

Radon Gas Portrayal in the Canadian Print Media: A Mixed Methods Approach

by

Lara Brewster

B.Sc., University of British Columbia, 2013

Capstone Project Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Public Health

in the
Public Health Program
Faculty of Health Sciences

© **Lara Brewster 2015**

SIMON FRASER UNIVERSITY

Summer 2015

All rights reserved.

However, in accordance with the *Copyright Act of Canada*, this work may be reproduced, without authorization, under the conditions for "Fair Dealing." Therefore, limited reproduction of this work for the purposes of private study, research, criticism, review and news reporting is likely to be in accordance with the law, particularly if cited appropriately.

Approval

Name: Lara Brewster
Degree: Master of Public Health
Title: *Radon Gas Portrayal in the Canadian Print Media:
A Mixed-Methods Approach*
Examining Committee: **Chair:** Zabrina Brumme
Assistant Professor

Zabrina Brumme
Senior Supervisor
Assistant Professor

Anne-Marie Nicol
Co-Supervisor
Assistant Professor

Kitty Corbett
Second Reader
Professor

Date Approved: June 26, 2015

Abstract

Radon is a carcinogenic gas that is responsible for over 3,000 lung cancer deaths in Canada each year. It is a colorless, odorless, and tasteless radioactive gas that naturally emanates from soil and bedrock, and can build up to unsafe levels within homes and buildings. In 2006 the Canadian federal government lowered the national radon action level guideline from 800 Bq/m³ to 200 Bq/m³. This means that Health Canada currently recommends that homeowners with radon concentrations above 200 Bq/m³ take remedial actions to reduce the concentration of radon in their homes. Despite the well-established health risks of radon exposure, less than 50% of Canadians are aware of radon and less than 5% have tested their homes for radon in the past 10 years. Media coverage is a key information channel for communicating important health risks, such as radon gas, to the Canadian public. The purpose of this paper is to evaluate the scope and nature of Canadian newspaper coverage of radon gas and its risks to human health before and after the new 200 Bq/m³ regulations were implemented. Headlines were collected from 490 newspaper articles on radon published in Canada between Jan. 2003 and Jan 2014. Content analysis was performed on article headlines using a qualitative frame to evaluate the nature of radon portrayal. Quantitative methods were used to examine the location, timing and other aspects of media coverage. The analysis indicated that media coverage of radon was a response to governmental regulation changes and research announcements. Headline messaging was mixed and conflicting with no clear authority or leadership portrayed. Radon coverage in the media was not higher in provinces with greater radon exposure. Coverage was neither correlated with public awareness nor understanding of radon health. The results show that media messaging needs to be clarified so that the idea of radon as a health risk that people should test for their homes is being communicated to the public. A clear leader in radon needs to be identified within the public health community to represent a clear, trusted authority and source of information on radon for the public.

Table of Contents

Approval.....	ii
Abstract.....	iii
Table of Contents.....	iv
Introduction.....	1
Critical Literature Review.....	3
Current Radon Initiative/Policies in Canada.....	3
PAPM and Individual Behaviour Change.....	6
Print News Media Headlines and Content Analysis.....	7
Radon Risk Communication.....	8
Research Questions:.....	10
Methodology.....	10
Timeframe.....	10
Databases.....	10
Article Selection.....	11
Data Collection and Qualitative Analysis.....	11
Quantitative Analysis.....	12
Results.....	12
Publication Date.....	12
Tone.....	13
Content.....	15
Spokesperson/agency.....	17
Authors.....	18
Location.....	18
Type of newspaper.....	19
Discussion.....	22
Publication Date.....	22
Tone.....	22
Content.....	23
Publishing Location.....	23
Newspaper Type.....	24
Limitations.....	24
Public Health Implications.....	25
Critical Reflection.....	26

References 1

Introduction

Radon gas is the second leading cause of lung cancer globally, accounting for 2% of all cancers worldwide (World Health organization, 2009). In Canada approximately 16% of lung cancer cases are attributable to residential radon exposure, leading to over 3,000 lung cancer deaths each year (Chen, Moir & Whyte, 2012). Radon is an odourless, colourless, and tasteless radioactive gas that is ubiquitous in the outdoor environment. It is produced from the breakdown of uranium-238, which is naturally present in bedrock and soil (Branion-Calles, Nelson, & Henderson, 2015). The decay sequence of uranium-238 produces radon gas that can migrate through cracks in rocks or soil into the atmosphere (Branion-Calles, Nelson, & Henderson, 2015). Once in the atmosphere radon gas cannot penetrate the skin, but it can be inhaled into the lungs. If inhaled, radon decay products (polonium-218 and polonium-214, solid form), which are unattached or attached to the surface of aerosols, dusts, and smoke particles, become deeply lodged or trapped in the lungs. There they can radiate and penetrate the cells of mucous membranes, bronchi, and other pulmonary tissues. This ionizing radiation energy affecting the bronchial epithelial cells is believed to initiate the process of carcinogenesis (Nicol, 2014). Over time prolonged radon exposure can cause chronic lung cell damage, leading to cancers in the lungs, trachea, and bronchi.

The link between radon and lung cancer is well-established; radon has been classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC) since 1988 (International Agency for Research on Cancer, 1988). The idea of radon as a significant health risk took off globally in the 1970s and 1980s when several countries discovered that a significant number of residences had high indoor concentrations of radon gas. Radon gas disperses quickly outdoors and generally poses a low risk to humans (Setton et al., 2013). However, radon can build up over time to hazardous levels within contained spaces, such as buildings or mines (Bisset & McLaughlin, 2010). For example, radon can enter houses through cracks in the foundation and accumulate in the basement or ground level floor.

In the early 1970s the main issue with radon, from a public health and regulatory standpoint, was occupational exposure to radon in uranium mine workers. According to a report from the 2004 Health Canada Radon Workshop, concern about residential radon exposure began in 1975 when high radon levels were found in several homes and public schools within the small town of Port Hope, Ontario due to radioactive waste from the local radium refinement facility (Tracey et al., 2006). The ionizing radiation contained in radon gas is traditionally characterized by a linear dose-response relationship, meaning that no level of exposure is free from adverse health effects. However, because radon is ubiquitous in the outdoor environment and present in all homes at some level, defining a radon action level is a somewhat arbitrary, but important, process. As part of the Port Hope cleanup process, the Federal-Provincial Task Force on Radioactivity determined that the normal level of household radon was 150 Bq/m³ by surveying a nearby town. Later, from 1977-1980, Health and Welfare Canada completed a national survey of indoor radon levels. The results of this survey indicated that 4% of homes in Canada were above the “normal” radon concentration of 150 Bq/m³ (Tracey et al., 2006). In 1988, when radon was officially classified as a carcinogen by the International Agency for Research on Cancer (IARC), the Federal-Provincial Sub-Committee on Radiation Surveillance proposed and adopted the national radon action level of 800 Bq/m³. By 1995 the Federal-Provincial Sub-Committee on Radiation Surveillance was being propositioned by Health Canada to lower the radon action level to 400 Bq/m³ to bring it more in accordance with international standards (Tracey et al., 2006). It was not until 2006 that the federal government lowered the radon guideline to 200 Bq/m³, after several scientific studies linking lung cancer with residential radon exposure were published (Statistics Canada, 2012).

There is significant variation in surficial and indoor radon concentrations across Canada (Hystad et al., 2014) and the only way to measure radon concentrations in a building is to conduct a radon test. The primary factor influencing indoor radon is the building permeability, which is affected by foundation type, construction methods, and ventilation systems (Branion-Calles, Nelson, & Henderson, 2015). This is why one house could have an indoor radon concentration below 100 Bq/m³, while a neighboring home could be well above 200 Bq/m³. In 2012 the *Cross-Canada Survey of Radon*

Concentrations in Homes estimated that 6.9% of Canadians are living in homes with radon levels above 200 Bq/m³ (Statistics Canada, 2012).

Critical Literature Review

Current Radon Initiative/Policies in Canada

There are two main approaches for reducing radon exposure in the general population:

- 1) Construct buildings with radon resistant features (e.g. subslab depressurization) and,
- 2) Identify and remediate existing buildings with high radon levels (Henderson et al., 2012).

The Canadian National Building Code (NBC), which guides building practices, is subject to revision every five years. In 2009 a joint task force was formed to investigate potential changes to the 2010 NBC that could reduce radon gas intrusion into new buildings. The task force recommended all new homes in Canada be built with a subslab depressurization system (this involves installing a vacuum system to suck the radon gas from the soil underneath the house to the exterior of the building, so that it does not leak into the house through the foundation). Once these changes to the NBC have been implemented, it is expected that the levels of radon gas in newly built residences, schools, and workplaces will decrease (Chen et al., 2011). However, building codes are actually under provincial jurisdiction, so each province must also choose to adopt these regulations if they are to have a significant impact on building practices.

Identifying and remediating existing buildings with high radon levels is generally the responsibility of individual building/home owners. To reduce residential radon levels in existing homes, homeowners must first buy radon detection kits and test their own homes. In 2008 the National Radon Program launched a national radon education and awareness program that, “focused on raising awareness of radon, the potential health risks from exposure and encouraging Canadians to test their homes and to reduce radon levels, if necessary,” (Chen, Moir, & Whyte, 2012).

Since 2009, the *Households and the Environment Survey* (HES) has included questions on radon gas (Statistics Canada, 2014a). The HES is an ongoing survey conducted every two years by Statistics Canada that measures the environmental practices and behaviors of Canadian households. The survey data is collected from all provinces except Yukon Territory, Northwest Territories, and Nunavut. The 2013 cycle of the HES suggested that, despite the health risks of radon exposure, less than five percent of Canadians have tested their homes for radon in the past 10 years (Statistics Canada, 2014a). The low rate of Canadians testing their homes is a barrier to the ultimate public health goal of reducing radon-related lung cancers.

Awareness of radon and its health risks are important because homeowners are more likely to test and mitigate their properties for radon gas if they believe the inhabitants are at an elevated health risk (Henderson et al., 2012). Findings from the HES survey suggest that the percentage of homeowners who are able to correctly describe radon has increased since 2009 (Fig. 1). Overall, it is estimated that only 34% of households know radon is a health hazard and less than 25% are able to give a correct description of radon (Statistics Canada, 2014a). However, the percentage of homeowners who have tested their homes for radon in the past ten years appears to have remained stable from 2009-2013 (Fig. 2).

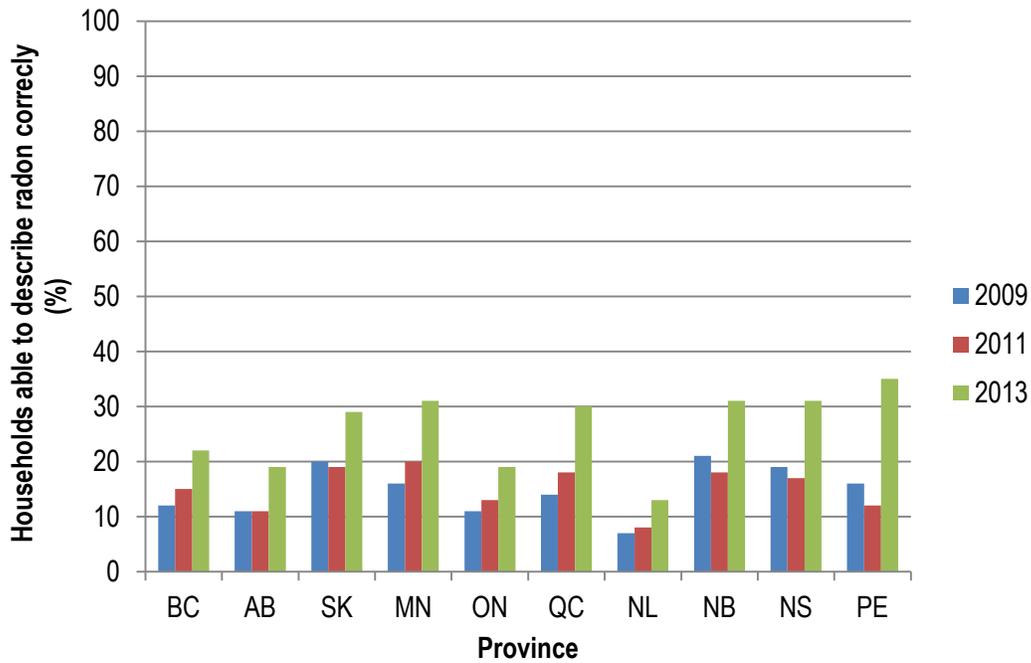


Figure 1. Percentage of household survey respondents who were able to describe radon correctly by province. Data from the 2009, 2011, and 2013 cycles of the HES survey (Statistics Canada, 2014a).

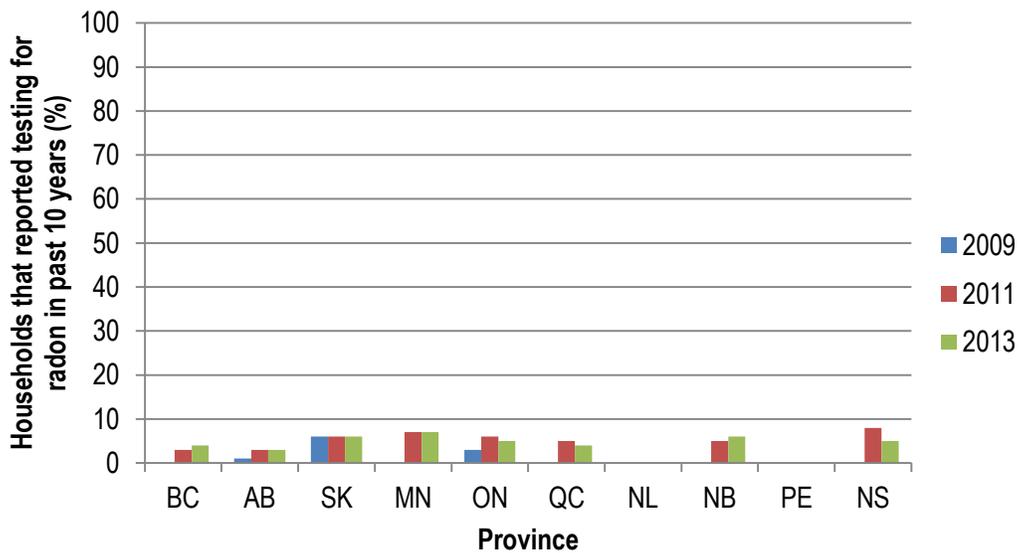


Figure 2. Percentage of household survey respondents who reported testing their homes for radon in the past 10 years. Data from the 2009, 2011, and 2013 cycles of the HES survey (Statistics Canada, 2014a). The HES notes to use this data with caution.

PAPM and Individual Behaviour Change

Several social and behavioral theories exist that can be used to understand what motivates people to test, or not test, their homes for radon gas. The Precaution Adoption Process Model (PAPM) is a health behaviour theory that focuses on the thought processes individuals must go through in order to take a health-related action (Edberg, 2015). The PAPM is commonly used in public health research and programming for various health issues. It was originally developed by Weinstein and Sandman in order to understand people's willingness to test their homes for radon gas (Edberg, 2015). The PAPM consists of six stages:

- 1) Stage 1: Unaware of the issue**
 - a. Never heard of Radon
 - b. Never heard about mitigation/doesn't know options
- 2) Stage 2: Unengaged by the issue**
 - a. Never thought about testing
 - b. Not considering mitigation
- 3) Stage 3: Deciding about acting**
 - a. Undecided about testing, may or may not
 - b. Undecided about mitigation (Cost is a factor here)
- 4) Stage 4: Deciding not to act OR Deciding to act**
 - a. Decides not to test house OR Decides to test house and plans to test,
 - b. Decides not to mitigate house OR Decides to mitigate house
- 5) Stage 6: Acting**
 - a. Obtains kit, conducts test
 - b. Hires mitigation specialist, pays for radon mitigation system
- 6) Stage 7: Maintenance**
 - a. Receives radon test results
 - b. If high, decides whether or not to mitigate, if does not know about mitigation, back to stage 1
 - c. After mitigation, continues to monitor radon levels in house, to see if mitigation was successful

Reducing radon exposure requires complex, multi-level interventions that occur at multiple points in the PAPM model. An individual who is unaware of radon but lives in a home with high radon concentrations will cycle through the PAPM twice before they have lowered the levels of radon in their home. According to the PAPM, an individual first has to be aware of and engaged by a health issue before they will even decide about taking the appropriate health-related action. Most individual homeowners will test their home for radon before they decide to invest time and money into radon

remediation. Before that, individuals must be aware of and engaged by the radon issue before they will decide about taking the health-related action of testing their homes.

Print News Media Headlines and Content Analysis

Content analysis is a popular social research method used to interpret meaning from the content of textual data (Miller & Brewer 2003). One of the branches of content analysis research is the study of media headlines. In health sciences, content analysis can be used to study newspaper headlines to help understand the media's portrayal of health issues.

The news media acts as an important conduit for information, as well as an influence on public opinion and policies (Collins et al., 2006; Iyengar, 1997). Multiple formats of news media exist including newspaper, television, radio, and social media. The proportion of news delivered through social media has grown in the past several years; Facebook was established in 2004 and in 2010 it was estimated that 33% of adults use social media to access health information (Hughes, 2010). However, the mainstream media is major influence on social media (Maier, 2010). Newspapers can directly shape health by influencing individual behaviour through information delivery (Gebbie, Rosenstock, Hernandez & IOM, 2003). They can also alter the conditions in which people make health-related decision by affecting public policies. They influence agenda setting, shape debate, can exert political pressure and contribute to policy advancement (Dorfman & Gonzalez, 2011). Reviewing the newspaper headlines of radon gas articles can uncover the current societal discourse surrounding radon and shed light on why greater change has not occurred in Canada around testing and awareness.

An analysis of newspaper headlines can provide just as much information as the analysis of a sample of newspaper articles. Emig, an early communication researcher, summarized the potential influence of newspaper headlines well, "When you stop to think how few people read beyond the headlines and how much of public opinion is made by headlines, you begin to realize the enormous influence exerted by the journalist (or editor) who sits at a desk and writes headlines" (1928, p.54). For people who only

read headlines on a particular subject, such as radon, headlines are an information channel. Even for those that do read past the headline, headlines influence the reader's interpretation of an article by acting as a framing device for article content (Condit et al., 2001). Furthermore, the less thoroughly a reader reads an article, the more their interpretation is influenced by the headline (Condit et al., 2001).

Headlines can also indicate the underlying attitudes of the editors or journalists who create them. Research from Fenichel and Dan (1980), O'Conner and Casey (2001) found that headlines are often more sensationalized than the articles they represent. Thus the tone of a headline can be indicative of the editorial attitude toward the facts contained within the article. Finally, headlines are responsible for attracting readers and affect whether or not an article is read. Research on the media coverage of cancer and HIV/AIDS showed that articles with encouraging headlines were more likely to be read than those with frightening headlines (Drushel, 1991). Thus headlines are useful for understanding:

- 1) The information being delivered to those who only read headlines on radon
- 2) The overall interpretation/opinion of the radon issue being taken away by people who read articles on radon,
- 3) The underlying attitude towards radon of the media/editors who wrote the headlines and,
- 4) The attention that the story will receive from readers.

Radon Risk Communication

According to Plough and Krinsky, "Risk communication' can refer to any public or private communication that informs individuals about the existence, nature, form, severity, or acceptability of risks," (p. 266, 1993). However, the conventional definition of risk communication usually refers to the one-way communication of scientific information from "experts" to others, (e.g. the public or policy makers). Radon provides an interesting challenge in risk communication for several reasons; the risk is relatively unfamiliar, there is usually no villain to blame, radon cannot be seen or smelled and so is

easily ignored, and people do not like to feel unsafe in their own homes. As a result, information campaigns are important for educating and convincing people to test their homes for radon.

The way information on the health risks of radon is presented to home owners affects their perception of risk and their related choices to test and/or mitigate their homes. Johnson et al. have summarized several studies conducted by the US Environmental Protection Agency that investigated how people understand and react to new information on indoor radon risks (1993). They found that how the information was delivered affected people's understanding of the risks. For example, informational booklets were more effective than fact sheets in teaching recipients about radon. Johnson et al., also found the tone of the information was important. A commanding tone, emphasizing what the reader should do, was the most effective for increasing readers' understanding of the health risks of radon (Johnson et al., 1993).

Effectively communicating the health risks of radon affects how likely homeowners are to test and mitigate their properties for radon gas (Henderson et al., 2012). A study in Winnipeg showed that homeowners were willing to spend more money on radon mitigation after receiving information about the health risks of radon gas exposure (Spiegel & Krewski, 2002). This observation was confirmed by Nissen et al, who reported that the number one reason people cited for testing their homes for radon was a concern for health (2012). Although the health risks of radon are well known in the scientific community, how these risks are communicated to the public affects their understanding of, perception of, and likelihood to act on said risks. Subtle differences in information format and tone can affect risk perception. Systematically analyzing print media headlines to conceptualize how these important risk messages are being communicated to the public will help shed light on why so little progress has been made on radon awareness and testing in Canada.

Research Questions:

1. Publication Date
 - Q1. When were articles being published?
 - Q2. Did the publication rate of articles change before/after the new 200Bq/m³ regulations were released?
2. Tone
 - Q1. What was the tone of the radon headlines?
 - Q2. Did it change by province or over time?
3. Content
 - Q1. What was the content/topic in the headlines?
 - Q2. Were the health effects of radon mentioned?
4. Authors
 - Q1. Were there certain authors who published more than other authors?
5. Spokesperson/agency:
 - Q1. Is there one agency or spokesperson consistently mentioned in the headlines?
6. Location:
 - Q1. Which provinces had the highest/lowest number of radon articles?
 - Q2. Was publication rate related to radon exposure?
 - Q3. Was publication rate related to radon awareness or understanding?
7. Type of newspaper
 - Q4. Were most of the articles being published in major newspapers or local ones?
 - Q5. Did this change over time?

Methodology

Timeframe

Analyses were limited to the years immediately preceding and following the 2007 announcement of the change in the federal radon action guideline, Jan. 2003 - Jan. 2014.

Databases

Articles and wires from indexed newspapers were retrieved from 2 separate databases. An initial search for all Canadian dailies was done using the SFU database of print newspapers, *Canadian Newsstand*, and retrieved 196 articles. 300 additional articles were found in *Proflex*, a UBC database of print newspapers.

Article Selection

A full search of English language articles with the keyword 'Radon' was conducted. 12 articles written in French were excluded because of the language restriction. Articles related to Port Hope or on nuclear reactors were excluded from the final sample. In 1975, high radon levels in Port Hope, Ontario were a result of contamination due to waste from the local radium refinement facility. Although this event sparked Canadian interest in radon, this analysis was focused on radon produced from the breakdown of uranium naturally present in rock and soil. Port Hope articles were excluded in order to remain focused on non-industrial related indoor radon exposures. The headlines of the articles were abstracted and compiled into Microsoft Excel.

Data Collection and Qualitative Analysis

A set of questions was developed to conduct the headline analysis. The survey included a qualitative framework used to assess the headline tone and content. Four independent coders developed an online coding matrix to qualitatively assess the tone and content of the headlines. The tone of headlines was classified as fearful, informative, reassuring, or ambiguous based on a qualitative frame that was developed iteratively by several students at the beginning of the project.

Other information, including each article's headline text, author, province of publishing, and newspaper name, was collected for each article during the survey process. Two variables were added after the article survey: 1) Did the headline mention schools (Yes/No) and 2) Type of Newspaper. During the data analysis interest in these two variables developed, and the headlines were resurveyed to gather this new information. The type of newspaper was determined by looking up each newspaper in the excel database and classifying it as Major Daily (A top 25 daily newspaper in Canada by 2011 circulation), Minor Daily (all other daily newspapers), or Local/Weekly (all non-daily newspapers).

Quantitative Analysis

Descriptive statistics were used to calculate the frequency and/or proportion of headline characteristics including Date of publication, Tone, Content, Authors, Expert Cited, Province of publishing and Type of newspaper. Data analyses were conducted using R version 3.1.2. When analyzing the date of publication, articles from 2014 were excluded because only articles from January 2014 were collected. When analyzing the province of publishing, other sources of data were used to standardize the number of articles by population, and to compare to provincial radon awareness and understanding data. The population estimates used to standardize the publication rate were recent as of July 1st, 2013 (Statistics Canada, 2014b). Data on the average household radon concentration was gathered in *the Cross Canada Survey of Radon Concentrations in Homes* (Statistics Canada, 2012). Data on the awareness of Radon was from the 2013 results of the *Households and the environment survey*, a time series study that has collected awareness data every two years since 2009 (Statistics Canada, 2014a).

Results

Publication Date

The study retrieved 490 articles on radon gas that were published in Canada from Jan. 2003 to Jan. 2014. Less than 13% of these articles were published before 2007 (Fig. 3). Radon was most prevalent in the media in 2007 (80 articles) and 2012 (82 articles) (Fig. 3). After the initial spike in publication in 2007, the number of articles decreased again, but remained above 40 articles per year (Fig. 3).

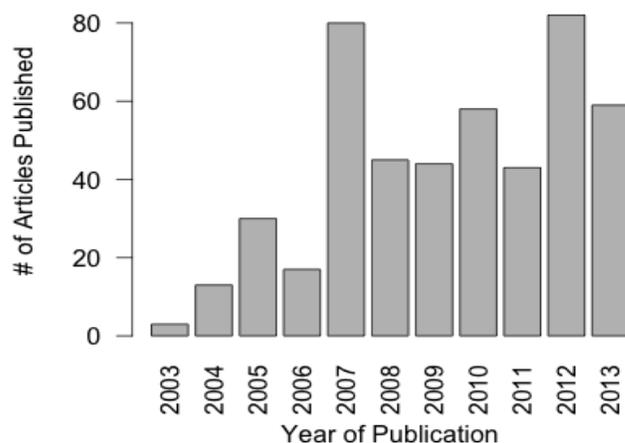


Figure 3. Yearly Publication of radon articles in Canada from 2003-2013.

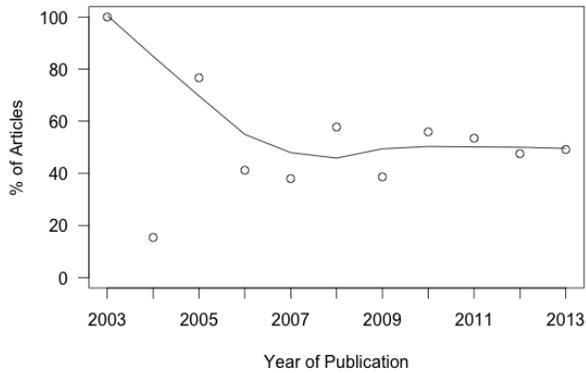
Tone

The tone of the headlines was assessed using the qualitative coding scheme that was developed. 44% of the headlines were fearful (e.g. “A silent monster lurks in the basement”), 33% of the headlines were informative (e.g. “No medical test reveals exposure to radon; Homeowners Houses can be tested for radon levels), 12% were reassuring (e.g. “Radon not an issue locally”) and 11% were ambiguous (e.g. “What the radar says about radon”) (Table 1).

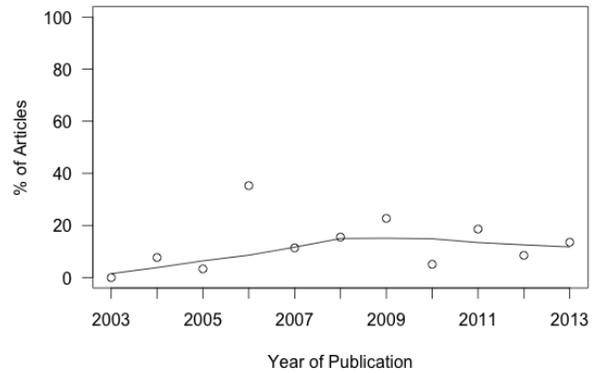
Table 1. Tone of radon headlines over time.

Tone	Year										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fear	3	2	23	7	31	25	14	28	23	31	26
Informative	0	1	2	7	24	11	21	19	13	33	25
Reassuring	0	8	2	1	15	6	6	2	3	8	2
Ambiguous	0	2	3	2	10	3	3	9	4	10	6
Total	3	13	30	17	80	45	44	58	43	82	59

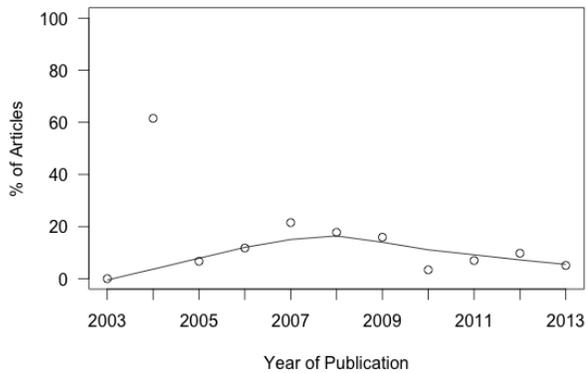
a. Fearful



b. Informative



c. Reassuring



d. Ambiguous

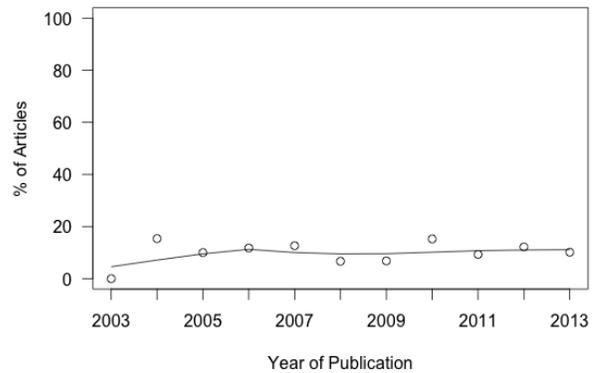


Figure 4a-d. The proportion of all published radon articles with Fearful/Informative/Reassuring/Ambiguous headlines by year from 2003-2013.

In 2005, over 75% of print media headlines had a fearful tone, whereas in all the following years the proportion of fearful headlines to informative or reassuring headlines was more equal (Table 1). The tone of newspaper headlines has been relatively stable since 2006 (Fig. 4). Since 2006 approximately 40-60% of radon headlines have been fearful (Fig. 4). In 2004 over 60% of headlines had a reassuring tone (Fig. 4). In 2004 several articles reported on a school with unsafe radon levels that was successfully remediated, leading to a reassuring headline.

The tone of headlines was also compared between the provinces. Fearful headlines were the majority in every province except British Columbia, Nova Scotia and Ontario (Table 2). Out of the 134 articles published in BC based newspapers, 61 headlines had an informative tone (Table 2). In Nova Scotia, there was an almost equal number of fearful, informative and reassuring headlines, and in Ontario there was an equal number of fearful and informative headlines (Table 2).

Table 2. Tone of radon headlines by province.

Tone	Province										
	AB	BC	MB	NB	NL	NS	ON	PE	QC*	SK	YK
	Count (% of Total)										
Fearful	15 (53)	50 (37)	10 (45)	39 (57)	2 (50)	9 (33)	53 (38)	8 (47)	8 (100)	1 (6)	2 (50)
Informative	7 (25)	61 (45)	4 (18)	15 (22)	0 (0)	8 (30)	53 (38)	5 (29)	0 (0)	4 (24)	1 (25)
Reassuring	2 (7)	8 (6)	1 (5)	10 (14)	1 (25)	10 (37)	17 (12)	2 (12)	0 (0)	2 (12)	1 (25)
Ambiguous	4 (14)	15 (11)	7 (32)	5 (7)	1 (25)	0 (0)	18 (13)	2 (12)	0 (0)	1 (6)	0 (0)
Total	28	134	22	69	4	27	141	17	8	17	4

*Note that only English language articles were retrieved from the databases

Content

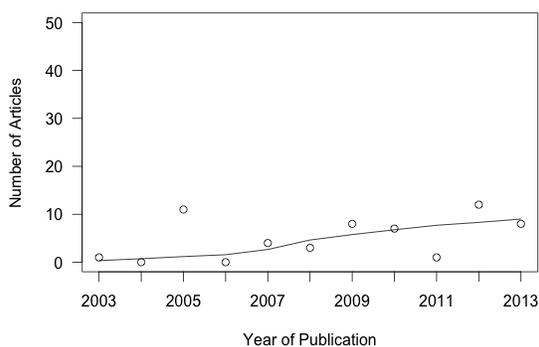
The content of the newspaper headlines varied widely (Table 3). 37.1% of the headlines mentioned an at-risk target population (Table 3). More than 40% of the time, the at-risk target population that was mentioned was the general public. 17.5% of the time it was homeowners, and another 17.5% of the time it was Children/School Kids/Daycare Attendees. The remainder of the time, the at-risk target population that was referenced was Families/Parents, Workers/Teachers, First Nations, or Tenants.

Table 3. Headline content of radon-related newspaper articles published in Canada between 2003-2014.

Headline Content	Coded Yes Number of Articles (%)
At-Risk target population mentioned	182 (37.1)
Expert cited	158 (32.3)
You should test your home	98 (20.0)
Mentions cancer	57 (11.6)
Headline is a question or statement that provides little or no information	40 (8.1)
Mentions schools	35 (7.1)
Result of a study or series	32 (6.5)
Radon is a risk (that is all that is mentioned)	30 (6.1)
Action is being taken by government health authorities	27 (5.5)
Journalist provides info on radon	21 (4.3)
Radon causes health effects	19 (3.9)
New standards/regulations	16 (3.3)
Forum events that raise awareness or discuss radon risk	16 (3.3)
Call for action	14 (2.9)
Don't panic about Radon	10 (2.9)
Actions are being taken by homeowners	4 (0.8)

Analyzing the content of newspaper headlines showed that 11.6% of newspaper headlines mentioned cancer and only 3.9% of headlines contained the message that radon causes health effects (Table 3). The number of radon articles with headlines that mention cancer may be increasing (Fig. 5a). Headlines that mention radon causes health effects were highest in 2013 (Fig. 5b). In terms of encouraging radon testing, 20% of the headlines that were analyzed had an underlying message of 'You should test your home' (Table 3).

a. Mentions Cancer



b. Radon Causes Health Effects

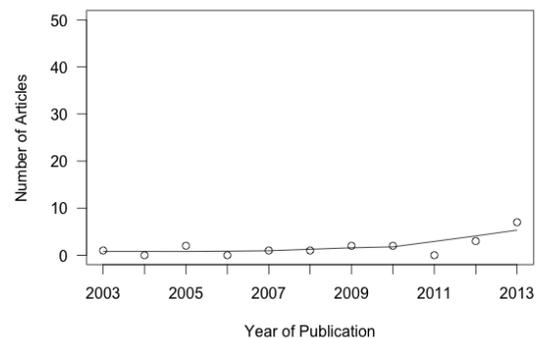


Figure 5a-b. Headline content from 2003-2013. the number of articles with a headline that a. mentions cancer and b. states radon causes health effects.

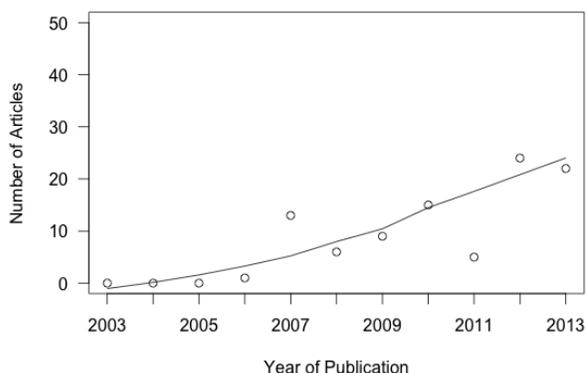


Figure 6. Headline content from 2003-2013. The number of articles with a headline that instructs people to test their homes for radon.

Newspaper headlines containing the message ‘You should test your home’ did not appear in the print media until 2006. However, since 2006, the presence of this message in the headlines appears to be increasing (Fig. 6).

Spokesperson/agency

Table 4. Expert cited in radon-related newspaper articles published in Canada between 2003-2014.

Expert Cited	Number of Articles (% of Total)
None	66.8
Ambiguous/Other	13.9
Health Canada	5.7
Public Health Organization	4.1
Non-Governmental Organization (i.e. Lung or Cancer Associations)	2.0
Elected Politician, School Board Trustee, Mayor, or Premier	1.8
Concerned Citizens	1.4
Officials (i.e. This word used exactly)	0.8
Celebrity Renovator or Designer	0.6
Patient, Lung Cancer Victim or Relation	0.6
First Nations Representative	0.4

The different sources of information that were cited in headlines of radon articles are presented in Table 4. Two-thirds of the radon articles retrieved did not cite an expert/spokesperson in their headline. Of the headlines that did cite an expert, most often this was an ambiguous persona (e.g. “Experts say Radon is a health risk”)(Table 4). When a specific source of information was cited in newspaper headlines, it was most often Health Canada.

Authors

Table 5. Journalists who authored radon-related newspaper articles that were published in Canada between 2003-2014.

Journalist	Number of Articles (Count)	Date Range of Articles
No Author Listed/Anonymous	197	n/a
John Chilibeck	19	July 2011 - May 2012
Mike Holmes	15	May - June 2002
Paul Donohue	13	Oct. 2005
Larry Pynn	12	Feb. 2007
Jessica Cunha	7	March 2012
Ted Clarke	5	Nov. 2011 - Sept. 2012
Laura Payton	5	Dec. 2010
Michael Prentice	5	Nov. 2008
Margaret Houben	4	Nov. 2011 - Feb. 2012
Andy Johnson	4	May - July 2004
Murray Lyons	4	Nov. 2003 - June 2004
Cameron Orr	4	Oct. - Dec. 2009
Dave Rogers	4	Feb. 2005 - Jan. 2007
Mike Youds	4	Nov. 2006 - Feb. 2008

* Authors who wrote 3 or fewer articles are not shown here

197 articles had no author entered (N/A) or were Anonymous. Even articles listed as coming from major daily newspapers, such as the Vancouver Sun, had the author listed as Anonymous. It appears that some of the article headlines may have been repeats of the same articles, which were picked up by different news outlets and given slightly different titles (Table 5). Overall John Chilibeck, Mike Holmes, Paul Donohue and Larry Pynn were the most prolific writers, each with over 10 articles to their respective names. John Chilibeck's articles were published in July, 2011, Jan. and May 2012. Mike Holmes's articles were published in May and June 2012, and November 2013. All of Paul Donohue's articles were published in Oct 2005 and all Larry Pynn's articles were published in Feb 2007.

Location

Ontario and BC were the provinces with the first and second highest number of radon articles published (143 and 149 articles respectively (Fig. 7)). This did not change when the number of published articles was standardized according to population (Fig.

8b,d,f). The average household concentration of radon in a province did not appear to be related to the number of radon articles published in that province (Fig. 8a-b). Average awareness of radon and ability to describe radon in a province also did not appear to be related to the media coverage of radon in that province (Fig. 8c-f). The number of articles published in a province was not related to the population of that province (Data not shown).

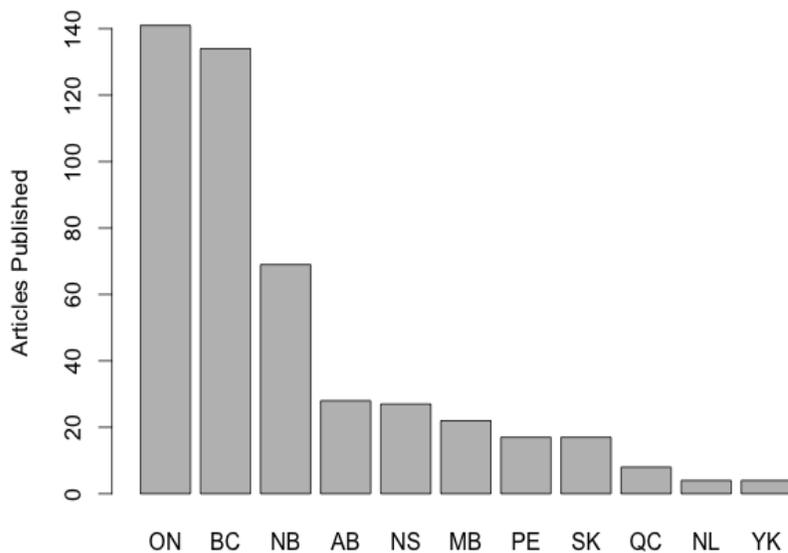


Figure 7. Number of radon related print media articles published in Canada between 2003-2014 by province.

Type of newspaper

Newspaper articles were also classified according to the type of newspaper they were published in. 129 different newspapers were responsible for published the 490 articles that were retrieved. 59 of the newspapers were Minor Daily newspapers, 53 were Local Weekly newspapers, and 19 were Major Daily newspapers (one of the top 25 daily newspapers in Canada, by circulation). Overall, 44% of the articles came from Minor Daily newspapers, 27% were published in Local/Weekly Newspapers and 22% were published in Major Daily Newspapers. 22 of the retrieved articles were published by the Canadian federal wire service and did not fall under one of the other classification schemes.

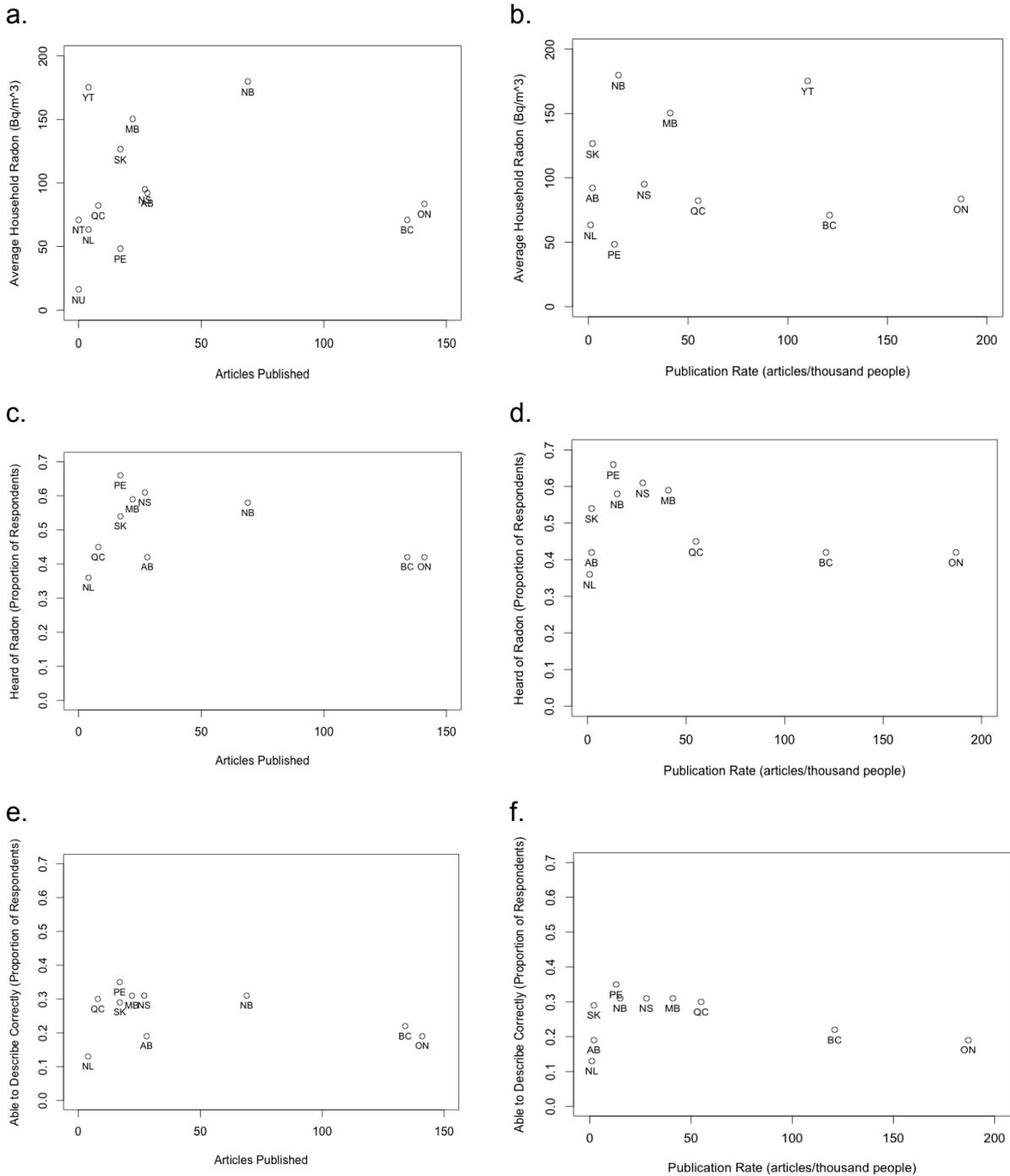


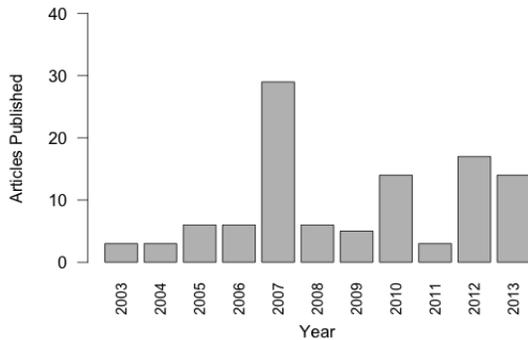
Figure 8a-f. Radon articles vs mean provincial household radon concentrations. Data on the average household radon was from the *Cross Canada Survey of Radon Concentrations in Homes* (Statistics Canada, 2012). c-f. Radon articles published vs. average awareness and knowledge of radon in homeowners. Awareness data was from the Households and the environment survey (Statistics Canada, 2014a).

Minor Daily newspapers have been the greatest publishers of radon-related articles since 2004, publishing the most radon-related articles overall (Table 6). The publication of radon articles over time varied according to newspaper type. There was a low publication rate of radon articles in major daily newspapers with a publication spike in 2007 (Fig. 9a). Minor Daily newspapers picked up the story in 2007 and continued to publish radon stories at a somewhat consistent rate (Fig. 9b). Finally, the publication of radon related small weekly community papers appears to be gradually increasing, with peaks in 2007 and 2012 (Fig. 9c).

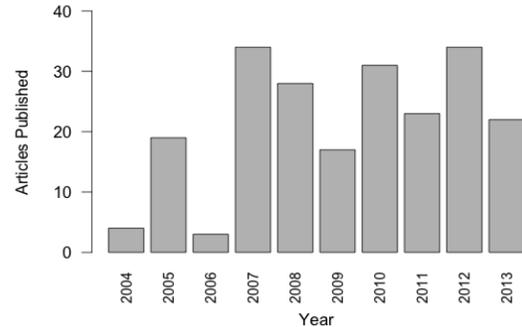
Table 6. Type of newspaper publication for radon articles by year.

Newspaper Type	Year											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
Major Daily	3	3	6	6	29	6	5	14	3	17	14	
Minor Daily	0	4	19	3	34	28	17	31	23	34	22	
Local/Weekly	0	6	5	7	13	5	19	11	16	28	21	

a. Major Dailies



b. Minor Dailies



c. Local Weeklies

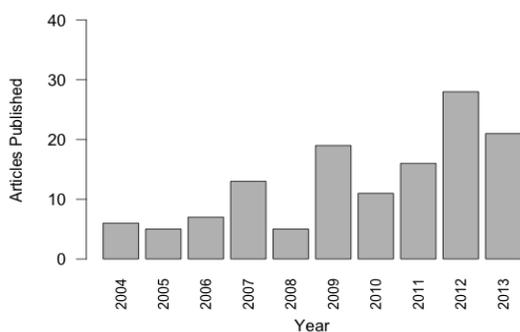


Figure 9a-c. Radon articles published in major daily, minor daily, and local weekly newspapers in Canada between Jan. 2003 – Jan. 2014.

Discussion

Publication Date

There were two years with a noticeably higher number of radon articles, 2007 and 2012. Prior to 2007 media coverage of radon was low but increasing slowly. After the initial spike in publication in 2007 the number of articles decreased but remained above 40 articles per year, indicating that the initial media attention in 2007 helped raise the media profile of radon. The 2012 peak in radon articles is likely related to the release of the results from the *Cross Canada Survey of Residential Radon Concentrations*. 2012 was also the year of the first national Radon Action month. These peaks in media coverage show that government regulatory changes and research publications have an important impact on the communication of radon risk to the public. It is notable that, according to data from the HES survey, the percentage of people who are able to correctly describe radon has increased since 2013 (Fig. 1; Statistics Canada, 2014a). This suggests an increase in the general public's understanding of radon. Whether this increase is related to the increasing media coverage of radon that began in 2007 is pure speculation. This would be an interesting direction for future investigation.

Tone

Assessing the tone of the retrieved articles revealed that radon exposure is often framed as a scary health issue; nearly half of all headlines analyzed had a fearful tone. The tone of the headline is important because headlines frame the underlying message of an article. The message that radon is scary has been consistently communicated by the media from 2003-2013. Although fear based marketing is tool sometimes used in public health campaigns to motivate behaviour change (Hastings, Stead, & Webb, 2004), it can have the opposite intended effect of an informational campaign. When media messages induce fear without including feasible and effective recommendations for change they can cause resistance to, and rejection of, the message (Witte & Allen, 2000). The extended parallel process model (EPPM) can be used to understand how the threat and efficacy components of fear appeals can interact to produce behaviour change (Witte, 1992). According to the EPPM, when individuals perceive that the threat in a message is high but their ability to effectively deter the threat is low (efficacy), they

will engage in maladaptive responses (e.g. denial) to cope with their fear (Witte, 1992). Alternatively, if individuals feel that threat and efficacy are both high, they will engage in strategies to avert the danger (Witte, 1992)

The media has been consistently communicating, since 2003, the message that radon is scary. Less media attention has been given to explaining the health risks of radon and encouraging home testing (Fig. 3a-c). Almost no discussion of radon mitigation strategies, such as building codes and sub slab depressurization systems, has taken place within the media. Strong fear appeals combined with high-efficacy messages are the most successful in producing behaviour change (Witte and Allen, 2000). Appealing to people's fear of radon will be most effective in encouraging home testing if the message includes an explanation of how easy it is to buy a radon test kit and set it up. The public health community should promote the health risks of radon and self-efficacy of homeowners in addressing this threat.

Content

The content of the newspaper headlines varied widely, as is expected for a collection of articles published over the span of ten years and multiple provinces and territories. The absence of messaging on the health risks of radon is concerning since this is a main motivator for people to test and mitigate their homes (Nissen et al., 2011). Another key observation that arose was the variety of different "Experts" quoted in headlines. Most often the expert was an ambiguous source of information, but over 14 categories of "experts" were identified in total. This highlights the absence of a single public health organization or radon spokesperson spearheading the radon gas initiative. Content analysis of newspaper headlines suggested that Canadian media coverage of radon is most often driven by scientific studies, regulatory changes, critical incidents (i.e. occupational exposures), and exposures to children in schools and daycares.

Publishing Location

The results showed that the media coverage of radon was not higher in provinces with higher residential radon levels. BC and Ontario were the two provinces with the highest number of radon articles and they are both provinces with less than 5% of residents living in homes with radon levels above 200 Bq/m³ (Statistics Canada,

2012). By comparison, Saskatchewan was one of the provinces with the lowest number of articles published (per 1,000 population) while over 15% of its residents live in homes above the radon guideline (Statistics Canada, 2012). The analysis also suggested that there was no relationship between the number of articles published in a province and the awareness or understanding of radon gas in that province. This could be partially due to the mixed messages surrounding radon as well as the lack of communication about the health risks of radon from the media.

Newspaper Type

Overall, the coverage of radon in Canadian newspapers varied according to newspaper type. The increase in radon articles since 2007 is being driven by minor daily and local/weekly newspapers, but this may be due to the fact that there are fewer major daily newspapers overall in Canada. However, the spike in radon articles in 2007 was due to major daily newspapers reporting on the lowering of the federal radon action level guideline. Interestingly, there was no spike in the coverage of radon in local/weekly newspapers during 2007 but media coverage by these publications has grown steadily since 2003. Perhaps as the understanding of radon gas exposure grows (Fig. 1), this issue is becoming more important to local communities. Community-based radon interventions are a popular and effective strategy used by public health professionals to reduce radon exposures by targeting high-risk communities (Henderson et al., 2012). This may help facilitate community level interventions if radon continues to be framed as a community issue through local/weekly newspapers.

Limitations

One limitation of this media content analysis is that it was restricted to headline analysis only. Another limitation is that it was conducted without surveying public perception of radon media coverage. Data from the HES provides some information on the public's awareness and perception of radon risk, but this information has only been collected since 2009 (Statistics Canada, 2014a). This analysis did not include articles written in French, which may represent an important media presence in Quebec. Articles for the analysis were only collected up until Jan 2014 when coding began. A few key articles on radon have been published since data collection was completed but it was

necessary to choose a cutoff point. The low number of articles published in this time period may affect the ability to detect trends and correlations. Limiting the article search to indexed newspapers and failing to include headlines from social media could have resulted in some articles being missed.

Public Health Implications

It seems that a large majority of the Canadian public is still at Stages 1-3 of the PAPM behavioral model. Less than 25% of Canadians are able to accurately describe radon and fewer than 5% have tested their homes for radon in the past 10 years (Statistics Canada 2014a). Communicating the health risks of radon to Canadian citizens is a key step in educating and engaging people in the process of testing and mitigating their homes. The media plays an important role in shaping public opinion and action. Currently, the media is not effectively communicating the health risks of radon to the Canadian public. These results indicated a lack of focus in the media messaging surrounding radon and a need to communicate the health hazards of radon in a way that will maximize the likelihood that people will test their homes. The message needs to be clarified; radon is a health threat at elevated levels that can be detected through home testing. It would also be beneficial for Health Canada, or another appropriate public health organization, to brand itself as the leader in radon exposure prevention. This will establish one organization as the clear authority and source of information on radon for Canadians. This will also help to prevent the creation of opportunistic businesses that could take advantage of a lack of understanding in homeowners to overcharge for unnecessary radon testing and mitigation services. A Canadian National Radon Proficiency Program has already been created, which establishes guidelines for training professionals in radon services.

The prevalence of fearful headlines and mixed messages surrounding radon has likely contributed to the low awareness, lack of media attention and low radon testing over the past decade. The ideal underlying message that should be communicated through the media is that radon is a health risk that people should test and mitigate their homes if necessary. It is key that people are instructed to test their homes for radon and informed why this is important. However, in order to reduce exposures to radon gas,

radon intervention programs need to be created that will address barriers to mitigation and testing (e.g. cost, access to labor and materials). It has been observed that radon programs tend to over serve a White, nonsmoking, well educated, middle-class, and partnered cohort (Larsson, 2015; Nissen et al., 2011). Future radon advocacy work needs to focus on addressing structural barriers to radon testing and mitigation in order to avoid reinforcing social inequalities. The traditional and social media can play an important role in communicating the health risks of radon to Canadians, but people will not act on this information to reduce their exposure to radon gas if they are facing strong social and structural barriers to action.

Critical Reflection

The process of completing this project has been a wonderful learning experience. I was not exposed to the environmental health side of public health practice until the second year of the masters of public health program, but I find it deeply engaging. Radon gas is an interesting environmental exposure and risk communication topic. Working on this project helped me appreciate how identifying and understanding a health hazard is only a preliminary step in improving population health. Exploring risk communication in the context of the media's portrayal of radon gas has helped me appreciate the importance of advocacy, communication, and knowledge translation in public health. I have learned that just because a health hazard has been identified does not mean it will be immediately accepted and acted upon by the government or public. Working on this project shown me some of the challenges that public health professionals must overcome in order to advocate and create positive change. As I begin my medical education, it is my hope that I can continue to work with environmental health issues and advocacy groups.

One thing I would have liked to explore further is the effect of socio-economic status on radon exposure and mitigation. I have noticed during this project that the radon industry is, for the most part, approaching radon exposure at the individual level of behaviour change. While promoting general awareness and testing homes is important, I hope that public health professionals have prioritized the need for more creative health

promotion interventions that will target demographic groups not easily reached by traditional media and government outreach programs.

I hope that the work I did for this paper can help guide future advocacy efforts in radon gas exposure as well as other environmental health issues. I believe that public health professionals can learn from this work, even if it is only to not feel discouraged if it takes decades for an unknown environmental hazard to gain recognition. I feel that the tide is beginning to turn for radon and that it could be used as a successful case study for other environmental health hazards. Finally, I deeply appreciate the wonderful mentorship I have received from both of my supervisors while completing this paper. They have provided significant inspiration and support throughout this entire process.

References

- Branion-Calles, M. C., Nelson, T. a., & Henderson, S. B. (2015). A geospatial approach to the prediction of indoor radon vulnerability in British Columbia, Canada. *Journal of Exposure Science and Environmental Epidemiology*, 1–12.
- Bissett, R.J., & McLaughlin, J.R. (2010). Radon. *Chronic Diseases in Canada*, 29(1), 38–50.
- Chen, J., Moir, D., Whyte, J. (2012). Canadian population risk of radon induced lung cancer: a re-assessment based on the recent cross-Canada radon survey. *Radiation Protection Dosimetry*, 152, 9–13.
- Chen, J., Ford, K., Whyte, J., Bush, K., Moir, D., & Cornett, J. (2011). Achievements and current activities of the Canadian radon program. *Radiation Protection Dosimetry*, 146(1-3), 14–18.
- Collins, P.A., Abelson, J., Pyman, H., & Lavis, J.N. (2006). Are we expecting too much from print media? An analysis of newspaper coverage of the 2002 Canadian healthcare reform debate. *Social science Media*, 63(1), 89-102.
- Condit, C. Ferguson, A., Kassel, R., Thadhani, C., Gooding, H.C. & Parrot, R. (2001). An exploratory study of the impact of news headlines on genetic determinism. *Science Communication*, 22, 379- 395.
- Dorfman, L. & Gonzalez, P. (2011). *Media advocacy*. New York: Oxford University Press.
- Drushel, B. E. (1991). Sensationalism or sensitivity: Use of words in stories on acquired immune deficiency syndrome (AIDS) by Associated Press Videotext. *Journal of Homosexuality*, 18(2), 21-40.
- Edberg, M. (2015). *Essential of Health Behaviour: Social and Behavioural Theory in Public Health*. Burlington, M.A.: Jones and Bartlett Learning.
- Emig, Elmer. (1928). The connotation of newspaper headlines. *Journalism Bulletin* 4: 53-60.
- Fenichel, M., & Dan, P. (1980). Heads from Post and Times on Three-Mile Island. *Journalism Quarterly*, 57(2), 338-39, 368.
- Gagnon, F., Courchesne, M., Lévesque, B., Ayotte, P., Leclerc, J. M., Belles-Isles, J. C., ... Dessau, J. C. (2008). Assessment of the effectiveness of radon screening programs in reducing lung cancer mortality. *Risk Analysis*, 28(5), 1221–1229.

- Gebbie, K.M, Rosenstock, L., Hernandez, L.M. & Institute of Medicine (U.S.) Committee on Education Public Health Professionals for the 21st Century. (2003). *Who will keep the public healthy?: Educating public health professionals for the 21st century*. Washington, D.C. National Academy Press.
- Hastings, G., Stead, M. & Webb, J. (2004). Fear appeals in social marketing: Strategic and ethical reasons for concern. *Psychology and Marketing*, 21(11), 961-986.
- Henderson, S. B., Kosatsky, T., & Prabjit, B. (2012). How to Ensure That National Radon Survey Results Are Useful for Public Health Practice. *Canadian Journal of Public Health*, 103(3), 231–34. doi:<http://dx.doi.org/10.1108/17506200710779521>.
- Hughes, A. (2010). *Using social media platforms to amplify public health messages: An examination of tenets and best practices for communicating with key audiences*. Retrieved May 25, 2015 from http://smexchange.ogilvypr.com/wp-content/uploads/2010/11/OW_SM_WhitePaper.pdf.
- International Agency for Research on Cancer. (1988). *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Man-made Mineral Fibres and Radon. Vol 43*. Lyon: World Health Organization.
- Iyengar, S. (1997). *Do the media govern? Politicians, voters, and reporters in America*. R. Reeves (Ed.) (pp. 211-216). Thousand Oaks, CA: Sage Publications.
- Johnson, F.R., Fisher, A., Smith, V.K. & Desvougues, W.H. (1993). Informed Choice or Regulate Risk? Lesson from a Study in Radon Risk Communication. In T.S. Glickman & M. Gough (Eds.), *Readings in Risk* (247-257). Washington, D.C.: Resources for the Future.
- Larsson, L.S. (2014). The Montana Radon Study: Social Marketing via Digital Signage Technology for Reaching Families in the Waiting Room. *American Journal of Public Health*, 105(4), 779-785.
- List of newspapers in Canada by circulation. (n.d.). In *Wikipedia*. Retrieved March 15, 2015, from http://en.wikipedia.org/wiki/List_of_newspapers_in_Canada_by_circulation.
- Miller, R.L. & Brewer, J.D. (2003). *The A-Z of social science research*. London: SAGE Publications, Ltd.
- Maier, S. (2010). All the news fit to post? Comparing news content on the web to newspapers, television, and radio. *Journalism & Mass Communication Quarterly*, 87(3-4), 548-562.
- Nissen, M.J., Leach, J.W., Nissen, J.A., Swenson, K.K., Kehn, H. (2012). Radon testing and mitigation: an intervention in a primary care setting. *Journal of Cancer Education*, 27(3), 566-572.
- Nicol, AM. (2014). CAREX Canada: Radon Exposure and Mitigation [Webinar].

November 19, 2014. .

- O'Conner, A., & Casey, P. (2001). What it says in the papers: An audit. *Irish Journal of Psychological Medicine*, 18(2), 68-71.
- Plough, A & Sheldon Krimsky. (1993). The Emergence of Risk Communication Studies: Social and Political Context. In T.S. Glickman & M. Gough (Eds.), *Readings in Risk* (223-231). Washington, D.C.: Resources for the Future.
- Setton, E., Hystad, P., Poplawski, K., Cheasley, R., Cervantes-Larios, A., Keller, C. P., & Demers, P. a. (2013). Risk-based indicators of Canadians' exposures to environmental carcinogens. *Environmental Health*, 12(1), 15.
- Statistics Canada. (2012). *The Cross Canada Survey of Radon Concentrations in Homes – Final Report*. Retrieved April 25, 2015 from Statistics Canada: <http://www.hc-sc.gc.ca/ewh-semt/radiation/radon/survey-sondage-eng.php>.
- Statistics Canada. (2014a). *Table 153-0098 - Households and the environment survey, knowledge of radon and testing, Canada, provinces and census metropolitan areas (CMA), every 2 years (percent)*, CANSIM (database). Last update September 5, 2014. Retrieved March 28, 2015 from Statistics Canada: <http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530098&parttern=radon&tabMode=dataTable&srchLan=-1&p1=1&p2=-1>.
- Statistics Canada. (2014b). *Table 051-0001, Population by year, by province and territory (Number)*. CANSIM (database). Last updated September 26, 2014. Retrieved May 2, 2015 from Statistics Canada: <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo02a-eng.htm>.
- Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs*, 59, (329-349).
- Witte, K. & Allen, M. (2000). A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education & Behaviour*, 27(5), 608-632.