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Original article

A population level study on smoking and radon induced adenocarcinoma and small-cell carcinoma among males and females in Canada

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ABSTRACT

Objective: To assess if there is a relationship between residential radon exposure and two lung cancer histological types, small-cell carcinoma (diagnosed in people with a smoking history) and adenocarcinoma (the most commonly diagnosed histologic type in people who have never smoked) among males and females in Canada.
Methods: With survey data of long-term radon measurements in residential homes, long-term averaged tobacco consumption rates in the units of cigarettes per day per person and long-term averaged age-standardized lung cancer incidence rates at provincial level, simple linear fitting (ANOVA linear regression) was applied in this study to determine the effect on lung cancer induction by smoking and exposure to indoor radon, and to assess if there is a relationship between residential radon exposure and lung cancer histological types.
Results: Lung cancer incidence rates correlate very well with the tobacco consumption rates ($P < 0.05$). However, females appear to be more likely than males to develop lung cancer at a given amount of cigarette consumption. For both small-cell carcinoma and adenocarcinoma, a statistically significant correlation between incidence rate and mean radon concentration was observed for females, the correlation was much stronger for adenocarcinoma ($P = 0.0057$) than small-cell carcinoma ($P = 0.0483$). However, there was no such correlation for males.
Conclusion: It is possible that female non-smokers are more susceptible to radon-induced lung cancer, and the joint effect of radon exposure and tobacco smoking may be worse in female smokers compared to males, such that higher incidence rate of adenocarcinoma among females compared to males were observed in recent decades, even though females never smoked more than males.

1. Introduction

For several decades, lung cancer has been the leading cause of cancer death, responsible for more cancer deaths among Canadians than the other three major cancer types (colorectal, breast and prostate) combined.[1] Lung cancer risk factors include tobacco smoking, exposure to second-hand smoke, exposure to airborne radon, exposure to asbestos and other carcinogens, as well as air pollution and aging. Tobacco smoking is by far the leading cause of preventable lung cancer, accounting for about 72% of all cases.[2] Radon is a naturally occurring radioactive gas generated by the decay of uranium-bearing minerals in rocks and soils. For decades, exposure to radon and its short-lived progenies in the air has been recognized as the second leading cause of lung cancer after tobacco smoking, and the primary cause of lung cancer among people who have never smoked.[3–6]

According to Canadian Cancer Statistics 2021,[7] lung cancer incidence and mortality rates are higher among males than females, but these rates have been getting closer over time. Lung cancer is divided into two main types: small-cell lung cancer (SCLC) and non small-cell lung cancer (NSCLC). SCLC is diagnosed much less frequently than NSCLC, which accounts for about 9 in 10 lung cancer cases. SCLC is almost always diagnosed in people with a smoking history. There are three subtypes of NSCLC, adenocarcinoma, squamous-cell carcinoma and large-cell carcinoma. Adenocarcinoma is the most commonly diagnosed histologic type: almost 1 in 2 of all lung cancer cases are those with adenocarcinoma. In addition, adenocarcinoma is the most commonly diagnosed histologic type in people who have never smoked.

Recent studies on indoor radon and lung cancer in Europe,[3] North America[4] and Asia[5] provide strong evidence that radon causes a substantial number of lung cancers in the general population. Because residential radon exposure is considered the second cause of lung cancer after tobacco smoking, majority of the radon-related cases were attributable to the joint effect of smoking and radon exposure. While tobacco smoking is clearly related to the risk of all histological types of lung cancer, the association between the different histological types of lung cancer and exposure to radon is not completely clear. With historical data

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