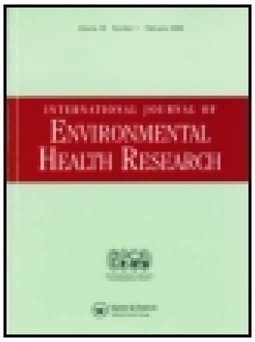

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A content analysis of Internet resources about the risks of seafood consumption

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ABSTRACT

Seafood consumption is a main source of human exposure to certain environmental contaminants. Therefore, it is valuable to assess the online health risk messages focused on this topic, as people in the US are increasingly accessing the Internet for health-related information. Previous research indicates that online health information tends to be written at a reading level that is more advanced than ability of the general population. The purpose of this research was to examine the content and readability of Internet resources targeted toward consumers in the US regarding the health risks from consumption of contaminated seafood. Sources for analysis were gathered through a targeted search of state and national government websites, as well as through a Google search. The overall mean readability level was Grade 9.21, which is slightly above the average reading level of US adults. Future research should evaluate the accuracy of the health risk messages, as well as consumer perceptions of risk.

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Internet; reading level; risk communication; seafood consumption; health communication

Introduction

It is well documented that fish and shellfish provide nutritional benefits that prevent many diseases (Burger & Waishwell 2001; Verbeke et al. 2004; Dickoff et al. 2007; Amiard et al. 2008). Regular seafood consumption has been linked with increased bone mineral density (Amiard et al. 2008), decreased cholesterol levels (Burger & Waishwell 2001), and decreased cancer risk (Verbeke et al. 2004; Liu & Lin 2014; Song et al. 2014). Dickoff et al. (2007) report that one additional 8 oz serving of salmon each week would result in 20,000 fewer deaths due to heart attacks and 8000 fewer stroke-related deaths in the US each year. These health benefits have been attributed to the low content of saturated fat, and the high content of nutrients such as vitamin D and omega-3 fatty acids found in seafood (Verbeke et al. 2004; Nichols et al. 2014; Gil & Gil 2015). Given its nutritional benefits, it is unsurprising that consumers tend to view seafood as good for their health, especially when compared to other sources of protein such as red meat (Verbeke et al. 2004; Ellis et al. 2014).

Despite the health benefits associated with seafood consumption, fish and shellfish may bioaccumulate and often biomagnify contaminants from the environment (Liao & Ling 2003; Ibelings & Chorus

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2007; Amiard et al. 2008) from a range of diffuse and point sources, to such an extent that contaminant concentrations in some species are sufficiently high to cause harmful health effects (Burger & Waishwell 2001). Seafood consumption is a main source of human exposure to many environmental contaminants that are both carcinogenic and toxicological (Verbeke et al. 2004; Bosch et al. 2015). Contaminants frequently found in fish include polychlorinated biphenyls (PCBs), chlordane, dioxins, DDT, and heavy metals such as methylmercury, cadmium, and arsenic (Verbeke et al. 2004; Amiard et al. 2008; Vieira et al. 2011; Bosch et al. 2015). Heavy metals, in particular, have been contaminants of concern from a public health standpoint because they easily accumulate in organic tissue and have been linked to a variety of health risks (Vieira et al. 2011; Bosch et al. 2015). Developing fetuses, infants, and children are particularly vulnerable to the harmful effects of toxicants such as pesticides, trace metals, and PCBs, which can lead to neurodevelopmental problems even at very low levels of exposure (Burger & Waishwell 2001; Crighton et al. 2013; McDermott et al. 2012). Of particular concern is the increased importation of seafood, currently the number two import in the US behind foreign petroleum, which may often result in exposure to “Circle of Poison” pesticides such as DDT (banned in the US but used abroad for mosquito control), finding its way to dinner plates in the US. For example, 80 % of shrimp in the US is imported often from countries where DDT is used for mosquito control (National Oceanic and Atmospheric Association 2015).

Given the high nutritional content of seafood and the often high contaminant load (Bosch et al. 2015), it is unsurprising that consumers often have misperceptions about seafood consumption safety messages. Dietary recommendations and fish consumption guidelines often conflict, indicating that the public may not be receiving clear health messages (Amiard et al. 2008). Health communication messages that are accessible, culturally appropriate, and written in plain language are effective for engaging the public in health-protective behaviors (Meade, McKinney and Barnas 1994; Houts et al. 2006; Best et al. 2015). Evaluating the health communication tools intended to inform the public about balancing the risks and benefits of seafood consumption is worthwhile.

Consumers in the US are increasingly turning to the Internet to seek health information (Hesse et al. 2005; Fox 2011; Tanner & Friedman 2011). It is reasonable to assume that the Internet would be a primary medium for consumers seeking information regarding seafood safety such as the levels of toxic chemicals in fish and shellfish. Therefore, it is valuable to examine the content of Internet resources related to this topic. Research has shown that health-related information on the Internet tends to be written at an upper high school or college grade level (Friedman et al. 2004). The average adult US citizen reads at an 8th or 9th grade level, and about a quarter of the US population reads at or below a 5th grade level, representing a gap in the readability of online health information and the literacy level of the general population (Friedman et al. 2004; Houts et al. 2006). Pictures and images present in health communication resources have the potential to make the material more understandable and increase recall and attention (Houts et al. 2006; Tanner & Friedman 2011). When assessing readability, it is important to assess both the reading level of the text as well as the images and pictures provided. Research has not yet fully examined the readability levels of Internet resources regarding seafood safety such as toxicity in fish and unsafe contaminants levels of these chemical contaminants by human consumers.

There is value in knowing what audiences and risk groups these resources are targeting, because communication tools that tailor their messages for their intended audiences are more effective than tools that do not (Grier & Bryant 2005; Friedman et al. 2015). Epidemiological analysis of exposure data for many seafood safety issues provides a mechanism to identify high exposure and high risk populations, so that more effective and often gender and culturally appropriate risk communication messages are developed. It is also important to determine if women who are pregnant, nursing, trying to become pregnant, or of reproductive age are well represented as a target audience within Internet resources about the hazards of eating fish. This group is at particular risk of possible harmful effects of toxic chemicals on their developing fetus or child (McDermott et al. 2012).

The purpose of this research was to examine the content and readability of Internet resources targeted toward seafood consumers in the US regarding concentration of toxic chemicals and associated risks in both fish and shellfish. Sources for analysis were gathered through a targeted search of state and national government websites, as well as through a Google search. The state government website search was focused on the South Atlantic states in the US: North Carolina, South Carolina, Georgia, and Florida. The South Atlantic states were selected for the analysis because they are coastal states, and research has shown that people living in coastal regions of the US eat significantly more seafood than those who live in non-coastal regions (Mahaffey et al. 2009). US federal agencies that focus on health, risk, and fish/shellfish toxicity also provide information regarding seafood consumption advice, justifying the inclusion of national websites in the targeted government search. Lastly, non-profit agencies and other Internet resources that can be accessed through a search engine also provide advice to consumers regarding this topic, and therefore were included for analysis.

Methods

Selection of web resources

Sources for the content analysis were obtained through targeted searches of state and national websites as well as a Google search. The searches were conducted in January 2015. The state website search was focused on the health department web pages for the South Atlantic states. National websites that typically provide information to the public about health, risk, toxicity in fish/shellfish, or safe food consumption were selected for the national website search. Websites were considered to have a focus on toxicity if they provided information about contaminants found in fish such as heavy metals or harmful chemicals. Table 1 outlines which state and national websites were explored, and how many sources (e.g. web pages and/or PDF documents) were obtained from each website. A complete listing and links to all state and national webpages analyzed is in Appendix 1. Sources had to contain at least 10 sentences of text for readability testing purposes in order to be included for analysis. Additionally, the sources had to be relevant to the topic, and intended for the public or seafood consumers.

Since most seafood consumers typically use a search engine to access health-related information online (Pang et al. 2014), a Google search was also conducted using eight search terms (number of valid sources found using each term is in parentheses): safe fish (21), fish safe to eat (20), safe fish guide (16), fish safety (11), fish advisory (11), fish guidelines (11), fish toxicity (4), and fish hazard (4). Since minimal original sources were yielded by the last two search terms, additional terms such as contaminants and risk that would have produced similar results were not explored. Shellfish was not used as a specific search term as our analysis indicated the term fish brought up shellfish as well in all searches. Additionally, since the purpose of the study was to evaluate the content of websites that focused on the risks associated with seafood consumption, terms related to the benefits of seafood consumption were not included. Twelve sources (14.3 %) were found using both search mechanisms – the targeted government website search and the Google search. For each term, the top 50 hits, or the first five pages of hits were recorded, for a total of 400 recorded hits. Advertisements or sponsored sites were not included. One hundred and seventeen hits were repeats, either from another search term or from the targeted state and national government website search. The Google search yielded 49 original sources. Table 2 shows the exclusion criteria used to generate the Google search results, along with the number of sources that were excluded, based on these set criteria.

Coding

A comprehensive codebook was developed, guided by examples of codebooks used for previous health and science focused content analysis papers (Friedman et al. 2008; Tanner & Friedman 2011; Friedman et al. 2014), as well as the Suitability Assessment of Materials (SAM) (Doak et al. 1996). The codebook included 47 items divided into four sections: basic information/general description of the source, format, content, and images/design. The content section included an item on readability, which was analyzed using the Simple Measure of Gobbledygook (SMOG) test, a common and validated tool used

Table 1. Sources yielded from the state and national website searches.

Search mode	Websites explored	Abbreviation	Sources yielded
Targeted State	North Carolina	NC	8
	South Carolina	SC	7
	Florida	FL	6
	Georgia	GA	2
	State Total		23
Targeted National	Environmental Protection Agency	EPA	6
	US Food and Drug Administration	FDA	4
	National Institute of Environmental Health Sciences	NIEHS	1
	National Oceanic and Atmospheric Administration	NOAA	1
	Centers for Disease Control and Prevention	CDC	0
	Department of Health and Human Services	DHHS	0
	National Total		12
	State and National Total		35

Table 2. Exclusion criteria for selecting sources for content analysis.

Criterion	Websites excluded
Advisories targeted toward locations outside of the South Atlantic States	71
Only links to other info	19
Not meant for consumers	14
Google image results	8
Lack of access to site	4
Only a video	1
Only a list	1
Only an interview transcription	1
Unrelated to our topic	
Radioactivity	26
Conservation	23
Sites trying to sell something	20
Safe handling or preparation of seafood	19
Histamine, scombroid, or ciguatera poisoning[a]	14
Safe fishing and boating	12
Fish oil supplements	1
Total	234

[a]Naturally occurring biological toxins were excluded. Only anthropogenic chemicals were included in the analysis.

to assess the readability of health education materials (Friedman & Hoffman-Goetz 2006). Sentences of text from each source were entered into an online readability calculator in order to obtain the SMOG score, which indicates the reading grade level of the material (http://www.readabilityformulas.com/free-readability-formula-tests.php). For sources with less than 600 words, the full text was entered into the readability calculator. For sources with 600 words or more, a sample from the beginning, middle, and end of the text was entered into the calculator. Table 3 provides a listing and definitions of the main variables coded for in this study.

The codebook was pilot tested multiple times with an average of five sources each time and adjusted accordingly. Once a final draft of the codebook was complete, two coders independently coded 11 sources (13 % of the sources) for reliability comparison using Cohen's Kappa (Vanderknyff, et al. 2014). Cohen's Kappa scores of 0.70 or higher indicate strong agreement among coders (Lombard et al. 2002). Initial Kappa scores were low on 15 items and the coders discussed discrepancies and made necessary changes, resulting in a final average Kappa score of 0.849 (overall Kappa score range: 0.421–1.000). Mean Kappa scores were also computed for variables within each section of the codebook, and results are as follows (with the range in parentheses): basic information = 0.827 (0.474–1.000); format = 0.881 (0.711–1.000); content = 0.827 (0.523–1.000); images/design = 0.859 (0.421–1.000), all showing satisfactory agreement.

Table 3. Codebook sections, main variable descriptions, and variable levels.

Codebook section	Item description	Response options
Basic Information	Can the source be accessed from the home page?	Yes/No: Internal search necessary
		If yes, how many clicks did it take from the home page to locate the web page?
	Where was the source found?	Targeted state and national search, Google search, both
	Organization type	State agency, national agency, non-profit agency, other
	Date listed?	Yes/No
Format	Format	Website, PDF, available as both
	Subheadings used to "chunk" information?	Yes/No
	Typographic cues (color, bold, size, background) used to emphasize key points?	Yes/No
Content	Focus area of the source (select all that apply)	Warning to limit or avoid specific species of fish/shellfish, warning about a specific contaminant, warning directed at a specific target population/risk group, warning about specific bodies of water, proper handling/preparation of fish/shellfish, encouraging people to include seafood in their diet, other
	Contaminants listed (select all that apply)	Mercury, Nickel, Lead, Chromium, Cadmium, Toluene, 1,2 Dichloroethane, PCBs, radioisotopes, none, other
	Target *audience* explicitly listed in (in text) is (select all that apply):Refers to who is reading the material	Women who are pregnant, nursing, trying to become pregnant, or of reproductive age (referred to as women of reproductive age throughout manuscript), males, children (ages 18 and under), parents, older adults (ages 65 and over), people consuming fish from local bodies of water, no target audience listed, other
	Target *risk group* explicitly listed (in text) is (select all that apply):Refers to who's health is at stake	Same response options as above plus fetuses
	Focus on fish or shellfish?	Fish, shellfish, both
	Focus on seafood that you purchase or catch?	Purchase, catch, both, neither specifically mentioned
	List specific fish/shellfish to limit or avoid that are "higher" in contaminants?	Yes/No
	List specific fish/shellfish that are "safe"/lower in contaminants?	Yes/No
	List a specific disease, health issue, or condition?	Yes/No
	Mention the health benefits of seafood?	Yes/No
	Contain an explicit call to action (e.g. Don't eat this fish!)	Yes/No
	Include a summary, review of key messages, or takeaway points?	Yes/No
	Phone number, email address, contact name, mailing address, "contact us" link	Yes/No for each
	Option to share the information via social media or email?	Yes/No
	Links to additional information relevant to our topic?	Yes/No
	Contain a video and/or sound bite?	Yes/No
	A place to leave or view comments?	Yes/No
	SMOG score	Readability score reflects grade level of material; Lower score reflects easier readability
Images/Design	Include photos or illustrations?	Yes/No
	If photos or illustrations are included, what are the images (select all that apply)?	People (without fish/shellfish), people eating fish/shellfish, fish/shellfish alive, fish/shellfish as food, water, map(s), other
	If yes, is a potential target audience/risk group explicitly depicted (select all that apply)?	Same response options as target audience explicitly listed in text.
	Include a table or a chart?	Yes/No
	If there is a table or chart, are captions and/or explanations included?	Yes/No
	Include statistics other than risk?	Yes/No

Analysis

All sources were coded using IBM SPSS version 22.0 (https://www-947.ibm.com/support/entry/portal/product/spss/spss_statistics?productContext=1987017883). Analysis of website content was conducted using frequencies, percentages, and chi-squares. SMOG readability scores were analyzed using non-parametric rank sum tests including Mann–Whitney U and Kruskal–Wallis tests where appropriate. *P*-values were set at 0.05 for all statistical tests.

Results

Overview of website sources

Twenty-three state web sources, 12 national web sources, and 49 other sources yielded from the Google search were analyzed for a total of 84 sources. A slight minority (45.2 %) of sources required an internal search to access them, whereas a slight majority of (54.8 %) could be accessed from the homepage of the website. Of those that could be accessed from the homepage, it took an average of 4.26 clicks (Standard deviation [SD] = 1.48) away from the homepage to locate them. The sources were 1.5 pages (Interquartile range (IQR) = 1.5) in length on average, which was calculated by copying and pasting the text from the source into a Microsoft Word document with 1-inch margins, single-spacing, and 12-point Times New Roman font.

Thirty sources (35.7 %) were authored by state agencies, 15 sources (17.9 %) by national agencies, and 15 (17.9 %) sources by non-profit organizations. Fifty-seven sources (67.9 %) listed a date on the web page. Most (53.7 %) indicated that this was the date that the page was last updated, while 18.5 % indicated that it was the date that the page was written or posted.

A Kruskal–Wallis test revealed that sources from national agencies (mean rank = 58.50) had significantly more recent years listed (e.g. more recent information) than non-profit organizations (mean rank = 38.10), X^2 (3, N = 56) = 19.600, p = .007, and sources classified as "other," (mean rank = 40.29), X^2 (3, N = 56) = 20.611, p = .025.

Format

Seventy sources (83.3 %) were web pages, 8 sources (9.5 %) were in PDF format, and 6 sources (7.1 %) were offered in both formats. Subheadings were used in 77.4 % of sources to break information into sections. Sources that used subheadings were significantly more likely to use typographic cues such as bold, color, differing font sizes, or backgrounds (43.1 %) and to contain an explicit call to action such as "Don't eat this fish!" (81.5 %) compared to sources that did not use subheadings [typographic cues: (15.8 %), X^2 (1, N = 84) = 4.701, p = .030; call to action: (36.8 %), X^2 (1, N = 84) = 3.918, p < .001]. Typographic cues were used to emphasize key points in 36.9 % of sources. A Mann–Whitney test revealed that sources that used typographic cues to emphasize key points were significantly more readable (Grade 8.74 ± 2.05) compared to sources that did not use typographic cues (Grade 9.49 ± 1.88), U = 599.50, p = .040.

Content

Fish and shellfish information

Most sources (67.9 %) listed specific species of fish or shellfish to limit or avoid because they were higher in contaminants. Many sources (63.1 %) also described species that were lower in contaminants. The majority of sources (60.7 %) mentioned the health benefits of eating seafood. Sources that listed specific fish or shellfish to limit or avoid were significantly more likely to mention the health benefits of seafood (71.9 %) compared to sources that did not list fish that should be avoided (37.0 %), X^2 (1, N = 84) = 9.352, p = .002. The majority of sources (67.9 %) focused on both fish and shellfish. A small number of sources (11.9 %) focused on seafood that you purchase, 21.4 % focused on seafood that you catch, and 22.6 % focused on both. The remaining sources (44.0 %) did not specifically mention if the focus was purchased or caught seafood. Sources from state agencies (50.0 %) were significantly more likely to focus on seafood that you catch (as opposed to purchase) compared with sources from other organizations including nonprofit (0.0 %) and national (6.7 %) agencies, X^2 (9, N = 84) = 32.873, $p < .001$. About 30 % of sources mentioned a specific body of water.

Disease focus

A specific disease or health issue was mentioned by 56.0 % of sources. The diseases and health issues mentioned are listed in Table 4. The majority (60.7 %) of sources mentioned the health benefits of eating seafood. Sources that mentioned a specific disease, health issue, or condition were significantly more likely to mention the health benefits of seafood (70.2 %) compared to sources that did not discuss a specific health issue (48.6 %), X^2 (1, N = 84) = 4.036, p = .045.

Contaminants mentioned

The vast majority (84.5 %) of sources mentioned mercury and a large minority of sources (44.0 %) mentioned PCBs as the contaminant of interest. Important contaminants for human health that were not listed include nickel, chromium, toluene, benzene, and 1, 2 dichloroethane (Järup 2003; Wang, Sato, Xing and Tao 2005). "Contaminant frequencies are listed in Table 5.

Readability and interactivity of content

The mean SMOG reading grade level score for the web pages was 9.21 (SD = 1.97), indicating that the sources were at about a 9th grade reading level on average, which is approximately the reading level of the average US adult citizen (Friedman et al. 2004). A Mann–Whitney test revealed that sources that contained an explicit call to action were significantly more readable (Grade 8.87 +/− 2.12) compared to sources that did not contain a call to action (Grade 10.07 +/− 1.18), U = 430.50, $p < .001$.

Just over 70 % of sources contained an explicit call to action. Only 11.9 % of sources included a summary or a review of key messages or takeaway points. Furthermore, only 6.0 % of sources contained a video and/or sound bite. There was a place to leave and/or view others' comments about the source in 27.4 % of the sources. There was an option to share the information via email or social media

Table 4. Frequencies of diseases or health issues mentioned in website sources.

Disease or health issue	*n*	%
Fetus/infant/child brain/nervous system development	24	51.1
Cognitive/neurological problems, learning disabilities	17	36.2
Cancer	9	19.1
Heart disease or problems	5	10.6
Mercury poisoning	5	10.6
Sexual health/infertility/hormone disruption	5	10.6
Birth defects/low birth weight/small infant head size/premature birth	4	8.5
Immune system problems	4	8.5
Other (e.g. respiratory, digestive, or central nervous system issues)	17	36.4

Note: % does not add up to 100 because this was a "select all that apply" item.

Table 5. Contaminants listed in websites.

Contaminant	*n*	%
Mercury	71	84.5
PCBs	37	44.0
Lead	3	3.6
Radioisotopes	2	2.4
Cadmium	1	1.2
Arsenic	1	1.2

Note: % does not add up to 100 because this was a "select all that apply" item.

within 67.9 % of the sources. The inclusion of an option to "share" the information via social media or email differed significantly by organization type, with sources classified as "other" (e.g. news articles, magazine websites) most frequently having this option (95.8 %) and sources from state agencies least frequently having this option (30.0 %), X^2 (3, N = 84) = 31.772, $p < .001$.

Focus areas: presentation of risks and benefits

Table 6 lists the frequencies of each focus area. Sources that focused on presenting a warning to limit or avoid specific species of fish or shellfish were significantly more likely to list women of reproductive age as their target audience (76.7 %) compared with sources that did not have this focus (63.4 %), X^2 (1, N = 84) = 5.246, p = .182. Additionally, they were more likely to mention the health benefits of consuming seafood (79.1 %) as well as contain an explicit call to action (88.4 %) compared with sources that did not have this focus [health benefits: 41.5 %, X^2 (1, N = 84) = 12.444, $p < .001$; call to action: 53.7 %, X^2 (1, N = 84) = 12.393, $p < .001$].

Sources that focused on presenting a warning about a specific contaminant were significantly more likely to list women of reproductive age as their target audience (81.4 %) compared with sources that did not have this focus (44.0 %), X^2 (1, N = 84) = 11.722, p = .001. Similarly, they were more likely to list fetuses (86.4 %) and children (74.6 %) as their target risk group compared with sources that did not have this focus [fetuses: 36.0 %, X^2 (1, N = 84) = 21.891, $p < .001$; children: 40.0 %, X^2 (1, N = 84) = 9.144, p = .002].

Mercury was mentioned more often than other contaminants when the information was targeted or directed at a specific population (91.7 %) when compared with sources that did not list a target population (75.0 %), X^2 (1, N = 84) = 4.368, $p < .037$. Additionally, sources that focused on a specific target population were significantly more likely to list specific fish or shellfish to avoid (68.4 %) as well as list "safe" fish (77.1 %) compared to sources that did not have this focus [limit: 31.6 %, X^2 (1, N = 84) = 9.211, p = .002; safe: 44.4 %, X^2 (1, N = 84) = 9.411, p = .002]. Sources that focused on encouraging people to include seafood in their diet were significantly more likely to list women of reproductive age as their target audience (91.3 %) compared to sources that did not have this focus (62.3 %), X^2 (1, N = 84) = 6.724, p = .010.

Sources that listed mercury as a contaminant were significantly more likely to list parents (54.9 %) and women of reproductive age (80.3 %) as their target audience, and children (74.6 %) and fetuses (83.1 %) as their target risk group, compared to sources that did not mention mercury [parents: 7.7 %, X^2 (1, N = 84) = 9.830, p = .002; women: 15.4 %, $p < .001$; children: 7.7, $p < .001$; fetuses: 7.7 %, X^2 (1, N = 84) = 30.615, $p < .001$]. Additionally, sources that mentioned mercury were significantly more likely to list specific fish or shellfish to limit (74.6 %) and list "safe" fish or shellfish (69.0 %) compared to sources that did not (limit: 30.8 %, p = .003; safe: 30.8 %, p = .013). Lastly, sources that listed mercury were significantly more likely to mention the health benefits of seafood (69.0 %) compared to sources that did not mention mercury (15.4 %) X^2 (1, N = 84) = 13.250, $p < .001$.

Table 6. Focus on the website sources.

Focus area	n	%
Warning about a specific contaminant	59	70.2
Warning directed at a specific target population/risk group	48	57.1
Warning to limit or avoid specific species of fish/shellfish	43	51.2
Encouraging people to include seafood in their diet	23	27.4
Warning about a specific body of water	13	15.5
Proper handling/preparation of fish/shellfish	13	15.5
Other	11	13.1

Note: % does not add up to 100 because this was a "select all that apply" item within the codebook.

Target audiences

The most commonly listed target audience (70.2 %) was women of reproductive age. No specific racial or ethnic group was listed in any source as a target audience, and no sources targeted children. Similarly, the most commonly listed risk group was fetuses, with 71.4 % of sources mentioning this risk group. Table 7 displays frequencies for each target audience and target risk group listed explicitly in the text.

Sources that listed women of reproductive age were significantly more likely to list specific fish to limit or avoid (81.4 %) as well as list "safe" fish (76.3 %) compared to sources that did not list this target audience [limit: 36.0 %, X^2 (1, N = 84) = 16.562, $p < .001$; safe: 32.0 %, X^2 (1, N = 84) = 14.780, $p < .001$]. Additionally, sources that listed this target audience were significantly more likely to mention a specific disease or health issue (66.1 %) compared to sources that did not list this target audience (32.0 %), X^2 (1, N = 84) = 8.286, p = .004. Finally, sources that targeted this group were significantly more likely to mention the health benefits of seafood (79.7 %) compared to sources that did not list this target audience (16.0 %), X^2 (1, N = 84) = 4.447, $p < .001$. Sources that listed fetuses as their target risk group also showed the same significant results for all of these factors (p values ranged from 0.000 to 0.010).

Mobilizing information provided

Mobilizing information includes any information that could cue the consumer to take action. Links to additional information relevant to our topic and targeted toward consumers were found in 59.5 % of sources. A "contact us" link was provided by 71.4 % of sources, 49.9 % provided a phone number, 31.0 % provided a mailing address, 9.5 % provided an email address, and 7.1 % provided a name of a contact person. Sources from state agencies (66.7 %) were significantly more likely to provide a phone number compared with sources from other organizations including nonprofit (53.3 %) and national (40.0 %) agencies, X^2 (3, N = 84) = 19.347, $p < .001$

Images and design

Photographs and/or illustrations were found in 47.6 % of sources. Sources that included photographs or illustrations were significantly more readable (Grade 8.60 +/- 2.13) compared to sources that did not include images (Grade: 9.768 +/- 1.643), U = 548.50, p = .004. Of those sources with photos and/or illustrations, seafood depicted as food was the most common image (75.0 %). Fish or shellfish that were alive were depicted in 30.0 % of the sources with images, 30.0 % depicted fish or shellfish alive, 20.0 % depicted people (with fish), 17.5 % depicted people (without fish), 17.5 % depicted water, and 10.0 % contained a map. Tables and/or charts were found in 11.9 % of sources. Of the sources that had a table and/or a chart, 70.0 % included explanations or captions. Table 7 displays the frequency of each target risk group depicted.

Table 7. Target audience and risk group frequencies.

	Audience		Risk group			
			Mentioned in text		Depicted in image	
Target group	*n*	%	*n*	%	*n*	%
Women of reproductive age	59	70.2	59	70.2	8	20.0
Fetuses	–	–	60	71.4	–	–
Children	–	–	54	64.3	2	5.0
Parents	40	47.6	–	–	2	5.0
Local seafood consumers	35	41.7	33	39.3	–	–
Males	4	4.8	3	3.6	2	5.0
Older adults	1	1.2	1	1.2	–	–
Whites	–	–	–	–	1	2.5
No target group	16	19.0	9	10.7	18	45.0
Other	5	6.0	4	4.8	3	7.5

Note: % does not add up to 100 because these were "select all that apply" items.

Discussion

Findings from the content analysis

This is a first study to evaluate the content and readability of Internet resources intended for consumers regarding concentration of toxic chemicals in fish and shellfish, and the associated risks. Considering consumers are increasingly turning to the Internet for health information, there is value in assessing online health messages focused on this topic (Tanner & Friedman 2011). Targeted state and national government website searches, as well as a Google search were used to obtain sources for analysis. The analysis was completed through the use of a comprehensive codebook.

Overall, there seemed to be a considerable effort to communicate messages about the both the risks and benefits of eating seafood. For example, sources that focused on a warning about a specific contaminant were significantly more likely to mention the health benefits of seafood. However, risk messages tend to be more salient than messages about benefits (Verbeke et al. 2004), therefore health messages focused on the risk of seafood consumption may have the unintended consequence of discouraging people to eat seafood altogether. Verbeke et al. (2004) also found that there was a stronger belief among consumers that fish contained heavy metals when compared with the belief that fish contained omega-3 fatty acids, strengthening this argument. Therefore, further research assessing consumer perceptions about the health messages contained within these sources would be beneficial, as it would be valuable to know if consumer perceptions match the intended message. Moreover, the purpose of this research was not to assess the accuracy of the content; therefore, additional research comparing the accuracy and appropriateness of the messages intended for lay audiences with the scientific literature would be advantageous.

A large majority of sources focused on women who were pregnant, trying to become pregnant, nursing, or of reproductive age as a target risk group. The attention given to this target audience is consistent with previous research showing that pregnant women and new mothers are often the focus of risk communication strategies in public health campaigns (Crighton et al. 2013). It is particularly important to ensure that both the benefit and risk messages are salient for this population, because just as fetuses, infants, and children are more susceptible to the risks associated with toxicants in seafood, seafood consumption is especially beneficial for their neurodevelopment (Hibbeln et al. 2007; Mahaffey et al. 2011; Golding et al. 2013). Once again, further research examining consumer perceptions would be informative when evaluating these health messages.

There was an overwhelming focus on mercury as a contaminant in fish in comparison to other contaminants. Sources that mentioned mercury as a contaminant were significantly more likely to target women of reproductive age, which is appropriate as mercury presents the highest risk for this target group (McDermott et al. 2012). While the toxic effects of mercury are well documented (Burger & Waishwell 2001; Verbeke et al. 2004; Amiard et al. 2008; McDermott et al. 2012), Internet sources may be ignoring other important contaminants from seafood such as lead, cadmium, arsenic, and other organic contaminants that could also negatively impact consumer health (Järup 2003; Ju et al. 2012; Kim et al. 2013; Lee et al. 2013).

The average SMOG score for the sources was around a 9th grade reading level, which is lower than other health information found on the Internet (Friedman et al. 2004). However, given that about a quarter of the US adult population reads at a 5th grade level or below, there is still room for improvement in this area (Friedman et al. 2004). Only 11.9 % of sources included a summary or review of key messages or takeaway points, revealing one potential way to improve readability. Furthermore, less than half of Internet sources included photographs or illustrations, which are known to increase attention, comprehension, and recall of health communication materials (Houts et al. 2006; Tanner & Friedman 2011). Finally, sources that used typographic cues to emphasize key points were significantly more readable, however, only 36.9 % of sources used typographic cues.

One weakness found across the Internet sources was the lack of mobilizing information. Less than half of sources provided a phone number, email address, mailing address, or a name of a contact person.

It has been shown that providing mobilizing information may act as a cue to action that can encourage consumers to engage in health-protective behavior (Tanner & Friedman 2011). Furthermore, although over two-thirds of Internet sources provided an option to share the information via social media or email, sources from state and national agencies were significantly less likely to have this option when compared with sources classified as "other" (defined in Table 3). Recent recommendations indicate that environmental risk communications should promote information sharing (Janmaimool & Watanabe 2014), therefore it would be valuable to increase the number of websites with the option to share. National and non-profit agencies were significantly less likely to provide a phone number in comparison to state agencies, which is logical because the information that state agencies are providing is geographically specific, therefore consumers may be more likely to utilize a telephone number to find out more about fish advisories in their area. However, the lack of mobilizing information could be greatly enhanced by staffing the phone lines directed to web sites with highly trained volunteers with a strong backgrounds in environmental/public health at state, national, and non-profit agencies. This would be especially beneficial for reaching populations that are not technologically savvy and still use phones as their primary means of communication.

Post hoc analysis

In order to obtain more information about resources available to consumers in the South Atlantic states regarding toxicity in fish/shellfish, qualitative information and print resources were gathered in a second round of data collection. Agencies that would be likely provide this kind of information to the public were identified by contacting the state agencies used for the targeted state search as well as through regional contacts that may have useful suggestions for additional contacts. An email was sent requesting that they send any print resources they had available and asking if they would participate in a brief telephone interview. Eleven agencies were contacted in total. Contacts included public health agencies, environmental protection agencies, agencies focused on conservation, and land-grant institutions in North Carolina, South Carolina, Georgia, and Florida. Only South Carolina had print resources available to send and this was a printed version of a PDF that can be accessed on the South Carolina Department of Health and Environmental Control website. Additionally, they indicated that they also printed a brochure about mercury in fish targeting pregnant women but did not have any copies on hand to send. The brochure is distributed to healthcare providers around the state, but the booklet was only available upon request. Lack of funding was cited by the other states as a reason for the lack of printed materials. Six out of the eleven agencies sent links to web resources in place of print resources.

The relative absence of print resources draws attention to an important trend in health communication. Although the Internet enables consumers to access health information in a way that they have never been able to before, people who do not use the Internet are likely to be missing out on important information if there are limited other sources available. (Hesse et al. 2005). Low-income, older, and rural populations, in particular, are less likely to have access to and/or use the Internet (Hesse et al. 2005). One qualitative study conducted in the Southeastern US found that people living in rural areas preferred printed resources as a primary source of information in comparison to Internet and other information sources (Ellis et al. 2014). It is the duty of agencies that produce health risk messages to ensure these messages are reaching the intended target audiences. This is of particular importance as often people without Internet access may be user groups, which consume large amounts of seafood due to their economic status. State agencies should consider multiple communication strategies beyond the Internet to reach all risk groups. Creative communication channels such as radio, television, billboards, and printed materials disseminated in locations likely to be frequented by the target audience are all possibilities.

Limitations

Focusing on the South Atlantic region presented a potential limitation to this study. The sources of pollution that were focused on in this review were limited to pollutants commonly found at Superfund sites in this region. Seafood from other regions in the US and other countries may present different risks, and should be the subject of future assessment.

The nature of using a search engine to obtain sources for analysis presented some potential limitations to this study. First, results from Google searches are constantly fluctuating. A consumer searching the same terms used even one day later may not find the same results. Secondly, sponsored sites or advertisements were not recorded. These links always appeared on the first page of the Google search, so it is possible that a consumer may follow these links for information. Thirdly, although an exhaustive search of each state and national government website was performed, links that appeared on the Google search sources, which could lead to useful information, were not further studied. Fourthly, the selection of our eight search terms was based on an educated guess about what terms typical consumers would select when seeking this type of information. There is a possibility that words such as "hazard," "advisory," and "toxicity" may be too technical for the average consumer entering terms into a search engine. Finally, the term "shellfish" was not included in any of our search terms, however, many of the sources that we found focused on both fish and shellfish indicating that "fish" was used as an encompassing term.

A strength of the present study was the use of multiple methods to gather our sources for analysis. The state and national government website search along with the Google search provided us with a broad range of sources from state, national, and non-profit agencies as well as commercial sites. A second strength of this study was the development of the comprehensive codebook used for analysis. The codebook went through multiple phases of pilot testing, resulting in high-inter-rater agreement. Additionally, it was guided by previous codebooks analyzing health-related information as well as the SAM instrument, and adapted to fit our unique content analysis.

Conclusions

Overall, sources meant for consumers regarding toxicity in fish contain messages about the risks as well as the benefits of seafood consumption. Further research assessing consumers' assessment of the risks and benefits of seafood consumption would be beneficial. Additionally, it would be useful to compare the perceptions of the readers with the state of the science in this field. Toxicity is hugely complex, therefore, it is vital to know whether or not the health messages being presented to the public about risk are constructed in a way that they are well understood and accurate. In comparison to other health-related information on the Internet, sources communicating the risks and benefits of seafood consumption had better readability scores. However, small changes such as adding pictures, typographic cues, and calls to action could further improve the readability of these sources. Evaluating Internet resources about risk communication is worthwhile as consumers increasingly turn to the Internet for health information; however, state and national public health agencies need to continue to use multiple communication channels in order to reach all target audiences and prevent the widening of the digital divide and to better ensure that these important health prevention messages reach the largest target audience possible.

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Appendix 1.

Website	web pages	Hyperlink
South Carolina Department of Health and Environmental Control	What are Fish Consumption Advisories?	http://www.scdhec.gov/fish/WhatareFishConsumptionAdvisories/
	Cleaning and Cooking Fish to Reduce PCB's	http://www.scdhec.gov/FoodSafety/Docs/cook.pdf
	High Risk Groups	http://www.scdhec.gov/FoodSafety/FishConsumptionAdvisories/HighRiskGroups/
	How to Follow the Advisories	http://www.scdhec.gov/HomeAndEnvironment/Mercury/MercuryinFish/
	Shellfish Safety	http://www.scdhec.gov/FoodSafety/ShellfishMonitoring/ShellfishSafety/
	Prepare Meat, Eggs, and Fish Safely	http://www.scdhec.gov/FoodSafety/GuidanceHomeCooks/PrepareMeatEggsFishSafely/
Georgia Environmental Protection Division	Guidelines for Eating Fish from Georgia Water	https://epd.georgia.gov/sites/epd.georgia.gov/files/related_files/site_page/FCG_2014_073114_EAB.pdf
	A Woman's Guide to Eating Fish and Seafood from Coastal Georgia	http://epd.georgia.gov/sites/epd.georgia.gov/files/related_files/site_page/wfcg_coastal.pdf
Florida Department of Health	Seafood Consumption	http://www.floridahealth.gov/%5C/programs-and-services/prevention/healthy-weight/nutrition/seafood-consumption/index.html
	Printable Wallet Card	http://www.floridahealth.gov/%5C/programs-and-services/prevention/healthy-weight/nutrition/seafood-consumption/_documents/comms-wallet-card.pdf
	Florida's Freshwater Fish	http://www.floridahealth.gov/%5C/programs-and-services/prevention/healthy-weight/nutrition/seafood-consumption/_documents/freshwater-advice.pdf

(*Continued*)

Appendix 1. (*Continued*)

Website	web pages	Hyperlink
	Most Current Florida Fish Advisories	http://www.floridahealth.gov/%5C/programs-and-services/prevention/healthy-weight/nutrition/seafood-consumption/_documents/2013-advisory-brochure.pdf
	Florida Commercial Fish Wallet Card for Women of Child-Bearing Age	http://www.floridahealth.gov/%5C/programs-and-services/prevention/healthy-weight/nutrition/seafood-consumption/_documents/purdue-wallet-card-as-one.pdf
	Fish Consumption Advisories for Freshwater Anglers, Florida Fish and Wildlife Commission	http://www.floridahealth.gov/%5C/programs-and-services/prevention/healthy-weight/nutrition/seafood-consumption/_documents/fwc-advice.pdf
North Carolina Department of Health and Human Services	Occupational & Environmental Epidemiology: Fish Consumption Advisories	http://epi.publichealth.nc.gov/oee/programs/fish.html
	Dioxins	http://epi.publichealth.nc.gov/oee/a_z/dioxins.html
	Mercury	http://epi.publichealth.nc.gov/oee/a_z/mercury.html
	PCBs	http://epi.publichealth.nc.gov/oee/a_z/pcbs.html
	Q&A – Mercury in Fish	http://epi.publichealth.nc.gov/oee/mercury/in_fish.html
	What Fish are Safe to Eat?	http://epi.publichealth.nc.gov/oee/mercury/safefish.html
	How Are Fish Consumption Advisories Developed?	http://epi.publichealth.nc.gov/oee/fish/howdeveloped.html
	Current Advisories for NC	http://epi.publichealth.nc.gov/oee/fish/advisories.html
US Food and Drug Administration	Fresh and Frozen Seafood: Selecting and Serving it Safely	http://www.fda.gov/Food/FoodborneIllnessContaminants/BuyStoreServeSafeFood/ucm077331.htm
	What You Need to Know about Mercury in Fish and Shellfish	http://www.fda.gov/Food/FoodborneIllnessContaminants/BuyStoreServeSafeFood/ucm110591.htm
	Before You're Pregnant: Methylmercury	http://www.fda.gov/Food/FoodborneIllnessContaminants/PeopleAtRisk/ucm083324.htm
	Fish: What Pregnant Women and Parents Should Know	http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm393070.htm
Environmental Protection Agency	Fish Consumption Advice	http://www.epa.gov/mercury/advisories.htm
	Fish consumption advisories	http://water.epa.gov/scitech/swguidance/fishshellfish/fishadvisories/index.cfm
	What You Need to Know About Mercury in Fish and Shellfish	http://water.epa.gov/scitech/swguidance/fishshellfish/outreach/upload/2004_05_24_fish_MethylmercuryBrochure.pdf
	General Information: "About Advisories" Tab	http://water.epa.gov/scitech/swguidance/fishshellfish/fishadvisories/general.cfm#tabs-2
	General Information: "Advice to Consumers" Tab	http://water.epa.gov/scitech/swguidance/fishshellfish/fishadvisories/general.cfm#tabs-2
	Should I Eat the Fish I Catch?	http://water.epa.gov/scitech/swguidance/fishshellfish/fishadvisories/upload/1999_01_26_fish_fisheng.pdf
National Oceanic and Atmospheric Administration	Health and Safety	http://www.fishwatch.gov/eating_seafood/health_and_safety.htm