Work Environment and Prostate Cancer Risk

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ABSTRACT: A case-referent study of 345 prostate cancer cases and 1,346 referents was carried out in the Netherlands to investigate the relationship between work environment and prostate cancer risk. Cases were selected from the Cancer Registry of the Comprehensive Cancer Centre IKO. Referents (men diagnosed with benign prostate hyperplasia) were recruited with assistance of the pathology laboratories in the IKO region. Questionnaires were mailed to all subjects to obtain information on their work history and occupational exposure. Moreover, workers in farming (n = 323), and in metal work and maintenance (n = 340), were requested to complete short supplements to the questionnaire inquiring in more detail into specific types of exposure. Significantly elevated risks were found for work in food manufacturing and for bookkeepers. Significantly elevated odds ratios (OR) were also observed for jobs held between 1960 and 1970 in administration, in storage, or as farm laborer. In addition, a statistically significant excess risk was found for subjects who reported frequent occupational exposure to cadmium. Cases who worked in farming applied pesticides during significantly more days per year than the referents did. A nonsignificantly elevated OR was found for maintenance of tractors and agricultural machinery. Among metal workers, mechanics, and repairmen, nonsignificantly increased ORs were observed with regard to the use of acids, solvents, iron, and steel, and for welding and maintenance of machinery. © 1995 Wiley-Liss, Inc.

KEY WORDS: prostate cancer, occupation, farming, metal work, maintenance

Introduction

Prostate cancer is a very common malignancy in most Western countries. In the Netherlands, the incidence and mortality rates from this tumor are only exceeded by those of lung cancer: 3% of total mortality among men and 10% of male mortality from cancer was caused by this type of cancer [1]. Since 1950 the crude mortality figure for prostate cancer among Dutch men increased 3.4-fold, while the age-adjusted mortality rate rose 1.5-fold [1].

Current knowledge of the etiology of prostate cancer is still limited. This applies especially to risks associated with occupational exposures. A pilot study conducted in 1989 and a review of literature led us to the conclusion that farmers, metal workers, repairmen, and mechanics may have a slightly higher risk for prostate cancer [2]. It is unclear, however, what the actual risk factors for these occupations are. Therefore, a larger case-referent study was started on the relation between prostate cancer, on the one hand, and occupation (job title and industrial branch) and particular occupational exposures, on the other. In total 345 cases and 1,346 referents (patients with benign prostate hyperplasia) returned a self-administered questionnaire on work history. To obtain more insight into the actual risk factors in farming, metal work, and maintenance, workers in these branches were also requested to complete short, specific supplements to the questionnaire inquiring in more detail into particular types of exposure. The main results of this study are summarized and discussed in this paper.

Received for publication May 19, 1994; accepted November 18, 1994.

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Methods and Populations

In our study, cases are defined as men in whom histologically confirmed prostate cancer was diagnosed between January 1, 1988 and April 1, 1990. For this study 469 cases who met the criteria were selected from the Cancer Registry of the regional Comprehensive Cancer Centre IKO. IKO covers a region in which 1.25 million people live in 64 mainly small municipalities in the mid-eastern part of the Netherlands. The referents are patients who were treated in the same period for prostate hyperplasia in one of the 17 hospitals in the IKO region, and who exhibited no signs of malignancy upon histological examination. These referents (1,872 in all) were selected from the National Computerized Archive of Pathology Reports (PALGA) with assistance from the six pathology laboratories in the IKO region.

Questionnaires were mailed to both cases and referents to collect information on work history and occupational exposures and on potential confounding factors such as age, smoking, and drinking habits and socioeconomic status (SES). The questionnaire used was a slightly modified version of a validated questionnaire on occupational history, developed recently by an EC study group [3,4]. For farmers, metal workers, repairmen, and mechanics, several specific questions were added, inquiring in more detail into particular types of exposure. All data were coded without knowledge of the subjects’ case-referent status. Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated by means of cross tabulation and logistic regression modelling. Bearing in mind a latency period of 20–30 years [5], we calculated ORs for the branches of industry in which the respondents were employed between 1960 and 1970. ORs were also estimated for the occupations and the branches of industry in which the respondents had spent the major part of their working lives.

Results

General Aspects

Although all subjects had been affirmed by their attendant urologists to be alive and eligible to participate in the study, 45 cases and 103 referents died before the study began. Twelve cases and 39 referents could not be traced owing to change of address. Of the remaining 2,142 subjects, a total of 1,691 (79%) returned a completed questionnaire; of the originally eligible subjects, 72% participated. The response rate was roughly the same among cases and referents, and it was high in all age groups, even in the group over age 80. The mean age of the cases was 72 years (SD 7.0), and of the referents, 69 (SD 8.1). Ages ranged between 45 and 91 years. Almost all cases (95%) and referents (90%) were current or ex-smokers, and most of them were in the habit of consuming alcoholic drinks (94% and 92%, respectively) [6]. No clear relationship was found between socioeconomic status and prostate cancer risk, nor between urbanization grade (based on current addresses of the subjects) and the occurrence of prostate cancer [7].

Occupational History

Both groups started working when they were 16 years of age on average (SD 4.0). The cases stopped at the mean age of 62 years (SD 5.7), while the referents stopped at 60 years of age on average (SD 6.3). At the time of the study only 9% of the cases and 14% of the referents were still active at work. The mean number of jobs held by cases and referents was three (SD 1.4).

In Table I the age-adjusted ORs are summarized for prostate cancer according to the branch of industry in which the subjects had worked in their longest held job and the job held during 1960–1970. In both analyses significantly elevated ORs were found for workers in food manufacturing. For jobs in storage during 1960–1970, an OR of 2.35 was found (95% CI 1.02–5.46). However, the OR for those who did storage work during their longest held job is only 1.23 (95% CI 0.37–3.46). Relatively high (although nonsignificant) ORs were found for policemen. The ORs computed for other branches are all smaller than 1.5.

A borderline significant OR was found for administrative work during 1960–1970 (OR = 1.43; 95% CI 0.98–2.09), with an almost comparable OR computed for longest held jobs in administration.

Table II summarizes the ORs for prostate cancer according to occupation during the job held longest and the job between 1960 and 1970. Significantly elevated ORs were observed for workers in insurance and financing (e.g., cashiers, bookkeepers). A significant elevated OR was also found for subjects who worked as farm laborers during 1960–1970. With the exception of the ORs calculated for butchers and welders, the risks estimated for other occupations are all smaller than 1.5.

Farming

The supplement to the questionnaire containing detailed questions for subjects who had worked in
TABLE I. Age-Adjusted Odds Ratios and 95% Confidence Intervals for Prostate Cancer According to Branch of Industry

<table>
<thead>
<tr>
<th>Branch of industry</th>
<th>Job held longest</th>
<th></th>
<th></th>
<th>Job between 1960 and 1970</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases</td>
<td>Referents</td>
<td>OR(^a)</td>
<td>95% CI</td>
<td>Cases</td>
<td>Referents</td>
</tr>
<tr>
<td>Agriculture</td>
<td>37</td>
<td>147</td>
<td>0.85</td>
<td>0.57–1.25</td>
<td>34</td>
<td>130</td>
</tr>
<tr>
<td>Horticulture</td>
<td>6</td>
<td>21</td>
<td>1.00</td>
<td>0.39–2.53</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Food manufacturing</td>
<td>21</td>
<td>35</td>
<td>2.37</td>
<td>1.35–4.17</td>
<td>18</td>
<td>32</td>
</tr>
<tr>
<td>Wood industry</td>
<td>18</td>
<td>56</td>
<td>1.17</td>
<td>0.67–2.03</td>
<td>16</td>
<td>54</td>
</tr>
<tr>
<td>Footwear manufacturing</td>
<td>4</td>
<td>13</td>
<td>1.20</td>
<td>0.38–3.80</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Paper and printing industry</td>
<td>5</td>
<td>17</td>
<td>1.26</td>
<td>0.45–3.52</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Chemical industry</td>
<td>8</td>
<td>51</td>
<td>0.66</td>
<td>0.31–1.41</td>
<td>7</td>
<td>49</td>
</tr>
<tr>
<td>Electrical industry</td>
<td>8</td>
<td>33</td>
<td>0.98</td>
<td>0.44–2.17</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>Metal industry</td>
<td>43</td>
<td>151</td>
<td>1.22</td>
<td>0.84–1.76</td>
<td>41</td>
<td>152</td>
</tr>
<tr>
<td>Construction industry</td>
<td>29</td>
<td>139</td>
<td>0.77</td>
<td>0.51–1.18</td>
<td>27</td>
<td>143</td>
</tr>
<tr>
<td>Transport</td>
<td>10</td>
<td>52</td>
<td>0.76</td>
<td>0.38–1.51</td>
<td>9</td>
<td>57</td>
</tr>
<tr>
<td>Storage</td>
<td>4</td>
<td>16</td>
<td>1.13</td>
<td>0.37–3.46</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>Retail trade</td>
<td>19</td>
<td>81</td>
<td>0.90</td>
<td>0.54–1.52</td>
<td>19</td>
<td>81</td>
</tr>
<tr>
<td>Hotel and catering</td>
<td>6</td>
<td>24</td>
<td>0.86</td>
<td>0.34–2.14</td>
<td>7</td>
<td>73</td>
</tr>
<tr>
<td>Management</td>
<td>24</td>
<td>115</td>
<td>0.87</td>
<td>0.55–1.38</td>
<td>28</td>
<td>121</td>
</tr>
<tr>
<td>Administration</td>
<td>40</td>
<td>119</td>
<td>1.39</td>
<td>0.94–2.04</td>
<td>42</td>
<td>122</td>
</tr>
<tr>
<td>Social services</td>
<td>7</td>
<td>20</td>
<td>1.26</td>
<td>0.52–3.03</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Educational services</td>
<td>14</td>
<td>72</td>
<td>0.79</td>
<td>0.43–1.43</td>
<td>14</td>
<td>70</td>
</tr>
<tr>
<td>Police</td>
<td>7</td>
<td>20</td>
<td>1.48</td>
<td>0.61–3.59</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Army</td>
<td>9</td>
<td>18</td>
<td>1.34</td>
<td>0.62–2.91</td>
<td>8</td>
<td>26</td>
</tr>
</tbody>
</table>

\(^a\)Odds ratio relative to all other industrial branches.

farming was completed by 64 cases and 259 referents. The mean age of the farmers in the case group was 73 years (SD 8.2) and in the reference group 71 years (SD 8.2). The smoking and drinking habits of these subjects were almost the same as those in the entire study group. The majority of the farmers (44 cases and 191 referents) worked in mixed farming including cattle. The data about specific exposures were analyzed for those who worked in farming during 1960–1970. The results are summarized in Tables IV and V.

Small differences were found in the average sizes of fields and pastures farmed by either cases or referents; the mean numbers of cows, pigs, or chickens held; and the mean numbers of days per year on which cases and referents used fertilizers. Cases had a smaller stock of cattle and a larger area of fields, but the differences were statistically nonsignificant. Cases applied pesticides during significantly more days per year on average than the referents (Table IV). No statistically significant association was found between the occurrence of prostate cancer and several potentially risky activities in farming inquired about (Table V). An elevated (but statistically nonsignificant) OR was found for maintenance of tractors and other machinery. The results of analyses for the subjects who worked in farming during their longest held job (data not shown) did not differ much from the results presented in Tables IV and V.

Metal, Mechanical, and Repair Work

In a second specific supplement, several questions were put to men who had been employed as metal workers, or as mechanics or repairmen. This supplement was completed by 67 cases and 263 referents. The mean age for the cases was 70 years (SD 6.3) and for the referents 67 years (SD 8.0). The smoking and drinking habits of the cases and referents in this subgroup were comparable with those found for the study group as a whole. Again, further analyses were conducted for those employed in the occupations involved during 1960–1970. The results are noted in Table VI. Elevated, but statistically nonsignificant, ORs were found for use of acids, solvents, iron, and steel; for welding; and for maintenance of machinery. The ORs calculated for the exposures experienced by subjects who did metal or maintenance work during their longest held job (data not shown) were almost the same as those presented in Table VI.

Discussion

Some potential limitations of this study should be realized before interpreting the study results. The
### TABLE II. Age-Adjusted Odds Ratios and 95% Confidence Intervals for Prostate Cancer According to Occupation

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Cases</th>
<th>Referents</th>
<th>ORa</th>
<th>95% Cl</th>
<th>Cases</th>
<th>Referents</th>
<th>ORa</th>
<th>95% Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer/owner</td>
<td>30</td>
<td>129</td>
<td>0.78</td>
<td>0.51–1.18</td>
<td>27</td>
<td>113</td>
<td>0.76</td>
<td>0.49–1.19</td>
</tr>
<tr>
<td>Farm worker</td>
<td>6</td>
<td>9</td>
<td>2.74</td>
<td>0.94–7.98</td>
<td>6</td>
<td>4</td>
<td>7.82</td>
<td>2.09–29.29</td>
</tr>
<tr>
<td>Baker</td>
<td>6</td>
<td>18</td>
<td>1.21</td>
<td>0.47–3.12</td>
<td>6</td>
<td>13</td>
<td>1.68</td>
<td>0.62–4.57</td>
</tr>
<tr>
<td>Butcher</td>
<td>6</td>
<td>14</td>
<td>1.78</td>
<td>0.67–4.72</td>
<td>7</td>
<td>15</td>
<td>2.16</td>
<td>0.86–5.43</td>
</tr>
<tr>
<td>Carpenter</td>
<td>15</td>
<td>39</td>
<td>1.40</td>
<td>0.75–2.60</td>
<td>12</td>
<td>37</td>
<td>1.21</td>
<td>0.62–2.38</td>
</tr>
<tr>
<td>Wood worker</td>
<td>6</td>
<td>21</td>
<td>1.07</td>
<td>0.42–2.72</td>
<td>6</td>
<td>22</td>
<td>1.02</td>
<td>0.40–2.56</td>
</tr>
<tr>
<td>Printer</td>
<td>4</td>
<td>14</td>
<td>1.10</td>
<td>0.35–3.42</td>
<td>4</td>
<td>13</td>
<td>1.16</td>
<td>0.37–3.63</td>
</tr>
<tr>
<td>Painter</td>
<td>4</td>
<td>28</td>
<td>0.52</td>
<td>0.18–1.50</td>
<td>3</td>
<td>30</td>
<td>0.37</td>
<td>0.11–1.22</td>
</tr>
<tr>
<td>Electrician</td>
<td>7</td>
<td>26</td>
<td>1.01</td>
<td>0.43–2.39</td>
<td>6</td>
<td>27</td>
<td>0.84</td>
<td>0.34–2.07</td>
</tr>
<tr>
<td>Metal worker</td>
<td>22</td>
<td>69</td>
<td>1.33</td>
<td>0.80–2.20</td>
<td>22</td>
<td>75</td>
<td>1.22</td>
<td>0.74–2.00</td>
</tr>
<tr>
<td>Mechanic</td>
<td>11</td>
<td>40</td>
<td>1.20</td>
<td>0.60–2.39</td>
<td>11</td>
<td>42</td>
<td>1.15</td>
<td>0.58–2.29</td>
</tr>
<tr>
<td>Welder</td>
<td>4</td>
<td>12</td>
<td>1.51</td>
<td>0.48–4.78</td>
<td>4</td>
<td>11</td>
<td>1.66</td>
<td>0.52–5.31</td>
</tr>
<tr>
<td>Construction worker</td>
<td>11</td>
<td>52</td>
<td>0.83</td>
<td>0.43–1.63</td>
<td>12</td>
<td>54</td>
<td>0.87</td>
<td>0.46–1.66</td>
</tr>
<tr>
<td>Production worker</td>
<td>16</td>
<td>51</td>
<td>1.27</td>
<td>0.71–2.28</td>
<td>14</td>
<td>50</td>
<td>1.12</td>
<td>0.61–2.07</td>
</tr>
<tr>
<td>Driver</td>
<td>5</td>
<td>37</td>
<td>0.53</td>
<td>0.20–1.37</td>
<td>5</td>
<td>40</td>
<td>0.49</td>
<td>0.19–1.26</td>
</tr>
<tr>
<td>Trader</td>
<td>13</td>
<td>71</td>
<td>0.74</td>
<td>0.40–1.37</td>
<td>15</td>
<td>70</td>
<td>0.86</td>
<td>0.49–1.54</td>
</tr>
<tr>
<td>Hotel/catering worker</td>
<td>5</td>
<td>15</td>
<td>1.18</td>
<td>0.42–3.34</td>
<td>5</td>
<td>17</td>
<td>1.05</td>
<td>0.37–2.92</td>
</tr>
<tr>
<td>Manager</td>
<td>39</td>
<td>160</td>
<td>1.00</td>
<td>0.68–1.45</td>
<td>39</td>
<td>162</td>
<td>0.97</td>
<td>0.67–1.42</td>
</tr>
<tr>
<td>Clerical worker</td>
<td>10</td>
<td>55</td>
<td>0.68</td>
<td>0.34–1.36</td>
<td>14</td>
<td>54</td>
<td>0.99</td>
<td>0.54–1.83</td>
</tr>
<tr>
<td>Insurance/financing worker</td>
<td>16</td>
<td>33</td>
<td>2.26</td>
<td>1.22–4.20</td>
<td>16</td>
<td>32</td>
<td>2.32</td>
<td>1.24–4.32</td>
</tr>
<tr>
<td>Civil servant</td>
<td>14</td>
<td>40</td>
<td>1.42</td>
<td>0.76–2.66</td>
<td>14</td>
<td>41</td>
<td>1.37</td>
<td>0.73–2.57</td>
</tr>
<tr>
<td>Teacher</td>
<td>16</td>
<td>74</td>
<td>0.88</td>
<td>0.50–1.56</td>
<td>15</td>
<td>74</td>
<td>0.91</td>
<td>0.51–1.63</td>
</tr>
<tr>
<td>Priest/clergyman</td>
<td>7</td>
<td>20</td>
<td>1.23</td>
<td>0.51–2.95</td>
<td>7</td>
<td>21</td>
<td>1.20</td>
<td>0.50–2.86</td>
</tr>
<tr>
<td>Serviceman</td>
<td>9</td>
<td>33</td>
<td>1.06</td>
<td>0.50–2.26</td>
<td>8</td>
<td>25</td>
<td>1.37</td>
<td>0.61–3.08</td>
</tr>
</tbody>
</table>

*Odds ratio relative to all other occupations.*

A questionnaire chosen to collect data on work history and on past exposures is a modified version of a validated list on occupational history [3]. A substantial improvement in the accuracy of work-history reporting was observed after some minor adaptations of the questionnaire were made [4], and it was found to be feasible for use to ascertain the work histories of men older than 70 years of age [8]. Furthermore, the consistency of self-reported data on occupational exposure to particular compounds obtained from this questionnaire appeared to be satisfactory [9]. Obviously, there might be some bias in the data ascertained, but there is little reason to assume that cases and referents systematically responded in different ways.

The possibility of inviting all subjects to participate in a study on the etiology of illness of the prostate, and the recent experiences of both cases and referents with urological treatment, should largely reduce differential recall. The choice of a reference group selected from amongst men exhibiting benign prostate hyperplasia had other advantages. The fact that both prostate cancer and hyperplasia patients were referred to urology services on account of similar symptoms and complaints reduced selection bias. Histological confirmation of the diagnosis of all subjects precluded misclassification of disease. A practical advantage of the choice of referents who were treated in the same services as the cases was that only a small group of physicians had to be requested to participate. All urologists who were invited to collaborate agreed to do so. Recruitment of a reference series of prostate hyperplasia patients would, unintentionally, introduce a bias toward an underestimation of risk, should the origins and development of hyperplasia and cancer of the prostate be closely related. However, most morphological and epidemiological data indicate that the diseases involved are distinct entities, developing independently from one another in anatomically and embryologically different parts of the prostate [10–12].

There are no indications that the occurrence of prostate hyperplasia is associated with particular occupations or industrial branches. However, very little is known about the risk factors for benign hyperplasia so far [12,13].

In this study statistically significant associations of prostate cancer were observed with reference to work...
TABLE III. Age-Adjusted Odds Ratios and 95% Confidence Intervals for Prostate Cancer According to Particular Types of Occupational Exposure

<table>
<thead>
<tr>
<th>Type of exposure</th>
<th>&quot;Sometimes&quot; or &quot;frequently&quot; exposed</th>
<th>&quot;Frequently&quot; exposed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases</td>
<td>Referents</td>
</tr>
<tr>
<td>Pesticides</td>
<td>72</td>
<td>321</td>
</tr>
<tr>
<td>Fertilizers</td>
<td>77</td>
<td>330</td>
</tr>
<tr>
<td>Cadmium</td>
<td>18</td>
<td>73</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>140</td>
<td>512</td>
</tr>
<tr>
<td>Nonferrous metals</td>
<td>92</td>
<td>387</td>
</tr>
<tr>
<td>Welding fumes</td>
<td>64</td>
<td>306</td>
</tr>
<tr>
<td>Rubber</td>
<td>49</td>
<td>251</td>
</tr>
<tr>
<td>Solvents</td>
<td>102</td>
<td>500</td>
</tr>
<tr>
<td>Limes</td>
<td>86</td>
<td>402</td>
</tr>
<tr>
<td>Pigments</td>
<td>48</td>
<td>240</td>
</tr>
<tr>
<td>Paints</td>
<td>127</td>
<td>606</td>
</tr>
<tr>
<td>Lubricating oils</td>
<td>115</td>
<td>483</td>
</tr>
<tr>
<td>Cutting oils</td>
<td>34</td>
<td>166</td>
</tr>
<tr>
<td>Exhaust gases</td>
<td>109</td>
<td>440</td>
</tr>
<tr>
<td>Tar products</td>
<td>81</td>
<td>338</td>
</tr>
<tr>
<td>Textile products</td>
<td>40</td>
<td>196</td>
</tr>
<tr>
<td>Leather products</td>
<td>36</td>
<td>130</td>
</tr>
<tr>
<td>Ionizing radiation</td>
<td>20</td>
<td>64</td>
</tr>
</tbody>
</table>

*Odds ratio relative to nonexposed subjects.

TABLE IV. Mean Sizes of Lands and Pastures, Number of Cattle, and Mean Numbers of Days/Year That Subjects Worked in Farming Using Pesticides or Fertilizers, Itemized for Cases and Referents who Worked in Farming During 1960-1970

<table>
<thead>
<tr>
<th>Aspect of activity</th>
<th>Unit</th>
<th>n</th>
<th>%</th>
<th>Mean</th>
<th>SD</th>
<th>n</th>
<th>%</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of fields</td>
<td>Hectare</td>
<td>27</td>
<td>82%</td>
<td>11.6</td>
<td>10.6</td>
<td>84</td>
<td>72%</td>
<td>8.8</td>
<td>8.6</td>
</tr>
<tr>
<td>Area of pasture</td>
<td>Hectare</td>
<td>23</td>
<td>70%</td>
<td>9.5</td>
<td>4.9</td>
<td>94</td>
<td>80%</td>
<td>10.7</td>
<td>9.4</td>
</tr>
<tr>
<td>Number of cows</td>
<td></td>
<td>26</td>
<td>79%</td>
<td>29.6</td>
<td>22.8</td>
<td>86</td>
<td>74%</td>
<td>44.4</td>
<td>55.9</td>
</tr>
<tr>
<td>Number of pigs</td>
<td></td>
<td>23</td>
<td>70%</td>
<td>62.6</td>
<td>90.5</td>
<td>71</td>
<td>61%</td>
<td>95.2</td>
<td>118.4</td>
</tr>
<tr>
<td>Number of chickens</td>
<td></td>
<td>19</td>
<td>58%</td>
<td>212.1</td>
<td>173.3</td>
<td>48</td>
<td>41%</td>
<td>246.2</td>
<td>184.5</td>
</tr>
<tr>
<td>Use of pesticides</td>
<td>Days/year</td>
<td>19</td>
<td>58%</td>
<td>11.4</td>
<td>8.6</td>
<td>73</td>
<td>62%</td>
<td>7.5</td>
<td>8.8*</td>
</tr>
<tr>
<td>Use of fertilizers</td>
<td>Days/year</td>
<td>27</td>
<td>82%</td>
<td>15.0</td>
<td>11.3</td>
<td>102</td>
<td>77%</td>
<td>13.3</td>
<td>10.4</td>
</tr>
</tbody>
</table>

*Mann-Whitney test: P = 0.03.

In the manufacturing of food and in storage. An increased occurrence of prostate cancer among food workers was also reported in some previous studies [14-17] but not in others [18-21]. In our study non-significantly elevated risks were found among bakers and butchers, especially for jobs held between 1960 and 1970. Hall and Rosenman observed a significant risk excess among bakers [17]. James reported an increased mortality from prostate cancer among meat workers [22]. In other studies, however, no excess risk was found for these occupations [19,21,23,24]. In one earlier study a significantly elevated risk for stock clerks and storekeepers was found [25]. In other studies, however, no association with storage work has been observed [15,16,26], while Adelstein [18] even reported a negative association with storage.

In our study also an increased OR was found for employment as bookkeeper, cashier, insurance, or finance worker. A borderline significant association was found with work in administration during the years 1960 and 1970. Ernster et al. observed a non-significant elevated risk among bookkeepers [15].
How and Lindsay reported a significant excess risk among sales clerks [23]. No association between prostate cancer risk and bookkeeping was found by Williams et al. [14], Blair et al. [27], nor by Minder and Beer-Porizek [21]. However, in the latter study a slight excess risk was found for the broader category of commercial and administrative employees [21]. Such an association has not been found in other studies [14,19,23,28].

Adelstein [18] observed a slightly increased risk among administrators and managers, but not among clerical workers. It is unlikely that workers in bookkeeping, finance, and insurance are exposed to occupational carcinogens, but higher than average exposure to life-style related risk factors (e.g., particular dietary habits) might be possible. Lack of occupational physical exertion might be a potential risk factor for prostate cancer, but study results concerning this factor have been conflicting so far [28,29]. In our study no other categories of “white collar” workers have been found with an increased risk for prostate cancer.

An elevated OR was found in this study for farm laborers, but not for farm owners or for agriculture in general. Most studies involving farming and prostate cancer have noted an elevated risk [2,30]. Although several potential risk factors have been mentioned, it is still uncertain what the harmful factors are in farming. An increased OR was found for the numbers of days/year cases and referents used pesticides, but not for the proportions of cases and referent who applied these compounds. An association with pesticide exposure was revealed in some previous studies among agricultural workers too [28,30,31]. However, in other studies among farmers [32,33] and among workers licensed to apply pesticides [34,35], no association was found. It may be relevant to mention that application of pesticides could be supplemented by exposure to solvents and other chemicals as well [36].

Use of fertilizers has been suggested to be another potential risk factor in farming. Rotkin [37] indeed observed a significant relation to fertilizer use, but no clear association was found in the present study, nor in some other studies [30,32–34]. Associations have

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**TABLE V. Age-Adjusted Odds Ratios and 95% Confidence Intervals for Prostate Cancer According to Particular Types of Occupational Activity in Farming**

<table>
<thead>
<tr>
<th>Type of exposure</th>
<th>Cases</th>
<th>Referents</th>
<th>OR*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Care of cattle</td>
<td>29</td>
<td>105</td>
<td>0.94</td>
<td>0.27–3.23</td>
</tr>
<tr>
<td>Pesticides</td>
<td>19</td>
<td>73</td>
<td>0.93</td>
<td>0.41–2.12</td>
</tr>
<tr>
<td>Fertilizers</td>
<td>27</td>
<td>102</td>
<td>0.81</td>
<td>0.28–2.39</td>
</tr>
<tr>
<td>Solvents</td>
<td>13</td>
<td>60</td>
<td>0.74</td>
<td>0.33–1.68</td>
</tr>
<tr>
<td>Disinfectants</td>
<td>18</td>
<td>76</td>
<td>0.80</td>
<td>0.35–1.81</td>
</tr>
<tr>
<td>Painting or tarring</td>
<td>24</td>
<td>94</td>
<td>0.78</td>
<td>0.31–1.99</td>
</tr>
<tr>
<td>Maintenance of tractors and other machinery</td>
<td>19</td>
<td>58</td>
<td>2.08</td>
<td>0.87–4.93</td>
</tr>
</tbody>
</table>

*Odds ratio relative to nonexposed farmers calculated for subjects who worked in farming during 1960–1970.

**TABLE VI. Age-Adjusted Odds Ratios and 95% Confidence Intervals for Prostate Cancer According to Particular Types of Occupational Activity in Metal Work and Maintenance**

<table>
<thead>
<tr>
<th>Type of exposure</th>
<th>Cases</th>
<th>Referents</th>
<th>OR*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron and steel</td>
<td>32</td>
<td>108</td>
<td>1.94</td>
<td>0.61–6.12</td>
</tr>
<tr>
<td>Lead</td>
<td>12</td>
<td>46</td>
<td>1.05</td>
<td>0.47–2.36</td>
</tr>
<tr>
<td>Aluminum</td>
<td>20</td>
<td>74</td>
<td>1.20</td>
<td>0.54–2.64</td>
</tr>
<tr>
<td>Welding (autogenous)</td>
<td>18</td>
<td>59</td>
<td>1.51</td>
<td>0.69–3.31</td>
</tr>
<tr>
<td>Welding (electric)</td>
<td>20</td>
<td>60</td>
<td>1.75</td>
<td>0.80–3.84</td>
</tr>
<tr>
<td>Solvents</td>
<td>21</td>
<td>62</td>
<td>1.80</td>
<td>0.82–3.39</td>
</tr>
<tr>
<td>Acids</td>
<td>10</td>
<td>22</td>
<td>2.38</td>
<td>0.96–5.92</td>
</tr>
<tr>
<td>Cutting oils</td>
<td>18</td>
<td>64</td>
<td>1.23</td>
<td>0.55–2.77</td>
</tr>
<tr>
<td>Painting</td>
<td>14</td>
<td>52</td>
<td>1.21</td>
<td>0.56–2.61</td>
</tr>
<tr>
<td>Maintenance of machinery</td>
<td>24</td>
<td>79</td>
<td>1.48</td>
<td>0.66–3.32</td>
</tr>
</tbody>
</table>

*Odds ratio relative to nonexposed metal workers and maintenance men calculated for subjects who worked in metal work or maintenance during 1960–1970.
been observed with cattle and sheep [34,38], with poultry [31,34,39], or with livestock production in general [40]. No association, however, was detected in our study or in some others [30,33]. Brownson et al. [40] reported an excess risk in agricultural crop production, but no association was found in our study, nor in others [30,34]. The association found with the maintenance of tractors and agricultural machinery corresponds to the finding that most studies of prostate cancer occurrence among mechanics and repairmen show a slight excess of incidence or mortality [2].

In contrast with our pilot study and several other studies [2], this study demonstrated no clear excess prostate cancer incidence among metal workers. A nonsignificantly elevated OR was found for welders. For none of the specific occupational activities and exposures mentioned in the supplement for metal workers, mechanics, and repairmen was a statistically significant association found. However, the ORs for use of acids, solvents, iron, and steel; for welding; and for maintenance of machinery ranged between 1.5 and 2.4. The literature on potential risk factors in metal work and maintenance has been discussed in more detail in our previous paper [2].

Most of the ORs estimated for self-reported exposure to particular types of occupational exposure specified in the general part of the questionnaire are close to unity. The strongest associations observed involve frequent exposure to ionizing radiation and to cadmium. Only the latter association is statistically significant. This OR, however, is based on only seven cases. Occupational exposure to both ionizing radiation and to cadmium have been suggested to be related to prostate cancer risk [11,20,41].

CONCLUSIONS

It has to be stressed that it cannot be concluded definitely from this study that prostate cancer is not related to specific occupations or specific occupational exposures. Some limitations of the study mentioned earlier might have resulted in an underestimation of effect. In addition, it has to be considered that the study was conducted in a particular region of the Netherlands. Potential risks in industries not being represented in the IKO region (e.g., mining, blast furnace plants, aluminum processing, aircraft manufacturing) could not be identified in the present study.

In view of these limitations, further research on the relationship between work environment and prostate cancer might be desirable to reach a deeper insight into the origins of the disease, although our study results do not indicate particular occupational activities to be strong risk factors.

Acknowledgments

We thank all subjects who completed and returned a questionnaire, the Comprehensive Cancer Centre IKO, the urological services and pathology laboratories in the IKO region, and the National Computerized Archive of Pathology Reports (PALGA) for participating in this study.

References

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