

# State of the Evidence

2008  
FIFTH  
EDITION

## The Connection Between Breast Cancer and the Environment



### INTRODUCTION

There is a growing body of scientific evidence linking chemicals and radiation in our environment to the current high rates of breast cancer. *State of the Evidence 2008*, published by the Breast Cancer Fund, summarizes the evidence from more than 400 scientific studies, discusses major themes that are changing the state of the evidence and outlines the Breast Cancer Fund's public policy and research recommendations to reduce toxic environmental exposures linked to the disease.

Learning more about the scientific evidence related to environmental exposures — as individual consumers and as members of communities — will enable us to push for research and policy changes that will protect our health. The Breast Cancer Fund is building a movement of advocates, educators, legislators, scientists and citizens who, working together, will make breast cancer prevention a priority for policymakers and opinion leaders on local, state and national levels.

**This companion guide to *State of the Evidence 2008*, edited by Janet Gray, Ph.D., highlights key research findings, emerging themes and research and policy recommendations from the full report.**

### THE PROBLEM

Breast cancer strikes more women throughout the world than any other type of cancer except skin cancer. In the United States between 1973 and 1998, breast cancer incidence rates in the United States increased by more than 40 percent. In 2008, a woman's lifetime risk of breast cancer in the U.S. is one in eight.

Breast cancer incidence rates rose during a period when thousands of synthetic chemicals were introduced into

consumer products and production processes. Today, an estimated 80,000 synthetic chemicals are used in the United States, yet only 7 percent have been fully tested for their impacts on human health; another 1,000 are added each year. Each of us is exposed to countless chemicals — some of which are known and suspected breast carcinogens and others which disrupt our hormonal systems — every day in our air, food, water, soil, medications, household products, personal care products, homes and workplaces. The scientific evidence shows that these chemicals are found throughout our environment and our bodies, including our breast tissue.

Since World War II, our exposure to ionizing radiation — the best- and longest-established cause of human breast cancer — has also increased. Multiple sources of ionizing radiation, including nuclear weapons testing, nuclear power plants and nuclear medical procedures like X-rays, CT scans, fluoroscopy and bone, thyroid and lung scans, increase exposure. Growing evidence also suggests that non-ionizing radiation (electromagnetic fields, or EMF) may also contribute to breast cancer risk.

### WHAT WE MEAN BY "ENVIRONMENT"

We recognize that the term "environment" encompasses all external factors that can affect health, including the totality of living and working conditions as well as physical, biological, social and cultural responses to these conditions. Some of those exposures are voluntary — within our individual control. Many others are not, and those involuntary exposures are the focus of *State of the Evidence 2008*.

## THE EVIDENCE

### **Evidence that the Environment is Playing a Role in Breast Cancer**

#### **Migration Studies**

Globally, breast cancer strikes more than 1 million women each year. The highest rates are in the industrialized nations of North America and Western Europe, while lower rates are generally found in western Asia, southern Africa and South America. In northern Africa and other countries that are developing or in transition, breast cancer rates are escalating sharply. Migration studies of women moving to new countries suggest that some of the variation in international incidence might be due to environmental factors. Women who move from countries with low breast cancer rates to industrialized countries soon acquire the higher risk of their new country.

---

*No more than 10% of women who have breast cancer have a genetic history of the disease.*

---

#### **Gene-Environment Interaction**

Another sign that environmental factors influence breast cancer risk comes from studies of women with inherited genetic mutations of two “breast cancer genes,” *BRCA1* and *BRCA2*. While they greatly increase the risk for the disease, these mutations account for no more than 10 percent of the current breast cancer cases. Women with these inherited mutations have a 60 to 82 percent chance of being diagnosed in their lifetimes, suggesting that something other than these mutations —like environmental and lifestyle factors— determines if a woman gets breast cancer. Similarly, studies of breast cancer in twins (with identical genetic makeup) indicate that environmental factors play a significant role and that most breast cancer is not inherited. In the largest study of twins ever conducted, researchers found that among twins in which at least one woman developed breast cancer, environmental exposures unique to that woman contributed about two-thirds of the risk.

### **Identifying the Environmental Links to Breast Cancer**

A 2007 survey conducted at the Silent Spring Institute found that 216 chemicals have been identified as mammary carcinogens by regulatory agencies. Many other chemicals, especially those known as endocrine-disrupting compounds (EDCs), are not classified by regulatory agencies, even though the scientific evidence linking EDCs to breast cancer risk is substantial and growing.

---

*A 2007 survey by the Silent Spring Institute found that 216 chemicals have been identified as mammary carcinogens.*

---

#### **Hormones and Endocrine-Disrupting Compounds**

There is broad agreement that exposure over time to natural and synthetic estrogens in the body increases the risk of breast cancer. Hormone replacement therapy (HRT) and hormones in oral contraceptives (OC) and some other pharmaceuticals also increase the risk. In fact, both the National Toxicology Program (NTP) and the International Agency for Research on Cancer (IARC) classify steroidal estrogens (the natural chemical forms of estrogen) as known human carcinogens.

Synthetic chemicals that mimic the actions of estrogens are known as xenoestrogens, and are one category of EDCs that increase the risk of breast cancer by interfering with normal hormone function. Evidence indicates that EDCs also may contribute to early puberty, which is itself a risk factor for breast cancer. These compounds are present in many pesticides, fuels, plastics, air pollution, detergents, industrial solvents, tobacco smoke, prescription drugs, food additives, metals and personal care products, including sunscreens.

#### **More Chemicals of Concern**

Other non-hormone-disrupting chemicals cause cancer by damaging mammary cell DNA or cellular processes. For example, recent studies of occupational exposures to the industrial solvent benzene among women enlisted in the U.S.

## MOVING FORWARD

### ***Eliminating the Environmental Links to Breast Cancer***

The Moving Forward section of *State of the Evidence 2008* provides a menu of different ways breast cancer prevention, women's health, environmental health and environmental justice advocates can develop policy and research agendas at the state and federal levels that call for the identification and elimination of the environmental links to breast cancer. This advocacy tool addresses the key environmental exposures linked to high rates of breast cancer that are discussed in-depth in the Evidence section of *State of the Evidence 2008*.

Moving Forward also discusses the new scientific tools and research needed to help advocates and policymakers better understand, track and ultimately reduce the public's exposure to toxic chemicals and radiation. These tools include biomonitoring, health tracking and statistics that identify trends in breast cancer incidence and mortality in all populations. Areas requiring an investment in research include low-dose exposures, mixtures, timing of exposure, early puberty and nanotechnology.

Equipped with a foundation of strong science, together we can advocate for the research that identifies and the public policies that eliminate the environmental causes of breast cancer.

Army and women in different professions in Israel showed significant increases in breast cancer rates among women with the highest benzene exposures. Other chemicals of concern include industrial solvents used in the manufacture of electronics, textiles and furniture; vinyl chloride from polyvinyl chloride (PVC) used in medical devices, food packaging, toys, water pipes and many other products; 1,3-butadiene, a byproduct of petroleum refining and vehicle exhaust; ethylene oxide, a cosmetic ingredient and surgical instrument sterilizer; and aromatic amines, byproducts of manufacturing plastics, pesticides, dyes and polyurethane foams, as well as high-temperature grilling of foods.

### **Radiation: Ionizing and Non-Ionizing**

Ionizing radiation (X-rays and gamma radiation) has long been known to cause breast cancer, both by directly damaging DNA and by disrupting normal cellular and intra-cellular processes. There is no safe dose of radiation and the genetic damage caused by radiation accumulates over a lifetime. Post-menopausal women whose earlier breast cancers were treated with radiation therapy have increased risk of radiation-induced secondary cancers. Two recent studies also found that women with certain gene mutations (*BRCA1/BRCA2*, *ATM*, *TP53*) may be particularly susceptible to the cancer-inducing effects of ionizing radiation exposure.

Non-ionizing radiation (electromagnetic fields, or EMF) includes microwaves, radio waves, radar and artificial light. The mechanisms by which EMF can affect health are not completely understood. Recent studies in the United States and Poland showed an association between occupational EMF exposure and a modest but significant increased risk of breast cancer, confirming the findings of an earlier meta-analysis.

---

*Equipped with a foundation of strong science, together we can advocate for the research that identifies and the public policies that eliminate the environmental causes of breast cancer.*

---

### **ABOUT MOVING FORWARD**

**Moving Forward provides research and state and federal policy recommendations for each of the following issue areas:**

#### **Reduce Exposure to Radiation**

- Ionizing Radiation
- Non-Ionizing Radiation (EMF)

#### **Reduce Exposure to Toxic Chemicals**

- Air Contaminants
- Pesticides
- Consumer Exposures
  - Plastics, Household Cleaning Products, Hormones in Meat and Milk, Cosmetics and Personal Care Products
- Occupational Exposures

#### **Tools and Research Needed to Strengthen the Evidence and Reduce Exposures**

- Build Better Tools
  - Statistics on Breast Cancer in all Populations, Biomonitoring, Health Tracking
- Invest in New Science
  - Low-Dose Exposures, Mixtures, Timing of Exposure, Early Puberty, Nanotechnology

## BEYOND THE EVIDENCE

# Emerging Themes in the Study of Breast Cancer and the Environment

## 1. Mixtures Do Matter

All of us are exposed to multiple chemicals every day in differing mixtures and quantities. Mixtures of chemicals and of chemicals and radiation may interact with each other as well as with our genes and our hormones to increase breast cancer risk. Studying these interactions is difficult but necessary to fully understand the multiple risk factors for breast cancer. Only a few such studies of mixtures have been conducted, but several indicate either additive (to illustrate,  $2 + 3 = 5$ ) or synergistic ( $2 + 3 = 9$ ) effects from low levels of chemicals relevant to breast cancer risk in combination. One study that looked at the combined effects of 11 different contaminants — each added at a level so low that it had no effect by itself — showed that the chemicals had additive effects with each other and also with the naturally occurring estrogen, estradiol. This and many other studies show that even low-dose exposure may intensify the biological effects of natural estrogens.

## 2. Timing of Exposure: The “When” may Be as Important as the “What”

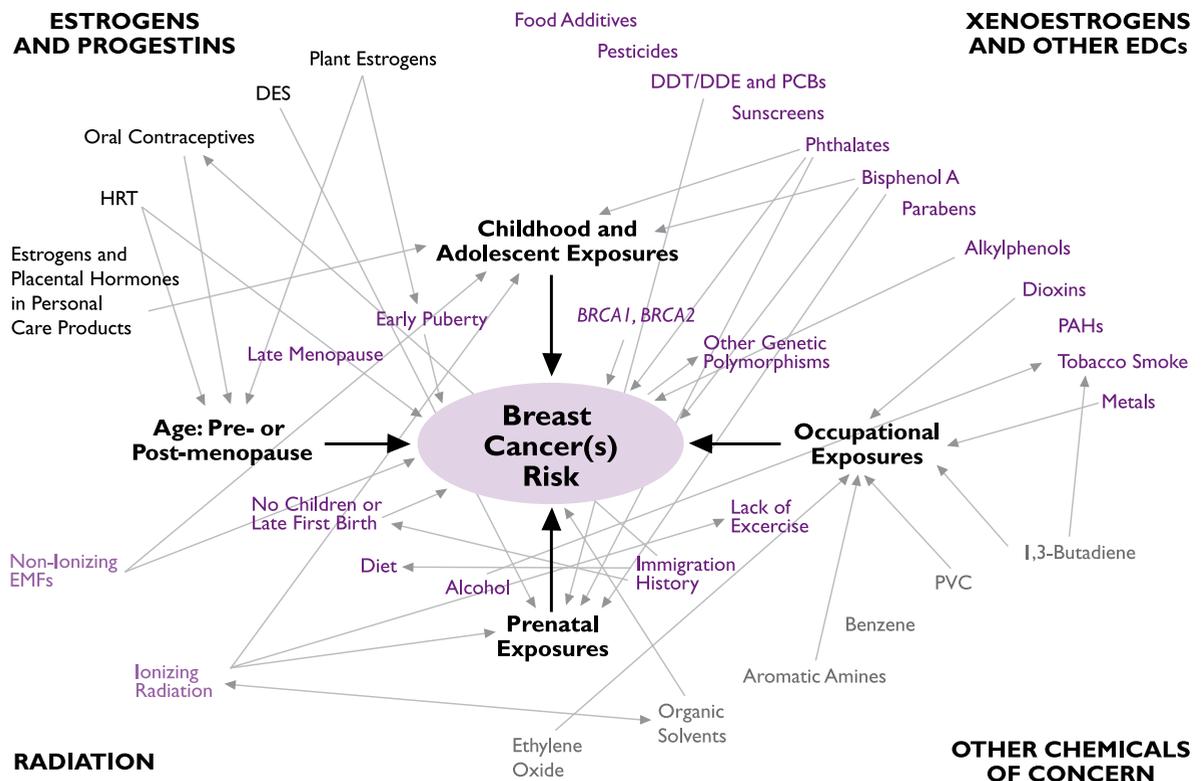
Two decades of science have shown the inadequacy of the long-held belief that “the dose makes the poison.” In fact, lower-dose exposures to chemicals sometimes may have more profound effects than higher-dose exposures, particularly early in the development of an organism. Scientists now know that the timing, duration and pattern of exposure are at least as important as the dose. The cells in mammary tissue are most vulnerable to the cancer-causing effects of hormones, chemicals and radiation from conception through first full-term pregnancy and the end of the breastfeeding period.

## 3. Embracing Complexity

Based on the scientific evidence, it is clear that breast cancer is a complex disease with multiple contributing risk factors. In fact, there are many types of breast cancer, each with its own unique risk and treatment profile. Rather than looking for single, direct causes of the disease, we need to recognize the multiple and often interacting factors that influence risk. Breast cancer causation is a complex web that includes exposures to radiation, hormones, chemical carcinogens and synthetic chemicals that act like hormones (known as endocrine-disrupting compounds, or EDCs), as well as individual genetic material, diet, lifestyle and reproductive history.

## COMPLEXITY OF BREAST CANCER CAUSATION

Arrows indicate just some of the many links among risk factors, exposures and breast cancer.



Compounds Linked to Breast Cancer	IARC*			NTP**		ENDOCRINE DISRUPTING COMPOUNDS***
	KNOWN	PROBABLE	POSSIBLE	KNOWN	REASONABLY ANTICIPATED	
<b>Evidence Linking Hormones and Endocrine Disrupting Compounds to Breast Cancer</b>						
<b>Estrogens and Progestins</b>						
Hormone Replacement Therapy (HRT) and Oral Contraceptives	X			X		
Diethylstilbestrol (DES)	X			X		
Estrogens and Placental Hormones (Progestins) in Personal Care Products	X			X		
<b>Xenoestrogens and Other Endocrine Disrupting Compounds (EDCs)</b>						
Dioxins	X			X		X
Persistent Organochlorines: DDT/DDE and PCBs						
DDT/DDE			X	X		X
PCBs		X			X	X
Pesticides						
Triazine Herbicides: Atrazine						X
Heptachlor			X			X
Dieldrin and Aldrin						X
Other Pesticides						X
Polycyclic Aromatic Hydrocarbons (PAHs)		X			X	X
Tobacco Smoke: Active and Passive Exposures	X			X		X
Bisphenol A (BPA)						X
Alkylphenols						X
Metals	X			X		X
Phthalates						X
Parabens						X
Sunscreens (UV Filters)						X
<b>Growth Promoters Used in Food Production</b>						
Recombinant Bovine Growth Hormone (rBGH)/Recombinant Bovine Somatotropin (rBST)						X
Zeranol (Ralgro)						X
<b>Evidence Linking Other Chemicals of Concern to Breast Cancer</b>						
Benzene	X			X		
Other Organic Solvents		X			X	
Vinyl Chloride	X			X		
1,3-Butadiene		X		X		
Ethylene Oxide	X			X		
Aromatic Amines		X			X	X

\* International Agency for Research on Cancer (IARC) carcinogenic risk classification is based on evaluation of potential tumor development at all sites, not only breast/mammary tissue. Categories include: Known, Probable, Possible, and others.

\*\* The National Toxicology Program (NTP), within the National Institute of Environmental Health Sciences of the National Institutes of Health, provides carcinogenicity ratings based on scientific evidence in both animals and humans. Categories include: Known, Reasonably Anticipated, and others.

\*\*\* To date, neither the NTP or IARC have classified most endocrine disruptors as carcinogens in humans. List of endocrine disruptors excerpted from: Brody JG, Rudel RA (2003). Environmental pollutants and breast cancer. Environmental Health Perspectives 111:1007-1019.

## WHAT YOU CAN DO

**Advocate for smarter laws that protect public health.** Laws are being drafted across the country at both the state and federal levels to reform this country's outdated system of managing chemicals. Visit Breast Cancer Fund's Legislative Toolkit at [www.breastcancerfund.org/toolkit](http://www.breastcancerfund.org/toolkit) to learn more about state efforts and what's going on in Congress to eliminate toxic chemicals from children's toys, child care items, baby bottles and cosmetics as well as broader efforts to create comprehensive chemicals policy reform.

**Take action.** Demand greater accountability from elected officials, government agencies and companies that can make a difference for our health. Each month, we feature a new action on our Web site and in our e-newsletter that makes it easy for you to support breast cancer prevention. Sign up online to receive our monthly e-newsletter and we'll send the action direct to you, along with the latest news about research, laws and product safety. Then, spread the word by sharing it with your family and friends.

**Get the facts.** Visit [www.breastcancerfund.org](http://www.breastcancerfund.org) to find the most recent science about breast cancer and the environment, learn how your state can pass legislation that reduces toxic environmental exposures and access electronic or hardcopy materials to help spread the word that prevention is possible. You can also visit the Breast Cancer Fund's blog at [www.breastcancerfund.org/blog](http://www.breastcancerfund.org/blog) and sign up for our RSS feed.

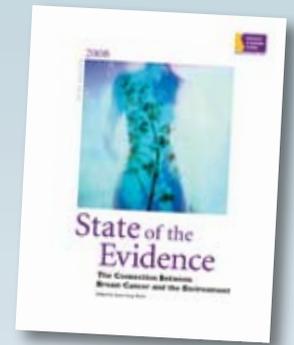
**Reduce your risk.** Make safer choices for you and your family with the consumer exposures over which you have control. Some examples: limit your use of plastic food and beverage containers, never heat foods in plastic, buy hormone-free meat and milk, avoid household pesticides, use safe cleaning products and choose personal care products that are free of toxic chemicals. Find more information at [www.breastcancerfund.org](http://www.breastcancerfund.org) and [www.safecosmetics.org](http://www.safecosmetics.org).

## ACKNOWLEDGMENTS

The Breast Cancer Fund gratefully acknowledges the following foundations and corporation that supported the production and printing of this edition of *State of the Evidence*: Betsy Gordon Foundation; The Twinkle Foundation, Inc.; the Heinz Endowments; The Center for Environmental Oncology at the University of Pittsburgh Cancer Institute as part of the Healthy Places, Healthy People program of the Highmark Foundation; Devra Lee Davis Charitable Foundation; and Clif Bar & Co., makers of LUNA.

## IN-DEPTH

**State of the Evidence 2008 includes tables and detailed explorations of:**



- Breast Cancer Rates Are Falling?
- Breast Cancer Incidence and Mortality by Race and Ethnicity
- The Falling Age of Puberty in U.S. Girls
- Breast Cancer Molecular Markers
- Timeline of the History of Sex Hormones and the Use of Estrogen for Menopause
- The Connection Between Pesticides and Breast Cancer
- Breathing It All In: Chemicals in the Air
- A Tale of Two Estrogens: BPA and DES
- Atrazine, Frogs and Breast Cancer
- The Connection Between Plastic and Breast Cancer
- Household Cleaning Products and Human Health Concerns
- Very Personal Pollution: Cosmetics Ingredients of Concern for Breast Cancer
- The Connection Between Cosmetics and Breast Cancer
- Occupations Associated with Increased Risk of Breast Cancer
- History of Cancer Registries
- Agencies That Track Cancer Data
- Nanotechnology: Friend or Foe?



1388 Sutter Street, Suite 400  
San Francisco, CA 94109  
(866) 760-8223  
[info@breastcancerfund.org](mailto:info@breastcancerfund.org)

For references for this document, visit [www.breastcancerfund.org/evidence](http://www.breastcancerfund.org/evidence)  
If you do not have Internet access, call the Breast Cancer Fund at 866-760-8223  
to request materials and get involved.

♻️ PRINTED ON 100% RECYCLED, 50% POST-CONSUMER, PROCESSED CHLORINE-FREE PAPER.