



A review of media effects: implications for media coverage of air pollution and cancer

Nandita Murukutla, Namrata Kumar, Sandra Mullin

Vital Strategies, New York, NY, USA

Contributions: (I) Conception and design: All authors; (II) Administrative support: None; (III) Provision of study material or patients: None; (IV) Collection and assembly of data: N Murukutla, N Kumar; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Nandita Murukutla, PhD. Vital Strategies, 100 Broadway, New York, NY 10006, USA. Email: nmurukutla@vitalstrategies.org.

Abstract: Air pollution is responsible for 7 million global deaths annually, including from non-communicable diseases such as cancer. Despite the fact that air pollution-related diseases and deaths are preventable, global action for clean air has been slow. Given the media's vital role in social and policy change, this paper reviews the existing literature on how the media portrays air pollution and the implications this has on perceived links between air pollution and cancer. Our review finds that the media has created public attention toward air pollution and has been effective in raising risk perceptions, but our review also indicates gaps in media reports, including an under-emphasis on health effects. There is a tendency to report episodic incidents rather than chronic air pollution issues, and also scant discussion on solutions to air pollution. The paper concludes with recommendations on how media can play a more effective role as an interlocutor of complex scientific information, enabling an accurate understanding of air pollution and its impacts on health in general and cancer in particular. The media can also improve its audience's ability to interpret and act on this information.

Keywords: Air pollution; cancer; media; news; reporting; social change; policy change

Received: 07 April 2019; Accepted: 09 July 2019; Published: 23 August 2019.

doi: 10.21037/ace.2019.07.03

View this article at: <http://dx.doi.org/10.21037/ace.2019.07.03>

Introduction

Air pollution is responsible for 7 million global deaths annually (1). Initially linked to lung diseases alone, recent epidemiological evidence has established air pollution as a risk factor for a range of noncommunicable diseases (2,3), including 24% of deaths due to strokes, 25% of deaths due to ischemic heart diseases, and 43% due to chronic obstructive pulmonary diseases (4). Air pollution is responsible for 16% of all premature noncommunicable disease (NCD) deaths (2,3) with most of these occurring in low- and middle-income countries (5).

The epidemiological evidence of the link between air pollution and cancer has been slower to emerge, not least because of the time lag between exposure and the manifestation of disease (6). However, evidence of this

association is also now growing: air pollution has been linked to about 500,000 annual premature lung cancer deaths (2), and it has been linked to the development of breast cancer, bladder cancer, lymphoma, and childhood leukemia (2,7-10).

Air pollution-related morbidity and mortality are preventable (2). Moreover, air quality improvements are associated with almost immediate positive effects, including demonstrated improvements in the birth weight of babies (11), increased lung function in children (12) and reduced mortality risk in adults (13). These findings suggest a tremendous opportunity to save lives by protecting people from the harms of air pollution.

Yet, global action to reduce air pollution has been slow (14). While there may be a number of reasons for this, misinformation in the media and the resultant apathy may

be at least in part to blame. Just as the misrepresentation of climate change and other environmental hazards have decelerated global action on these issues (15-17), so too is there evidence that the mischaracterization of the extent and harms of air pollution is impeding progress (18). Thus, intentionally or otherwise, the media itself can create a situation of apathy and inaction (19,20).

Given the media's vital role in political and social change (21,22) and the growing burden of air pollution, there is a critical need to identify how the media might influence global action for clean air. The media's role is likely to be particularly important as the public and policymakers grapple with increasing evidence of air pollution's impacts on longer-term complex illnesses, such as cancers.

Indeed, a significant body of research has found that the media has a tendency to mischaracterize cancer and thus perpetuate misinformation. Cancer is often described as an "evil, immoral predator" or a "fugitive killer" that must be vanquished (23), resulting in cancer being among the most highly feared illnesses (24,25). The media's descriptions of cancer's causes are often conflicting and have tended toward scientific oversimplification (26-28). When the causes of cancer and its prevention are mentioned, the explanations tend toward the biomedical with an emphasis on diagnostics to catch cancer early or to individual "lifestyle" choices as the cause. Rarely are the systemic causes of cancer, including environmental hazards such as air pollution, mentioned (24). Hence, as the public and policymakers grapple with the health impacts of air pollution, including on complex diseases like cancer, the role of the media in providing accurate information and scientific clarity is critical (29).

The goal of this paper is to review the existing literature on how the media portrays air pollution and the implications this has on perceived links between air pollution and cancer. Our review begins with a brief summary of media theories and the evidence on how the media influences social and political change. We then review and synthesize existing studies of media reports of air pollution. We conclude with a discussion of how the media could more accurately communicate the health risks of air pollution, which could in turn help to accelerate action for clean air.

To conduct this review, a comprehensive search was conducted in online databases for articles relevant to the topic of this paper¹. While our approach was not to conduct a systematic review, the result is a comprehensive summary of published studies to date. We have included all media studies that dealt primarily with the news coverage in mass media, including social media. We did not include in this analysis paid mass media campaigns that are explicitly designed to lead to social and behavior change.

A summary of media effects

The media plays a powerful role in society as purveyors of information. For the public as a whole, the media is often the primary source of information (30), and media representations, particularly those in news programs, are typically accepted uncritically as a true reflection of reality (19,31,32).

When it comes to scientific information, the media acts as a bridge between scientists and the general public, distilling complex facts into actionable information (33). On public health matters, the media has the additional important function of signaling health risks. The media plays a critical role in alerting audiences to health threats, particularly when these threats are unseen or impalpable. The media can act as "watchdogs" helping audiences weigh the likelihood and severity of the risk, their personal vulnerability to it, and how they can protect themselves from harm (34-36). Indeed, this critical role of the media in communicating risk and creating the desired social, political and behavioral change to adapt to the risk has been documented in a number of public health areas, including HIV, vaccines, tobacco control, road safety and injury prevention, to name a few (37).

The pathways through which the media effects social and political change have also been an area of intense examination. The evolution in thinking in the social sciences has led to the recognition of the fluid processes by which the media influences society but is also shaped by it (38-41). Thus, the impact of the media is not just one directional, but it is the result of the interactions between the message, the messenger and the audience. A key consideration here, highlighted by social psychologists, is the influence of the

¹ We searched the following databases for relevant articles: PubMed, Google Scholar. Search terms included the following in varied combinations to identify articles under each of the subsections in this paper: "air pollution" "haze" "smog" "media" "news" "media theory" "cancer" "news analysis" "media studies."

audience's prior interests and motivations on how a message is attended to and acted upon (42-45).

The three currently dominant theories of media effects include (46): Agenda Setting Theory, which posits that the media conveys an issue's importance—it sets an agenda—through the very emphasis it places on the topic (47). Literally, the more a topic is covered, and the greater the prominence it is given in the media, the more important it is perceived to be. Priming Theory is similar to agenda setting theory in that it also suggests that public priorities are communicated through the amount of available information on the topic (41,48). However, priming theory is more specifically focused on the memory traces that the media creates to make a topic memorable and salient, and thus to be perceived to be of higher importance.

Finally, the theory of framing refers to the angles that the media emphasizes and suggests are most noteworthy (38-40,46). Thus, the manner in which an issue is characterized—for example, as a public health versus an economic issue—influences how an audience will perceive information or assess a health threat. Journalists frequently frame and break down complex scientific data to help audiences understand the key implications (49,50). But, in doing so, they also—inadvertently or intentionally—influence how that data or public health risk is assessed and acted upon. Hence, a study of media frames can be critical to understanding the impact of media reporting on social and political change.

Thus, the media plays an important societal role in helping people gather information and thereby construct their reality. Through varied means—frequency and consistency of coverage, the frames provided to issues—the media distills complex information into usable form, and, in public health matters, enables risk to be assessed and evaluated for action. This function of the media may be particularly important on complex matters like air pollution where adverse experience may not be available to guide the assessment of risk.

Review of media coverage on air pollution

A number of studies have examined media reports on air pollution. Many of these studies have not only analyzed the content of the media reports, but have also associated it with public opinion, thus deducing how the media may have shaped discourse. In this section, we describe the key findings from these media studies arranged under the dominant themes that emerged through the review.

Our review found that the location where the media studies were conducted reflect political and social priorities. Most of the earlier studies of the media and air pollution took place in developed economies, in particular the United States and the United Kingdom (51-57). During that time, these were also the places where vigorous debates were occurring around clean air laws. More recently, as air pollution has been established as a global crisis with a particular burden in developing countries, so too have the studies of the media increased in those locations. Several recent media analyses have been in China (58-60), India (61,62), Southeast Asia (63), Mexico (64) and Korea (65), where issues of smog and transboundary haze have been acute. Our review also identified media studies on air pollution in Iran (66) and Macedonia (67).

Across these studies, it was established that the news media was the chief source of information for the public on air pollution (57,68-70). Media salience or the prominence given to air pollution issues was associated with increased public concern: for instance, in a media analysis of Japanese newspaper content, there was not only an increase in coverage of global warming (including air pollution) issues over a 10-year period, but this coverage also correlated with public concern on the issue (71). Similarly, an analysis of Korean news reports of transboundary haze from China found an association between the topics emphasized in the media and public attention to these issues (65).

Moreover, the media has been found to affect risk perceptions and attitudes toward air pollution. In one experimental study of media messages, articles that used a “social change” frame were more likely to increase a sense of personal risk and a desire for action than those that used a status quo frame in reporting (72). In the aforementioned study from South Korea, media frames on air pollution and China were associated with the public's negative attitudes toward China's actions to mitigate air pollution (65). Indeed, as noted in a study by Ader *et al.* (73), the association between media coverage of pollution (including air, water and waste) and subsequent public concern for the issue may occur irrespective of the reality of actual conditions. This association is consistent with the finding that for “unobtrusive” or impalpable issues that people cannot always feel or directly experience, such as air pollution, the media plays a particularly powerful agenda-setting role (73,74). When risk perceptions are heightened, they have been found to trigger protective action, such as the seeking of shelter indoors during acute events (75).

Media studies note shortfalls in the role that the media

has hitherto played on air pollution. A common observation across the studies and varied contexts was the adherence to traditional journalistic norms (76–82). For one, a number of studies have noted that air pollution, as an environmental or a public health issue, tends to receive less attention and less prime space than topics traditionally more favored by the media. For instance, a study from Macedonia found that articles on air pollution had a smaller number of columns or amount of space than articles on other topics thought to be of greater interest (67). A study in Mexico similarly found that the themes most often covered by the news related to conflicts, controversy, and confrontation; public health and air pollution received significantly fewer mentions (64). Similar trends were observed in a study from Iran (66). A study of Swedish television news over a three-decade period from 1979 to 2009 found that while all issues undergo “issue attention cycles,” that is, fluctuations in the amount of coverage accorded to the issue, environmental news (including air pollution), was most likely to be “crowded out” by topics such as the economy, conflict or war (83). Analysis of non-news television content from 1991 to 1997 in the United States found that environmental themes generally appear less frequently; themes that were prominent included law enforcement and family (53).

Furthermore, when air pollution is reported upon, it is often seen through a political or an economics lens. In media studies of climate change news that have examined the attention given to air quality as a health issue, it was found that health impacts were less often mentioned than other frames, such as “science,” political or ideological struggle and so on (84). Even when health is mentioned, it is done so in general terms and with a focus on more commonly known lung illnesses (62). This was the case even when health considerations underlay policy decisions to address air pollution. A study of Mexican news examined media reports of acute air pollution that led the government to issue an emergency measure to restrict the volume of traffic on the roads. Even though protection of public health was a prime consideration behind the policy, the study found that the news media mainly covered non-health issues, such as the economic effects and inconvenience to motorists, thereby losing the opportunity to make the public health case for the policy (64).

In a similar vein, a number of studies note the reliance of media reports on official documents and political sources over scientific sources. In a study from Iran, it was found that the news tended to take a conservative perspective and relied on non-scientific official documents, interviews

and commentaries to substantiate its stories. Moreover, it found that the authors of these news articles were less likely to be scientists than they were to be politically connected: only 10% of articles were authored by researchers; in contrast, officials and columnists represented about 45% of the contributions. Similarly, in a study of news reporting on the Indonesian haze, news reports in three Southeast Asian countries—Singapore, Indonesia and Malaysia—relied on “information subsidies” (ready-to-use information that is provided for immediate use to the news media) or government and official sources (63). Media studies out of China similarly note deference toward government officials (58,85). The aforementioned study of Mexican news (64) likewise found that there were relatively few sources quoted, and among those quoted, most were government officials, suggesting that the media was merely restating government information. Finally, a study of air pollution news reporting in India found that most articles tended to cite international news wires, with consequently too little emphasis on local issues. They also tended to place a greater emphasis on government and political sources, reflecting the media’s focus on policymakers (61). These findings illustrate the more political lens through which air pollution issues are often presented. This may be done to comply with journalistic norms that see more news value in politics while also reflecting lower capacity in newsrooms to report on scientific matters. The net outcome is that the scientific and medical significance of air pollution is downplayed as is the public health imperative for clean air policies.

A number of the media studies also highlight the common journalistic practice of media reporting around specific events or “news pegs,” including catastrophes that are rare but highly sensational (76–82). Hence, rather than address air pollution in an ongoing manner, the reporting has tended to revolve around extreme events or episodes. For instance, the 2012 study of online news reporting in China around the “Blue Sky Project” found that the news tended to focus on splashy events organized by government officials (85). Similarly, a study that looked at the news reporting in three Southeast Asian countries found that the newspaper reporting tended to be highest around specific events, such as the Indonesian haze episodes in this case (63). This trend may however be changing: a study of media coverage in China around and after the Beijing Olympics found that air pollution has started to receive longer-term media attention. Episodic reporting, which is more common than not, is problematic since it (I) results in focus on the shorter-term rather than the longer-term impacts, and (II)

it conveys that the episodes are what is particularly harmful, distorting the risk that accrues from chronic and systemic exposure (81). This skewed sense of risk is particularly harmful to issues like air pollution and diseases that develop over time, such as cancer.

Finally, a number of studies have noted a passive rather than an active tone on the issue of air pollution, particularly in terms of mentions of blame and solutions. The study of Mexican news stories (64) found that solutions to the problem were among the least-mentioned topics in the articles. Scientific explanations for the problem and potential solutions were not mentioned. Furthermore, the actors most often mentioned were public agencies and institutions rather than scientists. Likewise, preventive measures and recommendations to the public also received the lowest levels of mention.

Content analysis of three hundred news articles in the United States found that the articles tended to enable political apathy through the use of neutral tones and vague discussions of the causes of societal problems, including pollution (19). There was also relatively little description of civil society organizations or outlets for civic engagement or activism (19), thus contributing to a sense of apathy. The study of the three countries in the Southeast Asian study of haze reporting found that the reports of the haze episode tended to be non-confrontational in their tone (63). Likewise, media reports in China around the “Blue Sky Project” were found to be “face-saving” and downplayed conflicts, even where stories lent themselves to opposing sides—for example, stories of municipal confiscation of polluting stoves. Finally, although household air pollution represents a significant cause of air pollution in developing countries, only one media study conducted in India noted its mention (62). Considering the extent of the burden from household air pollution in India (5), very few articles described it as a major cause of air pollution. This is a missed opportunity to describe its harms to the public and to tell people how to reduce their risk and exposure. It also misses an opportunity to influence the need for household air pollution policies as a whole in India.

Finally, we found a few studies that monitored social media on the topic of air pollution. Studying social media has been increasingly used to monitor public conversations around outbreaks and disasters (86,87), and a similar application has been found for air pollution. Most of these studies that have used social media as surveillance for air pollution levels were from China, and they generally found that social media conversations mirrored real world air

pollution levels (88,89). In addition, analysis of social media conversations found that people seemed to care about the poor air quality, its health effects and the use of personal protection devices (88). Very few conversations dealt with solutions to the problem. A recent analysis of social media content across Southeast Asia found similar results: social media conversations tended to be about seasonal exposures to air pollution and vehicles as the primary sources of air pollution, reflecting the short-term narratives that are often present in traditional news media (90).

Implications for media reports of air pollution and cancer

Analyses of media reporting on air pollution indicate that the media can be effective in raising risk perceptions about air pollution’s harms. As is the case on other environmental issues such as global warming and climate change (69,72,73,91-94), so too on air pollution, the media has an important role to play in encouraging the public to prioritize the issue. The media plays a critical role in communicating health threats—particularly when those threats may not be immediately seen or felt. In the case of air pollution and cancer, where the effects may be felt more slowly and less palpably, the media’s role is critical in communicating the threat and urgency for action.

Our review also indicates an underrepresentation of the health perspective on air pollution. Air pollution is often reported through a political lens, with deference to political and official sources of information over scientific sources. The media’s reporting of air pollution’s health harms is generally found to lack details of specific harms, and the coverage of air pollution is often crowded out by topics such as the economy, defense and conflict. Furthermore, our review also highlighted the non-confrontational tone of the reporting, and the tendency to avoid discussion of problems and solutions. A prime example of this was the significant underreporting of household air pollution in India (62), which would be perceived as less critical an issue by virtue of this underreporting. Such gaps in media narratives may at best lead to apathy and at worst to misguided and ineffective solutions. Hence, it is critical that media narratives reflect the latest science and optimal policy solutions to ensure actionable and effective clean air policies.

In the context of the link between air pollution and cancer, there is a particular need for the media to provide scientific clarity on the association. From a public health perspective, the media has a particularly important role

to play in disambiguating air pollution from other risk factors for cancer, such as tobacco use, and in helping the public and policymakers recognize the independent effect of air pollution on the development of cancer. Hence, the empowerment of the media to disseminate scientific information appropriately must be a priority.

A number of media studies have also noted that the news tends to favor the “spectacular” over the “chronic” (81), and this may be particularly so for television news, which relies on more visual content (81). This may be an inevitable outcome of the media’s business model, which must rely on news hooks in its competition for audiences. Nevertheless, the infrequent and incomplete reporting means the longer-term costs of air pollution—and the possible remedies—are not adequately given consideration in the public domain. It therefore falls upon the public health community, health communicators and the media to work together to ensure a comprehensive approach to the reporting of air pollution and its health burdens.

Finally, our review notes some research into the role of social media on air pollution issues. Thus far it appears that the conversations on social media tend to reflect the narratives in traditional mass media. However, future studies might consider the role of a variety of social media platforms, including more visual platforms such as Instagram, in promoting the debate on air pollution. As social media platforms such as Twitter increasingly “break news,” it will be important to understand how these platforms may be shaping the reporting of news in traditional sources.

The media plays a critical role in society as an interlocutor of complex scientific information, helping its audience interpret and act as necessary on this information. The media has a particularly important role to play in this respect in enabling an accurate understanding of air pollution and cancer and in disambiguating this relationship from other risk factors for cancer. Risk is communicated by the media through the prominence it gives issues, the frequency of its reporting and the frame through which it communicates the threats. More sustained, comprehensive and thorough reporting will place a much-needed lens on the public health dimensions and consequences of air pollution.

Acknowledgments

The authors gratefully acknowledge Karen Schmidt of Vital Strategies for her thoughtful editorial review that has

strengthened this paper. We also acknowledge Bloomberg Philanthropies whose financial support to Vital Strategies enabled the authors to work on this paper.

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editor (Mark Parascandola) for the series “Air Pollution and the Global Cancer Burden” published in *Annals of Cancer Epidemiology*. The article has undergone external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/ace.2019.07.03>). The series “Air Pollution and the Global Cancer Burden” was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Open Access Statement: This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

References

1. WHO. 9 out of 10 people worldwide breathe polluted air, but more countries are taking action. WHO, Geneva Press Release, 2 May 2018. Available online: <https://www.who.int/news-room/detail/02-05-2018-9-out-of-10-people-worldwide-breathe-polluted-air-but-more-countries-are-taking-action>
2. Schraufnagel DE, Balmes JR, Cowl CT, et al. Air Pollution and Noncommunicable Diseases: A Review by the Forum of International Respiratory Societies’ Environmental Committee, Part 2: Air Pollution and Organ Systems. *Chest* 2019;155:417-26.

3. WHO. Preventing NCD deaths through better air quality. World Health Organization, Geneva, Switzerland 2018. Available online: https://www.who.int/airpollution/NCD_AP_2_pager_draft_v1_4_March_2018.pdf?ua=1
4. WHO. Global Health Observatory Data (GHO). World health Organization; Geneva, Switzerland 2018. Available online: <https://www.who.int/gho/en/>
5. WHO. Burden of disease from ambient air pollution for 2016. World health Organization, Geneva, Switzerland 2018. Available online: https://www.who.int/airpollution/data/AAP_BoD_results_May2018_final.pdf
6. Moshammer H. Communicating health impact of air pollution. *Air Pollution*. IntechOpen, 2010.
7. Balarajan R, McDowall M. Professional drivers in London: a mortality study. *Br J Ind Med* 1988;45:483-6.
8. Cao J, Yang C, Li J, et al. Association between long-term exposure to outdoor air pollution and mortality in China: a cohort study. *J Hazard Mater* 2011;186:1594-600.
9. Colli J, Lee BR, Thomas R. Population densities in relation to bladder cancer mortality rates in America from 1950 to 1994. *Int Urol Nephrol* 2012;44:443-9.
10. Wilson RT, Donahue M, Gridley G, et al. Shared occupational risks for transitional cell cancer of the bladder and renal pelvis among men and women in Sweden. *Am J Ind Med* 2008;51:83-99.
11. Huang C, Nichols C, Liu Y, et al. Ambient air pollution and adverse birth outcomes: a natural experiment study. *Popul Health Metr* 2015;13:17.
12. Gauderman WJ, Urman R, Avol E, et al. Association of Improved Air Quality with Lung Development in Children. *N Engl J Med* 2015;372:905-13.
13. Laden F, Schwartz J, Speizer FE, et al. Reduction in fine particulate air pollution and mortality: extended follow-up of the Harvard Six Cities study. *Am J Respir Crit Care Med* 2006;173:667-72.
14. World Bank. The cost of air pollution: strengthening the economic case for action. Washington: World Bank Group, 2016. Available online: <http://documents.worldbank.org/curated/en/781521473177013155/The-cost-of-air-pollution-strengthening-the-economic-case-for-action>
15. Farrell J, McConnell K, Brulle R. Evidence-based strategies to combat scientific misinformation. *Nature Climate Change* 2019;9:191-5.
16. Stauber JC, Rampton S. *Toxic Sludge Is Good For You: Lies, Damn Lies And The Public Relations Industry*. Monroe, ME, Common Courage Press, 1995.
17. Curtin PA, Rhodenbaugh E. Building the news media agenda on the environment: A comparison of public relations and journalistic sources. *Public Relations Review* 2001;27:179-95.
18. Air Pollution Denial Is the New Climate Denial | The New Republic. The New Republic. Available online: <https://newrepublic.com/article/141260/air-pollution-denial-new-climate-denial>
19. Kensicki LJ. No cure for what ails us: The media-constructed disconnect between societal problems and possible solutions. *Journalism & Mass Communication Quarterly* 2004;81:53-73.
20. Gamson WA, Croteau D, Hoynes W, et al. Media images and the social construction of reality. *Annu Rev Sociol* 1992;18:373-93.
21. Kielbowicz RB, Scherer CW. The Role of the Press in the Dynamics of Social Movements. 1984.
22. Van Zoonen EA. The women's movement and the media: Constructing a public identity. *Eur J Commun* 1992;7:453-76.
23. Clarke JN. Cancer, Heart Disease, and AIDS: What Do The Media Tell Us About These Diseases? *Health Communication* 2009;4:105-20.
24. Clarke JN, Everest MM. Cancer in the mass print media: Fear, uncertainty and the medical model. *Soc Sci Med* 2006;62:2591-600.
25. Reynolds T. News headlines feed on fear of cancer risk, experts say. *J Natl Cancer Inst* 2001;93:9-11.
26. Brody JE. Communicating cancer risk in print journalism. *J Natl Cancer Inst Monogr* 1999;1999:170-2.
27. Parascandola M. Health in the news: What happens when researchers and journalists collide. *Research Practitioner* 2000;1:1-29.
28. Russell C. Living can be hazardous to your health: How the news media cover cancer risks. *J Natl Cancer Inst Monogr* 1999;1999:167-70.
29. Johnson JD, Meischke H. Women's preferences for cancer-related information from specific types of mass media. *Health Care Women Int* 1994;15:23-30.
30. Project for Excellence in Journalism. The State of the News Media 2006. Washington, DC, USA: Project for Excellence in Journalism 2006. Available online: <http://assets.pewresearch.org/wp-content/uploads/sites/4/2011/01/2006Executivesummary.pdf>
31. Luhmann N, Cross K. *The reality of the mass media*. Stanford: Stanford University Press, 2000.
32. Harris RJ, Sanborn FW. *A cognitive psychology of mass communication*. Routledge, 2009.
33. Crow DA. *News Coverage and Access to Contextual*

- Policy Information in the Case of Recreational Water Rights in Colorado. *Applied Environmental Education & Communication* 2011;10:158-67.
34. Bastide S, Moatti JP, Pages JP, et al. Risk Perception and Social Acceptability of Technologies: The French Case. *Risk Analysis* 1989;9:215-23.
 35. Mary D. *Risk Acceptability According to the Social Sciences*. Russell Sage Foundation, 1986.
 36. Brewer NT, Chapman GB, Gibbons FX, et al. Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychol* 2007;26:136-45.
 37. Wakefield MA, Loken B, Hornik RC. Use of mass media campaigns to change health behaviour. *Lancet* 2010;376:1261-71.
 38. Goffman E. *Frame analysis: An essay on the organization of experience*. Harvard University Press, 1974.
 39. Kahneman D, Tversky A. Prospect theory: An analysis of decision under risk. *Handbook of the fundamentals of financial decision making: Part I*. World Scientific, 2013:99-127.
 40. Kahneman D, Tversky A. Choices, values, and frames. *Handbook of the Fundamentals of Financial Decision Making: Part I*. World Scientific, 2013:269-78.
 41. Tversky A, Kahneman D. Availability: A heuristic for judging frequency and probability. *Cognitive Psychology* 1973;5:207-32.
 42. Blumler JG, Katz E. editors. *The uses of mass communications: Current perspectives on gratifications research*. Sage Publications, Inc., 1974.
 43. Zillmann D, Bryant J. *Selective exposure to communication*. Routledge; 2013.
 44. Eveland WP Jr. The cognitive mediation model of learning from the news: Evidence from nonelection, off-year election, and presidential election contexts. *Communication Research* 2001;28:571-601.
 45. Slater MD. Reinforcing spirals: The mutual influence of media selectivity and media effects and their impact on individual behavior and social identity. *Communication Theory* 2007;17:281-303.
 46. Scheufele DA, Tewksbury D. Framing, Agenda Setting, and Priming: The Evolution of Three Media Effects Models. *J Commun* 2007;57:9-20.
 47. McCombs ME, Shaw DL. The agenda-setting function of mass media. *Public Opinion Quarterly* 1972;36:176-87.
 48. Iyengar S, Kinder DR. *News that matters: Television and American opinion*. University of Chicago Press, 2010.
 49. Gans HJ. Deciding what's news: story suitability. *Society* 1979;16:65-77.
 50. McQuail D. *Mass communication theory: An introduction*. Sage Publications, Inc., 1987.
 51. Antilla L. Climate of scepticism: US newspaper coverage of the science of climate change. *Global Environmental Change* 2005;15:338-52.
 52. McComas K, Shanahan J. Telling stories about global climate change: Measuring the impact of narratives on issue cycles. *Communication Research* 1999;26:30-57.
 53. Katherine AM, Shanahan J, Butler JS. Environmental Content in Prime-Time Network TV's Non-News Entertainment and Fictional Programs. *Society & Natural Resources* 2001;14:533-42.
 54. Carvalho A. Ideological cultures and media discourses on scientific knowledge: re-reading news on climate change. *Public Understanding of Science* 2007;16:223-43.
 55. Takahashi B. Framing and sources: a study of mass media coverage of climate change in Peru during the V ALCUE. *Public Underst Sci* 2011;20:543-57.
 56. Carvalho A, Burgess J. Cultural circuits of climate change in UK broadsheet newspapers, 1985-2003. *Risk Anal* 2005;25:1457-69.
 57. Bickerstaff K. Risk perception research: socio-cultural perspectives on the public experience of air pollution. *Environ Int* 2004;30:827-40.
 58. Wang G. A corpus-assisted critical discourse analysis of news reporting on China's air pollution in the official Chinese English-language press. *Discourse & Communication* 2018;12:645-62.
 59. Zhang MW, Ho C, Fang P, et al. Usage of social media and smartphone application in assessment of physical and psychological well-being of individuals in times of a major air pollution crisis. *JMIR Mhealth Uhealth* 2014;2:e16.
 60. Wang S, Paul MJ, Dredze M. Social Media as a Sensor of Air Quality and Public Response in China. *J Med Internet Res* 2015;17:e22.
 61. Nirmala T, Arul A. Framing of environment in English and Tamil newspapers in India. *Journal of Media and Communication Studies* 2017;9:1-9.
 62. Murukutla N, Negi N, Puri P, et al. Online media coverage of air pollution risks and current policies in India: A content analysis. *WHO South East Asia J Public Health* 2017;6:41-50.
 63. Massey BL. How three Southeast-Asian newspapers framed the haze' of 1997-98. *Asian J Commun* 2000;10:72-94.

64. Chavez M, Marquez M, Flores DJ, et al. The News Media and Environmental Challenges in Mexico: The Structural Deficits in the Coverage and Reporting by the Press. *News Media Coverage of Environmental Challenges in Latin America and the Caribbean* 2018;19-46.
65. Shapiro MA, Bolsen T. Transboundary Air Pollution in South Korea: An Analysis of Media Frames and Public Attitudes and Behavior. *East Asian Community Review* 2019;1:107-26.
66. Amiraslani F, Caiserman A. From air pollution to airing pollution news: multi-layer analysis of the representation of environmental news in Iranian newspapers. *The Journal of International Communication* 2018;24:262-82.
67. Karameti AN. Reporting environmental pollution: media and public discourse vs. political discourse in the republic of Macedonia. *Revista de Stiinte Politice* 2015;345-55.
68. Boykoff M. Indian media representations of climate change in a threatened journalistic ecosystem. *Climatic Change* 2010;99:17-25.
69. Boykoff MT. *Creating a climate for change: Communicating climate change and facilitating social change*. Cambridge: MIT Press, 2009.
70. Chan KK. Mass media and environmental knowledge of secondary school students in Hong Kong. *Environmentalist* 1998;19:85-97.
71. Sampei Y, Aoyagi-Usui M. Mass-media coverage, its influence on public awareness of climate-change issues, and implications for Japan's national campaign to reduce greenhouse gas emissions. *Global Environmental Change* 2009;19:203-12.
72. Durfee JL. "Social Change" and "Status Quo" Framing Effects on Risk Perception. *Science Communication* 2016;27:459-95.
73. Ader CR. A Longitudinal Study of Agenda Setting for the Issue of Environmental Pollution. *Journalism & Mass Communication Quarterly* 2016;72:300-11.
74. Eyal CH, Winter JP, DeGeorge WF. The concept of time frame in agenda-setting. *Mass Communication review yearbook* 1981;2:212-8.
75. Johnson BB. Experience with Urban Air Pollution in Paterson, New Jersey and Implications for Air Pollution Communication. *Risk Anal* 2012;32:39-53.
76. Singer E, Endreny PM. Reporting on risk: How the mass media portray accidents, diseases, disasters and other hazards. *Risk* 1994;5:261.
77. Stamm KR, Clark F, Eblacas PR. Mass communication and public understanding of environmental problems: the case of global warming. *Public Understanding of Science* 2000;9:219-38.
78. Sandman PM. *Environmental risk and the press*. Routledge, 2017.
79. Murray D, Schwartz JB, Lichter SR, et al. It ain't necessarily so: How media make and unmake the scientific picture of reality. Rowman & Littlefield, 2001.
80. Klaidman S. *Health in the headlines: The stories behind the stories*. 1991.
81. Greenberg MR, Sachsman DB, Sandman PM, et al. Network evening news coverage of environmental risk. *Risk Anal* 1989;9:119-26.
82. Major AM, Atwood LE. Environmental risks in the news: issues, sources, problems, and values. *Public Understanding of Science* 2004;13:295-308.
83. Djerf-Pierre M. The Crowding-out Effect. *Journalism Studies* 2012;13:499-516.
84. O'Neill S, Williams HTP, Kurz T, et al. Dominant frames in legacy and social media coverage of the IPCC Fifth Assessment Report. *Nature Climate Change* 2015;5:380-5.
85. Xu JH. Online news reports of air quality issues in Beijing. *Telematics and Informatics* 2012;29:409-17.
86. Nagel AC, Tsou M-H, Spitzberg BH, et al. The Complex Relationship of Realspace Events and Messages in Cyberspace: Case Study of Influenza and Pertussis Using Tweets. *J Med Internet Res* 2013;15:e237.
87. Salathé M, Khandelwal S. Assessing Vaccination Sentiments with Online Social Media: Implications for Infectious Disease Dynamics and Control. *PLoS Comput Biol* 2011;7:e1002199.
88. Jiang W, Wang Y, Tsou M-H, et al. Using social media to detect outdoor air pollution and monitor air quality index (AQI): a geo-targeted spatiotemporal analysis framework with Sina Weibo (Chinese Twitter). *PloS One* 2015;10:e0141185.
89. Lin X, Lachlan KA, Spence PR. Exploring extreme events on social media: A comparison of user reposting/retweeting behaviors on Twitter and Weibo. *Computers in Human Behavior* 2016;65:576-81.
90. *Hazy Perceptions*. Vital Strategies; New York, NY, 2019.
91. Atwater T, Salwen MB, Anderson RB. Media agenda-setting with environmental issues. *Journalism Quarterly* 1985;62:393-7.
92. Hester JB, Gonzenbach WJ. The environment: TV news, real-world cues, and public opinion over time. *Mass Comm Review* 1995;22:5-20.

93. Schoenfeld AC, Meier RF, Griffin RJ. Constructing a Social Problem: The Press and the Environment. *Social Problems* 1979;27:38-61.

94. Slovic P. Informing and educating the public about risk. *Risk Anal* 1986;6:403-15.

doi: 10.21037/ace.2019.07.03

Cite this article as: Murukutla N, Kumar N, Mullin S. A review of media effects: implications for media coverage of air pollution and cancer. *Ann Cancer Epidemiol* 2019;3:3.