risk for female lung cancer associated with other types of chemicals by a nested case referent analysis. No obvious pattern was seen, but the statistical power was low due to the few cases and referents.

A larger fraction of female workers than of male workers had had work tasks that potentially could have lead to airborne exposure to polyurethane dust. The nested case-referent analysis in the present study did, however, not support exposure to polyurethane dust as a risk factor for female lung cancer. It should, however, be emphasised that very few dust measurements had been performed at the plants and the exposure could therefore be only crudely assessed. This, together with the small size of the study limited the possibility to evaluate more than very strong associations between polyurethane dust and lung cancer.

Unfortunately no information on smoking habits was available for the UK, the USA, or the present cohort. There is, however, circumstantial evidences that makes smoking a less likely explanation for the excess risk for female lung cancer. First, no increase in male lung cancer was observed in any of the three cohorts (UK cohort: SMR 1.07; US cohort: SMR 0.79; present study: 0.40). Thus, if smoking has caused the increased risk for lung cancer among the female workers, we have to assume very different smoking habits between male and female workers. Second, smoking is a risk factor for cardiovascular mortality, but the corresponding SMRs for females were not increased in any of the three studies (UK cohort: 1.09; US cohort: 0.73; present study: 0.52). The age related increase in cardiovascular mortality occurs later in women than in men due to the protective effect of endogenous oestrogens. The low SMR for cardiovascular diseases for women in the present cohort was not the result of a still too young cohort as the SMR for the age category 70 years and above was 0.55.

No increased mortality in respiratory diseases, or more specifically in chronic obstructive lung diseases, was observed in the present study or in the US study. In the UK study female workers had a significant trend of SMRs for non-malignant respiratory diseases increasing with decade from hire. However, no association with isocyanates exposed employment was observed. Thus, there is no convincing evidence that exposure to isocyanates in the polyurethane foam manufacturing industry has resulted in increased mortality in obstructive lung diseases.

To conclude, the results from the present study support the findings from two other cohort studies of an increased lung cancer risk among female workers in the polyurethane foam manufacturing industry. However, no dose-response associations with occupational exposure to TDI or MDI have been observed. A caveat is, however, the inherent limitations of retrospective exposure assessments. A chance finding or confounding from smoking are not obvious explanations for the risk excesses. An occupational risk factor cannot yet be excluded and a prolonged follow up of all three cohorts with more in depth exposure analyses could contribute to a better understanding of the observations.

**ACKNOWLEDGEMENTS**

The work was financially supported by grants from AFA-insurances, the Medical Faculty, Lund University, Region Skåne, and Lund University Hospital.

**Authors’ affiliations**

Z Mikoczy, H Welinder, H Tinnerberg, L Hagmar, Department of Occupational and Environmental Medicine, Lund University Hospital, Lund, Sweden

**REFERENCES**

Asthma in domestic cleaners

 Recent studies have suggested that cleaners, especially domestic cleaners, may have an increased risk of asthma. A study in Barcelona, Spain has confirmed this increase in risk.

In a population thought to have a high number of domestic cleaners a previously validated questionnaire was sent to 5120 women aged 30–65 and with less than eight years’ education. Telephone follow up was employed as necessary. Satisfactory replies were received from 4521 women of whom half (2259) had worked as cleaners at some time and 593 (13%) were currently working as domestic cleaners. Most of the women (74%) had never smoked. Relative to women who had never worked in cleaning, women who had ever worked in cleaning had significant increases in wheezing with breathlessness (odds ratio (OR) 1.53), ever asthma (1.44), current asthma (1.73), chronic bronchitis (1.52), and ever rhinitis (1.2). The risks were increased for current cleaners but the increases were significant only for wheezing with breathlessness, current asthma, and chronic bronchitis in domestic, but not non-domestic, cleaners. The highest risks were in former domestic cleaners (OR for current asthma 2.09) but few former cleaners (1.3%) claimed to have quit the job because of respiratory symptoms. In general neither current nor previous non-domestic cleaning was significantly associated with asthma. Women who worked simultaneously as domestic and non-domestic cleaners had a higher risk of asthma (OR 1.79) than women who did only domestic cleaning. Among current non-domestic cleaners the asthma risk was increased for hospital or health centre cleaners but not for office, hotel, residence, laboratory, or kitchen cleaners. About a quarter of the asthma cases in this study population could be attributed to domestic cleaning work.

Domestic cleaning could have an important effect on public health, especially if the increased risks were found to apply to household members doing cleaning as well as paid cleaners. The precise causes of the increased asthma risk in domestic cleaners are unknown.