Mini Review

Open Access Journal of
Biomedical Science
ISSN: 2690-487X

Breast Cancer and Exposure to Hazardous Contaminants: A Minefield of Feats and Challenges

Diana Evelyn Villa-Guillen*

Departamento de Ciencias Químico-Biológicas, Universidad de Sonora, Mexico

ABSTRACT

Geographic heterogeneity of breast cancer prevalence suggests there are non-genetic factors related to cancer burden. Among those, residential exposure to pollutants, like hazardous waste sites, hazardous air pollutants, pesticides, and contaminated water sources, may contribute to breast cancer risk. This mini review discusses the main findings of several observational studies evaluating the association between historical exposure to contaminants and breast cancer development. The models used to evaluate breast cancer risk and hazardous contaminants are essential to reach a consensus in this highly debated field.

KEYWORDS: Breast cancer; Environmental hazards; Observational studies

ABBREVIATIONS: HWSs: Hazardous Waste Sites; HAPs: Hazardous Air Pollutants

INTRODUCTION

Breast cancer is considered as the major cause of cancer-related deaths in females worldwide Ferlay [1]. According to the American Cancer Society, one woman in every eight will be diagnosed with this disease in their lifetime De Santis [2]. There are modifiable and non-modifiable risk factors contributing to breast cancer. Some non-modifiable risk factors are age and germline mutations that compromise genomic integrity Walsh [3]. Modifiable risk factors include those depending on personal long-term exposure, like nutrition and exercise habits Chajès [4]. Also, the geographic variations of breast cancer prevalence in countries like the U.S. and Mexico raise the question of environmental exposure as a modifiable risk factor Landen [5]; Campos [6]. Residential exposure to specific chemicals, such as polyaromatic hydrocarbons, benzene, organic solvents and pesticides, may relate to breast carcinogenesis Garcia [7]; Labreche [8], Damstra [9]; Wolff [10]. Several studies examined the potential role of environmental pollutants for an increased breast cancer risk, with conflicting results. The association between breast cancer development and long-term exposure to chemical hazards is far to reach a consensus. This mini review aims to highlight the conundrum of residential exposure to hazards and breast cancer risk.

DISCUSSION

The relationship between breast cancer and environmental hazards is wide and complex. Environmental contaminants include hazardous waste sites (HWSs), hazardous air pollutants (HAPs), long-term exposure to pesticides, and chemicals present in water sources for human consumption. Studies evaluating the associations between those pollutants and breast cancer risk indicate the need for further investigations.

Quick Response Code:

Address for correspondence: Diana Evelyn Villa-Guillen, Departamento de Ciencias Químico-Biológicas, Universidad de Sonora, Mexico

Received: April 26, 2020 **Published:** May 08, 2020

How to cite this article: Diana Evelyn VG. Breast Cancer and Exposure to Hazardous Contaminants: A Minefield of Feats and Challenges. 2020 - 2(3) OAJBS.ID.000169. **DOI:** 10.38125/OAJBS.000169

Exposure to Hazardous Waste Sites (HWSs) and Breast Cancer Risk

Hazardous wastes are materials that exhibit ignitability, reactivity, corrosivity, and toxicity, presenting a potential source of hazard for the environment and human health EPA [11]. Despite international and national regulations for hazardous waste sites (HWSs), the improper disposal of those residues continues to be a worldwide problem affecting local communities in distinct countries Marsili [12]. Several epidemiological studies evaluated the health status of populations living closely with HWSs. Some investigations indicate a higher incidence of cancers (bladder, liver, non-Hodgkin lymphoma, and breast) for those citizens residing near to an HWS Griffith [13]. According to animal studies, more than 200 chemicals relate to breast carcinogenesis Rudel [14]. Preclinical data also suggests contaminants with estrogenic activities and mutagenic properties contribute to an increased breast cancer risk Brophy [15]. Other investigations show no significant increase in diseases related to a long-term residence close to an HWS. A WHO report in 2007 indicated there was insufficient evidence to establish an association between residential exposure to an HWS and cancer development WHO [16]. Living in proximity to an HWS relates to a higher rate for congenital malformations, but data do not confirm an association between residential exposure to HWSs and cancer burden Vrijheid [17]. The contrasting findings among those investigations indicate the need for clinical evidence of the health impact of hazardous waste exposure.

Exposure to Hazardous Air Pollutants (HAPs) and Breast Cancer Risk

Studies are supporting higher rates for breast carcinogenesis with the long-term exposure to hazardous air pollutants (HAPs). A couple of investigations conducted within the California Teachers' Study suggested a link between breast cancer risk and HAPs in patients residing in urban areas Garcia [7]; Liu [18]. Garcia et al. showed 24 HAPs related to an increased breast cancer risk Garcia [7]. The chemicals acrylamide, benzidine, carbon tetrachloride, ethylidene dichloride, and vinyl chloride were related to hormone-responsive breast cancers Garcia [7]. Another study within the same cohort showed a relationship between cadmium exposure and higher incidence of hormone receptor-negative breast cancers Liu [18]. However, findings in the literature are conflicting, as other studies show no associations between breast cancer burden and HAPs' exposure. A cross-sectional analysis within the Nurses' Health Study II showed that residential exposure to HAPs were unrelated to an increased breast cancer risk Hart [19]. Also, HAPs' exposure was not related to breast cancer subtypes in the US Hart [19]. We need to increase our knowledge about the consequences of HAPs' exposure on breast cancer burden for the development of policies that lessen the negative effects of air pollution.

Pesticide Exposure and Breast Cancer Risk

The usage of organochlorine pesticides may be related to an increased breast cancer burden. Several investigations indicate that environmental exposures to organochlorine pesticides can mimic the effects of endogenous estrogens Damstra [9]; Wolff [10]. Exposure to organochlorine pesticides can disrupt endocrine metabolism, promote the formation of genotoxic DNA adducts, and induce carcinogenesis Damstra [9]; Wolff [10]. The epidemiological data, though, is inconsistent as some studies show an association between organochlorine pesticides and breast cancer Romieu [20]; Snedeker [21], while others do not Aronson [22]; Demers [23]; Brody [24]. Discrepancies in the literature may be due to technical difficulties in assessing pesticide exposure, as people are usually unaware of their historical exposure to environmental chemicals O'Leary [25].

Contaminated Drinking Water and Breast Cancer Risk

Drinking water from sources impacted by wastewater, run-off from agricultural lands, or contaminated wells present a potential pathway of human exposure to hazardous chemicals Kuch [26]; Rudel [27]. Improper disposal from industrial operations and small businesses can also contribute to chemical exposure Moran [28]. Specific hazards, like tetrachloroethylene (PCE) and organic solvents, found in contaminated drinking water can accumulate in mammary tissue and may increase breast cancer risk Labreche [8]. Some case-control studies indicate slightly to moderate increases in breast cancer burden with high PCE exposure Aschengrau [29]; Gallagher [30]. However, other studies show no consistent associations between chemical hazards in drinking waters and breast cancer rates Brody []. Discrepancies in findings can be due to regional variations in hazardous exposure by water supply, methodological limitations for exposure assessment, and difficulties in collecting retrospective information about affected individuals.

Limitations for Assessing Long-Term Exposure to Hazards

Observational retrospective studies present several challenges for the assessment of environmental exposure. The approach for assessing long-term exposure to hazards is critical, as literature reports a tumor latency timeframe of ≥ 15 years Brender [31]. Move-outs can compromise the estimations for the time of residential exposure to a potentially hazardous site. Additionally, the personal risk for breast cancer can differ according to reproductive factors, familiar and personal history of cancer(s), nutritional and exercise habits, education, occupation, race, ethnicity, and prior chronic illnesses like diabetes mellitus type 2 and obesity Kang [32]. The evaluation of the associations between breast cancer risk and environmental hazards should consider those confounding factors.

Another important issue to consider is the mathematical model evaluating residential exposure to hazards. In the Nurse Health Study II and the California Teachers' Study, the models considered an annual exposure to chemicals derived from industrial activities Garcia [7]; Liu [18]; Hart [19]. Those models were based on the reports given by the Environmental Protection Agency (EPA) of the U.S. However, findings must be interpreted with caution, as the mathematical models did not consider fluctuations of air pollutants per season. Moreover, inhalation was the only route considered for HAPs' exposure in those studies Garcia [7]; Liu [18]; Hart [19]. On the same lines, issues with evaluating contaminated water sources are the non-equal distribution of water supply, the time of exposure, and the models used for evaluating chronic exposure to hazards. Studies differ in their use for mathematical models, and as such, it provides a source for discrepancies regarding the association of chemicals in water with breast cancer risk.

CONCLUSION

The role of environmental pollutants derived from anthropogenic activities may influence breast cancer risk. Several studies indicate a historical exposure to chemicals with estrogenic and mutagenic activities increase breast cancer risk. Other epidemiological data show no relationship between cancer burden and residential exposure to hazards. The interpretation of each study should consider the mathematical models used for

estimating long-term hazard exposure. Larger prospective studies with distinct modeling approaches may provide additional insights for breast cancer risk assessment and their relationship with environmental hazards.

REFERENCES

1. Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, et al. (2015) Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. Int J Cancer 136(5): E359-386.
2. DeSantis CE, Ma J, Gaudet MM, Newman LA, Miller KD, et al. (2019) Breast cancer statistics. Cancer J Clin 69 (6): 438-451.
3. Walsh T, King MC (2007) Ten genes for inherited breast cancer. Cancer Cell 11 (2): 103-105.
4. Chajès V, Romieu I (2014) Nutrition and breast cancer. Maturitas 77 (1): 7-11.
5. Landen F, Weiderpass E, Boffetta P, Vainio H, Vasama-Neuvonen K, et al. (1998) Environmental risk factors and female breast cancer. Annu Rev Public Health 19: 101-123.
6. Campos MRC (2017) The geography of Mexico breast cancer. Investigaciones Geográficas UNAM ISSN (digital): 2448 - 7279.
7. Garcia E, Hurley S, Nelson DO, Hertz A, Reynolds P (2015) Hazardous air pollutants and breast cancer risk in California teachers: a cohort study. Environ Health 14: 14.
8. Labreche FP, Goldberg MS (1997) Exposure to organic solvents and breast cancer in women: a hypothesis. Am J Ind Med 32: 1-14.
9. Damstra T, Barlow S, Bergman A, Kavlock R, Kraak GVD (2002) World health organization. Global Assessment of the State-of-the-Science of Endocrine Disruptors. World Health Organization.
10. Wolff MS, Toniolo PG (1995) Environmental organochlorine exposure as a potential etiologic factor in breast cancer. Environ Health Perspect 103 (Suppl 7): 141-145.
11. Environmental Protection Agency (EPA) (2017) Learn the basics of hazardous waste.
12. Marsili D, Fazzo L, Pietro C (2009) Health risks from hazardous waste disposal: the need for international scientific cooperation. Eur J Oncol 14: 151-59.
13. Griffith J, Duncan RC, Riggan WB, Pellom AC (1989) Cancer mortality in US counties with hazardous waste sites and ground water pollution. Arch Environ Health 44: 69-74.
14. Rudel RA, Attfield KR, Schifano JN, Brody JG (2007) Chemicals causing mammary gland tumors in animals signal new directions for epidemiology, chemicals testing and risk assessment for breast cancer prevention. Cancer 109: 2635-2666.
15. Brophy JT, Keith MM, Watterson A, Park R, Gilbertson M, et al. (2012) Breast cancer risk in relation to occupations with exposure to carcinogens and endocrine disruptors: a Canadian case-control study. Environ Health 11: 87.
16. World Health Organization (WHO) (2007) Population health and waste management: scientific data and policy options. Report of a WHO workshop. Rome, Italy, 29-30.
17. Vrijheid M (2000) Health effects of residence near hazardous waste landfill sites: a review of epidemiologic literature. Environ Health Perspect 108 (suppl 1): 101-112.
18. Liu R, Nelson DO, Hurley S, Hertz A, Reynolds P (2015) Residential exposure to estrogen disrupting hazardous air pollutants and breast cancer risk: the California Teachers Study. Epidemiology 26(3): 365-373.
19. Hart JE, Bertrand KA, DuPre N, James P, Vieira VM et al. (2018) Exposure to hazardous air pollutants and risk of incident breast cancer in the nurses' health study II. Environ Health 17: 28.
20. Romieu I, Hernandez-Avila M, Lazcano-Ponce E, Weber JP, Dewailly E (2000) Breast cancer, lactation history and serum organochlorines. Am J Epidemiol 152: 363-370.
21. Snedeker SM (2001) Pesticides and breast cancer risk: a review of DDT, DDE and dieldrin. Environ Health Perspect 109 (Suppl 1): 35-47.
22. Aronson KJ, Miller AB, Woolcott CG, Sterns EE, McCready DR, et al. (2000) Breast adipose tissue concentrations of polychlorinated biphenyls and other organochlorines and breast cancer risk. Cancer Epidemiol Biomarkers Prevent 9: 55-63.
23. Demers A, Ayotte P, Brisson J, Dodin S, Robert J, et al. (2000) Risk and aggressiveness of breast cancer in relation to plasma organochlorine concentrations. Cancer Epidemiol Biomarkers Prevent 9: 161-166.
24. Brody JG, Aschengrau A, McKelvey W, Swartz CH, et al. (2006) Breast cancer risk and drinking water contaminated by wastewater: a case control study. Environ Health 5: 28.
25. O'Leary ES, Vena JE, Freudenheim JL, Brasure J (2004) Pesticide exposure and risk of breast cancer: a nested case-control study of residentially stable women living on Long Island. Environ Res 94: 134-144.
26. Kuch HM, Ballschmiter K (2001) Determination of endocrine-disrupting phenolic compounds and estrogens in surface and drinking water by HRGC-(NCI)-MS in the picogram per liter range. Environ Sci Technol 35: 3201-3206.
27. Rudel RA, Melly SJ, Geno PW, Sun G, Brody JG (1998) Identification of alkylphenols and other estrogenic phenolic compounds in wastewater, septage, and groundwater on Cape Cod, Massachusetts. Environ Sci Technol 32: 861-869.
28. Moran MJ, Zogorski JS, Squillace PJ (2007) Chlorinated solvents in groundwater of the United States. Environ Sci Technol 41: 74-81.
29. Aschengrau A, Rogers S, Ozonoff D (2003) Perchloroethylene-contaminated drinking water and the risk of breast cancer: additional results from cape cod, Massachusetts, USA. Environ Health Perspect 111: 167-173.
30. Gallagher LG, Vieira VM, Ozonoff D, Webster TF, Aschengrau A (2011) Risk of breast cancer following exposure to tetrachloroethylene-contaminated drinking water in cape cod, Massachusetts: reanalysis of a case-control study using a modified exposure assessment. Environ Health 10: 47.
31. Brender JD, Maantay JA, Chakraborty J (2011) Residential proximity to environmental hazards and adverse health outcomes. AJPH 101: S37-S52.
32. Kang C, LeRoith D, Gallagher EJ (2018) Diabetes, obesity and breast cancer. Endocrinology 159 (11): 3801-3812.