

Wood Dust and Nasopharynx and Sinonasal Cancer

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Millions of workers around the world are exposed to wood dust, as a by-product of woodworking. Nasopharynx cancers (NPCs) and sinonasal cancers (SNCs) are two cancers that can be caused by occupational exposure to wood dust, but there is little evidence regarding their burden in Canada.

woodworking

forestry

carpentry

incidence

healthcare costs

1. Introduction

Wood dust is considered carcinogenic to humans (Group 1) according to the International Agency for Research on Cancer (IARC) ^[1]. Nasopharynx cancer (NPC) and sinonasal cancer (SNC) are two important cancers caused by exposure to wood dust. The incidence of NPC and SNC was estimated higher for men than women, mainly because of the historical gender composition of workforce in wood-dust-exposed occupations ^{[2][3]}. Other health issues associated with exposure to wood dust included respiratory disease such as asthma, bronchitis, chronic lung function impairment ^[4] and the development of allergic symptoms ^[5].

Millions of workers around the world are exposed to wood dust, as the by-product of woodworking. Forestry is one of the industrial sectors whose workers are at a considerable risk of exposure to wood dust ^[6]. Canada has a diverse forestry industry that employs about 210,000 workers across different provinces, and it accounted for about 7.2% of total exports in 2017 ^[7]. However, occupational exposure to wood dust is not limited to the forestry industry, and industrial sectors that use wood are frequently widespread, i.e., construction, manufacturing and services, such as carpenters, also reported high level of wood dust exposure ^{[8][9]}.

Although some studies reported prevalence of exposure to wood dust in workplaces in Canada, there is not much evidence regarding the incidence of attributed occupational NPC and SNC and their economic burden to society. Workers' compensation claims provide some insights into the magnitude of such a burden, but their approximation does not necessarily represent the whole picture. Though occupational cancers are compensable under most workers' compensation programs, few such cases make their way into that system in Canada due to their long latency period. Furthermore, there are other costs that are not captured in workers' compensation systems. For instance, from an employer's perspective, costs incurred for the recruitment and training of a replaced worker or costs associated with accommodating a claimant are not captured ^[10]. From worker's perspective, the loss of home production, informal care provided by family members or friends, and the intrinsic value of health are some cost components that are not usually captured in workers' compensation systems.

In a review of studies conducted by the research team, researchers were unable to identify peer-reviewed economic burden studies focused solely on NPC and SNC attributed to occupational exposure in Canada. The only closely related study identified is that of Orenstein et al., who estimated the economic burden of occupational cancers in Alberta for 2003 [11]. They estimated the costs of nose and nasal sinuses cancers at CAD 15,106 per-case in 2008 Canadian dollars (CAD 16,507 in 2011 Canadian dollars), however they did not distinguish between the NPC and SNC. Their total costs were divided into direct and indirect costs. Under the direct costs, since the researchers have only access to the healthcare costs for lung cancer, they used a proportion of the lung cancer costs to estimate nose and nasal sinuses healthcare costs (a ratio of 0.60). Under the indirect costs, they considered absenteeism, short and long-term disability, and premature mortality.

In the United States (US), Jacobson et al. estimated the healthcare costs of head and neck cancers between 2004 and 2008 [12]. They estimated healthcare costs of all head and neck tumors arising from five primary sites, i.e., larynx, pharynx, oral cavity, salivary glands and paranasal sinuses. They identified the annual average healthcare costs for patients during the year after diagnosis at CAD 79,151 per-case in 2009 US dollars (CAD 95,848 per-case in 2011 Canadian dollars). They calculated the direct healthcare costs of the cases, based on the analysis of administrative claims data, considering charges for inpatient admissions, outpatient hospital visits, office visits, emergency department visits, and outpatient prescription drugs. They also estimated the losses as a result of short-term disability for one year following the index date at CAD 7952 per-case in 2009 US dollars (CAD 9629 per-case in 2011 Canadian dollars).

In another study in the U.S., Epstein et al. estimated healthcare costs associated with treating oral and pharyngeal squamous cell carcinoma for the years 1995 to 2003 [13]. They estimated the average healthcare costs for those treated within the first year following initial diagnosis at USD 25,319 per-case in 2002 US dollars (CAD 51,895 per-case in 2011 Canadian dollars). They used administrative claims data to calculate direct payments for diagnosed patients and their total medical costs included amounts paid for inpatient, outpatient, long-term care, and prescription services.

Across all studies identified, most of them exclusively focused on healthcare costs, though they did not consider out-of-pocket costs or informal caregiving costs. Furthermore, no studies considered health-related quality of life losses associated with NPC and SNC. Given the lack of knowledge regarding the burden of occupational NPC and SNC in Canada, this study was designed to fill the gap and to estimate incidence and economic burden of newly diagnosed occupational NPC and SNC attributed to exposure to wood dust.

2. Discussion

This study shed some light on prevalence of occupational exposure to wood dust amongst Canadian workers, incidence of NPC and SNC attributed to wood dust exposure, and their economic burden on society. From approximately 1.3 million workers exposed to wood dust, researchers expected 28%, 43% and 29% were exposed to low, medium, and high levels, respectively. researchers identified 4.6% of all NPC cases and 4.4% of all SNC cases attributed occupational exposure to wood dust. Researchers estimated a total economic burden of

occupational NPC and SNC of about CAD 12.2 million. Breakdown of current estimates between direct and indirect costs indicated 27% of NPC and SNC costs were associated with direct costs and 72% with indirect costs.

Researchers considered conservative assumptions for the estimation of incidence and economic burden of NPC and SNC; thus, the real values were likely underestimated. Furthermore, current cases represented only a fraction of total occupational NPC and SNC cases in Canada, as there are other occupational agents such as formaldehyde, leather, and nickel, that are well-recognized for causing the same kind of cancers [11]. Regarding the incidence of NPC and SNC across occupations, not surprisingly, the highest cases were expected in manufacturing and construction, but surprisingly, a noticeable number of cancers can be expected in educational services, trade, and public administration occupational groups, to which less attention has been paid. It is worth noting that when generalizing these findings across countries, extra caution should be taken since many parameters such as availability of wood, types of technology being used, and working environment can make a considerable difference in exposure estimates [14].

To current knowledge, the present study is the first focused exclusively on the economic burden of occupational NPC and SNC, rather than population-level cancers. Consequently, it is difficult to compare current findings to other studies. The only comparable study in Canada is from Orenstein et al. who reported from six new cases of nasal sinuses cancer in Alberta, about two (ranges between one and three) cases were attributed to work [11]. However, their estimated incidence was not limited to occupational exposure to wood dust, and they also considered occupational exposure to other carcinogens such as formaldehyde, nickel, and mineral oils in their study. They estimated direct and indirect economic burden of nasal sinuses cancers at CAD 7977 and CAD 7129 per case in 2011 Canadian dollars. Their direct costs were lower than current estimate, as they only included healthcare costs, while out-of-pocket and informal caregiving costs were not considered in their estimates. Their indirect costs also were much lower than ours, as for productivity losses of mortality cases they only considered 18.1 days lost as an average. They also did not consider neither home production losses and employer's friction costs nor cost related to losses of health-related quality of life in the cases. Breakdown of their reported values indicated that 53% of total costs were attributed to direct and 47% attributed to indirect costs.

Jacobson et al. reported the direct and indirect costs of cancers in the U.S. at CAD 95,848 and CAD 9629 per case in 2011 Canadian dollars, respectively [12]. In terms of direct cost, although they considered cost categories relating to hospital visits, office visits, emergency department, they did not consider out-of-pocket costs and informal caregiving costs. In terms of indirect costs, authors estimated the indirect costs through short-term disability of the cancer cases. They calculated monetary value of days lost using hourly wage CAD 29.37 in 2009 US dollars. But they did not consider the premature mortality and home production losses. The breakdown of their reported costs indicated that 91% of total cancer costs were attributed to direct and only 9% attributed to indirect costs.

Epstein et al. reported direct costs of oral and pharyngeal cancer cases at CAD 51,895 per case in 2011 Canadian dollars [13]. They considered healthcare costs based on the administrative claims data, but they did not estimate the out-of-pocket costs and informal caregiving costs of the patients. Additionally, they did not include indirect cost, or any value related to the quality of the life losses. It is important to be mentioned that when researchers compare

current results with this study, researchers should be careful, not only because of the difference in cancers (i.e., oral and pharyngeal squamous cell carcinoma), but also because the sample was restricted to those who were continuously eligible for 1-year post-diagnosis. Therefore, this study has excluded patients who were diagnosed with and treated for the disease but died within the year.

The limitation of studies in the area of economic burden of occupational NPC and SNC may be attributed to two main reasons: a lack of methodological framework for estimation of the cancer cases attributed to occupational exposure; and lack of a framework for economic burden computation [10]. As a result, there is a great variety in terms of costs considered. Most considered only a narrow subset of the costs that comprise the societal burden. Some studies focused exclusively on healthcare costs and did not capture other costs such indirect or intangible costs. Such studies focused on the traditional insurance model, considering only provider costs, but the societal perspective. Although they provide useful information for insurers, they missed out a substantial portion of the societal burden and therefore may lead to suboptimal policy decision making.

The key strengths of current study were the detailed approach to estimate the economic burden of cancer cases under three categories—direct, indirect and intangible—which is more comprehensive in the terms of costs considered than most of the previous economic burden studies about these cancers. Furthermore, the model contains a large amount of detailed information on healthcare costs, personal earning losses and intangible losses that mainly incur to workers and their families. Researchers incorporated several Canadian data sources to account for sex, age, province, occupational group, and industrial sectors in current model. Researchers developed a framework based on several previously published papers to estimate the stage distribution, survival and recurrence rate of different stages of cancers, which allowed us to have better picture of the actual economic burden of occupational NPC and SNC related to wood dust in whole paradigm of disease. The study took a lifetime case costing approach, considering factors such as diagnosis, survival probabilities, recurrence probabilities, and death rate. Researchers captured a substantial portion of what the occupational health and safety literature describes as the hidden part of the cost's iceberg [15]. Additionally, in this study, researchers used incidence costing approach, which is preferred to the prevalence costing approach, from both occupational health and safety professionals and policy decision-maker perspectives. This approach fits well with investment decision making which requires estimates of future costs. Thus, The study provides not only estimates of the economic burden of NPC and SNC, but also can serve as an example for future economic burden or cost of illness studies.

Lack of data for key input parameters has often been cited as a limitation in occupational disease burden studies, which also was the case with the study. Some assumptions (and sometimes compromises) were made to address data gaps. researchers considered conservative assumptions; thus, the real economic burden of occupational NPC and SNC was likely underestimated. Regarding the informal caregiving costs, researchers only considered a fraction of the real costs based on the time that they spend; however, sometimes informal caregivers in practice may encounter challenges for finding a flexible job and may deal with significant losses in terms of paid work. Another limitation was related to the estimation of productivity losses as NPC and SNC may lead to other forms of work productivity losses such as presenteeism (i.e., reduced productivity while at work), reduced team effectiveness, and penalties associated with late production [16]. However, researchers only included labour

productivity losses based on the human capital approach. Although, there was some uncertainty associated with some input parameters, the sensitivity analysis indicated how changing input data can affect the estimated economic burden under different scenarios.

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