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Occupation and cancer in the Nordic countries

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The papers on occupation and cancer from the Nordic Occupational Cancer project (NOCCA) in this issue of *Acta Oncologica* [1,2] provide an important resource to aid in our understanding of the role of occupational exposures in the etiology of cancer. This effort updates the earlier work by Andersen et al. [3] that also used the unique resources in Nordic countries for data linkage to study cancer. Broad surveys of cancer and other diseases by occupation, e.g., from England [4], United States [5,6], Canada [7] and Australia [8], have generated numerous leads regarding workplace hazards, helped to create a safe workplace, and made significant contributions to our understanding of carcinogenesis. Even in the current “omics” era with its remarkable opportunities to understand carcinogenic processes, the NOCCA project reminds us that it is useful to periodically revisit approaches in the past that have been successfully used to identify occupational hazards. Linkage projects such as this provide the opportunity to simultaneously evaluate cancer patterns by occupation and occupational patterns by cancer that are not possible in any other approach. The NOCCA project followed this successful survey approach used in the past, but enhanced and expanded it in several ways. The major improvement is the development of exposure estimates for over 20 known or suspect occupational carcinogens [2]. Also useful is the information provided on living conditions, social-economic status, food consumption, and health care in the Nordic countries and the presentation of incidence ratios by gender and calendar time, which help put associations and differences observed among the countries in perspective.

The analysis includes 2.8 million cancers among 15 million people, aged 30–64, in Denmark, Finland, Iceland, Norway and Sweden. Occupational information was obtained from the national censuses over four decades from the 1960s to 1990s. The large number of cancers available for analysis provides the opportunity to evaluate possible occupational associations with rare cancers.

A number of expected associations were observed, e.g., mesothelioma among plumbers, seamen and mechanics with asbestos exposures; lip cancer among fishermen, gardeners and farmers engaged in outdoor work; nasal cancer among woodworkers; and lung cancer among miners exposed to radon and silica. Finding established associations is reassuring, but uncovering new leads for future investigation is the main objective of a project such as this. This was also accomplished. For example, some of the interesting new findings that deserve further attention include cancer of the tongue and vagina among women chemical process workers; melanoma and non-melanoma skin cancer, breast cancer (among men and women), and ovarian cancer among printers; fallopian tube cancer among packers and hairdressers; penis cancer among drivers; and thyroid cancer among female farmers.

Groupings of cancers within specific occupations also provide important clues to carcinogenic processes. For example, various occupations in the construction trades had excesses of many cancers, including lip, oral cavity, pharynx, esophagus, stomach, rectum, nose, larynx, lung,

bladder, and cervix. Cooks, stewards and waiters had excesses of cancers of the lip, tongue, oral cavity, pharynx, esophagus, rectum, liver, gallbladder, pancreas, nose, larynx, lung, kidney, bladder, and cervix. On the other hand, farmers, gardeners, fishermen and forestry workers had deficits for many cancers. Although cancer groupings such as these point to lifestyle exposures because most well-established occupational exposures are not known to affect as many cancer sites as lifestyle exposures as tobacco, alcohol and diet, a role for occupational factors should not be entirely discounted. The occurrence of excesses for many cancers in some occupations also reminds us that many cancer risk factors are unevenly distributed in populations and emphasize the need to promote healthy activities in all segments of society. Cancer patterns across various occupations are also informative. For example, 14 of the 53 occupational categories among men and four of 53 among women had excesses of mesothelioma. These include many occupations with possible asbestos exposure and underscore the widespread use of this product in the past. However, this may also suggest that other exposures might be worthy of consideration regarding the development of mesothelioma. The number and pattern of statistically significant cancer excesses or deficits across occupations can also help pinpoint possible occupational hazards. More excesses than deficits by occupation occur for cancers of the colon, rectum, larynx, lung, kidney and bladder among men and women; for tongue, oral cavity, liver, and pancreas among men; and for cervix, uterus and fallopian tube among women. On the other hand, the number of occupational excesses and deficits for mesothelioma are about equal (14 excesses and 18 deficits among men and four excesses and three deficits among women), which is somewhat surprising because, based on the known causes of mesothelioma, there is no obvious explanation for the deficits.

The NOCCA publications are welcome additions to the occupational literature, especially at a time when interest in and concern about occupational causes of cancer appears to be waning. These data demonstrate that cancer is still associated with the workplace, that many associations are not fully explained, and that resources are needed to identify occupational carcinogens and to protect workers from hazardous exposures.

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