



The relationship between breast cancer and air pollution: review article

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ABSTRACT

Air pollution consists of chemicals resulting from many human activities and natural resources, which can cause gene mutations. Almost, it is proven that air pollution contributes to lung cancer and its relationship with other cancers including bladder, cervical cancer, ovary, prostate, brain and breast cancer is suspected. Breast cancer is the most frequent cancer in women and the prominent cause of death among them all around the world. Poor prediction of risk factor leads to discovery of more reliable factors. Mammary tumors in animals that are generated by chemicals compounds, give possible mechanisms for effects of environmental pollutants. Therefore, the purpose of our study is to review the available literature for investigating the relation of ambient air pollution and breast cancer. Findings of our study highlight the possibility of increasing in occurrence of breast cancer, developing to invasive cancer and mortality in both premenopausal and postmenopausal women exposed to air pollution.

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Introduction

It is long known that urban air is polluted by gaseous and some solid particles, and long or short term exposure to these pollutants leads to various disease and mortality (1). Many of these solid or gas compounds are mutagenic and carcinogenic substances, which can lead to various types of cancer (1). Several studies have shown that exposure to air pollution is considered as a factor associated with breast cancer (2,3). It is almost proven that air pollution contributes to lung cancer, but its relationship with other cancers including bladder, cervical cancer, ovary, prostate, brain and breast is suspected (4). Increasing the knowledge about the consequence of air pollutants on public health is necessary for the development of practical policies to lessen the negative effect of air pollution (5). In

this study, we briefly reviewed the relationship between breast cancer and air pollution.

Air pollution

Pollutants in the air are composed of compounds that result from many human activities and natural resources. In many parts of the world, cooking, transportation, interior heating, industrial activities, power generation and biomass burning are dominant human-based activities of air pollution (6). Some countries have settled controlling system that records the degree of pollutants, such as solid particles include particulate matter with diameters of less than 10 μm (PM10), fine particulate matter (PM2.5), and the gases including sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen

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dioxide (NO₂), ozone (O₃) and polycyclic aromatic hydrocarbons (PAHs) (7).

Air pollution is very harmful and even low concentration of air pollution is a danger to human health. Air pollution is now considered as a vital public health issue and is responsible for a growing range of health impacts. Rapid urbanization can lead to expose to more unhealthy concentrations of environmental pollutants (8).

Ambient air pollution has become a major health problem for a long time, and the problem gets worse every day. Inefficient transportation system is the main cause of air pollution in big cities (6). Degree of air pollution in the overcrowded cities is greater than other parts, which can have serious human health impacts by affecting the water and land ecosystems. Tehran, Beijing, Sao Paulo, Shanghai, Cairo, Bangkok, Mexico City and Jakarta are the most polluted cities in the world (9).

Breast cancer

In women, breast cancer is considered as the most frequent cancer (10), which can lead to high rate of morbidity and mortality (1). Breast cancer is the commonly diagnosed cancer and the most prominent reason of cancer death among females in the world (11). The occurrence and fatality of cancer is growing universally, especially in developing countries (12). These findings are in accordance with Globocan cancer incidence reports. It is estimated that 1.7 million new cases were detected and 521,900 death occurred from this disease in 2012 worldwide (11). Incidence of breast cancer is so different between countries, with the highest incidence in the United States of America and North America and with the lowest incidence in Africa and Asia (13). Breast cancer alone accounts for 25% of whole cancer cases and 15% of whole cancer deaths in women (11). Increasing the incidence rates is reported up to 5% per year (14). Countries in the Asia, by having 59% of population in the world, have the greatest occurrence of breast cancer, with 44% of deaths, 39% of new cases and the world's five-year survivors about 37% (15).

Global diversity in breast cancer incidence indicates differences in risk factors (11). Since a range of well-known risk factor cannot explain the incidence of breast cancer, a comprehensive research should be performed to look for other potential risk factors (1). It is estimated that only around one-third of new cases of breast cancer are due to well-known risk factors, and a lot of causes remain unknown. So, it is a hypothesis that environmental exposures may also cause breast cancer (16). A large number of animal studies showed that animals exposing to air pollution are at increased risk

of mammary gland tumors (3). In general, mortality rate of breast cancer is much greater in the urban population (areas of industrialized) than population of rural area, and the "urban factor" is constantly attributed in the literatures to air pollution (16). Several studies have shown that air pollution has relationship with the increased risk of morbidity and death of patients with breast cancer (14,16,17).

Literature review

Bonner et al. (2005)

In a population-based, case-control study, it was assumed that exposure to PAHs in early life may lead to breast cancer in New York. In their study, 1,166 women with historically proved breast cancer, and 2,105 controls were matched by race, age, and the same township. The results suggested that the risk of postmenopausal breast cancer may increase by PAHs; although, other confounders linked with geography cannot be excluded (17).

Nie et al. (2007)

In a case-control study, the risk of breast cancer was evaluated in 1,170 cases exposed to traffic emissions during life and 2,116 controls from Citizens of Erie and Niagara Counties. Findings demonstrated that exposure to traffic emissions in menarche period had statistically significant relation with higher risk of breast cancer in premenopausal periods and exposure to traffic emissions at the time of a woman's first delivery had statistically significant relation with higher risk of breast cancer in postmenopausal periods (18).

Crouse et al. (2010)

A hospital-based case-control study was carried out on the relationship between breast cancer and exposure to traffic-related air pollution in Montreal, Canada. Since NO₂ is known as an indicator of pollution related to traffic, a land use regression model was expanded to predict concentrations of average annual NO₂. The places for sampling were selected by using a location-allocation model, which put samplers in region likely to have high changes in pollution related to traffic and high population densities. Samplers were deployed in 133 places across the Island of Montreal over the three seasons (spring, summer, winter). Cases were chosen from all 18 hospitals in the area where the patients with breast cancer had been admitted, and to reduce the possible recall bias, control subjects with historically proved cancers had one of 32 other selected sites of event. At the end, they found connection between the ambient concentrations of NO₂ and incidence of postmenopausal breast cancer (19).

Hung et al. (2012)

In an article about air pollution related to traffic and risk of mortality from breast cancer in Taiwan, the authors reported that exposure to vast amount of PM_{2.5}, a proxy measure of PAHs, may be linked with an increased risk of mortality from breast cancer. In this study, it has been paid more attention to the measure of mortality rather than incidence (16).

Ahmadi et al. (2013)

In a study in Saudi Arabia on the relationship between the number of cases and occurrence of the most prevalent cancers and exposure to NO₂, it was shown that at different atmosphere level, link between NO₂ concentration and the most prevalent cancers were increased in geographically weighted regression analysis. High correlation were observed between NO₂ concentration and breast and lung cancer incidences, followed by bladder, prostate, ovarian cancers and cervix, validating findings of other studies (2).

Huo et al. (2013)

In a study that was implemented in China to study the long-term effects of air pollution on breast cancer, they analyzed 1,832 female patients with breast cancer from Qilu hospital who had inhabited in similar cities for at least ten years before their diagnosis. The PM concentration was detected and arranged based on the yearly and daily mean of the PM₁₀ concentration from the environmental protection Bureau. Patients were categorized into three groups based on the PM₁₀ class of their habitation (high PM, medium PM, and low PM). Number of patients with invasive breast cancer significantly increased among high PM exposure patients. In addition, they declared increased effect of ambient PM on tumor grade in estrogen receptor positive cases, but not estrogen receptor negative cases. No differences were observed between groups regarding progesterone receptor (PR) or HER-2 status (20).

Hystad et al. (2014)

In another case-control study (N=cases 619 pre-menopausal and N=1140 postmenopausal) and (N=controls 611 premenopausal and N=1261 postmenopausal), a positive link was found between breast cancer occurrence and long-term exposure to ambient NO₂. This study hypothesized that traffic pollution may have connection with the progress of breast cancer, with a larger relations in pre-menopausal women (21).

Reding et al. (2015)

The results of a sister study on 47,591 women

showed that no connection exists between invasive breast cancer and PM_{2.5}, PM₁₀, or NO₂; however, associated was found between NO₂ and a growing risk of ER⁺/PR⁺ breast cancer. They reported that for a differential role of air pollution, there is biological plausibility by hormone receptor status (22).

White et al. (2016)

Moreover, the results of a study on the relationship between breast cancer incidence and exposure to multiple long-term PAH sources showed that PAH exposure is ubiquitous. Humans are exposed to PAHs during their life from variety of sources, such as diet, environmental tobacco smoke (ETS), cigarette smoking, and indoor and outdoor air pollution. In this population-based case-control study (1508 breast cancer cases/1556 controls), they found that the incidence of breast cancer rises about 30-50% in groups who are exposed to PAH sources (23).

Totally, although there are many other cancer-related risk factors associated with living in 'polluted' cities (i.e. exposure to other environmental toxins, higher levels of chronic stress, more inactive lifestyles, less healthful diets, etc.), when researchers excluded as many of these factors as possible it still seems that air pollution remains an important variable in increasing a breast cancer risk or dying from breast cancer (16,18,20). From both natural experiments and epidemiological studies, benefits of reducing exposure to air pollution are well reported (24). Usage of renewable sources of energy and improved energy efficiency in buildings can be useful. Pragmatic public health programs possibly need to be established or changed in the fastest time possible. There is a need to develop preventive health policies and health planning services such as education and information, traffic management and removal of old cars to improve women's life (25). Also, there are some essential requirements such as absenteeism of practical cancer registries system in several countries, including Iran (12). It should be noticed that reducing the effects of urban outdoor air pollution is largely beyond the control of each person and needs to take action by government authorities at the national, regional and even international levels (26).

Conclusion

Our review concluded a feasible correlation between air pollution and breast cancer risk in female at general and total level. Although the mechanisms for how air pollution has effect on the occurrence or progression of breast cancer is unknown, but because the relationship between these two variables was determined, action for

preventive efforts to improve health in females and quality of their life to protect them from air pollution is necessary, especially in patients who are at high risk of advancing breast cancer. It was found some recommendation for further study while reviewing the previous studies such as:

-More studies should be designed to find the association between duration of exposure to air pollution with the advancement of breast cancer.

-More research about the role of underlying mechanisms of air pollutants in the breast cancer development is needed.

-Even though a connection was observed between breast cancer and exposure to air pollution, most of the reports were based on the aggregate data; if being exposed to air pollution was found in individual-level data, our conclusion could be more trustworthy. Thus, these remain an active area of future research.

Conflict of Interest

The authors have no conflict of interest.

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