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A Comprehensive Analysis of How Environmental Risks of Breast Cancer are Portrayed on the Internet

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Abstract

Background—Effective online communication about the environmental risk factors of breast cancer is essential because of the multitude of environmental exposures and debate regarding the conclusiveness of scientific evidence.

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Purpose—The aim of this study was to assess the content, readability, and cultural sensitivity of online resources focused on the environmental risks factors of breast cancer.

Methods—A purposive sample of webpages focused on environmental risk factors of breast cancer was obtained through a Google search using 17 search terms. Using nonparametric statistics, we assessed the content, readability, and cultural appropriateness of 235 webpages.

Results—Eighty-two percent of webpages referred to research studies in their content. For the majority of sites, readability was at a high-school reading grade level. Webpages were not explicitly intended for specific racial/ethnic groups.

Discussion—Technical language and non-culturally specific messages may hinder users' attention to and comprehension of online breast cancer information. Additional research is needed to examine in-depth the accuracy of this online content.

Translation to Health Education Practice—Findings suggest that collaborations between scientists, health educators, website designers/media professionals, and the community will be critical to the delivery of accurate, up-to-date, plain-language, and culturally sensitive information about breast cancer and the environment.

Keywords

Breast cancer; environmental risk factors; readability; website content

Background

Breast cancer is the most common, non-skin cancer among women in the United States (US), and the second leading cause of death after lung cancer.[1] In 2017, 252,710 new cases and 40,610 deaths were expected from breast cancer.[1,2] National- and state-level statistics highlight breast cancer disparities among different racial/ethnic groups.[3–7] The mortality rate for African-American women is significantly higher with 29.2 deaths per 100,000 persons as compared 20.6 deaths per 100,000 persons for Whites.[2]

According to the National Institute of Environmental Health Sciences (NIEHS), environmental risk factors of breast cancer include exposure to chemicals such as pesticides, industrial pollutions, additives in everyday consumer products, and physical agents such as radiation (often from X-rays); and social-cultural factors in the community and society which influence exposure to cancer risks.[8] However, more research is still needed to understand how exposure to certain chemicals in the environment can affect breast cancer risk.[8] Emphasis is placed on understanding the dose-response relationship between breast cancer and chemicals with the added importance of understanding this exposure from a life course perspective, i.e. examining these exposures during sensitive phases of a woman's life such as puberty, pregnancy and lactation, and the post-menopausal phase.[9,10–13] Study of environmental factors is also critical from a social justice perspective for assessing differential exposures and risks based on race, ethnicity, and income, and promoting active participation of different communities in the planning and development of programs and policies with the ultimate goal of reducing health disparities.[14]

In October 2008, US Congress passed the *Breast Cancer and Environmental Research Act*,[15] requiring the Secretary of the Department of Health and Human Services to create an Interagency Breast Cancer and Environmental Research Coordinating Committee (IBCERCC; http://www.niehs.nih.gov/about/boards/ibcercc/) to assess the current state of research on breast cancer and the role of the environment in elevating risk. In 2012, an Institute of Medicine (IOM) report entitled, *Breast Cancer and the Environment: A Life Course Approach* was published.[16] A major report recommendation was to identify effective strategies for communicating accurate and reliable breast cancer risk information to diverse audiences given that individuals possess different literacy and numeracy skills and may prefer different formats for receiving and responding to health-related information.[17–19] Prior research has examined the format and readability of breast cancer risk assessment tools [20,21], however, important research questions persist regarding messaging about the link between breast cancer and environmental exposures.

Key recommendations from a 2013 report of the IBCERCC guiding our research are to translate and communicate science to society and prioritize disease prevention.[8] Seeking health information online for diseases, symptoms, causes, and treatment is now commonplace.[22,23,24] There is an abundance of information through web searches, social media, blogs, videos, health-specific websites, and information from non-governmental organizations among others.

Quality of online resources in terms of source credibility and content accuracy is questionable.[25–27] Accurate and actionable information is important to promote health behavior change. One manner in which the media may influence health behavior is through mobilizing information –information and resources that encourage individuals to take action and seek further communication.[28, 29] ‘Contact us’ links, links to other websites, or content containing calls for action are considered to be mobilizing information.[28,29] The importance of mobilizing information is emphasized by the health belief model[30] and in a framework of consumer health literacy[31] in which media coverage of health is a cue to action that can initiate individuals’ readiness to engage in health behaviors. Therefore, the quality of information is critical for online health communication if the expectation is that users apply the health knowledge gained from the Internet for positive behavior change.

Several studies have reviewed general breast cancer information on different online platforms.[32–34] A recent study examining online content about breast cancer treatment showed variability in the quality of websites as indicated by date, disclosure of authorship, and sources/references provided. Health-related websites such as WebMD scored high on quality while commercial websites, that sold goods or provided a service for a fee, scored low.[32] Another analysis of breast cancer posts on different online portals, such as websites, social media, blogs, and peer-reviewed journals showed that accuracy of information was highest among media websites, peer-reviewed journals, and social media sites, and lowest among blogs.[33] The authors also noted that having an identifiable author(s) was more likely to be associated with accurate information.

Another study by Quinn and colleagues showed that Internet searches for symptoms, signs, stages, care and survival of breast cancer on search engines may not yield relevant

information, which may make it difficult to find credible websites to obtain pertinent and accurate information. They demonstrated that websites related to educational institutions contained the most accurate information while websites run by groups with special interests presented the least accurate information.[34] Overall, credibility and accuracy of information remains an issue due to high volume of content and varied sources of information on the Internet.[18,33,35]

Readability of online content also is an important issue to consider for effective communication and comprehension.[36] The United States Department of Health and Human Services recommends health information be available at a sixth grade reading level,[37,38] but evidence suggests that readability is usually at a high-school level. For example, Internet-based patient education for mammography screening is written at a high school reading level.[39] Other research on the readability of online risk assessment tools for breast cancer found that the mean reading grade level for these tools was 12.1,[20] indicating possible difficulty in the public's understanding of this information. Providing messages in plain language is crucial for effective health communication and ultimately better health outcomes.[17,40] Creating understandable health information is critical for improving health literacy, which is an asset that encourages empowerment and opportunities for participation that allow individuals and communities to take control of their healthcare and the health of their families.[41]

Culture influences health beliefs and values, and affects health message uptake and health utilization, therefore, adapting health information to the cultural perspective of different racial/ethnic groups (i.e., using culturally sensitive materials), is critical for effective health communication.[42,43] Information from internet sources may not be culturally sensitive, especially regarding messaging geared for racial/ethnic minorities.[44] A systematic review of studies assessing web-based materials for various cancers found that most of the online information did not include risk information specific to racial/ethnic groups or include representative images demonstrating that the content would be relevant to specific racial/ethnic groups,[36] Developing culturally sensitive information is essential for better receptivity and acceptance of health messages.

Assessment of information content, readability, and cultural sensitivity has been studied, mostly separately, on several aspects of breast cancer including general risks, symptoms, and treatment.[35,45,46] However, there is limited evidence regarding Internet communication of environmental risks causing breast cancer. Specific to environmental factors related to breast cancer risk, research has focused either on certain environmental factors, effects of visual presentation in communication of health risk, or information available in the news media.[47,48] Accuracy of content, readability, and cultural sensitivity are important for the communication of environmental risks of breast cancer because of the variety of environmental exposures studied, the debate on the conclusiveness of current findings, misinterpretation of findings in the media.[49] Effective environmental risk communication for breast cancer also underscores the need for more research and collaboration between clinicians, health educators, and media professionals for improved public knowledge.[50] To be able to deliver appropriate health information through one of the most commonly used

forms of media, it is essential to understand the existing landscape of online information about the environmental risks of breast cancer.

Purpose

Our study focused on assessing the content, readability, and cultural sensitivity of online resources found through targeted web searches focused on the environmental risks of breast cancer. Our study specifically focuses on known or suspected carcinogens including industrial pollutions and additives in every day consumer products that act as endocrine disruptors.[51,52]

Methods

Sampling Procedure

We conducted a Google™ search to obtain a purposive sample of online resources related to environmental risks of breast cancer. Our search was guided by the IBCERCC's description of environment that includes chemical agents and physical agents.[8] We sought to include names of specific chemicals found in everyday consumer products or the environment such as in air or water. We also included plain-language search terms that lay individuals would choose to use when conducting a search themselves. The technical search terms were guided by an appraisal of the systematic review literature on specific chemicals and their relationship with breast cancer risks.[53–57] We also collaborated with an environmental health scientist to guide the inclusion of specific chemicals/physical agents in the search terms. For the determination of plain-language terms to be used for the search, information was drawn from community focus groups and partners from community-based adult literacy centers.

Each search term included a specific chemical or physical agent, which is a known or suspected environmental risk in combination with the words "and breast cancer" (e.g. BPA and breast cancer, air pollution and breast cancer etc.). In total, we used 17 search terms (Table 1). Specific chemicals included in our search terms are known or suspected environmental risk factors present several products, and are mainly endocrine disruptors mimicking the role of estrogen, which promotes cell growth. The chemicals included were: 1) phthalates - a group of chemicals added to give a variety of plastic products more flexibility to prevent breakage[58]; 2) bisphenol A (BPA) - a chemical used in plastic production to make products such as containers, bottles, and are used in linings of food cans; [59] 3) parabens - chemicals routinely used in cosmetics as preservatives to prevent the growth of bacteria and mold;[60] 4) polychlorinated biphenyls (PCB) and dioxins - chemicals resulting from industrial pollution,[61] 5) polyaromatic hydrocarbons (PAH) - group of chemicals resulting from incomplete burning of fossil fuels or other organic substances such as meat or tobacco;[62] and 6) aluminum - active ingredient of chemical compounds used in antiperspirants to block the sweat from sweat glands to the skin, thus preventing perspiration.[63] The search was conducted on July 6, 2017. We selected the first 30 results for each search term to obtain a total sample of 510 webpages. Only webpages relevant to environmental risk and breast cancer were included while webpages that were duplicates, only contained images, videos, abstracts or scientific articles, and forums were excluded (Figure 1). The final sample for the analysis consisted of 235 webpages.

Codebook Development

A comprehensive codebook was developed to assess and quantify the content, readability, and cultural appropriateness of the online resources.

1. Content—For content, we assessed multiple aspects including format, focus area of information, accuracy, and mobilizing information. We coded for written format structure, type of webpage- state or national agencies, non-governmental/non-profit organizations, educational institutions, consumer websites, newspaper and other news media, magazines, and blogs. We noted types of chemicals described, and focus of the webpage content including description of risks and relationship between breast cancer and environmental risks. To assess the content, we included codes indicating the description or mention of research studies in the webpage text as well as the nature of the relationship between environmental factors and breast cancer risk described in the research studies. We coded for the presence of mobilizing information such as providing contact information for author/ organization or having a specific call for action. We also coded for provision of additional links for references to research, other media articles, or organizations.

2. Readability—The SMOG (Simple Measure of Gobbledygook) readability instrument used previously in content analysis research[64–66] was used to calculate reading levels for each of the resources located. Application of the SMOG measure required 10 – 30 lines of continuous text and produces a grade level.[67] SMOG was obtained through the online tool: https://www.webpagefx.com/tools/read-able/. We calculated the mean SMOG index as well as assessed the readability by the type of website.

3. Cultural Appropriateness—The Cultural Sensitivity Assessment Tool (CSAT) is the only published instrument for determining the cultural appropriateness of printed cancer information developed specifically for African Americans.[68,69] Administered by Friedman and colleagues in prior research, [65,70,71] the tool assesses three aspects of materials – format, written message, and visual presentation. The CSAT uses a Likert-type scale, ranging from 4 (strongly agree) to 1 (strongly disagree) on 3 format questions, 11 message questions, and 16 visual questions. Average scores of the three categories are compared with a minimum score of 2.5.[68] Materials with scores less than 2.5 are classified as culturally insensitive. CSAT is primarily used to assess cultural sensitive of print media therefore we only used the written section CSAT scoring for 10 out of the11 items for written messages based on their relevance to the online content. We calculated the mean score for the 10 items to obtain the final score. We also coded whether the webpages were explicitly intended for a particular racial/ethnic group and if they mentioned risk burden in a particular group.

4. Inter-rater Agreement—Two of the authors (SK, KL) coded the webpages. Percent agreement was first assessed on over 20% of the sample (n=50) between the two coders. Items requiring a yes/no or subjective responses were included in the inter-rater reliability analysis. The mean percent agreement across items was 97% with a range of 88%-100% indicating excellent agreement between coders.[72]

5. Data Analysis—All analyses were conducted in Stata SE, version 14. We used nonparametric statistics (frequencies and chi-square) for analyzing the content i.e. chemicals described, type of webpage, mobilizing information, research-based evidence, SMOG, and CSAT items. We used chi-square tests to examine the relationships between specific products/chemicals and the nature of the associations described in the research studies presented on the webpages. For this analysis, chemicals and products were grouped into specific categories to ensure that the expected cell count was not below five for the chi-square test. We grouped the webpages into four categories based on focus of the content: 1) personal beauty and care products, and related chemicals: cosmetics, deodorants, sunscreen, baby powder, aluminum, and paraben; 2) hair products: as is; 3) plastics: BPA, plastics, and phthalates; 4) industrial pollutants: air pollution, water pollution, pesticides, PAH, PCB, and dioxins. We compared readability scores across the types of webpages using the non-parametric Kruskal-Wallis test. P-values below 0.05 were considered statistically significant.

Results

The three most commonly discussed chemicals/products on the webpages (Table 2) were paraben (n=62; 26.4%), followed by deodorants (n=55; 23.4%), and cosmetics (n=47; 20%). Radiation was the least discussed physical agent (n=6; 2.3%). All of the results for the aluminum and breast cancer search focused on aluminum present in deodorants/antiperspirants and not from any other sources. Most webpages (Table 3) were authored by commercial organizations (n=86, 36.6%), followed by nongovernmental organizations (n=56, 23.8%), newspaper and news media (n=41, 17.4%), magazines and other media website (n=20, 8.5%), blog/independent authors (n=13; 5.5%), educational institutions (n=11; 4.7%), and national agencies (n=8, 3.4%). The intended audience for 78.7% of the webpages (n=185) was female, while 12.0% of the webpages (n=28) were intended for females and males. Two webpages were intended specifically for men that discussed risk related to male breast cancer.

Most of the webpages mentioned or supported their information of environmental risks of breast cancer with research studies portrayed in the media (Table 4) (n=192; 81.7%). Nearly 52% of the webpages mentioned research studies that highlighted a potential correlation between increased exposure to chemicals or product use and breast cancer. Thirty seven percent (n=87) of webpages referred to research showing the inconclusive nature of the relationship between environmental factors and breast cancer risk, followed by 12.3% (n=29) that suggested no associations between environmental factors and breast cancer risks. The associations described in the research studies environmental factors and breast cancer risks mentioned in the webpages was not mutually exclusive, i.e., in 25.1% of the webpages (n=59) contained information on studies showing positive association and negative association, or studies showing inconclusive findings with breast cancer, but positive association with other types of cancers. Mobilizing information such as ‘contact us’ information, links to other websites, or content containing a call for action was available on nearly 70% of the webpages.

Readability was generally high with mean SMOG of 10.9 indicating a high-school level reading at about an 11th grade level. The SMOG score did not differ significantly by type of

webpage (Table 3). With regard to cultural sensitivity, we did not find any webpages that were specifically intended for an audience of certain race/ethnicity. Twenty-three webpages (9.8%) specifically discussed increased breast cancer risk in African Americans, while 18 webpages (7.7%) discussed risks in White women. The majority of these webpages discussed elevated risks in both African-American and White women from a recent study on hair product use and breast cancer risk (n=24, 10.2%). [73] Five webpages focused on minorities in general, without specifying any given race/ethnicity and discussed exposure to PCBs and its relationship with breast cancer risk. The mean CSAT score was 3.6 with a range of 1.8–4.0, indicating that the webpages were culturally appropriate overall.

Significant differences were observed when webpages described the association between environmental factors and breast cancer risk by products/chemicals (Table 5, $p<0.001$). For example, when describing industrial pollutants, webpages were more likely to discuss an association with breast cancer risk (n=26; 11.1%) than having no or inconclusive association (n=16; 6.8%). Similarly, when describing plastics, webpages were more likely to discuss an association with breast cancer risk (n=14; 5.9%) than having no association (n=7; 3%).

Discussion

Our study contributes to the growing literature on online communication about environmental risks and breast cancer. Prior studies have either assessed specific websites, such as particular online media outlets[47] or specific chemicals.[48] To our knowledge, our study is the first to focus on multiple, suspected environmental risk factors to assess the current state of information available on the Internet. Our comprehensive analysis found that webpages were generally credible and contained information on research studies mainly from studies popularized by the media. We also found that readability of information was often written in technical terms and at a high-school reading grade level. Webpages were not specifically intended for a particular racial or ethnic group, but some webpages discussed increased risk for particular minority groups including African Americans and Latinos.

The majority of online content discussing the associations between environmental factors and breast cancer risk corresponded with the current science in this area.[53–57] For example, use of deodorant/antiperspirant specifically, its aluminum content, has been a common concern for breast cancer risk. A systematic review of deodorant/antiperspirant use by Allam et al. did not find an association between deodorant use and increased breast cancer risk.[57] In our sample, of the webpages mentioning research on deodorants and breast cancer, 70.6% (n=36) noted studies that had non-significant or inconclusive relationships, while 29.4% (n=15) only portrayed increased risk due to deodorant use. Another systematic review on aluminum exposure from deodorant/antiperspirant use and breast cancer showed no clear evidence of an association.[55] Our analysis of online content found that 75% (n=27) of the webpages discussing aluminum exposure from deodorant use and breast cancer mentioned inconclusive or non-significant relationship between aluminum and breast cancer risk, while 25.0% (n=9) only focused on increased risk due to aluminum exposure.

Increased risk from deodorant use was emphasized mainly in commercial websites, such as those promoting natural products, blogs, or websites related to holistic health issues. Several

websites also cautioned that inconclusive findings should still raise concerns regarding the safety of these products and suggested the use of aluminum- and/or paraben- free products. More credible websites such as those of American Cancer Society or Susan G. Komen Foundation clearly indicated no relationship between deodorant use and breast cancer.

With regard to the link between PCB exposure and breast cancer, systemic review evidence suggests mixed findings. For example, Mouly et al. found an inconclusive relationship between PCB and breast cancer[53]; two other reviews showed a positive association between PCB and breast cancer.[54,56] Similarly, our content analysis showed that of the webpages discussing research studies, 56.3% (n=9) showed non-significant or inconclusive relationship, while 43.8% (n=7) showed increased risk due to PCB exposure. While webpages mainly discussed the negative aspects of PCB exposure and breast cancer risk, the uncertainty about the exact nature of the relationship was evident.

A systematic review on PAH showed a small, but significant association between PAH exposure and breast cancer risk.[54] Our content analysis revealed mixed findings. Of the webpages that mentioned PAH-related research, 54.6% (n=6) mentioned non-significant or inconclusive findings, while 45.5% (n=5) webpages only discussed increased risk of breast cancer due to PAH exposure. Several webpages for PAH discussed a recent study on smoked meats and breast cancer-related mortality.[74]

When discussing research on environmental factors such as PAH, PCB, and deodorant, webpages provided accurate description of research studies, but conclusions derived from the findings were based on personal interests.

A majority of the webpages (70%) contained mobilizing information. In our analysis, we selected the first 30 webpages for each Google search. Popularity of websites is shown to be associated with more information on current research, regulations, and advocacy issues related to breast cancer,[45] which could also relate to more mobilizing information in our sample. Future studies should assess the quality of mobilizing information that guides calls to action to understand how it may influence behaviors. Webpages could also be examined for the quality of sources and website provided to understand if they link to credible research and/or accurate information.

The readability recommendation for the general public is at a sixth-grade reading level, however, readability of the webpages in our sample was at a high-school reading level indicating possible difficulty in reading and comprehension of the information.[38] There were no differences in readability scores based on type of webpage; webpages often used the same technical jargon described in original research studies being referenced. Our readability results are consistent with previous studies, which have found high readability levels for other breast cancer-related topics such as risk assessment and treatment.[20,65,75] Our results clearly highlight the need for more plain-language dissemination of research about environmental risk factors.[76]

Webpages in our sample were not targeted toward a particular racial/ethnic group, but some webpages discussed higher risk of environmental exposure and/or breast cancer in a certain group mainly within the context of discussing research studies. The CSAT score was high

indicating the information on webpages was culturally sensitive. Previous research on assessment of cultural sensitivity of cancer information has also demonstrated similar findings.[31,44] Future studies could focus on using other items of the CSAT to understand more comprehensively additional aspects of cultural sensitivity such as pictures/images.

Our study has certain limitations. First, our sample was purposive and dependent on the popularity and placement of websites on a search engine at one particular point in time. The temporary nature of placement search results does not make our study generalizable to all search results over time. Future studies can triangulate search results from other web search engines to understand how placement of search results influences content of health information. Second, SMOG and other readability formulas do not take into consideration readers' comprehension or familiarity of words. Text with long words, sentences, and paragraphs receive higher scores. Readability tests such as SMOG do not provide information on the organization of text, which may aid in better comprehension, however, readability is not a sole predictor of comprehension.[77] Despite the limitations of readability instruments, this is the first comprehensive assessment of the reading grade level of breast cancer and environmental risk education materials in combination with other analyses on the resource content. Future studies could test sample text from webpages with low and high readability scores to understand readers' perspectives and comprehension.

Third, although the CSAT is a quick and useful tool for assessing surface cultural sensitivity, as would be appropriate for online content analysis, it is not intended to evaluate deeper, historical characteristics.[78] With multiple potential environmental risk factors that might affect racial/ethnic groups, qualitative evaluation is required to understand the responses that might be elicited by specific groups from information that is categorized as culturally sensitive. This community-engaged exercise could help provide a more targeted approach to developing culturally sensitive health information.

Translation to Health Education Practice

Our research findings have several implications for health education practice. It is essential to provide the most up-to-date information about the evolving research on environmental risk factors and breast cancer. Information inconsistent with the current state of the science may be supported and propagated through selective studies; therefore, it is important for health educators to help clarify existing misinformation about environmental risks and to know the current position, including uncertainties. National- and state-level websites have accurate messages about environmental risks, but the majority of websites intended for the general public may not provide relevant and accurate information with appropriate references. This issue could be addressed through collaborations between health educators, scientists, website organizers, and media professionals to ensure the provision of accurate information.[79] Collaboration between health educators and website organizers can help in not only providing accurate, current, and relevant information, but it can also help provide information on relatively simple, preventive measures to minimize exposure to relevant environmental chemicals. The general public should also be made aware of credible websites by incorporating information from credible research agencies on various websites and providing necessary links to their websites.[2, 80,81] A community-based effort involving

clinicians, a local library, and consumer representatives to guide the general public regarding online information seeking found improved ability among participants to locate evidence-based information.[82]

The translation of technical research findings into plain language, without loss of meaning or accuracy, will also be essential for all websites (government, educational, commercial, etc.) to improve understanding of scientific evidence and communities' health literacy regarding the environmental risks of breast cancer. For example, previous research has involved rewriting a technical report on water quality into plain language information and providing clear information on necessary steps needed for this process.[83] Such efforts should be extended to additional environmental risks for people with varying literacy levels. Health educators need to be involved in the development and dissemination of such information to ensure clear language.[52] In addition, health educators can play a role in helping communities access this information in the first place and help improve their computer literacy by providing education on how to access credible information online.[72]

Culturally sensitive materials need to be developed in collaboration with intended communities so that messages are identifiable and acceptable to particular high-risk ethnic groups. For example, to help guide the development of messages about breast cancer screening for African-American women, Best et al. actively engaged with African-American women through nominal group sessions and key informant interviews to identify themes related to spirituality and health.[84] Given the vast amount of online content and the complexity of the evidence regarding the environmental risks of breast cancer, it is critical that health educators and communication and media professionals are involved in the dissemination of clear and culturally relevant messaging for diverse, high-risk communities.

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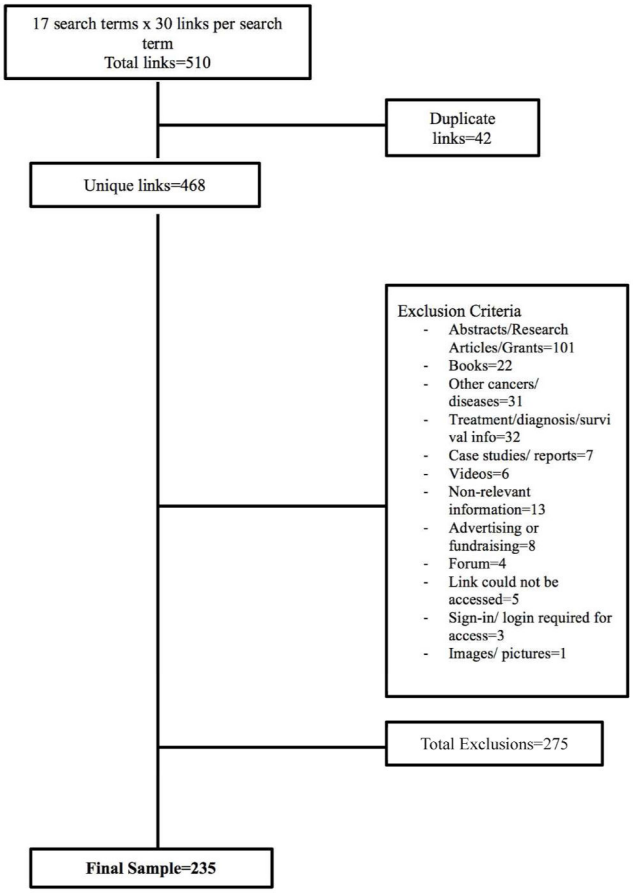

Figure 1.
Sampling procedure for selection on online resource for environmental risks of breast cancer

Table 1

Search terms for online resources of environmental risks of breast cancer

No.	Search Terms
1.	Cosmetics and breast cancer
2.	Deodorant and breast cancer
3.	Sunscreen and breast cancer
4.	Hair products and breast cancer
5.	Baby powder and breast cancer
6.	Pesticides and breast cancer
7.	Air pollution and breast cancer
8.	Water contamination and breast cancer
9.	Plastic and breast cancer
10.	Phthalate and breast cancer
11.	BPA and breast cancer
12.	Paraben and breast cancer
13.	PCB and breast cancer
14.	Dioxin and breast cancer
15.	PAH and breast cancer
16.	Aluminum and breast cancer
17.	Radiation and breast cancer

BPA: Bisphenol A

PCB: Polychlorinated Biphenyls

PAH: Polyaromatic Hydrocarbons

Table 2

Commonly mentioned chemicals and products in online searches related to breast cancer, n=235

Products/Chemicals	N (%)
Paraben	62 (26.4)
Deodorants	55 (23.4)
Cosmetics	47 (20.0)
Plastic	45 (19.1)
BPA	38 (16.2)
Aluminum	37 (15.7)
Hair Products	33 (14.0)
Phthalates	29 (12.3)
Air pollution	29 (12.3)
Pesticides	29 (12.3)
Sunscreens	19 (8.1)
PCB	16 (6.8)
Dioxins	12 (5.1)
PAH	12 (5.1)
Radiation	7 (3.0)
Others	77 (32.3)

BPA: Bisphenol A

PCB: Polychlorinated Biphenyls

PAH: Polyaromatic Hydrocarbons

Table 3

Readability assessments of breast cancer webpage by type of website, n=235

Type of Website	N (%)	Median SMOG Score (Grade level)	Interquartile Range
Commercial websites	86 (36.6)	11.1	10.1–12.3
Non-profit organization websites	56 (23.8)	10.9	9.7–11.9
Newspaper and other news media websites	41 (17.4)	10.7	9.9–11.6
Magazines and other media websites	20 (8.5)	10.8	9.4–11.6
Blogs/Independent authors	13 (5.5)	10.4	9.3–12.2
Educational institution websites	11 (4.7)	10.8	9.0–13.1
National agencies	8 (3.4)	10.9	9.7–11.5
All	235	10.9	9.9–11.9

Kruskal-Wallis statistic: 2.008; p=0.9189

Table 4

Association between environmental factors and breast cancer risks described in research studies referenced on webpages, n=235

Research focus on webpages	N	Percent*
Shows association between environment factors and breast cancer risk	123	52.3
Shows inconclusive findings about environmental risk factors and breast cancer risk	87	37.0
Shows no association between environmental factors and breast cancer risk	29	12.3
Shows association between environmental factors and *ANY* cancer risk	23	9.8
Show no association between environmental factors and *ANY* cancer risk	2	0.8
No research studies included	43	18.3

* Multiple research focus categories applicable, therefore adds up to greater than 100%.

Table 5

Association between environmental factors and breast cancer risks described in research studies referenced on webpages by products/chemicals, n=235

Products/Chemicals	Association with breast cancer risk N (%)	No association or inconclusive association with breast cancer risk N (%)	Multiple research foci N (%)	No research or research findings for other cancers only N (%)	Total N (%)
Personal beauty and care products, and related chemicals[1]	23 (9.8)	25 (10.6)	19 (8.1)	24 (10.2)	91 (38.7)
Hair Products[2]	12 (5.1)	9 (3.8)	1 (0.4)	2 (0.8)	24 (10.2)
Plastics[3]	14 (5.9)	7 (3.0)	7 (3.0)	12 (5.1)	40 (17.0)
Industrial Pollutants[4]	26 (11.1)	16 (6.8)	32 (13.6)	6 (2.5)	80 (34.1)
Total	75 (31.9)	57 (24.3)	59 (25.1)	44 (18.7)	235 (100)

Chi-square: 32.4747; $p<0.001$

Note:

[1]Personal beauty and care products, and related chemicals: Cosmetics, deodorants, sunscreen, baby powder, aluminum, and paraben

[2]Hair Products: as is

[3]Plastics: BPA, plastics, and phthalates

[4]Industrial Pollutants: Air pollution, water pollution, pesticides, PAH, PCB, and dioxins