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Research and Applications

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Comparing public health-related material in print and web page versions of legacy media

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Abstract

Objectives: The objectives of this study were to create a database of public health content from a sample of legacy media, and to compare the prevalence of public health themes in print and web-based versions over time.

Materials and Methods: A database was created from eleven nationally published magazines as a sample of legacy media content. Relevant material was extracted and coded by the title of the article, periodical, print or web edition, month of publication, item type, and 1-3 public health theme codes.

Results: Theme codes emerged as the documents were reviewed based on the primary discussion in each piece. A total of 2558 unique documents were extracted from print issues and 6440 from web-based issues. Seventeen public health themes were identified. Individual coded documents were saved with file names identical to the code string, thus creating a searchable database.

Discussion: Legacy media are those that existed before the internet and social media. Publishers target readership groups defined by age, gender, race, sexual orientation, and other commonalities. Although legacy media have been identified as trusted sources of health information, they have not been examined as sources of public health communication. Because both print and web-based versions exist as unstructured textual data, these are rarely examined with informatics methods.

Conclusion: The process described can serve as a model for application of informatics approaches to similar data and assist development of targeted public health communications. Having a better understanding of what types of health content is distributed through legacy media can help to target health messages to specific demographic and interest groups in ways that are understandable and appealing to them.

Lay Summary

Many people still subscribe to and read legacy media, magazines, and newspapers that have been published since before the internet existed. Many of these legacy media now also have websites, providing web-based issues and additional content to their subscribers. Because they are subscription-driven, publishers of legacy media are very attuned to the interests and preferences of their readers, continuously tracking these and adjusting their content accordingly. This has in turn earned them a level of trust from the specific gender, race, sexual orientation, political and other identity or interest groups they target. There have been many studies of health misinformation on the internet, but most of these have focused on social media. Our study looked at public health information presented in articles, editorials, and advertisements in eleven magazines in their print and website forms over 1 year. Public health-related themes were identified and examined for each magazine. A better understanding of public health themes in these sources may help to guide future design and targeting of public health communications to specific groups of people using themes and terms that resonate with them and make messaging more effective.

Key words: health communication; health information interoperability; periodicals; public health informatics.

Background and significance

Legacy media are those that existed before the internet and the dawn of social media, including newspapers, newsletters, and magazines. Most of these now also publish online via dedicated websites which are often found behind a paywall and accessible only to subscribers, or to non-subscribers on a very limited basis (eg, 1 or 2 articles per month). Because magazine subscription is an opt-in choice, readers choose the type of content to which they will be exposed. In addition to paid subscriptions, there are casual readers who might buy a copy at a newsstand or bookstore, share someone else's subscription copy, or read a copy at a public venue, such as a barber shop, beauty salon, or library. Analysis of the content provided within these sources is limited. However, there is evidence that users of these media consider them trusted sources of information.[1–5]

The importance of identifying trusted sources of information was amplified by the public's need for guidance during the emergence of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), in early 2020. In the setting of this global health crisis, individuals sought solutions about how to manage a wide array of concurrent issues, ranging from the acquisition of daily necessities and changes to work, school, and social routines, along with how to maintain their physical and mental health and protect themselves from infection with the virus itself. An increasing amount of information being provided from all sources presented challenges as to the accuracy and relevance of what was being said.

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As a result of experiences with public health communications around COVID-19, the term *infodemic* has been applied to describe an excessive array of information of varying accuracy being communicated simultaneously to the public.[6] Since so much of this communication was in the form of social media, the majority of research in this area has focused on this medium.[7–10] While this work makes important contributions to the understanding of public health communication, it has excluded communication that has happened via legacy media. This risks presenting an incomplete picture of public health communications, especially for less tech-savvy and underserved populations.

Disparities in the communication of health information have been recognized as a significant public health issue.[11–15] Compounding these differences are the means by which various demographic groups seek health information, including via print media and the Internet. There is an extensive body of literature examining information-seeking behavior, or the "pull" side of exposure to health information,[5,16–18] as well as trust in various media formats.[3,17,19]

Likewise, there have also been many studies looking at exposure to the content of both websites and print media, with a specific focus on the presentation of one or another aspect of health and/or disease. In particular, there is a focus on how the media push health information to readers.[20–24] However, these have been limited to 1, or at most 2, groups of users. Furthermore, in identifying a specific content area or population in advance, these studies miss emergent data and essential elements of what and how health and illness messages are conveyed to the general public and to a broader range of demographic groups.

Although print media use has been decreasing, many popular magazines have combined their media footprints, to produce both a print version and web-based content that may or may not be limited to subscribers.[4] To date, there have been no studies that examined health information across demographic groups in this hybrid matrix.

Media readership analysis by industry sources

One source of information about magazine readership access and usage is analysis from the publishing industry. In order to promote the sale of advertising, media producers keep track of readership data. Information about the specific demographics of readership, number of subscriptions, and monthly unique webpage views is typically available in a media kit for potential advertisers.[25–35] These statistics show a wide range of total readership, from 160 000 for *MS*[31] to 26 million for *Time*.[35]

Industry organizations also collect survey data about the reading habits and preferences of readers and the general public. The 2023 Market Report: News and Magazine Media: Providing a Trusted, Brand Safe Source for Reaching Engaged & Influential Audiences compiled information extracted from MRI-Simmons surveys, Nielson Scarborough surveys, and The Edelman Trust Barometer.[36–39] This report states that 87% of Americans say that they have read a magazine within the past 6 months. They also note that according to the surveys cited, magazines have a greater appeal to minority groups, with Black, Hispanic, and LGBT (Lesbian, Gay, Bisexual or Transexual) Americans reading more magazines per month than the US average. Not surprisingly, this report also mentions that the average magazine reader is somewhat older (49.6 years) than the US average (47.7 years). This analysis can begin to provide some initial structure for examination of legacy media.

Accessibility of legacy media to informatics analysis

Given the large volumes of information about health communications, informatics methods have been employed to examine these as they appear in social media and websites.[40–43] However, the application of these methods to legacy media has not followed suit. Print media are not formatted in a way that lends itself to detailed analytics. Legacy media websites are not indexed for searches that would facilitate data extraction and analysis. Both data extraction and analysis exist as unstructured textual data, lacking in standardization. This leaves them bereft of the critical feature of interoperability needed for application of informatics methods.[44] These media require substantial processing to render them accessible to informatics applications. This effort is a worthwhile endeavor since it can unlock understanding of health communications to target populations.

Objectives

The current study was undertaken to examine the public health-related content of legacy media in both print and website editions and to create a multi-periodical database for content analysis.

Materials and methods

Content analysis methodology

In settings such as open-ended survey questions, transcripts of interviews or videos, and other texts, content analysis is a method to categorize and examine objective and subjective ideas and themes embedded in these sources. Content analysis has a long history of use in the social sciences,[45] and also in health professions.[46–48] Bengtsson provides a concise overview of the content analysis methodology.[49]

Data collection

Periodicals in English available for purchase at newsstands in Penn Station and Grand Central Terminal in New York City in November 2019 were screened for broadly defined public health-related content by visual inspection. This content included articles or advertisements discussing any topics that could be relevant to any area of public health, such as smoking, exercise, pollution, climate change, diet and nutrition, or mental health. Sixteen periodicals were identified and purchased for a more detailed review. Eleven met the inclusion criteria of including public health-related content and also having a corresponding website available to subscribers. One-year subscriptions were purchased for the selected periodicals. The timeline for this is shown in Figure 1.

Data extraction and coding

Each printed issue was reviewed, and any articles, editorials, or advertisements, including public health-related content, were coded, then scanned and saved as individual MS Office files. Codes included the full title of the article, the periodical in which it appeared, print or web edition, month of publication, item type (article, advertisement, or editorial), and 1-3 public health theme codes.

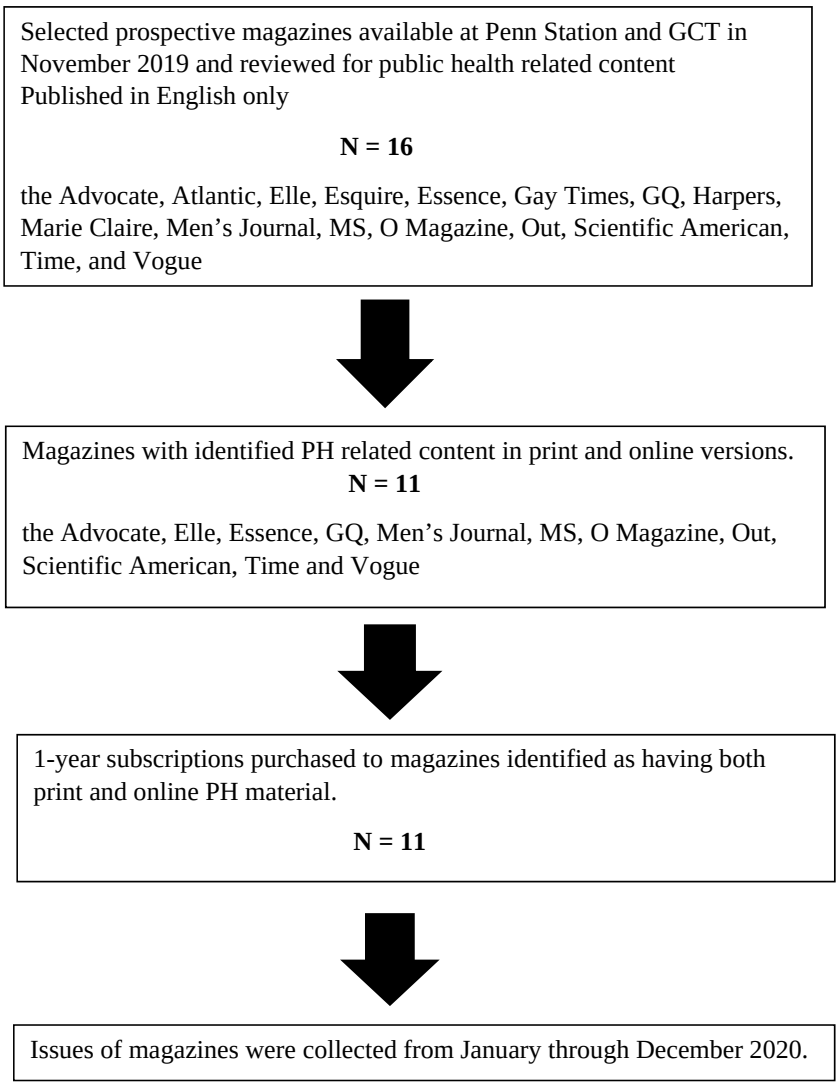

Figure 1. Data selection and collection process.

Utilizing an inductive content analysis approach, theme codes emerged as the documents were reviewed. New themes were added as the periodicals were reviewed, until no more new general categories were found. These were based on the primary themes of each piece. Where there were possibly more than 3 themes under discussion, coding was based on the largest amount of text devoted to each theme. Theme codes were intentionally kept as broad categories. This inclusive method was designed to capture as many relevant items as possible, and to leave room for more detailed sub-analysis of these data across content areas. While all categories were initially very general, as analysis proceeded, some narrower categories emerged.

To examine content validity, the completed list of theme codes was compared to topics in public health listed on prominent public health websites.[50–52] While, as expected, there were many topics of public health significance not included in these lay publications, there were no identified themes derived from the legacy media examined that were found to be extraneous to public health.

Development of dataset

Since websites of popular media are not optimized for content searches following research criteria, documents from each monthly issue were extracted through a hand search. These were then downloaded, coded, and filed in MS Office files, the same as was done with scanned copies of the printed versions. Coded documents were saved in MS Office with file names identical to the coding string. This created a searchable database of these files utilizing the MS Office search box. The database thus created will be utilized for subsequent studies, as well as serve as a model for additional database development.

Results

Descriptive data

Following this process, 2558 unique documents were extracted and coded from print issues and 6440 unique documents were extracted and coded from websites. The numbers of total documents in each item type—articles, advertisements, and editorials—appearing in the print issues are shown in Table 1. Print editions included 41.4% public health-related content, whereas web-based versions were only 15%. These proportions showed a statistically significant difference when compared by a Z-test ($P < .001$).

Distribution of public health-related items in each periodical by month is shown in Table 2. Not every periodical

Table 1. Periodicals by Public Health (PH) document type.

Print issues	All 2020	Total PH (% PH)	Articles	Advertisements	Editorials
The Advocate	204	89 (43.6)	132	65	7
Elle	764	234 (30.6)	175	578	10
Essence	393	166 (42.2)	169	224	0
GQ	383	118 (30.8)	112	263	8
Men's Journal	321	191 (59.5)	127	188	6
MS	74	31 (41.9)	56	16	2
Oprah (O)	653	368 (56.3)	247	385	22
Out	172	71 (41.3)	93	72	7
Scientific American	852	274 (32.1)	543	278	31
Time	1585	757 (47.7)	1065	503	17
Vogue	771	259 (33.6)	225	535	11
Totals	6172	2558 (41.4)	2944	3107	121
Website issues	**All 2020**	**Total PH (% PH)**	**Articles**	**Advertisements**	**Editorials**
The Advocate	834	251 (30.1)	248	3	0
Elle	759	328 (43.2)	290	37	1
Essence	4342	171 (3.9)	142	28	1
GQ	2674	346 (12.9)	301	45	0
Men's Journal	1980	528 (26.7)	284	244	0
MS	2027	638 (31.5)	638	0	0
Oprah (O)	950	332 (34.9)	279	53	0
Out	793	323 (40.7)	310	12	1
Scientific American	7741	1446 (18.7)	1433	6	7
Time	12 113	1005 (8.3)	952	53	0
Vogue	8645	1072 (12.4)	860	203	9
Totals	42 858	6440 (15.0)	5737	684	19

Table 2. Total PH documents per periodical by month.

Print issues	All 2020	Total PH	(% PH)	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	Jun 2020	Jul 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020
The Advocate	204	89	(43.6)	X	16	X	15	X	24	13	X	13	X	8	X
Elle	764	234	(30.6)	13	9	18	30	23	47	X	X	37	21	19	17
Essence	393	166	(42.2)	28	X	27	X	23	X	34	X	27	X	27	X
GQ	383	118	(30.8)	X	12	8	13	13	13	X	13	17	7	9	13
Men's Journal	321	191	(59.5)	19	X	33	42	34	X	X	X	28	X	35	X
MS	74	31	(41.9)	10	X	X	X	9	X	X	X	12	X	X	X
Opera (O)	653	368	(56.3)	34	27	34	34	39	30	31	X	41	27	33	38
Out	172	71	(41.3)	X	7	X	11	X	15	15	X	12	X	11	X
Scientific American	852	274	(32.1)	25	29	19	26	15	35	16	32	15	23	18	21
Time	1585	757	(47.7)	19	49	69	131	72	82	73	72	35	47	71	37
Vogue	771	259	(33.6)	17	15	29	23	29	23	X	25	40	18	18	22
Totals	6172	2558	(41.4)	165	164	237	325	257	269	182	142	277	143	249	148
Website issues	**All 2020**	**Total PH**	**(% PH)**	**Jan 2020**	**Feb 2020**	**Mar 2020**	**Apr 2020**	**May 2020**	**Jun 2020**	**Jul 2020**	**Aug 2020**	**Sep 2020**	**Oct 2020**	**Nov 2020**	**Dec 2020**
The Advocate	834	251	(30.1)	18	17	33	34	22	20	9	22	16	18	13	29
Elle	759	328	(43.2)	10	7	44	64	36	25	24	19	21	31	19	28
Essence	4342	171	(3.9)	10	5	22	19	32	15	18	12	6	6	15	11
GQ	2674	346	(12.9)	32	32	40	27	33	20	15	21	23	43	35	25
Men's Journal	1980	528	(26.7)	102	90	89	55	26	29	23	27	25	20	23	19
MS	2027	638	(31.5)	15	21	60	117	79	33	53	42	62	71	44	41
Opera (O)	950	332	(34.9)	12	13	55	46	45	31	19	18	23	18	23	29
Out	793	323	(40.7)	5	8	24	37	28	36	38	28	34	36	21	28
Scientific American	7741	1446	(18.7)	123	118	154	188	131	174	93	88	87	117	91	82
Time	12 133	1005	(8.3)	85	84	157	130	84	70	58	67	50	69	76	75
Vogue	8645	1072	(12.4)	17	21	206	230	113	75	89	67	58	69	57	70
Totals	42 878	6440	(15.0)	429	416	884	947	629	528	439	411	405	498	417	437

generated 1 print issue per month. For those with fewer than twelve issues, the first month of issue was used as the publication month. Website articles were tabulated by the month they first appeared online.

Figure 2 compares the total numbers of public health-related items by month. The shapes of the curves are similar, with changes in the line for print lagging somewhat behind changes in the web-based line from January to August. From

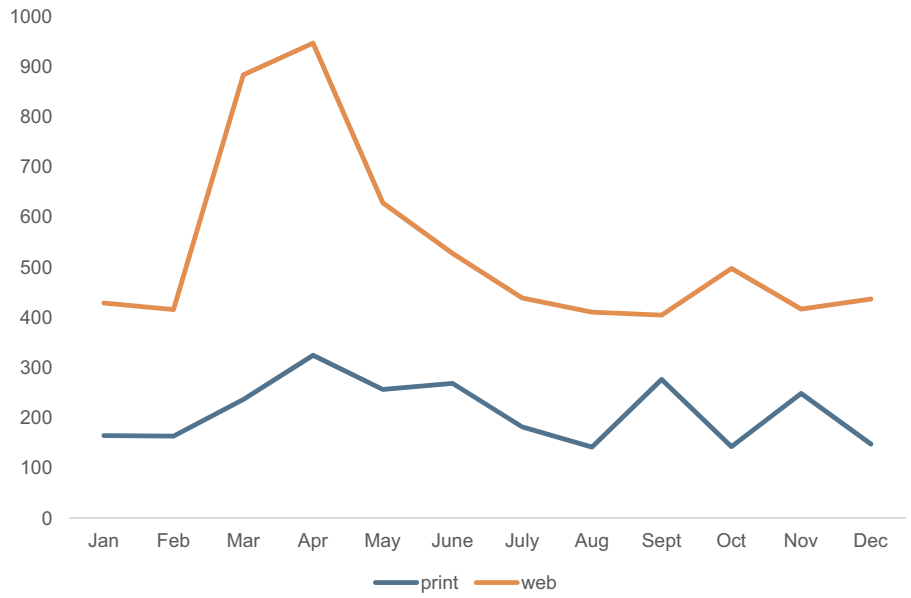

Figure 2. Public health-related content by month in print and web-based issues.

August to December, these trends reverse, with print issues increasing public health content ahead of an increase shown on websites. For further comparison, monthly totals were converted into proportions of the total items published by print or web-based sources. Once again, these proportions were compared by month using *Z*-tests. The proportions differed significantly in the months of March ($P < .001$), April ($P = .014$), June ($P < .001$), September ($P < .001$), October ($P < .001$), and November ($P < .001$), indicating a difference in the amounts of articles published by each media type in those months.

Analysis of public health-related content

Through the iterative process of data extraction and coding, 17 public health-related themes were identified. These were: child health, COVID-19, diet-food-nutrition, environment, health policy and practices, housing-built environment, LGBTQ+, men's health, mental health, non-COVID-19 infectious diseases, physical activity and sports, self-care, sex-sexuality, sleep, substance use/abuse, violence, and women's health.

In order to observe any changes or patterns by specific themes across the year, the number of items coded under each theme per month was tabulated for print and web-based material. As an assessment of the relative importance given to each of these themes, they were ranked by the total number of items coded under each theme. These ranked data are shown in Table 3. For print issues, the top 3 themes were self-care, health policy and practices, and COVID-19. For web-based issues, COVID-19 was the most frequent theme, followed by health policy and practices and mental health. Statistical comparisons by *Z*-tests were carried out using MS Excel.

Figure 3 shows a comparison between print and web-based content across the 17 themes. *Z*-tests comparing the proportion of content dedicated to each theme in print and website issues found significant differences between these for 13 of the 17 themes. The print issues were significantly higher in discussing 6 topics: self-care; diet, food and nutrition; physical activity and sports; housing and built environment; substance use and abuse; and sleep ($P < .001$ for all of these). Web-based issues had higher proportions of content in 7 areas: COVID-19, environment, women's health, LGBTQ+, sex and sexuality ($P < .001$ for all of these), as well as men's health ($P = .004$), and violence ($P = .041$). Discussion of health policy and practices, mental health, non-COVID-19 infectious diseases, and children's health was comparable in both print and web-based issues ($P = .400$).

Upon examining these clusters of thematic differences, more traditional magazine content, such as diet, exercise, and self-care, appeared in the print issues. This may be due to the longer production schedules for this format, as well as inclusion of more "evergreen" articles, such as weight loss advice in January, sun-related skin care tips in the summer months, and health-related gift ideas during the winter holidays. Themes with no difference between print and web issues were also in content areas typically seen in legacy media, although the specific focus may have differed. For example, more traditional mental health topics would include coping with interpersonal stressors with family members or at work, or adjustments to life changes such as getting married or changing jobs. Emerging mental health topics more prevalent in the web-based content were more likely to focus on mental health issues related to COVID-19 or inter-racial tensions.

Themes significantly higher in the web-based versions were more focused on emerging news that could be presented more quickly online. These themes were driven by the COVID-19 pandemic, environmental events such as the California wildfires, women's health news around the reversal of Roe v Wade, and increased violence in multiple contexts.

In view of the substantial impact of material related to COVID-19, selected themes—diet, food, nutrition, mental health, and environment—were graphed against COVID-19 to provide a visual comparison throughout the year for both print (see Figure 4) and web-based content (see Figure 5). While there was some degree of variability in the first 3 themes, they were all of a similar magnitude in both formats, all of which were dwarfed by the discussion of COVID-19.

Given the differences in total percent of content devoted to public health themes between the eleven magazines (shown in

Table 3. Themes ranked by totals print vs websites.

Print issues	Total items by theme for year	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	Jun 2020	Jul 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020
Self-Care	782	50	35	91	76	87	58	47	34	114	50	89	51
Health Policy, Practices	728	35	51	53	121	65	73	59	60	74	44	58	35
COVID	656	1	6	25	117	58	137	51	63	53	42	65	38
Diet, Food, Nutrition	370	33	23	41	46	41	22	22	12	32	20	43	35
Mental Health	341	23	17	30	41	32	35	31	14	47	18	32	21
Environment	228	18	26	19	32	21	12	21	16	22	12	18	11
Women's Health	162	20	12	22	19	17	11	4	5	20	11	14	7
Physical Activity, Sports	154	18	10	14	22	19	3	8	5	22	5	26	2
Violence	152	7	10	4	12	6	22	27	17	27	5	7	8
LGBTQ+	106	1	16	2	15	3	23	22	1	14	0	9	0
Housing, Built Environment	92	3	6	12	13	13	3	2	8	11	6	8	7
All Non-COVID-19Infectious Diseases	88	4	15	2	11	5	17	5	3	8	4	11	3
Substance Use, Abuse	88	6	3	7	12	10	9	6	5	12	4	8	6
Child Health	72	9	9	9	10	10	2	5	4	4	2	6	2
Sleep	46	8	3	5	1	2	5	1	8	5	4	2	2
Sex, Sexuality	40	5	5	6	5	5	3	2	0	5	1	3	0
Men's Health	5	0	0	1	0	0	1	0	0	0	0	1	2
Total *N* for all documents in print issues	**4110**	241	247	343	553	394	436	313	255	470	228	400	230
Website issues	**Total items by theme for year**	**Jan 2020**	**Feb 2020**	**Mar 2020**	**Apr 2020**	**May 2020**	**Jun 2020**	**Jul 2020**	**Aug 2020**	**Sep 2020**	**Oct 2020**	**Nov 2020**	**Dec 2020**
COVID	1617	20	25	261	359	214	148	98	96	94	129	77	96
Health Policy, Practices	1188	63	75	122	150	108	100	91	80	95	120	91	93
Mental Health	561	36	38	54	53	59	68	45	40	38	62	34	34
Environment	551	55	44	47	58	46	51	41	45	42	41	45	36
LGBTQ+	490	21	22	35	51	37	57	44	41	41	56	30	55
Women's Health	486	18	22	48	66	58	27	36	29	63	56	36	27
Violence	289	3	8	12	24	28	46	24	32	31	34	25	22
Sex, Sexuality	238	21	18	25	27	25	15	26	12	16	18	16	19
Diet, Food, Nutrition	212	19	22	13	19	22	16	13	18	12	16	22	20
Self-Care	212	17	12	22	20	23	14	12	14	15	18	23	22
Physical Activity, Sports	144	17	13	16	18	10	11	11	9	10	13	11	5
All Non-COVID-19Infectious Diseases	132	10	15	13	18	9	7	12	8	11	12	8	9
Child Health	115	3	7	4	23	15	11	8	13	7	9	8	7
Housing, Built Environment	73	8	4	6	6	11	4	10	5	4	8	2	5
Substance Use, Abuse	41	4	2	4	4	3	3	4	1	1	5	6	4
Men's Health	29	1	2	1	3	3	4	2	3	2	4	4	0
Sleep	19	3	0	2	3	1	2	2	0	3	0	1	2
Total *N* for all documents in website issues	**6397**	319	329	685	902	672	584	479	446	485	601	439	456

Table 1), further analysis was done to examine the prevalence of specific themes in each of these. This varied greatly across the eleven periodicals. These are shown for the print issues in Table 4. These differences reflect the varied interests and focus areas of these readership groups, as well as the format of the content, print or web based.

Comparisons by readership groups

There was substantial variation in the amount of public health-related content in each of the eleven magazines studied. These ranged from 30.6% (Elle) to 59.5% (Men's Journal) in print and 3.9% (Essence) to 43.2% (Elle) online (see Table 1). Producers of these magazines are likely to be responding to the needs and preferences of their readership demographics. This may have implications for the receptivity of different demographic groups to health-related content presented in these ways. This can be seen when looking at which themes were included most often in each of the periodicals individually, and in clusters of periodicals targeted to similar readership groups. While for web pages, COVID-19 and mental health were frequent themes across all eleven magazines, LGBTQ+ issues were mentioned much more frequently in The Advocate and Out. Women's health was most frequently discussed in MS, while diet, food, and nutrition were most frequently discussed in Men's Journal and Vogue.

As shown in Table 4, the most predominant themes were similar in both formats, but did vary somewhat. The top 5 themes in print issues were: (1) self-care, (2) health policy and practices, (3) COVID-19, (4) diet, food, and nutrition, and (5) mental health. The top 5 themes in web-based issues were: (1) COVID-19, (2) health policy and practices, (3) mental health, (4) environment, and (5) LGBTQ+ issues. With 1-3 possible themes coded for each item, web-based articles were found to have included more complex content, with an average of 1.901 themes per item, as compared to 1.001 for print issues.

Comparisons of themes across periodicals showed substantial differences in predominant content for various readership groups. These also differed between formats. Self-care content, the most prevalent topic in print issues, was concentrated within magazines targeted at women; Vogue (18.9%), Oprah (23.9%), Elle (17.4%), and Essence (12.8%). In web pages, self-care was also predominant in Vogue (45.8%) and Oprah (4.9%) with an additional 13.0% found in Men's Journal. Health policy and practices in both print and web-based issues were concentrated in Time (56.6% print and

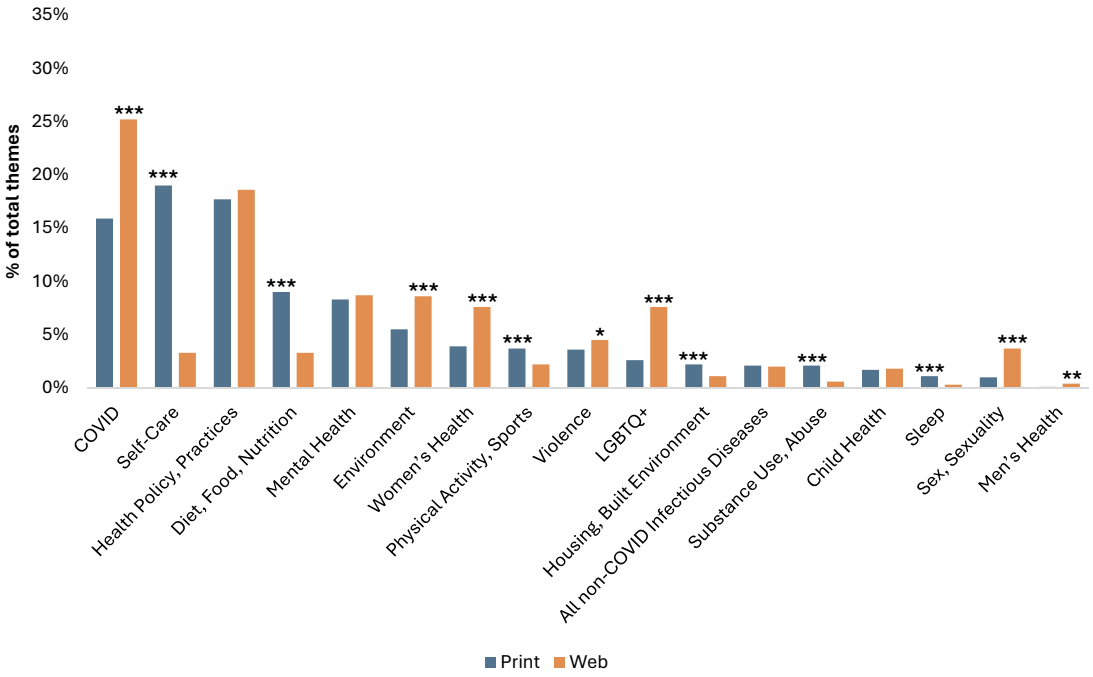

Figure 3. Percent by theme comparing print vs web editions. *P*-values for *Z*-tests: ***$P < .001$, **$P < .01$, and *$P < .05$.

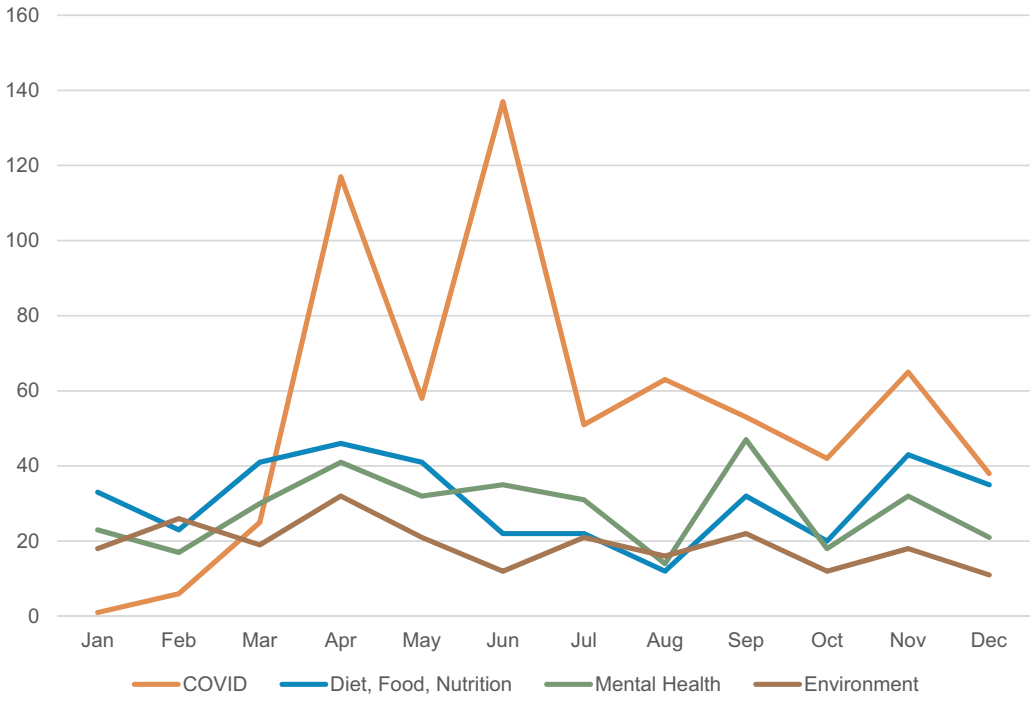

Figure 4. Themes by month in print editions.

27.8% web) and Scientific American (18.1% print, 26% web). These periodicals included the majority of items about COVID-19 in both print (Time 57.3% and Scientific American 14.6%) and web-based issues (Time 19.2% and Scientific American 17.7%). Another high contributor to COVID-19 material was the web version of Vogue, contributing 25% of items in this category. The diet, food, and nutrition theme was divided across multiple readership groups. In the print issues, the majority of items under this theme appeared in Men's Journal (26.2%), Oprah (22.4%) and Time (21.3%). Men's Journal was again the largest proportion of this theme in the web-based issues (30.2%), with the Vogue website

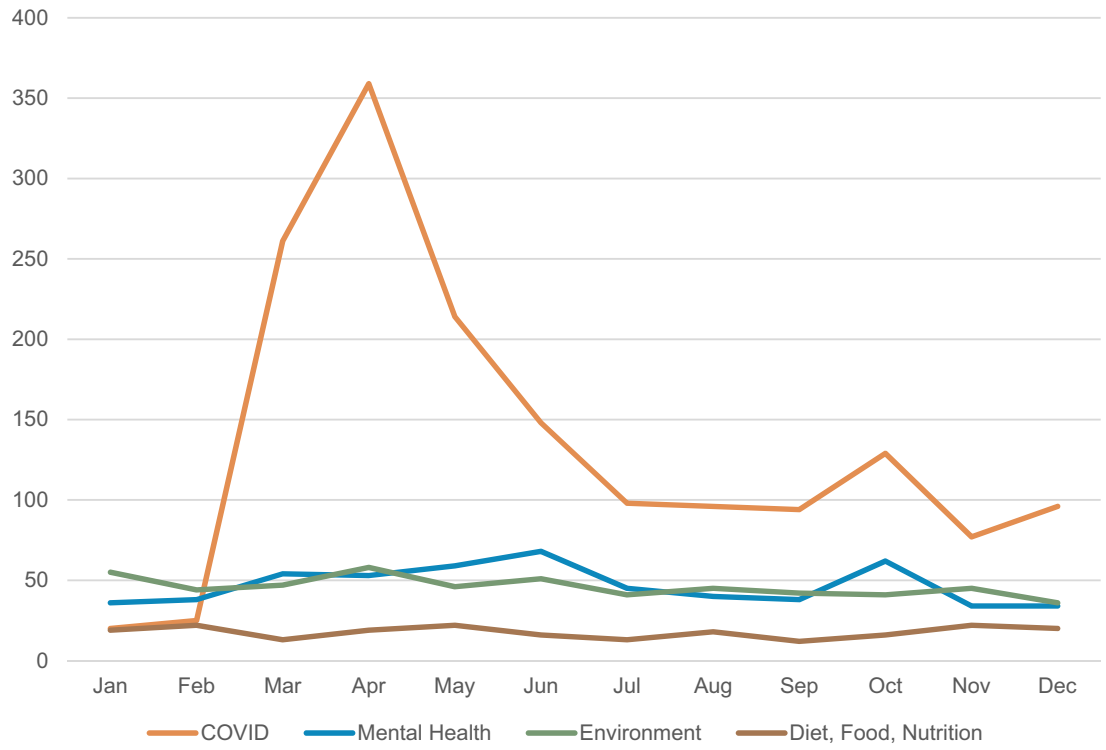

Figure 5. Themes by month in web editions.

being second, with 17.5% of items in this theme. Scientific American had a high number of items under mental health, both in print (15.4%) and web pages (25.7%). However, Time (31.7%) and Oprah (19.3%) had more in print issues. Vogue was second in the web-based editions with 19.6%.

Looking at the predominance of themes within periodicals aimed at specific groups reveals a different perspective. The Advocate and Out have a primarily LGBTQ readership, and this was reflected in the most prevalent themes for these periodicals. The top 3 themes for these 2 periodicals were LGBTQ+ issues, non-COVID-19 infectious diseases, and violence.

Three magazines targeted primarily at women—Elle, MS, and Vogue—had a different thematic focus.. Women's health, self-care, and health policy and practices were prominent themes in the print issues of these periodicals. Web-based issues had a higher proportion of items about COVID-19, mental health, and self-care. Essence and Oprah with a primary readership of Black women had similar themes to those of the other women's magazines. Self-care was the most prevalent theme in the print issues of both of these, with self-care, COVID-19, and mental health being the most frequent themes on their websites. The 2 periodicals targeted at men, Gentlemen's Quarterly (GQ) and Men's Journal, showed a different pattern of themes being emphasized. Diet, food, and nutrition were important themes in both of these magazines, in both print and web-based issues. Physical activity and sports, self-care, health policy, and practices were also frequently mentioned themes, and on both websites, COVID-19. Although their target readerships are quite different, the predominant themes appearing in Scientific American and Time were very similar. In both print and web-based issues, health policy and practices, COVID-19, mental health, and the environment were the most prevalent themes. One difference was noted; in the web-based version of Time, violence was also a significant theme.

Discussion

The total number of documents on websites was much higher than in print issues due to the relative ease of online publishing vs print and the lower cost per each additional article. Despite this, the percentage of public health-related content in print issues was more than twice that of online content. Given that none of the selected periodicals was specifically focused on health, the proliferation of non-health-related content, especially online, is not surprising. Celebrity gossip, fashion trends, reviews of movies and television shows, travel and other forms of entertainment dwarfed health-related content on the websites, even during an emerging pandemic. However, as was seen in Figure 2, the content of print editions lagged behind that of websites by about 1-3 months. It is possible that editorial decisions in this longer process prioritized including more public health-related material. Alternatively, as the much larger volume of material online included larger *totals* of health-related material, and especially related to COVID-19, this was published faster. So it may be that the subscribers to legacy media were exposed to both the late-breaking health stories through the websites along with many other pieces, and more traditional health-related content in the print editions. Differential priorities as seen in Figure 3 were consistent with this, showing more traditional material in print issues, with more emerging new themes found in websites. Further analysis of specific content

Table 4. Distribution of themes by periodical.

Print issues[a]	The Advocate *N* (%)	Elle *N* (%)	Essence *N* (%)	GQ *N* (%)	Men's Journal *N* (%)	MS *N* (%)	Oprah (O) *N* (%)	Out *N* (%)	Scientific American *N* (%)	Time *N* (%)	Vogue *N* (%)	Total Coded items by theme
Self-Care	2 (0.2)	136 (17.4)	100 (12.8)	19 (2.4)	43 (5.5)	3 (0.4)	187 (23.9)	13 (1.7)	7 (0.9)	124 (15.8)	148 (18.9)	782
Health Policy, Practices	16 (2.2)	33 (4.5)	23 (3.2)	21 (2.9)	1 (0.1)	28 (3.8)	34 (4.7)	3 (0.4)	132 (18.1)	412 (56.6)	27 (3.7)	728
COVID	15 (2.3)	52 (7.9)	21 (3.2)	17 (2.6)	5 (0.7)	6 (0.9)	16 (2.4)	16 (2.4)	96 (14.6)	376 (57.3)	44 (6.7)	656
Diet, Food, Nutrition	4 (1.1)	11 (3.0)	21 (5.7)	26 (7.0)	97 (26.2)	0 (0)	83 (22.4)	8 (2.2)	21 (5.7)	76 (21.3)	23 (6.2)	370
Mental Health	12 (3.5)	14 (4.1)	20 (5.9)	11 (3.2)	7 (2.0)	0 (0)	66 (19.3)	6 (1.7)	53 (15.4)	108 (31.7)	34 (10.0)	341
Environment	0 (0)	23 (8.4)	1 (0.4)	7 (2.6)	22 (8.0)	2 (0.7)	9 (3.3)	1 (0.4)	60 (22.0)	105 (38.5)	20 (7.3)	273
Women's Health	0 (0)	30 (18.5)	5 (3.1)	0 (0)	1 (0.6)	23 (14.2)	30 (18.5)	0 (0)	6 (3.7)	26 (16.0)	42 (25.9)	162
Physical Activity, Sports	3 (1.9)	6 (3.9)	10 (6.5)	18 (11.7)	69 (44.8)	0 (0)	15 (9.7)	8 (5.2)	3 (1.9)	14 (9.1)	8 (5.2)	154
Violence	16 (10.5)	3 (2.0)	7 (4.6)	6 (3.9)	1 (0.6)	9 (5.9)	8 (5.3)	49 (32.2)	3 (2.0)	85 (55.9)	10 (6.6)	152
LGBTQ+	56 (52.8)	1 (0.9)	2 (1.9)	1 (0.9)	0 (0)	2 (1.9)	3 (2.8)	31 (29.2)	1 (0.9)	7 (6.6)	2 (1.9)	106
Housing, Built Environment	0 (0)	5 (5.4)	3 (3.2)	14 (15.2)	5 (5.4)	0 (0)	6 (6.5)	0 (0)	2 (2.2)	28 (30.4)	29 (31.5)	92
All Non-COVID-19Infectious Diseases	20 (22.7)	0 (0)	7 (7.9)	4 (4.5)	0 (0)	0 (0)	0 (0)	15 (17.0)	25 (28.4)	16 (18.2)	1 (1.1)	s88
Substance Use, Abuse	9 (10.2)	6 (6.8)	1 (1.1)	15 (17.0)	7 (7.9)	0 (0)	3 (3.4)	4 (4.5)	12 (13.6)	26 (29.5)	5 (5.7)	88
Child Health	5 (6.9)	3 (4.2)	2 (2.8)	0 (0)	0 (0)	2 (2.8)	5 (6.9)	1 (1.4)	14 (19.4)	23 (31.9)	7 (9.7)	72
Sleep	0 (0)	5 (10.9)	0 (0)	4 (8.7)	1 (2.2)	0 (0)	11 (23.9)	1 (2.2)	6 (13.0)	10 (21.7)	8 (17.4)	46
Sex, Sexuality	6 (15.0)	7 (17.5)	8 (20.0)	0 (0)	0 (0)	8 (20.0)	3 (7.5)	5 (12.5)	0 (0)	3 (7.5)	0 (0)	40
Men's Health	0 (0)	1 (20.0)	1 (20.0)	1 (20.0)	0 (0)	0 (0)	1 (20.0)	0 (0)	1 (20.0)	0 (0)	0 (0)	5
Totals	89 (3.5)	234 (9.1)	166 (6.5)	118 (4.6)	193 (7.5)	31 (1.2)	368 (14.4)	71 (2.8)	275 (10.7)	757 (29.5)	259 (10.0)	**Σ = 2561**
Website issues[b]	**The Advocate *N* (%)**	**Elle *N* (%)**	**Essence *N* (%)**	**GQ *N* (%)**	**Men's Journal *N* (%)**	**MS *N* (%)**	**Oprah (O) *N* (%)**	**Out *N* (%)**	**Scientific American *N* (%)**	**Time *N* (%)**	**Vogue *N* (%)**	**Total Coded items by theme**
COVID	117 (3.4)	238 (6.9)	65 (1.9)	183 (5.3)	131 (3.8)	338 (9.8)	169 (4.9)	73 (2.1)	613 (17.7)	665 (19.2)	864 (25.0)	3456
Health Policy, Practices	65 (2.9)	66 (2.9)	15 (0.7)	30 (1.3)	40 (1.8)	291 (13.0)	62 (2.8)	140 (6.3)	581 (26.0)	621 (27.8)	319 (14.3)	2230
Mental Health	59 (6.1)	59 (6.1)	62 (6.4)	65 (6.7)	39 (4.0)	34 (3.5)	72 (7.5)	39 (4.0)	248 (25.7)	97 (10.1)	189 (19.6)	963
Environment	4 (0.5)	14 (1.7)	0 (0)	13 (1.6)	62 (7.4)	24 (2.9)	9 (1.1)	4 (0.5)	492 (59.0)	117 (14.0)	94 (11.3)	833
LGBTQ+	169 (29.4)	8 (1.4)	2 (0.3)	10 (1.7)	0 (0)	30 (5.2)	19 (3.3)	264 (46.0)	5 (0.9)	42 (7.3)	26 (4.5)	574
Women's Health	9 (1.4)	36 (5.8)	42 (6.7)	2 (0.3)	1 (0.2)	341 (54.8)	43 (6.9)	7 (1.1)	19 (3.0)	62 (10.0)	60 (9.6)	622
Violence	33 (7.0)	23 (4.9)	6 (1.3)	13 (2.8)	5 (1.1)	124 (25.3)	25 (5.3)	69 (14.6)	21 (4.4)	113 (24.0)	39 (8.3)	471
Sex, Sexuality	26 (9.0)	14 (4.9)	7 (2.4)	24 (8.3)	5 (1.7)	139 (48.3)	19 (6.6)	21 (7.3)	7 (2.4)	6 (2.1)	20 (6.9)	288
Diet, Food, Nutrition	5 (0.9)	29 (5.1)	23 (4.0)	63 (11.0)	173 (30.2)	18 (3.1)	16 (2.8)	6 (1.0)	68 (11.9)	73 (12.8)	100 (17.5)	572
Self-Care	2 (0.2)	58 (5.7)	46 (4.5)	65 (6.4)	132 (13.0)	0 (0)	106 (10.4)	20 (2.0)	21 (2.1)	99 (9.8)	465 (45.8)	1014
Physical Activity, Sports	7 (1.5)	11 (2.4)	33 (7.0)	59 (12.6)	230 (49.1)	2 (0.4)	17 (3.6)	10 (2.1)	22 (4.7)	32 (6.8)	45 (9.6)	468
Child Health	14 (5.9)	11 (4.7)	10 (4.2)	0 (0)	2 (0.8)	45 (19.1)	17 (3.6)	19 (8.1)	18 (7.6)	56 (23.7)	44 (18.6)	236
Housing, Built Environment	2 (1.4)	3 (2.1)	2 (1.4)	6 (4.3)	6 (4.3)	12 (8.6)	9 (6.4)	0 (0)	48 (34.3)	18 (7.6)	34 (24.3)	140
All Non-COVID-19Infectious Diseases	30 (16.7)	1 (0.5)	2 (1.1)	0 (0)	3 (1.7)	0 (0)	3 (1.7)	14 (7.8)	88 (49.2)	34 (19.0)	4 (2.2)	179
Substance Use, Abuse	4 (5.6)	4 (5.6)	4 (5.6)	2 (2.8)	13 (18.0)	0 (0)	1 (1.4)	3 (4.2)	24 (33.3)	7 (9.7)	10 (13.9)	72
Men's Health	1 (1.7)	3 (5.1)	0 (0)	5 (8.5)	17 (28.8)	9 (15.2)	0 (0)	3 (5.1)	8 (13.6)	7 (11.9)	6 (10.2)	59
Sleep	0 (0)	3 (4.4)	3 (4.4)	4 (4.4)	21 (30.9)	0 (0)	5 (7.4)	0 (0)	9 (13.2)	15 (22.0)	8 (11.8)	68
Totals	547 (4.5)	581 (4.7)	322 (2.6)	544 (4.4)	880 (7.2)	1407 (11.5)	589 (4.8)	696 (5.7)	2292 (18.7)	2064 (16.9)	2327 (19.0)	**Σ = 12 245**

[a] Themes are listed as ranked for overall totals for all print issues.
[b] Themes are listed as ranked for overall totals for all website issues.

could be of benefit in further understanding these differences, and the ways in which they can inform public health communications.

Applications in public health communications

Having a better understanding of what types of health content is distributed through legacy media can help to target health messages to specific demographic and interest groups in ways that are understandable and appealing to them. Sampling vocabulary use and literary tone could promote improved health literacy by presenting information in a way that appeals to specific groups of readers. This can also help to effectively tailor communications to diverse populations, especially those seeking content-specific periodicals that are trusted sources of information for them.[53] Since members of the public use different media sources of information in different ways, identifying the most pertinent channel or channels for targeted messages would improve the efficacy of public health campaigns.[20] Having an understanding of how literature targeted to specific groups "talks" to them can help health professionals to couch their messages in engaging and effective ways.

Vocabulary, tone, and language usage, as well as which content is relatable to the target readership are juxtaposed to the complex systems in which people live, and the many needs and desires embedded in those systems.[54] Having a better understanding of readers and how they prefer to receive content can help to target public health communications. Closer collaboration between journalists, researchers, health professionals, and community stakeholders to create clear and consistent messages would do much to improve the efficacy of such communications.[55]

Sampling periodicals targeted to relevant groups prior to launching public health campaigns could aid in the fine-tuning of messages and could make them more likely to be successful. Identifying media sources of trusted health information for specific groups could also be used to "reverse engineer" important health messages to those populations. Accomplishing this translational work requires cross-disciplinary methods and collaboration. Informatics methods are needed to extract and analyze original data. Systems science is needed to understand how that fits into people's complex lives to optimize focus. Communication skills are needed to close the loop and bring public health messages back to people in a way that makes sense to them, so they can "hear" the messages and take appropriate actions.

Our study has shown that legacy media in both print and web-based formats present a highly varied range of themes to their readers, and that these differ between the 2 formats. Examining media for specific groups may make it easier to target public health messages in a way that is engaging and understandable to their group.

Limitations

The main limitation of this study is the small number of magazines sampled. While the eleven included are all nationally distributed, selecting from those available at newsstands in New York City may not represent the overall landscape of magazines published in the United States. Collecting data during only 1 year of publication may also have introduced bias into the overall findings, especially given the much-discussed COVID-19 pandemic that may have led not only to high interest in pandemic-related content but to greater interest overall in health-related topics during 2020.

Directions for further research

Detailed analysis of specific topics within this data set—both quantitative and in-depth content analysis of documents for themes, vocabulary, tone, and other factors—can help develop an understanding of how health information is delivered to specific readership groups. This may help to guide future efforts at tailoring and fine-tuning public health messages.

Conclusions

The database developed for this study can serve as a model for the development of effective informatics approaches to data extraction and analysis in non-indexed data sources such as legacy media. This has potential for application in other contexts, such as publications in different languages or countries, as well as across different times. Combining novel informatics approaches with a systems science focus may contribute to development of effective precision communications in public health.

Author contributions

Conceptualiztion, AG; Funding Aquisition, AG; Methodology, AG; Data Collection, AG and RB; Formal Analysis, AG and RB; Visualization, AG and RB; Writing - Original Draft, AG & RB; Writing - Review & Editing, AG and RB. Both authors approved the final version of this manuscript and agreed to be accountable for all aspects of this work.

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Conflicts of interest

The authors report there are no competing interests to declare.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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Research and Applications