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ABSTRACT

Objective: To examine the nature of media coverage of vitamin D in relation to its role in health and the need for vitamin D supplementation.

Design: Media content analysis

Setting: Print articles from elite newspapers in the UK, USA, and Canada and from popular North American health and lifestyle magazines.

Participants: 294 print newspaper articles and 65 print magazine articles appearing over five years (2009-2014)

Results: The most common framing of vitamin D in print articles was "adequate vitamin D is necessary for good heath." Articles also framed vitamin D as difficult to obtain from natural sources and framed vitamin D deficiency as a widespread concern. In discussions of supplementation, 80% of newspaper articles suggested supplementation is or may be necessary for the general population, while 95% of magazine articles suggested supplementation is or may be necessary. Overall, magazines were more definitive in their support for vitamin D supplementation than newspapers, yet neither newspapers nor magazines discussed the potential harms of vitamin D supplementation in any detail. Print articles named 41 different health conditions in relationship to vitamin D. The most commonly cited conditions included bone health, cancer, and cardiovascular health. Although print articles referred to a wide range of scholarly research on vitamin D with varying degrees of endorsement for supplementation, a general tone of support for vitamin D supplementation in media coverage persisted.

Conclusions: Newspaper and magazine articles conveyed overall support for vitamin D supplementation. News articles linked vitamin D to a wide range of health conditions for which there is no conclusive scientific evidence. Media coverage downplayed the limitations of existing science and overlooked any potential risks associated with supplementation.

Strengths and limitations of this study

This study examines a large sample of print media articles from venues with high circulation rates.

This study demonstrates that media coverage links Vitamin D to a wide range of health conditions for which there exists no conclusive evidence.

This study does not examine internet-based news sources, which are becomingly an increasingly important source of health information.

Introduction

Despite numerous empirical studies and policy recommendations[1, 2] that have questioned its health value, the natural health product industry, which includes vitamin and mineral supplements, is a vast multi-billion dollar industry. Research has shown that between 35-50% of the Canadian and US population including children, take some form of dietary supplements,[3-6] and individuals take vitamins and other supplements because they believe this practice will improve their health and offer protection against a range of diseases. However, little evidence exists to suggest that supplementation in addition to a standard diet provides this benefit[5, 7, 8] and in some cases it may in fact be harmful.[9] Given the popularity of nutritional supplements, it is no surprise that individuals who take them often believe they are more beneficial than existing evidence would support. [10] This seeming contradiction prompts the question: What is driving public attitudes towards an interest in vitamin supplementation? Such a question is particularly salient considering the nature of existing evidence, the possible harm and cost associated with some supplements, and that health care providers rarely recommend their use.[7] While undoubtedly a complex and multi-factorial social phenomenon,[11] it seems likely that media representation of vitamins and supplements may play a role.

The public continues to get much of its information about health and science from the popular press,[12] and studies have shown that media coverage, in addition to aggressive marketing strategies[13] can have an impact on perceived health beliefs and utilization patterns.[14] While the relation between the media and public opinion is undoubtedly complex, research has consistently indicated that news media, including newspapers, comprise one of the most important sources of health information for the adult general public,[15, 16] although the influence of the internet as a source of news and information is growing.[17]

Vitamin D has received a great deal of attention in the popular press over the past few

years. Headlines have, for example, declared a "'Plethora' of diseases caused by vitamin D"[18] and that increased vitamin D supplementation/fortification "could stop 'modern' diseases."[19] Given the equivocal and evolving nature of the vitamin D research,[20-22] such definitive headlines and their accompanying stories and testimonies may not provide the public with an accurate picture of the relevant science. Furthermore, such stories may – for better or worse – help to drive the market for vitamin D, which some industry reports suggest has grown significantly over the past few years.[23-25] Indeed, some have suggested that market growth for the sale of vitamin D has reached triple digits and is worth hundreds of millions of dollars.[25] It has been posited that 50% of the US population may be taking some form of vitamin D supplement, [26] and this may be higher in individuals with chronic diseases.[27]

The Evidence Surrounding Vitamin D Supplementation

The state of the existing evidence around the health benefits of vitamin D supplementation is best described as unsettled.[26, 28] A recent trial sequential meta-analysis[20] reported on the results from 40 RCT's (roughly 100,000 patients) of vitamin D supplementation alone or vitamin D plus calcium. Most studies followed subjects for at least one year and in some cases for up to 5-7 years. When looking at the important clinical endpoints of myocardial infarction or ischemic heart disease, stroke or cerebrovascular disease, cancer, total fracture and mortality, vitamin D supplementation did not significantly reduce risk of these outcomes. There were also no reported negative outcomes associated with supplementation in these studies. Studies of vitamin D supplementation combined with calcium did show a statistically significant reduction in fractures (8% relative reduction) but no statistically significant results from any other endpoints. The authors concluded, "Available evidence does not lend support to vitamin D supplementation and it is very unlikely that the results of a future single randomised clinical trial will materially alter the results from current meta-analyses."[20(p318)] These findings provide some support for vitamin D combined with calcium for reducing fracture risk, but suggest other health claims associated with vitamin D supplementation are not currently supported by the literature.

To address dietary requirements and assessment of vitamin D levels, a comprehensive report was recently completed by the Institute of Medicine (IOM).[29, 30] The IOM committee tasked with determining the North American population needs of vitamin D and calcium concluded that higher concentrations of vitamin D "were not consistently associated with greater benefit, and for some outcomes U-shaped associations were observed, with risks at both low and high levels" [30(p53)] and "the prevalence of vitamin D inadequacy in North America has been overestimated." [30(p53)] For some conditions, such as obesity, the causal relation might actually run counter to conventional wisdom – that is, the condition (increase in adipose tissue) results in lower vitamin D concentrations and not the other way around.[31] Another recent meta-analysis concluded "[d]espite a few hundred systematic reviews and meta-analyses, highly convincing evidence of a clear role of vitamin D does not exist for any outcome"[21 (abstract)]. This umbrella review examined over 200 meta-analyses and systematic reviews and reported a probable evidence of association between vitamin D concentrations and birth weight, maternal vitamin D concentrations at term, dental caries in children, and parathyroid hormone

concentration in patients experiencing chronic kidney disease requiring dialysis. However, the authors concluded there was no convincing evidence to support universal vitamin D supplementation – a conclusion that fits with the work of others.[20-22]

While these conclusions are somewhat definitive in tone, others in the scientific community have been more cautious, emphasizing the equivocal nature of the research surrounding the health value of population wide vitamin D supplementation.[26, 28] For the purposes of our study, we do not need to take a stand on the value of vitamin D supplementation; as this is a complex issue (involving biomarkers and the multiple functions of vitamin D in the body and through the lifecycle). We also do not address the use of vitamin D for specific, vulnerable populations[32] or those that clearly have vitamin D levels that would be associated with important health outcomes like rickets. Instead, we merely seek to highlight that even a cursory review of the relevant academic literature reveals the science around the value of vitamin D supplementation is far from conclusive, particularly in the context of recommending or implementing vitamin D supplementation as a preventative strategy for the general population.

The evolving and conflicting nature of the relevant scientific research, outlined briefly above, and the substantial media coverage on vitamin D presents a timely opportunity to explore the nature and tone of the media attention paid to this popular vitamin supplement. Therefore, this article examines media coverage of vitamin D and identifies the dominant messages conveyed around vitamin D, health, and the need for supplementation.

Methods

We conducted a content analysis of print articles appearing in elite newspapers and popular health and lifestyle magazines that addressed vitamin D over a five-year period (2009 – 2014). Search terms included: 'vitamin D' and 'health'. The Factiva database was used to collect newspaper articles about vitamin D in elite newspapers in Canada, the United States, and the United Kingdom. The search was limited to the top five daily newspapers in a broadsheet format in each country based on recent circulation reports.[33, 34] Our initial search yielded 408 results. Articles were excluded from analysis if vitamin D was not linked to discussions of health or supplementation, or if vitamin D was not a general focus of the article. Our final data set consisted of 294 newspaper articles published between January 2009 and January 2014.

The CPI Q database was used to collect magazine articles about vitamin D appearing in the top 8 most widely circulated health/fitness/lifestyle magazines in North America.[35] The same search terms as above were used and we included only articles for which the full text was available. The final dataset consisted of 65 articles published between January 2009 and January 2014.

Our coding frame was developed through an in-depth analysis of a random sample of 40 articles (approximately 10%) from the entire sample. Re-emergent frames of discussion were identified inductively and coded into a codebook. This inductive approach allowed for the creation of a coding framework that captured relevant themes that emerged in the

articles rather than being limited to predefined frames. The final coding framework was organized into three sections. The first section included general, descriptive information about publication date, word count, article type, author, and article source. The second section captured the health conditions discussed in relation to vitamin D, whether vitamin D supplementation was mentioned and/or recommended, whether the article referred to a specific research study about vitamin D and the extent of the information provided, and whether the potential harms of vitamin D supplementation were discussed. Finally, each article was coded as being overall supportive of, skeptical of, merely descriptive, or as presenting multiple perspectives on vitamin D supplementation.

Two researchers completed coding. All articles were coded in Excel according to the coding framework and data were tallied using SPSS. Overall we sought to capture the general messages the media conveyed about vitamin D in relation to health by determining which messages and frames appeared most often, and whether these messages changed over the five-year span of our sample.

Results

Our results suggest that vitamin D garnered considerable media attention over the five-year period of interest. Vitamin D coverage peaked in 2010 (which may have been influenced by the release of the revised vitamin D recommendations by the Institute of Medicine in November 2010[29]), and showed only a slight decline in subsequent years. While newspaper coverage was most prominent in Canada, media attention was fairly evenly distributed between all three countries, as shown in Table 1. The largest number of newspaper articles were featured in health and lifestyle sections (48%), followed by the news and front-page sections (31%).

Table 1. Newspapers Included in Sample

Newspaper Title	Country	Number of Articles
Globe and Mail	Canada	45
Montreal Gazette	Canada	9
National Post	Canada	12
Toronto Star	Canada	19
Vancouver Sun	Canada	18
The Los Angeles Times	US	11
The New York Times	US	15
USA Today	US	11
The Wall Street Journal	US	24
The Washington Post	US	26
The Daily Telegraph	UK	9
Financial Times	UK	8
The Guardian	UK	19
The Independent	UK	11
The Times (London)	UK	57
TOTAL		294

What's the Big Deal About D?

Our coding framework identified the major frames used in media coverage of vitamin D. In general, articles frequently identified and exalted vitamin D's role in maintaining or promoting good health and in preventing chronic disease. The most commonly utilized frame overall was: "adequate vitamin D is necessary for good health" (57% newspapers, 87% magazines). Most articles used several frames. Other major frames included, "vitamin D supplements may be necessary for good health and the prevention of chronic disease" (36 % newspapers, 53% magazines), "it is impossible or difficult to get vitamin D from natural sources" (28% newspaper, 31% magazines), and "vitamin D deficiency is widespread and cause for concern" (30% newspapers, 21% magazines). Overall, this framing positioned vitamin D as important for good health, but also suggested it is difficult to achieve sufficient vitamin D levels without supplementation, and that deficiency is a widespread concern.

Articles were also coded to identify the specific health conditions linked to vitamin D. In total, newspaper articles named 40 different health conditions associated with vitamin D, while magazines named 41. Cancer was mentioned most frequently by both newspapers (43%) and magazines (36%), followed by bone health, identified in 40% of newspaper and 33% of magazine articles. After cancer and bone health, newspaper articles cited MS (28%), cardiovascular health (25%), and diabetes (24%) most frequently. Magazines identified cardiovascular health (17%), depression (17%) and diabetes (15%) after cancer and bone health. Interestingly, these conditions varied slightly by year, as shown in **Figure 1**, but cancer and bone health remained relatively steady when looking at magazines and newspapers combined.

Figure 1. Most frequently named health conditions discussed in relationship to vitamin D in newspapers and magazines over 5 years.

Although these were the most frequently mentioned health concerns, vitamin D was credited for preventing or decreasing the risk of a vast array of health conditions ranging from hair loss, influenza, the common cold, Parkinson's disease, and for assisting with muscle recovery. All conditions listed appear in the word cloud (**Figure 2**) below. Furthermore, the majority of articles (88%) listed more than one health concern in connection to vitamin D. As a result, an overarching narrative emerged that celebrated vitamin D as a wonder drug that is 'good for everything.'

Figure 2. All health conditions named in relationship to vitamin D in magazines and newspapers over 5 years.

To Supplement or Not to Supplement?

In light of the zeal with which the North American population purchases and consumes vitamin supplements, and given the media's emphasis on vitamin D's role in a wide range of health conditions established above, we examined how media coverage framed the specific issue of vitamin D supplementation. Our analysis revealed 86% of newspaper and 85% of magazine articles explicitly referred to vitamin D supplementation. Of these, 59% of newspaper articles suggested 'supplementation may be necessary for good health' while 21% more assertively declared 'supplementation is necessary for good health'. In other words, 80% of newspaper articles suggest supplementation is or may be necessary. Magazines were more definitive in tone overall. Similar to newspapers, 55% suggested that 'supplementation may be necessary for good health' but 40% suggested 'supplementation is necessary for good health' (95% suggesting supplementation is or may be necessary). Therefore, magazines were almost universally supportive of supplementation and were more than twice as likely to frame it as a clear necessity for the general population than newspapers, as shown in **Figure 3**.

Figure 3. Overall tone of articles regarding vitamin D supplementation.

Additionally, over time, newspapers appeared to slightly soften their stance on supplementation and showed a decrease in the frames "supplementation may be beneficial" and "supplementation is necessary" compared to magazines. See **Figure 4**.

Figure 4. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year.

Newspaper articles, although supportive of Vitamin D supplementation overall, were more moderate in their approach than magazine articles. For example, 25% of newspapers suggested that more research is needed before unequivocal guidance around supplementation is possible. Only 5% of magazines acknowledged this need. Newspapers also made mention of the potential harms of too much Vitamin D in 8% of cases, whereas less than 1% of magazines addressed this issue. In both cases however, the issue of potential harm was basically absent from discussion.

Importantly, many newspaper articles utilized the inverted pyramid style,[36] which often puts more detailed information, such as the potential for harm further down in the article. We coded for the tone of the entire article, but it may be that if audiences read only the first part of the article, they may not read the more nuanced, detailed pieces of information included in the article.

Articles in both magazines (83%) and newspapers (53%) provided specific vitamin D daily intake recommendations for the general public. Our coding framework sought to identify if these recommendations were attributed to any expert, professional or governing body, and if so, which one. Of the articles that made specific recommendations, 58% of newspaper and 86% of magazines articles failed to attribute the recommended intake to any expert body. Of those articles that did, IOM was the most frequently cited

(13% in both magazines and newspapers), followed by Health Canada and the Cancer Society of Canada (both 10%) in newspapers.

Many articles suggested that obtaining Vitamin D through dietary means and sun exposure was preferable to supplementation. And, 57% of magazines and 43% of magazines identified one or more dietary sources of vitamin D such as fortified milk and some fish. However, articles simultaneously reminded readers that sufficient vitamin D is difficult to obtain through these non-supplementary means; indeed, this was one of the primary frames mentioned above. Therefore, although articles often acknowledged that non-supplementary sources of vitamin D were preferable, they also indicated that this approach would likely fail to meet recommendations. As a result we interpreted these discussions as contributing to general support for supplementation.

Deciphering the Science: Accurate Messages in the News?

The ongoing scientific research on Vitamin D was reflected and, at times, explicitly noted in the media coverage. Of the articles that discussed supplementation, 40% of newspaper and 45% of magazine articles referred to one or more specific scientific research studies (i.e., a peer-reviewed journal article) on vitamin D. These studies were positioned as 'evidence' around vitamin D supplementation and vitamin D's role in specific health conditions. The level of detail provided about these studies varied importantly between newspapers and magazines. For example, 35% of newspapers provided detail that extended beyond the study's overall conclusions (i.e., type of study, sample population and size) while only 1% of magazines did the same.

We also coded articles to assess whether news articles interpreted the research as an endorsement of vitamin D supplementation. Our results showed that 56% of newspaper articles and 59% of magazine articles did not interpret the research as taking an explicit stand one way or the other on supplementation. However, 40% of magazines did interpret the research as an endorsement of supplementation while only 22% of newspaper framed the research in this way. This finding supports our earlier observation that newspapers tend to take a more balanced approach.

Given the ongoing scholarly debate surrounding Vitamin D, we analyzed this data to identify any potential change in how the science was positioned over the 5-year sample period. We found that the interpretation of research as endorsement of Vitamin D supplementation dropped noticeably in 2012 as seen in **Figure 5.** This may reflect the increasing number of research studies that do not call for or support supplementation, or a more cautious approach to interpretation on part of the news media. However, despite this decline in referencing scientific support for supplementation, articles maintained a supportive tone in favor of supplementation overall.

Figure 5.
Percentage of articles citing research about vitamin D that interpreted research as endorsement of supplementation.

Discussion

Our results revealed several consistencies in newspaper and magazine coverage of vitamin D. First, both magazine and newspaper coverage framed vitamin D in a favorable light and suggested it was positively linked to good health and the prevention of chronic diseases. We suggest that this is a fair reflection of the science as adequate levels of vitamin D are, obviously, required for good health. Most of the controversy in the literature is not about whether vitamin D is needed, but about the amount we should get, whether natural sources are sufficient, and the need for supplementation. Second, both newspapers and magazines conveyed overall support for vitamin D supplementation. Given the equivocal nature of the relevant evidence, this is not an appropriate representation of the science nor consistent with existing policy recommendations.[29, 37] Third, despite the equivocal nature of scientific evidence, even on frequently studied outcomes such as cancer, fractures, cardiovascular health, and all-cause mortality,[20-22] media coverage overall suggested an established link between vitamin D and multiple health conditions beyond these. However, potential harm of excessive vitamin D levels and supplementation was very rarely discussed. Therefore, vitamin D supplementation was constructed as risk-free and as providing myriad potential health benefits.

Despite these similarities, an important difference emerged between magazine and newspaper coverage. Newspaper articles were less definitive in their tone than magazines in discussions of vitamin D supplementation. Furthermore, newspaper articles provided more nuance and detail overall than magazine articles. Specifically, newspaper coverage was more likely to acknowledge the equivocal nature of the science and the need for further research around supplementation guidelines. Magazines generally did not point to this existing uncertainty. The definitive tone of the magazine articles may have relevance to how the public views the value of supplementation.

Our findings are consistent with other research, which has shown that news stories about medicine and health emphasize potential benefits and downplay potential harms and limitations.[38, 39] We identified an overarching narrative that celebrated vitamin D as good for everything and risk-free. By downplaying risks and the limitations of the existing science, the discussion provides few reasons not to supplement. This contributes to a tone that is largely supportive of the practice. Our results also indicate that media coverage was inconsistent and at times contradictory – which, given the state of the science, is not surprising. For example, articles reported inconsistent daily intake recommendations, which may create confusion among readers.[14] Recent research has also shown both health professionals and the general public are uncertain about many aspects of vitamin D, including how much is needed per day and how much can be easily obtained through natural sources.[40]

We know the media is a powerful, persuasive source of health information.[41, 42] Given our findings that the popular press have been consistently endorsing supplementation, it seems reasonable to conclude the popular press is, at least in part, helping to fuel the demand for vitamin D supplements and to the confusion about its value. However, the actual impact of media on public perceptions was beyond the scope of this study and could be the subject of future research. Our study also highlights the need for good,

independent and reliable sources of health information that present a more nuanced and contextualized picture of the relevant science.

Limitations

This study examined a large number of print news articles but it is important to note potential limitations. For example, we did not examine the content or influence of popular vitamin D information websites such as www.vitamindcouncil.org or of social media outlets such as Facebook, YouTube, and Twitter. However, social media are becoming an increasingly important source of health information for the general public.[43-45]

Implications for Future Research

Future research should examine how Vitamin D is represented in social media and on popular health-related information websites to determine how the general public integrates and makes sense of these diverse sources of information. It would also be important to examine the public's perceptions of the relationship between vitamin D and health and their beliefs about supplementation. Bennett and colleagues[40] provide an important starting point and future research could examine more explicitly what messages the general public takes home from media coverage of vitamin D. Finally, future research that captured the perspectives of health professionals would be important.

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Contributions

TC conceptualized study and assisted with analysis. MC collected, coded, and analyzed data. TC, MC, JPM, and CJF reviewed data and contributed to writing the manuscript.

Competing Interest Declaration

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pd (available upon request from the corresponding author) and declare that (1) All authors report no support from any organisation for the submitted work (2) All authors have no relationships with companies that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have

no financial relationships that may be relevant to the submitted work; and (4) all authors have not non-financial interests that may be relevant to submitted work.

Data Sharing

Dataset consisting of coded articles available upon request from corresponding author Marianne Clark mclark1@ualberta.ca

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The authors confirm they are independent from their funders and that the funders of this work did not play a role in study design, collection, analysis or interpretation of the data, in the writing of the article, or in the decision to submit the article for publication.

Transparency

The authors affirm that the manuscript is an honest, accurate, and transparent account of the study being reported. No important data or aspects of the study have been intentionally omitted

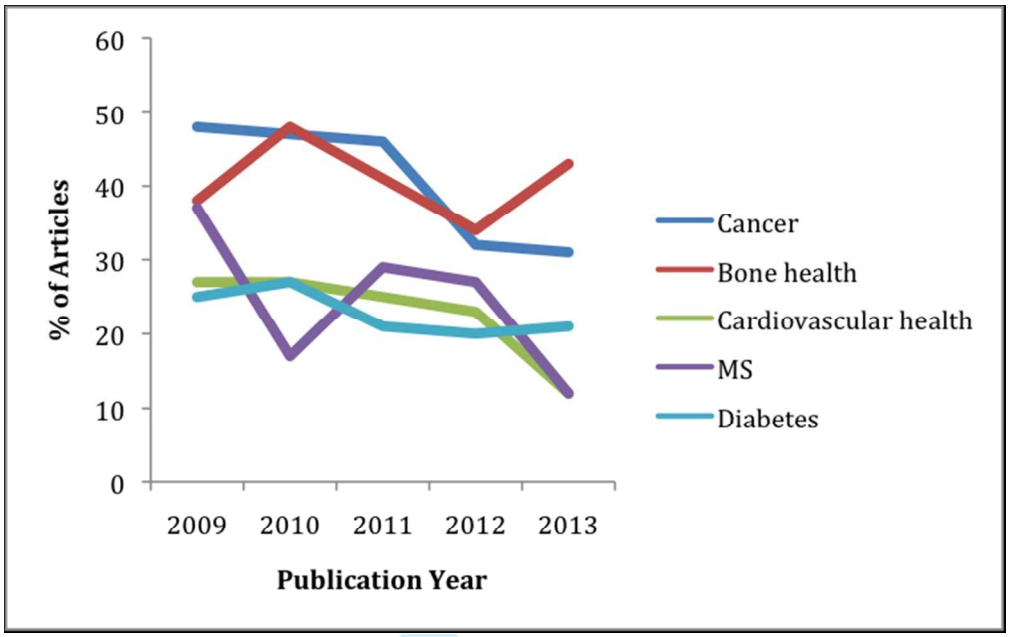
References

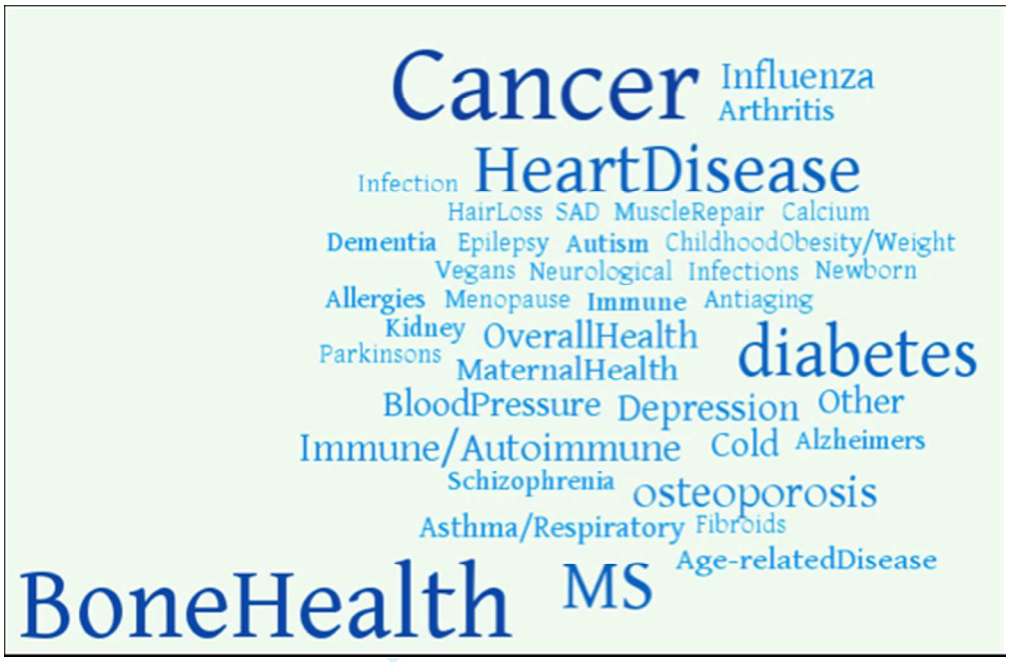
1. Fortmann SP, Burda BU, Senger CA, et al. Vitamin and mineral supplements in the primary prevention of cardiovascular disease and cancer: an updated systematic evidence review for the U.S. Preventive Services Task Force. *Ann Intern Med* 2013;159: 824-834.
2. Lamas GA, Boineau R, Goertz C, et al. Oral high-dose multivitamins and minerals after myocardial infarction: a randomized trial. *Ann Intern Med* 2013;159: 797-805.
3. Community Health Survey [2004] Statistics Canada. Available from: http://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htmhttp://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htm
4. Bailey RL, Fulgoni VL, Keast DR, et al. Examination of vitamin intakes among US adults by dietary supplement use. *J Acad Nutr Diet* 2012;112: 657-663.
5. Blendon RJ, Benson JM, Botta MD, et al. Users' views of dietary supplements. *JAMA Intern Med* 2013;173: 74-76.
6. Dwyer J, Nahin RL, Rogers GT, et al. Prevalence and predictors of children's dietary supplement use: the 2007 National Health Interview Survey. *Am J Clin Nutr* 2013;97: 1331-1337.
7. Bailey RL, Gahche JJ, Miller PE, et al. Why US adults use dietary supplements. *JAMA Intern Med* 2013;173: 355-361.
8. Martínez ME, Jacobs ET, Baron JA, et al. Dietary supplements and cancer

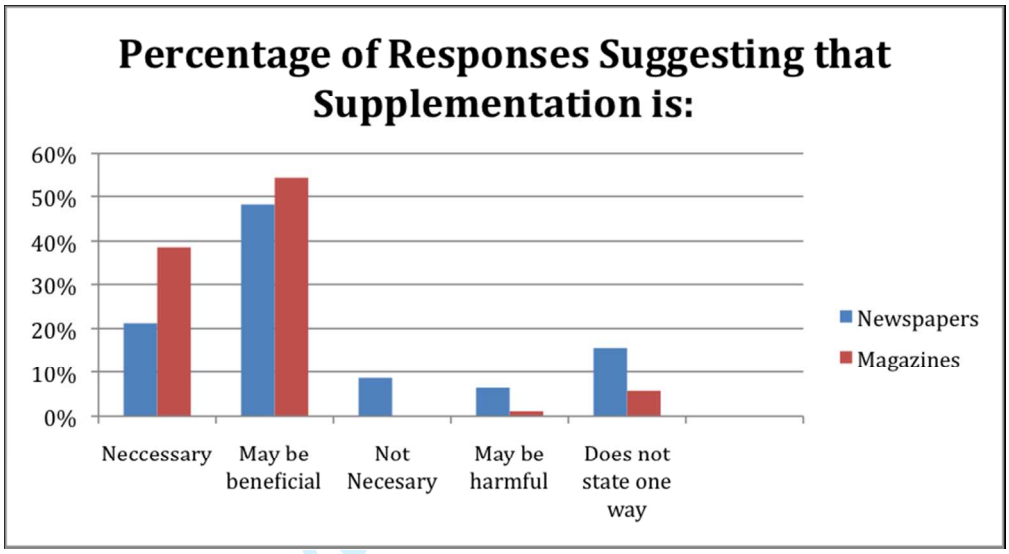
prevention: balancing potential benefits against proven harms. *JNCI J Natl Cancer Ist* 2012;104: 732-739.
9. Bjelakovic G, Nikolova D, Gluud LL, et al. Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases. *Cochrane Database Syst Rev* 2012; 3:CD007176.
10. Fan X, Lee KS, Frazier SK, et al. The use of, and perceptions about, dietary supplements among patients with heart failure. *Eur J Cardiovasc Nurs* [Internet]. 2014 [cited 2014 July 20];13: 311-319. EPub 2013 June 19. Available from: http://cnu.sagepub.com/content/13/4/311.
11. Nichter M, Thompson JJ. For my wellness, not just my illness: North Americans' use of dietary supplements. *Cult Med Psychiatry* 2006 Jun; 30:175-222.
12. Geller G, Bernhardt BA, Holtzman NA. The media and public reaction to genetic research. *JAMA* 2002; 287:773.
13. Story M, French S. 2004. Food advertising and marketing directed at children and adolescents in the U.S. *Int J Behav Nutr Phys Act* 2004;1: 3-17.
14. Nagler RH. Adverse outcomes associated with media exposure to contradictory nutrition messages. *J Health Commun* 2014;19: 24-40.
15. Percheski C, Hargittai, E. Health information-seeking in the digital age. *J Am Coll Health* 2011;59: 379-386
16. Dutta-Bergman, MJ. Primary sources of health information: comparisons in the domain of health attitudes, health cognitions, and health behaviors. *Health Communication* 2004;16: 273-288.
17. Internet gains on television as public's main news source. [Internet] 2011 Jan 4 [cited 2014 June 18]. Available from: http://www.peoplepress.org/2011/01/04/internet-gains-on-television-as-publics-main-news-source/
18. Smith R. 'Plethora' of diseases caused by low vitamin D. *The Telegraph* 2012 Dec 12.
19. Gillie O. Vitamin D – could it stop 'modern' diseases? *The Telegraph* 2014 March 10.
20. Bolland MJ, Grey A, Gamble GD, et al. The effect of vitamin D supplementation on skeletal, vascular, or cancer outcomes: a trial sequential meta-analysis. *Lancet Diabetes Endocrinol* 2014;2: 307-320.
21. Theodoratou E, Tzoulaki I, Zgaga L, et al. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. *BMJ* 2014; 348:g2035.
22. Chowdhury R, Kunutsor S, Vitezova A, Oliver-Williams C, et al. Vitamin D and risk of cause specific death: systematic review and meta-analysis of observational cohort and randomised intervention studies. *BMJ* 2014;348:g1903.
23. Vitamin D use increased 52% in past two years [Internet]. 2011 Feb 1 [cited 2014 March 9]. Available from: http://www.consumerlab.com/news/Vitamin_Supplement_Use_Survey_Report/01_31_2011
24. Feldman M. Is the market for vitamin D supplements at risk of decline? 2011 April 7 [cited 2014 March 9] In: Euromonitor International Blog. [Internet]. London: Euromonitor International Ltd. Available from:

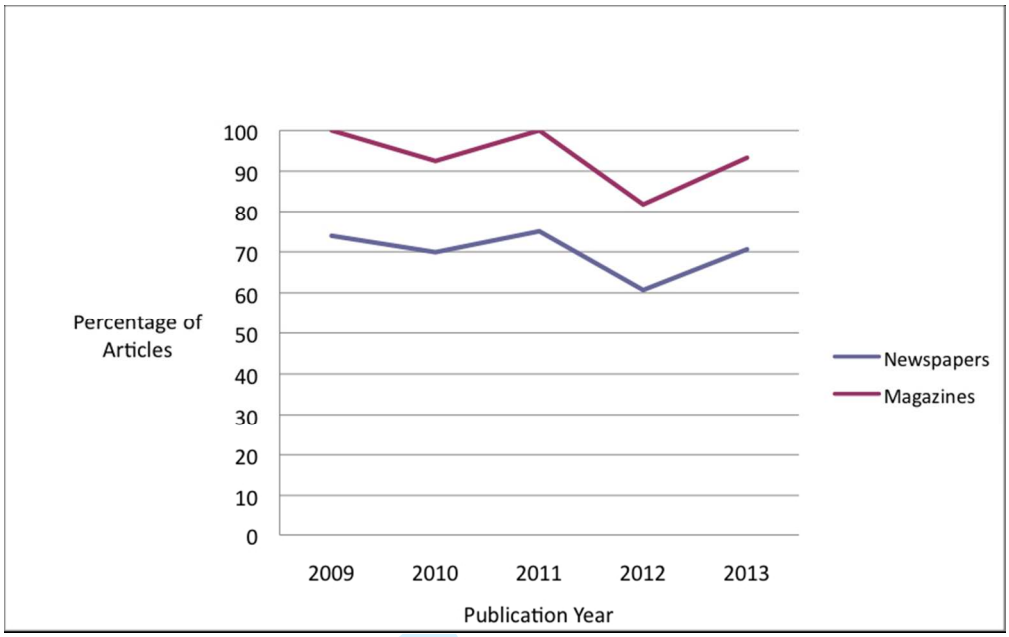
http://blog.euromonitor.com/2011/04/vitamin-d-supplements-losing-their-star.html
25. Montague-Jones G. Markets: global vitamin D boom remains elusive [Internet]. 2010 March 25 [cited 2014 March 9] Available from: http://www.nutraingredients.com/content/view/print/283513
26. Anonymous. Vitamin D: chasing a myth? (Editorial). *Lancet Diabetes Endocrinol* (2014); 2(1):1.
27. Mariani LH, White MT, Shults J, et al. Increasing use of vitamin D supplementation in the Chronic Renal Insufficiency Cohort study. *Journal of Renal Nutrition* 2014; 24:186-193.
28. Kupferschmidt K. Uncertain verdict as vitamin D goes on trial. *Science* 2012;337(6101):1476-1478.
29. IOM. Dietary reference intakes for calcium and vitamin D. Report Brief 2011. http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-calcium-and-vitamin-D.aspx
30. Ross AC, Manson JE, Abrams SA, et al. The 2011 report on dietary reference intakes for calcium and vitamin D from the Institute of Medicine: what clinicians need to know. *J Clin Endocrinol Metab* 2011;96: 53-58.
31. Vimaleswaran KS, Berry DJ, Lu C, et al. Causal relationship between obesity and vitamin D status: bi-directional Mendelian randomization analysis of multiple cohorts. *PLoS Med* 2013;10(2):e1001383.
32. Verbrugge FH, Gielen E, Milisen K, et al. Who should receive calcium and vitamin D supplementation? *Age Ageing* 2012;41: 576-580.
33. Alliance for Audited Media [Internet]. 2013 [cited 2013 December 15]. http://www.auditedmedia.com/news/research-and-data/top-25-us-newspapers-for-march-2013.asp.
34. The Audit Bureau of Circulation [Internet]. 2013 [cited 2013 December 15]. http://www.abc.org.uk/Certificates-Reports/Our-Reports/.
35. Alliance for Audited Media [Internet]. 2013 [cited 2013 December 15]. http://abcas3.auditedmedia.com/ecirc/magtitlesearch.asp.
36. Pöttker, H. News and its communicative quality: the inverted pyramid – when and why did it appear? *Journalism Studies* 2003;4:501–511.
37. Health Canada. Vitamin D and calcium: updated dietary reference intakes. [Internet]. n.d. [cited 2014 July 24]. Available from: http://www.hc-sc.gc.ca/fn-an/nutrition/vitamin/vita-d-eng.php.
38. Cassels A, Hughes MA, Cole C, et al. Drugs in the news: an analysis of Canadian newspaper coverage of new prescription drugs. *CMAJ* 2003;168: 1133-1137.
39. Schwitzer G. Addressing tensions when popular media and evidence-based care collide. *BMC Medical Informatics and Decision Making* 2013;13(Suppl 3):S3.
40. Bennett K, Frisby BN, Young LE, et al. Vitamin D: an examination of physician and patient management of health and uncertainty. *Qual Health Res* 2014;24: 375-386.
41. Begley A, Coveney J. Wonder vitamin or mass medication? Media and academic representation of folate fortification as a policy problem in Australia and New Zealand. *Aust N Z J Public Health* 2010;34: 466-471.
42. Caulfield T, Bubela T, Murdoch CJ. Myriad and the mass media: the covering of

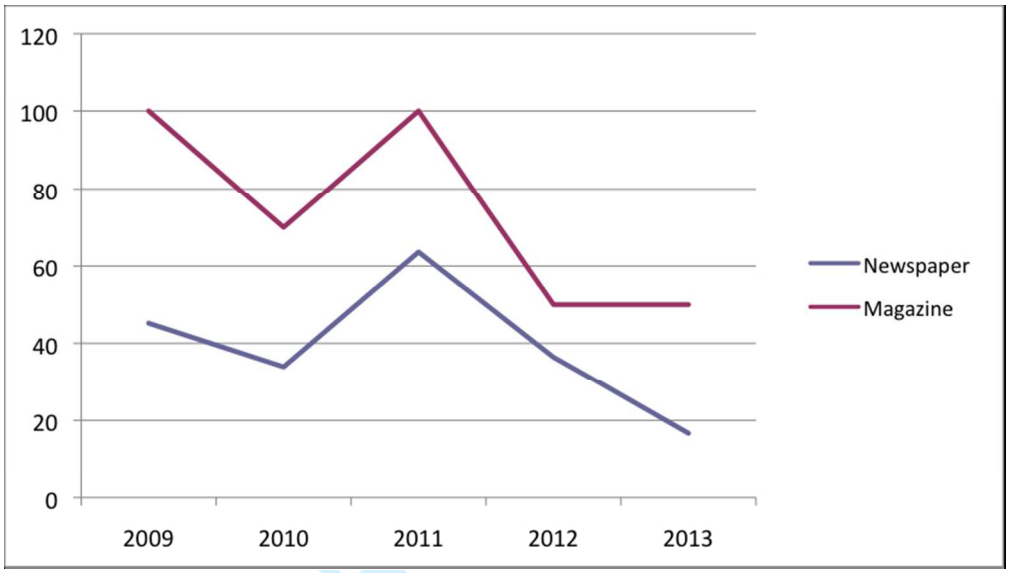
a gene patent controversy. *Genetics in Medicine* 2007;9: 850–855.
43. Logsdon CM, Mittelberg M, Myers J. Use of social media and Internet to obtain health information by rural adolescent mothers. *Appl Nurs Res* [Internet]. 2014 [cited 2014 July 20]. EPub 2014 June 7. Available from: http://www.appliednursingresearch.org/article/S0897-1897(14)00087-1/pdf.
44. Scanfeld D, Scanfelt V, Larson EL. Dissemination of health information through social networks: Twitter and antiobiotics. *Am J Infect Control* 2010;38: 182-188.
45. Vance K, Howe W, Dellavalle RP. Social Internet sites as a source of public health information. *Dermatol Clin* 2009;27:133-136.











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Representations of the Health Value of Vitamin D Supplementation in Newspapers : media content analysis

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Representations of the Health Value of Vitamin D Supplementation in Newspapers

ABSTRACT

Objective: To examine the nature of media coverage of vitamin D in relation to its role in health and the need for supplements. The evidence surrounding vitamin D in relation to health is equivocal, yet supplementation is a prevalent behavior. Investigating media coverage of vitamin D may provide important insight into one of the multiple sources of health information consumed by the general public.

Design: Media content analysis

Setting: Print articles from elite newspapers in the UK, USA, and Canada.

Participants: 294 print newspaper articles appearing over five years (2009-2014)

Results: Newspaper coverage of vitamin D generally supported supplementation. The most common framing of vitamin D in print articles was "adequate vitamin D is necessary for good heath." Articles also framed vitamin D as difficult to obtain from food supply and framed vitamin D deficiency as a widespread concern. In discussions of supplementation, 80% articles suggested supplementation is or may be necessary for the general population, yet almost none of the articles discussed the potential harms of vitamin D supplementation in any detail.
Print articles named 40 different health conditions in relationship to vitamin D. The most commonly cited conditions included bone health, cancer, and cardiovascular health. Although print articles referred to a wide range of scholarly research on vitamin D with varying degrees of endorsement for supplementation, a general tone of support for vitamin D supplementation in media coverage persisted.

Conclusions: Newspaper articles conveyed overall support for vitamin D supplementation. News articles linked vitamin D to a wide range of health conditions for which there is no conclusive scientific evidence. Media coverage downplayed the limitations of existing science and overlooked any potential risks associated with supplementation.

Strengths and limitations of this study

This study examines a large sample of print media articles from venues with high circulation rates.

This study demonstrates that media coverage links Vitamin D to a wide range of health conditions for which there exists no conclusive evidence.

This study does not examine internet-based news sources, which are becomingly an increasingly important source of health information.

Introduction

Despite numerous studies and policy recommendations that have questioned the health value of dietary supplementation,[1, 2] the sale of supplements is a vast multi-billion dollar industry. Research has shown that between 35-50% of the Canadian and US population, including children, take some form of dietary supplements,[3-6] primarily because they believe the food supply is not sufficient to meet their needs and that supplements will improve health and offer protection against a range of diseases. However, little evidence exists to suggest that supplementation in addition to a healthy diet provides these benefits[5, 7, 8, 9] and in some cases it may in fact be harmful.[10]

The reasons people take supplements are undoubtedly complex and multi-factorial[11] and are set within the current cultural context that emphasizes the importance of actively taking personal responsibility for one's health.[12,13] In order to successfully manage one's health, the "citizen-come-consumer"[12(p356)] is compelled, it has been suggested, to make consumer choices that both demonstrate one's commitment to improving one's health and promise to minimize health risks.

Within this context, understanding how supplements are framed in the popular press may provide insight into the nature of the representation that are informing decisions to purchase and consume vitamins and supplements.[14,15] News frames, or the central organizing ideas, can highlight certain aspects of an issue or topic over others and affect readers' resonance with a story.[16] Examining news framing is particularly important in this context given that the public continues to get much of its information about health and science from the popular press.[17] Studies have also shown that media coverage, in

addition to aggressive marketing strategies[18] can have an impact on perceived health beliefs and utilization patterns.[19] While the recursive relationship between the media, science, and public opinion is complex[20] – for example, the media both shapes and reflects public perceptions – research has consistently indicated that news media, including newspapers, comprise one of the most important sources of health information for the adult general public,[21, 22] although the influence of the internet as a source of news and information is growing.[23]

Given the popularity and health implications of vitamins and supplements, an analysis of news media representations may provide valuable insights that could inform future approaches to public, patient and health professional education. While researchers have previously examined and critiqued the misrepresentation of health-related issues in the popular media[24,25] and some research has been conducted on portrayals of dietary supplements in magazines[26] and advertisements[27], there has, to date, been little analysis of news media coverage related to the value of vitamins or supplements. As such, this study provides a systematic analysis of how one of the most widely consumed supplements, vitamin D, has been portrayed in the popular press and identifies the dominant messages conveyed around vitamin D, health, and the need for supplementation.

The Evidence Surrounding the Need For Vitamin D Supplementation

Vitamin D has received a great deal of attention in the popular press over the past few years. Headlines have, for example, declared a "'Plethora' of diseases caused by vitamin D"[28] and that increased vitamin D supplementation/fortification "could stop 'modern' diseases."[29] However, the state of the existing evidence around the health benefits of vitamin D supplementation is best described as unsettled.[30,31] A recent trial sequential meta-analysis[32] reported on the results from 40 RCT's (roughly 100,000 patients) of vitamin D supplementation alone or vitamin D plus calcium. Most studies followed subjects for at least one year and in some cases for up to 5-7 years. When looking at the important clinical endpoints of myocardial infarction or ischemic heart disease, stroke or cerebrovascular disease, cancer, and mortality, vitamin D supplementation did not significantly reduce risk of these outcomes. Vitamin D supplementation combined with calcium did show a statistically significant reduction in total fractures (8% relative reduction).There were also no reported negative outcomes associated with supplementation in these studies. The authors concluded, "Available evidence does not lend support to vitamin D supplementation and it is very unlikely that the results of a future single randomised clinical trial will materially alter the results from current meta-analyses."[32(p318)] These findings provide some support for vitamin D combined with calcium for reducing fracture risk, but suggest other health claims associated with vitamin D supplementation are not currently supported by the literature.

To address dietary requirements and assessment of vitamin D levels, a comprehensive report was recently completed by the Institute of Medicine (IOM).[33,34] The IOM committee tasked with determining the North American population needs of vitamin D and calcium concluded that higher concentrations of vitamin D "were not consistently associated with greater benefit, and for some outcomes U-shaped associations were

observed, with risks at both low and high levels"[34(p53)] and "the prevalence of vitamin D inadequacy in North America has been overestimated."[34(p53)] For some conditions, such as obesity, the causal relation might actually run counter to conventional wisdom – that is, the condition (increase in adipose tissue) results in lower vitamin D concentrations and not the other way around.[35] Another recent meta-analysis concluded "[d]espite a few hundred systematic reviews and meta-analyses, highly convincing evidence of a clear role of vitamin D does not exist for any outcome"[36(abstract)]. This umbrella review examined over 200 meta-analyses and systematic reviews and reported a probable evidence of association between vitamin D concentrations and birth weight, maternal vitamin D status at term, dental caries in children, and parathyroid hormone concentration in patients experiencing chronic kidney disease requiring dialysis. However, the authors concluded there was no convincing evidence to support universal vitamin D supplementation – a conclusion that fits with the work of others.[32,36,37]

While these conclusions are somewhat definitive in tone, others in the scientific community have been more cautious, emphasizing the equivocal nature of the research surrounding the health value of population wide vitamin D supplementation.[30,31]

Given the equivocal and evolving nature of the vitamin D research,[32,36,37] definitive news headlines and their accompanying stories and testimonies may not provide the public with an accurate picture of the relevant science. Furthermore, such stories may – for better or worse – help to drive the market for vitamin D, which some industry reports suggest has grown significantly over the past few years.[38-40] Indeed, some have suggested that market growth for the sale of vitamin D supplements has reached triple digits and is worth hundreds of millions of dollars.[40]

For the purposes of our study, we do not need to take a stand on the value of vitamin D supplementation; as this is a complex issue (involving biomarkers and the multiple functions of vitamin D in the body and through the lifecycle). We also do not address the use of vitamin D for specific, vulnerable populations[41] or those that clearly have vitamin D status that would be associated with important health outcomes like rickets. Instead, we merely seek to highlight that even a cursory review of the relevant academic literature reveals the science around the evidence that the population requires vitamin D supplementation for optimal health and prevention of diseases is far from conclusive.

The evolving and conflicting nature of the relevant scientific research, outlined briefly above, the absence of research that examines media representation of vitamins and supplements, and the substantial media coverage on vitamin D presents a timely opportunity to explore the nature and tone of the media attention paid to this popular vitamin supplement.

Methods

Our study sought to understand how the news media framed Vitamin D supplementation and whether the framing changed over a 5-year period. Our study was modeled after previous studies that took an inductive approach to analysing the content of print news media,[24,25] we conducted a content analysis of print articles appearing in elite newspapers

that addressed vitamin D over a five-year period (2009 – 2014). Search terms included: 'vitamin D' and 'health'. The Factiva database was used to collect newspaper articles about vitamin D in elite newspapers in Canada, the United States, and the United Kingdom. The search was limited to the top five daily newspapers in a broadsheet format in each country based on recent circulation reports.[42, 43] Our initial search yielded 408 results. Articles were excluded from analysis if vitamin D was not linked to discussions of health or supplementation, or if vitamin D was not a general focus of the article. Our final data set consisted of 294 newspaper articles published between January 2009 and January 2014.

Exploratory qualitative coding was initially conducted on a random sample of 40 articles (approximately 10%) from the entire sample.[44] Based on recurring themes that emerged during initial qualitative coding, a coding instrument was developed which was organized into three sections. The first section included general, descriptive information about the publication. The second section captured the health conditions discussed in relation to vitamin D, whether vitamin D supplementation was mentioned and/or recommended, whether the article referred to a specific research study about vitamin D and the extent of the information provided, and whether the potential harms of vitamin D supplementation were discussed. Finally, each article was coded as being overall supportive of, skeptical of, merely descriptive, or as presenting multiple perspectives on vitamin D supplementation. For the purposes of this study, these items were considered important elements in the framing, or central organizing ideas, of representations of vitamin D supplementation in news media.

Two researchers each coded half of the data set. All articles were coded in Excel and data were tallied using SPSS v.22. A random sample of 20% of the articles was then coded by a third coder who was previously uninvolved in the project. Inter-rater reliability was then calculated on SPSS v.22 using Cohen's Kappa. The results of inter-rater reliability for all items ranged between k=0.644 and 0.86 with an average score of k=0.724, indicating substantial to almost perfect agreement.[45]

Results

Our results suggest that vitamin D garnered considerable media attention over the five-year period of interest. Vitamin D coverage peaked in 2010 (which may have been influenced by the release of the revised vitamin D recommendations by the Institute of Medicine in November 2010[33]), and showed only a slight decline in subsequent years. While newspaper coverage was most prominent in Canada, media attention was fairly evenly distributed between all three countries, as shown in Table 1. The largest number of newspaper articles were featured in health and lifestyle sections (48%), followed by the news and front-page sections (31%).

Table 1. Newspapers Included in Sample

Newspaper Title	Country	Number of Articles
Globe and Mail	Canada	45

Montreal Gazette	Canada	9
National Post	Canada	12
Toronto Star	Canada	19
Vancouver Sun	Canada	18
The Los Angeles Times	US	11
The New York Times	US	15
USA Today	US	11
The Wall Street Journal	US	24
The Washington Post	US	26
The Daily Telegraph	UK	9
Financial Times	UK	8
The Guardian	UK	19
The Independent	UK	11
The Times (London)	UK	57
TOTAL		294

***What's the Big Deal About D**?*

Our content analysis revealed the major themes used in media coverage of vitamin D. In general, articles frequently identified and exalted vitamin D's role in maintaining or promoting good health and in preventing chronic disease. The most common theme overall was: "adequate vitamin D is necessary for good health" (57% articles). Most articles contained several themes. Other major themes included, "vitamin D supplements may be necessary for good health and the prevention of chronic disease" (36 % articles), "it is impossible or difficult to get vitamin D from natural sources" (28% articles), and "vitamin D deficiency is widespread and cause for concern" (30% articles). Overall, the themes in news articles positioned vitamin D as important for good health, but also suggested it is difficult to achieve sufficient vitamin D levels without supplementation, and that deficiency is a widespread concern.

Articles were also coded to identify the specific health conditions linked to vitamin D. In total, newspaper articles named 40 different health conditions associated with vitamin D. Overall, cancer was mentioned most frequently (43%), followed by bone health (39%). After cancer and bone health, newspaper articles cited MS (28%), cardiovascular health (25%), and diabetes (24%) most frequently. Interestingly, these conditions varied slightly by year, as shown in **Figure 1**, but cancer and bone health remained relatively steady.

Figure 1. Most frequently named health conditions discussed in relationship to vitamin D in newspapers over 5 years.

Although these were the most frequently mentioned health concerns, vitamin D was credited for preventing or decreasing the risk of a vast array of health conditions ranging from hair loss, influenza, the common cold, Parkinson's disease, and for assisting with muscle recovery. Furthermore, the majority of articles (88%) listed more than one health concern in connection to poor vitamin D status. As a result, an overarching narrative emerged that celebrated vitamin D as a wonder drug that is 'good for everything.'

To Supplement or Not to Supplement?

In light of the zeal with which the North American population purchases and consumes vitamin supplements, and given the media's emphasis on vitamin D's role in a wide range of health conditions, we examined how media coverage addressed the specific issue of vitamin D supplementation. Our analysis revealed 86% of newspaper articles explicitly referred to vitamin D supplementation. Of these, 59% of newspaper articles suggested 'supplementation may be necessary for good health' while 21% more assertively declared 'supplementation is necessary for good health'. In other words, 80% of newspaper articles suggest supplementation is or may be necessary.

Figure 2. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year.

It is important to note, however, some newspaper articles, although supportive of vitamin D supplementation overall, were moderate in their approach. For example, 25% of articles suggested that more research is needed before unequivocal guidance around supplementation is possible. Some articles (8%) also made mention of the potential harms of too much vitamin D.

Importantly, many newspaper articles utilized the inverted pyramid style,[46] which often puts more detailed information, such as the potential for harm further down in the article. We coded for the tone of the entire article, but it may be that if audiences read only the first part of the article, they may not read the more nuanced, detailed pieces of information included in the article.

We also sought to identify if vitamin D daily intake recommendations for the general public were attributed to any expert, professional or governing body, and if so, which one. Of the newspaper articles (53%) that provided these recommendations for the general public, 58% of articles failed to attribute the recommended intake to any expert body. Of those articles that did provide recommendations and attributed them to a professional body, IOM was the most frequently cited (13%), followed by Health Canada and the Cancer Society of Canada (10%).

Many articles suggested that obtaining vitamin D through dietary means and sun exposure was preferable to supplementation. And, 57% of articles identified one or more dietary sources of vitamin D such as fortified milk and some fish. However, articles simultaneously reminded readers that sufficient vitamin D is difficult to obtain through these non-supplementary means; indeed, this was one of the primary themes about vitamin D mentioned above. Therefore, although articles often acknowledged that non-supplementary sources of vitamin D were preferable, they also indicated that this approach would likely fail to meet recommendations. As a result we interpreted these discussions as contributing to general support for supplementation.

Deciphering the Science: Accurate Messages in the News?

The ongoing scientific research on vitamin D was reflected and, at times, explicitly noted in the news media coverage. Of the articles that discussed supplementation, 40% of newspaper articles referred to one or more specific scientific research studies (i.e., a peer-reviewed journal article) on vitamin D. These studies were positioned as 'evidence' around vitamin D supplementation and vitamin D's role in specific health conditions.. In addition, 35% of newspaper articles provided detail that extended beyond the study's overall conclusions (i.e., type of study, sample population and size).

We also coded articles to assess whether news articles interpreted the research as an endorsement of vitamin D supplementation. Our results showed 56% of those newspaper articles that mentioned research did not interpret the research as taking an explicit stand one way or the other on supplementation. However, 22% of the articles that mentioned research did interpret the research as an endorsement of supplementation.

Given the ongoing scholarly debate surrounding vitamin D, we analyzed this data to identify any potential change in how the science was positioned over the 5-year sample period. We found the interpretation of research as endorsement of vitamin D supplementation dropped noticeably in 2012 as seen in **Figure 3.** This may reflect the increasing number of research studies that do not call for or support supplementation, or a more cautious approach to interpretation on part of the news media. However, despite this decline in referencing scientific support for supplementation, articles maintained a supportive tone in favor of supplementation overall.

Figure 3.
Percentage of articles citing research about vitamin D that interpreted research as endorsement of supplementation by year.

Discussion

Our results found several consistencies in newspaper coverage of vitamin D. First, the content analysis revealed that newspaper coverage represented vitamin D in a favorable light and suggested it was positively linked to good health and the prevention of chronic diseases. We suggest this is a fair reflection of the science as adequate levels of vitamin D are, obviously, required for good health. Most of the controversy in the literature is not about whether vitamin D is needed, but about the amount we should get, whether natural sources are sufficient, and the need for supplementation. Second, newspapers conveyed overall support for vitamin D supplementation. Given the equivocal nature of the relevant evidence, this is not an appropriate representation of the science nor consistent with existing policy recommendations.[33, 47]

Third, despite the equivocal nature of scientific evidence, even on frequently studied outcomes such as cancer, fractures, cardiovascular health, and all-cause mortality,[32,36,37] media coverage overall suggested an established link between vitamin D and multiple health conditions beyond these. However, potential harm of excessive vitamin D levels and supplementation was very rarely discussed. Therefore, vitamin D supplementation

was constructed as risk-free and as providing myriad potential health benefits.

This study is one of few to study media representations of vitamins or supplements. Our findings are consistent with other research of media coverage of health issues, which has shown that news stories about medicine and health emphasize potential benefits and downplay potential harms and limitations.[48, 49] Our results also indicate that media coverage was inconsistent and at times contradictory – which, given the state of the science, is not surprising. For example, articles reported inconsistent daily intake recommendations, which may create confusion among readers.[19] Recent research has also shown both health professionals and the general public are uncertain about many aspects of vitamin D, including how much is needed per day and how much can be easily obtained through natural sources.[50]

Overall, results of the content analysis demonstrate that the print news media often frame vitamin D and supplementation in terms of the health benefits of vitamin D for everything. While some articles did include qualifying details regarding potential risks and the need for additional research, the positive framing of vitamin D in news articles draws readers' attention towards supplementation while downplaying these risks.[15] This framing may resonate particularly with readers who were already inclined towards vitamin supplementation, thus providing them little reason to not supplement.[14]

We know the media is a powerful, persuasive source of health information.[51, 52] Given our findings that the popular press have been consistently endorsing supplementation, it seems reasonable to conclude the popular press is, at least in part, helping to fuel the demand for vitamin D supplements and to the confusion about its value. This framing of vitamin D supplementation may be interacting with salient ideas about the need to take responsibility for one's health, which is often demonstrated through consumer behavior and other health-related decisions.[12,13] However, the actual impact of media on public perceptions was beyond the scope of this study and could be the subject of future research. Our study also highlights the need for good, independent and reliable sources of health information that present a more nuanced and contextualized picture of the relevant science.

Implications for Future Research

This study examined a large number of print news articles but it is important to note limitations. For example, we did not examine the content or influence of popular vitamin D information websites such as www.vitamindcouncil.org or of social media outlets such as Facebook, YouTube, and Twitter. Social media are becoming an increasingly important source of health information for the general public.[53-55] Future research should examine how vitamin D is represented in social media and on popular health-related information websites. It would also be important to examine the public's perceptions of the relationship between vitamin D and health and their beliefs about supplementation. Bennett and colleagues[40] provide an important starting point and future research could examine more explicitly what messages the general public takes home from media coverage of vitamin D.

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Contributions

TC conceptualized study and assisted with analysis. MC collected, coded, and contributed to analysis. CR contributed to analysis. . TC, MC, JPM, CR and CJF reviewed data and contributed to writing the manuscript.

Competing Interest Declaration

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pd (available upon request from the corresponding author) and declare that (1) All authors report no support from any organisation for the submitted work (2) All authors have no relationships with companies that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) all authors have not non-financial interests that may be relevant to submitted work.

Data Sharing

Dataset consisting of coded articles available upon request from corresponding author Marianne Clark mclark1@ualberta.ca

Funding and Independence

The authors confirm they are independent from their funders and that the funders of this work did not play a role in study design, collection, analysis or interpretation of the data, in the writing of the article, or in the decision to submit the article for publication.

Transparency

The authors affirm that the manuscript is an honest, accurate, and transparent account of the study being reported. No important data or aspects of the study have been intentionally omitted

Figure 1. Most frequently named health conditions discussed in relationship to vitamin D in newspapers over 5 years.

Figure 2. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year.

Figure 3.
Percentage of articles citing research about vitamin D that interpreted research as endorsement of supplementation by year.

References

1. Fortmann SP, Burda BU, Senger CA, et al. Vitamin and mineral supplements in the primary prevention of cardiovascular disease and cancer: an updated systematic evidence review for the U.S. Preventive Services Task Force. *Ann Intern Med* 2013;159: 824-834.
2. Lamas GA, Boineau R, Goertz C, et al. Oral high-dose multivitamins and minerals after myocardial infarction: a randomized trial. *Ann Intern Med* 2013;159: 797-805.
3. Community Health Survey [2004] Statistics Canada. Available from: http://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htmhttp://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htm
4. Bailey RL, Fulgoni VL, Keast DR, et al. Examination of vitamin intakes among US adults by dietary supplement use. *J Acad Nutr Diet* 2012;112: 657-663.
5. Blendon RJ, Benson JM, Botta MD, et al. Users' views of dietary supplements. *JAMA Intern Med* 2013;173: 74-76.
6. Dwyer J, Nahin RL, Rogers GT, et al. Prevalence and predictors of children's dietary supplement use: the 2007 National Health Interview Survey. *Am J Clin Nutr* 2013;97: 1331-1337.
7. Bailey RL, Gahche JJ, Miller PE, et al. Why US adults use dietary supplements. *JAMA Intern Med* 2013;173: 355-361.
8. Martínez ME, Jacobs ET, Baron JA, et al. Dietary supplements and cancer prevention: balancing potential benefits against proven harms. *JNCI J Natl Cancer Ist* 2012;104: 732-739.
9. Fan X, Lee KS, Frazier SK, et al. The use of, and perceptions about, dietary supplements among patients with heart failure. *Eur J Cardiovasc Nurs* [Internet]. 2014 [cited 2014 July 20];13: 311-319. EPub 2013 June 19. Available from: http://cnu.sagepub.com/content/13/4/311
10. Bjelakovic G, Nikolova D, Gluud LL, et al. Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases. *Cochrane Database Syst Rev* 2012; 3:CD007176.

11. Nichter M, Thompson JJ. For my wellness, not just my illness: North Americans' use of dietary supplements. *Cult Med Psychiatry* 2006 Jun; 30:175-222.
12. Fries CJ. Governing the health of the hybrid self: Integrative medicine, neoliberalism and the shifting biopolitics of subjectivity. *Health Soc Review* 2008; 17(4): 353-367.
13. Petersen A, Lupton D. The new public health: Discourses, knowledges, strategies. Thousand Oaks: Sage; 1996.
14. Nisbet MC. Communicating climate change: why frames matter for public engagement. *Environ* 2009; 51:12–23. doi:10.3200/ENVT.51.2.12-23 CrossRef
15. Scheufele DA. Framing as a theory of media effects. *Journal of Communication* 1999; 49: 103-122.
16. Gamson WA, Modigliani A. Media discourse and public opinion on nuclear power: A constructionist approach. *American Journal of Sociology* 1989;95: 1-37.
17. Geller G, Bernhardt BA, Holtzman NA. The media and public reaction to genetic research. *JAMA* 2002; 287:773.
18. Story M, French S. Food advertising and marketing directed at children and adolescents in the U.S. *Int J Behav Nutr Phys Act* 2004;1: 3-17.
19. Nagler RH. Adverse outcomes associated with media exposure to contradictory nutrition messages. *J Health Commun* 2014;19: 24-40.
20. Fahnestock J. Accommodating science: The rhetorical life of scientific facts. *Written Comm* 1998;15: 330-350.
21. Percheski C, Hargittai, E. Health information-seeking in the digital age. *J Am Coll Health* 2011;59: 379-386.
22. Dutta-Bergman, MJ. Primary sources of health information: comparisons in the domain of health attitudes, health cognitions, and health behaviors. *Health Communication* 2004;16: 273-288.
23. Internet gains on television as public's main news source. [Internet] 2011 Jan 4 [cited 2014 June 18]. Available from: http://www.peoplepress.org/2011/01/04/internet-gains-on-television-as-publics-main-news-source/
24. Zarzeczny A, Rachul C, Nisbet MC, et al. Stem cell clinics in the news. *Nature Biotechnology* 2010; 28: 1243-1246.
25. Kamenova K, Reshef A, Caulfield T. Angelina Jolie's faulty gene: newspaper coverage of a celebrity's preventive bilateral mastectomy in Canada, the United States, and the United Kingdom. *Genetics in Medicine* 2013; 16: 522-528.
26. Kava R. Meister KA, Whelan EM, et al. Dietary supplement safety information popular among older readers. *Journal of Health Comm: Int Perspectives* 2002;7: 13-23.
27. DeLorme DE, Huh J, Reid LN, et al. Dietary supplement advertising in the US. *Int Journal of Advertising* 2012;31 (3): 547-577.
28. Smith R. 'Plethora' of diseases caused by low vitamin D. *The Telegraph* 2012 Dec 12.
29. Gillie O. Vitamin D – could it stop 'modern' diseases? *The Telegraph* 2014 March 10.
30. Anonymous. Vitamin D: chasing a myth? (Editorial). *Lancet Diabetes Endocrinol* 2014; 2(1):1.

31. Kupferschmidt K. Uncertain verdict as vitamin D goes on trial. *Science* 2012;337(6101):1476-1478.
32. Bolland MJ, Grey A, Gamble GD, et al. The effect of vitamin D supplementation on skeletal, vascular, or cancer outcomes: a trial sequential meta-analysis. *Lancet Diabetes Endocrinol* 2014;2: 307-320.
33. IOM. Dietary reference intakes for calcium and vitamin D. Report Brief 2011. http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-calcium-and-vitamin-D.aspx
34. Ross AC, Manson JE, Abrams SA, et al. The 2011 report on dietary reference intakes for calcium and vitamin D from the Institute of Medicine: what clinicians need to know. *J Clin Endocrinol Metab* 2011;96: 53-58.
35. Vimaleswaran KS, Berry DJ, Lu C, et al. Causal relationship between obesity and vitamin D status: bi-directional Mendelian randomization analysis of multiple cohorts. *PLoS Med* 2013;10(2):e1001383.
36. Theodoratou E, Tzoulaki I, Zgaga L, et al. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. *BMJ* 2014; 348:g2035.
37. Chowdhury R, Kunutsor S, Vitezova A, Oliver-Williams C, et al. Vitamin D and risk of cause specific death: systematic review and meta-analysis of observational cohort and randomised intervention studies. *BMJ* 2014;348:g1903.
38. Vitamin D use increased 52% in past two years [Internet]. 2011 Feb 1 [cited 2014 March 9]. Available from: http://www.consumerlab.com/news/Vitamin_Supplement_Use_Survey_Report/01_31_2011
39. Feldman M. Is the market for vitamin D supplements at risk of decline? 2011 April 7 [cited 2014 March 9] In: Euromonitor International Blog. [Internet]. London: Euromonitor International Ltd. Available from: http://blog.euromonitor.com/2011/04/vitamin-d-supplements-losing-their-star.html
40. Montague-Jones G. Markets: global vitamin D boom remains elusive [Internet]. 2010 March 25 [cited 2014 March 9] Available from: http://www.nutraingredients.com/content/view/print/283513
41. Verbrugge FH, Gielen E, Milisen K, et al. Who should receive calcium and vitamin D supplementation? *Age Ageing* 2012;41: 576-580.
42. Alliance for Audited Media [Internet]. 2013 [cited 2013 December 15]. http://www.auditedmedia.com/news/research-and-data/top-25-us-newspapers-for-march-2013.asp.
43. The Audit Bureau of Circulation [Internet]. 2013 [cited 2013 December 15]. http://www.abc.org.uk/Certificates-Reports/Our-Reports/.
44. Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Los Angeles: Sage.
45. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33: 159-174.
46. Pöttker, H. News and its communicative quality: the inverted pyramid – when and why did it appear? *Journalism Studies* 2003;4:501–511.

47. Health Canada. Vitamin D and calcium: updated dietary reference intakes. [Internet]. n.d. [cited 2014 July 24]. Available from: http://www.hc-sc.gc.ca/fn-an/nutrition/vitamin/vita-d-eng.php.
48. Cassels A, Hughes MA, Cole C, et al. Drugs in the news: an analysis of Canadian newspaper coverage of new prescription drugs. *CMAJ* 2003;168: 1133-1137.
49. Schwitzer G. Addressing tensions when popular media and evidence-based care collide. *BMC Medical Informatics and Decision Making* 2013;13(Suppl 3):S3.
50. Bennett K, Frisby BN, Young LE, et al. Vitamin D: an examination of physician and patient management of health and uncertainty. *Qual Health Res* 2014;24: 375-386.
51. Begley A, Coveney J. Wonder vitamin or mass medication? Media and academic representation of folate fortification as a policy problem in Australia and New Zealand. *Aust N Z J Public Health* 2010;34: 466-471.
52. Caulfield T, Bubela T, Murdoch CJ. Myriad and the mass media: the covering of a gene patent controversy. *Genetics in Medicine* 2007;9: 850–855.
53. Logsdon CM, Mittelberg M, Myers J. Use of social media and Internet to obtain health information by rural adolescent mothers. *Appl Nurs Res* [Internet]. 2014 [cited 2014 July 20]. EPub 2014 June 7. Available from: http://www.appliednursingresearch.org/article/S0897-1897(14)00087-1/pdf.
54. Scanfeld D, Scanfelt V, Larson EL. Dissemination of health information through social networks: Twitter and antiobiotics. *Am J Infect Control* 2010;38: 182-188.
55. Vance K, Howe W, Dellavalle RP. Social Internet sites as a source of public health information. *Dermatol Clin* 2009;27:133-136.

Does the Message Fit the Science? Representations of the Health Value of Vitamin D Supplementation in Newspapers ~~and Magazines~~: media content analysis

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Does the Message Fit the Science? Representations of the Health Value of Vitamin D Supplementation in Newspapers ~~and Magazines~~

ABSTRACT

Objective: To examine the nature of media coverage of vitamin D in relation to its role in health and the need for vitamin D supplementation.

Design: Media content analysis

Setting: Print articles from elite newspapers in the UK, USA, and Canada. ~~and from popular North American health and lifestyle magazines.~~

Participants: 294 print newspaper articles ~~and 65 print magazine articles~~ appearing over five years (2009-2014)

Results: The most common framing of vitamin D in print articles was "adequate vitamin D is necessary for good heath." Articles also framed vitamin D as difficult to obtain from natural sources and framed vitamin D deficiency as a widespread concern. In discussions of supplementation, 80% of newspaper articles suggested supplementation is or may be necessary for the general population~~, while 95% of magazine articles suggested supplementation is or may be necessary.~~ Overall, magazines were more definitive in their support for vitamin D supplementation than newspapers, yet neither newspapers nor magazines discussed the potential harms of vitamin D supplementation in any detail. Print articles named 41 different health conditions in relationship to vitamin D. The most commonly cited conditions included bone health, cancer, and cardiovascular health. Although print articles referred to a wide range of scholarly research on vitamin D with varying degrees of endorsement for supplementation, a general tone of support for vitamin D supplementation in media coverage persisted.

Conclusions: Newspaper ~~and magazine~~ articles conveyed overall support for vitamin D supplementation. News articles linked vitamin D to a wide range of health conditions for which there is no conclusive scientific evidence. Media coverage downplayed the limitations of existing science and overlooked any potential risks associated with supplementation.

Strengths and limitations of this study

This study examines a large sample of print media articles from venues with high circulation rates.

This study demonstrates that media coverage links Vitamin D to a wide range of health conditions for which there exists no conclusive evidence.

This study does not examine internet-based news sources, which are becomingly an increasingly important source of health information.

Introduction

Despite numerous empirical studies and policy recommendations[1, 2] that have questioned its health value, the natural health product industry, which includes vitamin and mineral supplements, is a vast multi-billion dollar industry. Research has shown that between 35-50% of the Canadian and US population including children, take some form of dietary supplements,[3-6] primarily because they believe the food supply is not sufficient to meet their needs and that supplements will improve health and offer protection against a range of diseases.~~and individuals take vitamins and other supplements because they believe this practice will improve their health and offer protection against a range of diseases~~. However, little evidence exists to suggest that supplementation in addition to a standard diet provides this benefit[5, 7, 8] and in some cases it may in fact be harmful.[9]

The reasons people take supplements are undoubtedly complex and multi-factorial[11] and are set within the current cultural context that emphasizes the importance of actively taking personal responsibility for one's health.[12,13] In order to successfully manage one's health, the "citizen-come-consumer"[12(p356)] is compelled, it has been suggested, to make consumer choices that both demonstrate one's commitment to improving one's health and promise to minimize health risks.

Within this context, understanding how supplements are framed in the popular press may provide insight into the nature of the representation that are informing decisions to purchase and consume vitamins and supplements.[14,15] News frames, or the central organizing ideas, can highlight certain aspects of an issue or topic over others and affect

readers' resonance with a story.[16] Examining news framing is particularly important in this context given that the public continues to get much of its information about health and science from the popular press.[17] Studies have also shown that media coverage, in addition to aggressive marketing strategies[18] can have an impact on perceived health beliefs and utilization patterns.[19] While the recursive relationship between the media, science, and public opinion is complex[20] – for example, the media both shapes and reflects public perceptions – research has consistently indicated that news media, including newspapers, comprise one of the most important sources of health information for the adult general public,[21, 22] although the influence of the internet as a source of news and information is growing.[23]

Given the popularity of nutritional supplements, an analysis of news media representations may provide valuable insights that could inform future approaches to public, patient and health professional education. While researchers have previously examined and critiqued the misrepresentation of health-related issues in the popular media[24,25] and some research has been conducted on portrayals of dietary supplements in magazines[26] and advertisements[27], there has, to date, been little analysis of news media coverage related to the value of vitamins or supplements. As such, this study provides a systematic analysis of how one of the most widely consumed supplements, vitamin D, has been portrayed in the popular press and identifies the dominant messages conveyed around vitamin D, health, and the need for supplementation.

~~it is no surprise that individuals who take them often believe they are more beneficial than existing evidence would support.[10] This seeming contradiction prompts the question: What is driving public attitudes towards an interest in vitamin supplementation? Such a question is particularly salient considering the nature of existing evidence, the possible harm and cost associated with some supplements, and that health care providers rarely recommend their use.[7] While undoubtedly a complex and multi-factorial social phenomenon,[11] it seems likely that media representation of vitamins and supplements may play a role.~~

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Vitamin D has received a great deal of attention in the popular press over the past few years. Headlines have, for example, declared a "'Plethora' of diseases caused by vitamin D"[18] and that increased vitamin D supplementation/fortification "could stop 'modern' diseases."[19] Given the equivocal and evolving nature of the vitamin D research,[20-22] such definitive headlines and their accompanying stories and testimonies may not provide the public with an accurate picture of the relevant science. Furthermore, such stories may –

for better or worse – help to drive the market for vitamin D, which some industry reports suggest has grown significantly over the past few years.[23-25] Indeed, some have suggested that market growth for the sale of vitamin D has reached triple digits and is worth hundreds of millions of dollars.[25] It has been posited that 50% of the US population may be taking some form of vitamin D supplement, [26] and this may be higher in individuals with chronic diseases.[27]

The Evidence Surrounding Vitamin D Supplementation

Vitamin D has received a great deal of attention in the popular press over the past few years. Headlines have, for example, declared a "'Plethora' of diseases caused by vitamin D"[28] and that increased vitamin D supplementation/fortification "could stop 'modern' diseases."[29]

However, t~~T~~he state of the existing evidence around the health benefits of vitamin D supplementation is best described as unsettled.[26, 28] A recent trial sequential meta-analysis[20] reported on the results from 40 RCT's (roughly 100,000 patients) of vitamin D supplementation alone or vitamin D plus calcium. Most studies followed subjects for at least one year and in some cases for up to 5-7 years. When looking at the important clinical endpoints of myocardial infarction or ischemic heart disease, stroke or cerebrovascular disease, cancer, total fracture and mortality, vitamin D supplementation did not significantly reduce risk of these outcomes. There were also no reported negative outcomes associated with supplementation in these studies. Studies of vitamin D supplementation combined with calcium did show a statistically significant reduction in fractures (8% relative reduction) but no statistically significant results from any other endpoints. The authors concluded, "Available evidence does not lend support to vitamin D supplementation and it is very unlikely that the results of a future single randomised clinical trial will materially alter the results from current meta-analyses."[20(p318)] These findings provide some support for vitamin D combined with calcium for reducing fracture risk, but suggest other health claims associated with vitamin D supplementation are not currently supported by the literature.

To address dietary requirements and assessment of vitamin D levels, a comprehensive report was recently completed by the Institute of Medicine (IOM).[29, 30] The IOM committee tasked with determining the North American population needs of vitamin D and calcium concluded that higher concentrations of vitamin D "were not consistently associated with greater benefit, and for some outcomes U-shaped associations were observed, with risks at both low and high levels" [30(p53)] and "the prevalence of vitamin D inadequacy in North America has been overestimated." [30(p53)] For some conditions, such as obesity, the causal relation might actually run counter to conventional wisdom – that is, the condition (increase in adipose tissue) results in lower vitamin D concentrations and not the other way around.[31] Another recent meta-analysis concluded "[d]espite a few hundred systematic reviews and meta-analyses, highly convincing evidence of a clear role of vitamin D does not exist for any outcome"[21 (abstract)]. This umbrella review examined over 200 meta-analyses and systematic reviews and reported a probable evidence of association between vitamin D concentrations and birth weight, maternal vitamin D concentrations at term, dental caries in children, and parathyroid hormone concentration in patients experiencing chronic kidney disease requiring dialysis. However,

the authors concluded there was no convincing evidence to support universal vitamin D supplementation – a conclusion that fits with the work of others.[20-22]

While these conclusions are somewhat definitive in tone, others in the scientific community have been more cautious, emphasizing the equivocal nature of the research surrounding the health value of population wide vitamin D supplementation.[26, 28] For the purposes of our study, we do not need to take a stand on the value of vitamin D supplementation; as this is a complex issue (involving biomarkers and the multiple functions of vitamin D in the body and through the lifecycle). We also do not address the use of vitamin D for specific, vulnerable populations[32] or those that clearly have vitamin D levels that would be associated with important health outcomes like rickets. Instead, we merely seek to highlight that even a cursory review of the relevant academic literature reveals the science around the value of vitamin D supplementation is far from conclusive, particularly in the context of recommending or implementing vitamin D supplementation as a preventative strategy for the general population.

Given the equivocal and evolving nature of the vitamin D research,[32,36,37] definitive news headlines and their accompanying stories and testimonies may not provide the public with an accurate picture of the relevant science. Furthermore, such stories may – for better or worse – help to drive the market for vitamin D, which some industry reports suggest has grown significantly over the past few years.[38-40] Indeed, some have suggested that market growth for the sale of vitamin D supplements has reached triple digits and is worth hundreds of millions of dollars.[40]

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The evolving and conflicting nature of the relevant scientific research, outlined briefly above, and the substantial media coverage on vitamin D presents a timely opportunity to explore the nature and tone of the media attention paid to this popular vitamin supplement. ~~Therefore, this article examines media coverage of vitamin D and identifies the dominant messages conveyed around vitamin D, health, and the need for supplementation.~~

Methods

Our study sought to understand how the news media framed Vitamin D supplementation and whether the framing changed over a 5-year period. Our study was modeled after previous studies that took an inductive approach to analysing the content of print news media,[24,25] we conducted a content analysis of print articles appearing in elite newspapers

that addressed vitamin D over a five-year period (2009 – 2014).
Search terms included: 'vitamin D' and 'health'. The Factiva database was used to collect newspaper articles about vitamin D in elite newspapers in Canada, the United States, and the United Kingdom. The search was limited to the top five daily newspapers in a broadsheet format in each country based on recent circulation reports.[33, 34] Our initial search yielded 408 results. Articles were excluded from analysis if vitamin D was not linked to discussions of health or supplementation, or if vitamin D was not a general focus of the article. Our final data set consisted of 294 newspaper articles published between January 2009 and January 2014.

~~The CPI.Q database was used to collect magazine articles about vitamin D appearing in the top 8 most widely circulated health/fitness/lifestyle magazines in North America.[35] The same search terms as above were used and we included only articles for which the full text was available. The final dataset consisted of 65 articles published between January 2009 and January 2014.~~

Exploratory qualitative coding was initially conducted on a random sample of 40 articles (approximately 10%) from the entire sample.[44] Based on recurring themes that emerged during initial qualitative coding, a coding instrument was developed which was organized into three sections. ~~Our coding frame was developed through an in-depth analysis of a random sample of 40 articles (approximately 10%) from the entire sample. Re-emergent frames of discussion were identified inductively and coded into a codebook. This inductive approach allowed for the creation of a coding framework that captured relevant themes that emerged in the articles rather than being limited to predefined frames. The final coding framework was organized into three sections.~~ The first section included general, descriptive information about publication date, word count, article type, author, and article source. The second section captured the health conditions discussed in relation to vitamin D, whether vitamin D supplementation was mentioned and/or recommended, whether the article referred to a specific research study about vitamin D and the extent of the information provided, and whether the potential harms of vitamin D supplementation were discussed. Finally, each article was coded as being overall supportive of, skeptical of, merely descriptive, or as presenting multiple perspectives on vitamin D supplementation.

For the purposes of this study, these items were considered important elements in the framing, or central organizing ideas, of representations of vitamin D supplementation in news media.

Two researchers each coded half of the data set. All articles were coded in Excel and data were tallied using SPSS v.22. A random sample of 20% of the articles was then coded by a third coder who was previously uninvolved in the project. Inter-rater reliability was then calculated on SPSS v.22 using Cohen's Kappa. The results of inter-rater reliability for all items ranged between k=0.644 and 0.86 with an average score of k=0.724, indicating substantial to almost perfect agreement.[45]

~~Two researchers completed coding. All articles were coded in Excel according to the coding framework and data were tallied using SPSS. Overall we sought to capture the general messages the media conveyed about vitamin D in relation to health by determining which messages and frames appeared most often, and whether these messages changed over the five-year span of our sample.~~

Results

Our results suggest that vitamin D garnered considerable media attention over the five-year period of interest. Vitamin D coverage peaked in 2010 (which may have been influenced by the release of the revised vitamin D recommendations by the Institute of Medicine in November 2010[29]), and showed only a slight decline in subsequent years. While newspaper coverage was most prominent in Canada, media attention was fairly evenly distributed between all three countries, as shown in Table 1. The largest number of newspaper articles were featured in health and lifestyle sections (48%), followed by the news and front-page sections (31%).

Table 1. Newspapers Included in Sample

Newspaper Title	Country	Number of Articles
Globe and Mail	Canada	45
Montreal Gazette	Canada	9
National Post	Canada	12
Toronto Star	Canada	19
Vancouver Sun	Canada	18
The Los Angeles Times	US	11
The New York Times	US	15
USA Today	US	11
The Wall Street Journal	US	24
The Washington Post	US	26
The Daily Telegraph	UK	9
Financial Times	UK	8
The Guardian	UK	19
The Independent	UK	11
The Times (London)	UK	57
TOTAL		294

What's the Big Deal About D?

Our coding framework identified the major frames used in media coverage of vitamin D. In general, articles frequently identified and exalted vitamin D's role in maintaining or promoting good health and in preventing chronic disease. The most commonly utilized

frame overall was: "adequate vitamin D is necessary for good health" (57% newspapers, ~~87% magazines~~). Most articles used several frames. Other major frames included, "vitamin D supplements may be necessary for good health and the prevention of chronic disease" (36 % newspapers, ~~53% magazines~~), "it is impossible or difficult to get vitamin D from natural sources" (28% newspaper, ~~31% magazines~~), and "vitamin D deficiency is widespread and cause for concern" (30% newspapers, ~~21% magazines~~). Overall, this framing positioned vitamin D as important for good health, but also suggested it is difficult to achieve sufficient vitamin D levels without supplementation, and that deficiency is a widespread concern.

Articles were also coded to identify the specific health conditions linked to vitamin D. In total, newspaper articles named 40 different health conditions associated with vitamin D, while magazines named 41. Cancer was mentioned most frequently ~~by both newspapers~~ (43%) ~~and magazines (36%),~~ followed by bone health (40%) ~~, identified in 40% of newspaper and 33% of magazine articles. After cancer and bone health, newspaper articles cite~~d MS (28%), cardiovascular health (25%), and diabetes (24%) most frequently. ~~Magazines identified cardiovascular health (17%), depression (17%) and diabetes (15%) after cancer and bone health.~~ Interestingly, these conditions varied slightly by year, as shown in **Figure 1**, but cancer and bone health remained relatively steady ~~when looking at magazines and newspapers combined.~~

Figure 1. Most frequently named health conditions discussed in relationship to vitamin D in newspapers ~~and magazines~~ over 5 years.

Although these were the most frequently mentioned health concerns, vitamin D was credited for preventing or decreasing the risk of a vast array of health conditions ranging from hair loss, influenza, the common cold, Parkinson's disease, and for assisting with muscle recovery. ~~All conditions listed appear in the word cloud (**Figure 2**) below.~~ Furthermore, the majority of articles (88%) listed more than one health concern in connection to vitamin D. As a result, an overarching narrative emerged that celebrated vitamin D as a wonder drug that is 'good for everything.'

~~**Figure 2. All health conditions named in relationship to vitamin D in magazines and newspapers over 5 years.**~~

To Supplement or Not to Supplement?

In light of the zeal with which the North American population purchases and consumes vitamin supplements, and given the media's emphasis on vitamin D's role in a wide range of health conditions established above, we examined how media coverage framed the specific issue of vitamin D supplementation. Our analysis revealed 86% of newspaper ~~and 85% of magazine~~ articles explicitly referred to vitamin D supplementation. Of these, 59% of newspaper articles suggested 'supplementation may be necessary for good health' while 21% more assertively declared 'supplementation is necessary for good health'. In

other words, 80% of newspaper articles suggest supplementation is or may be necessary. ~~Magazines were more definitive in tone overall. Similar to newspapers, 55% suggested that 'supplementation may be necessary for good health' but 40% suggested 'supplementation is necessary for good health' (95% suggesting supplementation is or may be necessary). Therefore, magazines were almost universally supportive of supplementation and were more than twice as likely to frame it as a clear necessity for the general population than newspapers, as shown in **Figure 3**.~~

Figure 2. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year
~~**Figure 3. Overall tone of articles regarding vitamin D supplementation.**~~

~~Additionally, over time, newspapers appeared to slightly soften their stance on supplementation and showed a decrease in the frames "supplementation may be beneficial" and "supplementation is necessary" compared to magazines. See **Figure 4**.~~

~~**Figure 4. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year.**~~

It is important to note, however, some newspaper articles, although supportive of vitamin D supplementation overall, were moderate in their approach. For example, 25% of articles suggested that more research is needed before unequivocal guidance around supplementation is possible. Some articles (8%) also made mention of the potential harms of too much vitamin D.

~~Newspaper articles, although supportive of Vitamin D supplementation overall, were more moderate in their approach than magazine articles. For example, 25% of newspapers suggested that more research is needed before unequivocal guidance around supplementation is possible. Only 5% of magazines acknowledged this need. Newspapers also made mention of the potential harms of too much Vitamin D in 8% of cases, whereas less than 1% of magazines addressed this issue. In both cases however, the issue of potential harm was basically absent from discussion.~~

Importantly, many newspaper articles utilized the inverted pyramid style,[36] which often puts more detailed information, such as the potential for harm further down in the article. We coded for the tone of the entire article, but it may be that if audiences read only the first part of the article, they may not read the more nuanced, detailed pieces of information included in the article.

Articles in both magazines (83%) and newspapers (53%) provided specific vitamin D daily intake recommendations for the general public. Our coding framework sought to identify if these recommendations were attributed to any expert, professional or governing body, and if so, which one. Of the articles that made specific recommendations, 58% of newspaper and 86% of magazines articles failed to attribute the recommended intake to any expert body. Of those articles that did, IOM was the most frequently cited

(13% in both magazines and newspapers), followed by Health Canada and the Cancer Society of Canada (both 10%) in newspapers.

Many articles suggested that obtaining Vitamin D through dietary means and sun exposure was preferable to supplementation. And, 57% of ~~magazines and 43% of magazines~~ newspapers identified one or more dietary sources of vitamin D such as fortified milk and some fish. However, articles simultaneously reminded readers that sufficient vitamin D is difficult to obtain through these non-supplementary means; indeed, this was one of the primary frames mentioned above. Therefore, although articles often acknowledged that non-supplementary sources of vitamin D were preferable, they also indicated that this approach would likely fail to meet recommendations. As a result we interpreted these discussions as contributing to general support for supplementation.

Deciphering the Science: Accurate Messages in the News?

The ongoing scientific research on Vitamin D was reflected and, at times, explicitly noted in the media coverage. Of the articles that discussed supplementation, 40% of newspaper and 45% of magazine articles referred to one or more specific scientific research studies (i.e., a peer-reviewed journal article) on vitamin D. These studies were positioned as 'evidence' around vitamin D supplementation and vitamin D's role in specific health conditions. The level of detail provided about these studies varied importantly between newspapers and magazines. For example, 35% of newspapers provided detail that extended beyond the study's overall conclusions (i.e., type of study, sample population and size) while only 1% of magazines did the same.

We also coded articles to assess whether news articles interpreted the research as an endorsement of vitamin D supplementation. Our results showed that 56% of newspaper ~~articles and 59% of magazine~~ articles did not interpret the research as taking an explicit stand one way or the other on supplementation. However, 40% of magazines did interpret the research as an endorsement of supplementation. ~~while only 22% of newspaper framed the research in this way. This finding supports our earlier observation that newspapers tend to take a more balanced approach~~.

Given the ongoing scholarly debate surrounding Vitamin D, we analyzed this data to identify any potential change in how the science was positioned over the 5-year sample period. We found that the interpretation of research as endorsement of Vitamin D supplementation dropped noticeably in 2012 as seen in **Figure 3~~5~~.** This may reflect the increasing number of research studies that do not call for or support supplementation, or a more cautious approach to interpretation on part of the news media. However, despite this decline in referencing scientific support for supplementation, articles maintained a supportive tone in favor of supplementation overall.

Figure 3~~5~~.
Percentage of articles citing research about vitamin D that interpreted research as endorsement of supplementation.

Discussion

Our results revealed several consistencies in newspaper and magazine coverage of vitamin D. First, ~~both magazine and~~ newspaper coverage framed vitamin D in a favorable light and suggested it was positively linked to good health and the prevention of chronic diseases. We suggest that this is a fair reflection of the science as adequate levels of vitamin D are, obviously, required for good health. Most of the controversy in the literature is not about whether vitamin D is needed, but about the amount we should get, whether natural sources are sufficient, and the need for supplementation. Second, ~~both~~ newspapers ~~and magazines~~ conveyed overall support for vitamin D supplementation. Given the equivocal nature of the relevant evidence, this is not an appropriate representation of the science nor consistent with existing policy recommendations.[29, 37] Third, despite the equivocal nature of scientific evidence, even on frequently studied outcomes such as cancer, fractures, cardiovascular health, and all-cause mortality,[20-22] media coverage overall suggested an established link between vitamin D and multiple health conditions beyond these. However, potential harm of excessive vitamin D levels and supplementation was very rarely discussed. Therefore, vitamin D supplementation was constructed as risk-free and as providing myriad potential health benefits.

~~Despite these similarities, an important difference emerged between magazine and newspaper coverage. Newspaper articles were less definitive in their tone than magazines in discussions of vitamin D supplementation. Furthermore, newspaper articles provided more nuance and detail overall than magazine articles. Specifically, newspaper coverage was more likely to acknowledge the equivocal nature of the science and the need for further research around supplementation guidelines. Magazines generally did not point to this existing uncertainty. The definitive tone of the magazine articles may have relevance to how the public views the value of supplementation~~.
This study is one of few to study media representations of vitamins or supplementsOur findings are consistent with other research, which has shown that news stories about medicine and health emphasize potential benefits and downplay potential harms and limitations.[38, 39] We identified an overarching narrative that celebrated vitamin D as good for everything and risk-free. By downplaying risks and the limitations of the existing science, the discussion provides few reasons not to supplement. This contributes to a tone that is largely supportive of the practice. Our results also indicate that media coverage was inconsistent and at times contradictory – which, given the state of the science, is not surprising. For example, articles reported inconsistent daily intake recommendations, which may create confusion among readers.[14] Recent research has also shown both health professionals and the general public are uncertain about many aspects of vitamin D, including how much is needed per day and how much can be easily obtained through natural sources.[40]

We know the media is a powerful, persuasive source of health information.[51, 52] Given our findings that the popular press have been consistently endorsing supplementation, it seems reasonable to conclude the popular press is, at least in part, helping to fuel the demand for vitamin D supplements and to the confusion about its value. This framing of vitamin D supplementation may be interacting with salient ideas about the need to take

responsibility for one's health, which is often demonstrated through consumer behavior and other health-related decisions.[12,13] However, the actual impact of media on public perceptions was beyond the scope of this study and could be the subject of future research. Our study also highlights the need for good, independent and reliable sources of health information that present a more nuanced and contextualized picture of the relevant science.

~~We know the media is a powerful, persuasive source of health information.[41, 42] Given our findings that the popular press have been consistently endorsing supplementation, it seems reasonable to conclude the popular press is, at least in part, helping to fuel the demand for vitamin D supplements and to the confusion about its value. However, the actual impact of media on public perceptions was beyond the scope of this study and could be the subject of future research. Our study also highlights the need for good, independent and reliable sources of health information that present a more nuanced and contextualized picture of the relevant science.~~

~~Limitations~~ Implications for Future Research

This study examined a large number of print news articles but it is important to note limitations. For example, we did not examine the content or influence of popular vitamin D information websites such as www.vitamindcouncil.org or of social media outlets such as Facebook, YouTube, and Twitter. However, social media are becoming an increasingly important source of health information for the general public.[43-45]

Future research should examine how Vitamin D is represented in social media and on popular health-related information websites. ~~to determine how the general public integrates and makes sense of these diverse sources of information.~~ It would also be important to examine the public's perceptions of the relationship between vitamin D and health and their beliefs about supplementation. Bennett and colleagues[40] provide an important starting point and future research could examine more explicitly what messages the general public takes home from media coverage of vitamin D. ~~Finally, future research that captured the perspectives of health professionals would be important.~~

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Contributions

TC conceptualized study and assisted with analysis. MC collected, coded, and analyzed data. CR assisted with analysis. TC, MC, JPM, CR and CJF reviewed data and contributed to writing the manuscript.

Competing Interest Declaration

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pd (available upon request from the corresponding author) and declare that (1) All authors report no support from any organisation for the submitted work (2) All authors have no relationships with companies that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) all authors have not non-financial interests that may be relevant to submitted work.

Data Sharing

Dataset consisting of coded articles available upon request from corresponding author Marianne Clark mclark1@ualberta.ca

Funding and Independence

The authors confirm they are independent from their funders and that the funders of this work did not play a role in study design, collection, analysis or interpretation of the data, in the writing of the article, or in the decision to submit the article for publication.

Transparency

The authors affirm that the manuscript is an honest, accurate, and transparent account of the study being reported. No important data or aspects of the study have been intentionally omitted

References

1. Fortmann SP, Burda BU, Senger CA, et al. Vitamin and mineral supplements in the primary prevention of cardiovascular disease and cancer: an updated systematic evidence review for the U.S. Preventive Services Task Force. *Ann Intern Med* 2013;159: 824-834.
2. Lamas GA, Boineau R, Goertz C, et al. Oral high-dose multivitamins and minerals after myocardial infarction: a randomized trial. *Ann Intern Med* 2013;159: 797-805.

3. Community Health Survey [2004] Statistics Canada. Available from: http://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htmhttp://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htm
4. Bailey RL, Fulgoni VL, Keast DR, et al. Examination of vitamin intakes among US adults by dietary supplement use. *J Acad Nutr Diet* 2012;112: 657-663.
5. Blendon RJ, Benson JM, Botta MD, et al. Users' views of dietary supplements. *JAMA Intern Med* 2013;173: 74-76.
6. Dwyer J, Nahin RL, Rogers GT, et al. Prevalence and predictors of children's dietary supplement use: the 2007 National Health Interview Survey. *Am J Clin Nutr* 2013;97: 1331-1337.
7. Bailey RL, Gahche JJ, Miller PE, et al. Why US adults use dietary supplements. *JAMA Intern Med* 2013;173: 355-361.
8. Martínez ME, Jacobs ET, Baron JA, et al. Dietary supplements and cancer prevention: balancing potential benefits against proven harms. *JNCI J Natl Cancer Ist* 2012;104: 732-739.
9. Bjelakovic G, Nikolova D, Gluud LL, et al. Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases. *Cochrane Database Syst Rev* 2012; 3:CD007176.
10. Fan X, Lee KS, Frazier SK, et al. The use of, and perceptions about, dietary supplements among patients with heart failure. *Eur J Cardiovasc Nurs* [Internet]. 2014 [cited 2014 July 20];13: 311-319. EPub 2013 June 19. Available from: http://cnu.sagepub.com/content/13/4/311.
11. Nichter M, Thompson JJ. For my wellness, not just my illness: North Americans' use of dietary supplements. *Cult Med Psychiatry* 2006 Jun; 30:175-222.
12. Geller G, Bernhardt BA, Holtzman NA. The media and public reaction to genetic research. *JAMA* 2002; 287:773.
13. Story M, French S. 2004. Food advertising and marketing directed at children and adolescents in the U.S. *Int J Behav Nutr Phys Act* 2004;1: 3-17.
14. Nagler RH. Adverse outcomes associated with media exposure to contradictory nutrition messages. *J Health Commun* 2014;19: 24-40.
15. Percheski C, Hargittai, E. Health information-seeking in the digital age. *J Am Coll Health* 2011;59: 379-386
16. Dutta-Bergman, MJ. Primary sources of health information: comparisons in the domain of health attitudes, health cognitions, and health behaviors. *Health Communication* 2004;16: 273-288.
17. Internet gains on television as public's main news source. [Internet] 2011 Jan 4 [cited 2014 June 18]. Available from: http://www.peoplepress.org/2011/01/04/internet-gains-on-television-as-publics-main-news-source/
18. Smith R. 'Plethora' of diseases caused by low vitamin D. *The Telegraph* 2012 Dec 12.
19. Gillie O. Vitamin D – could it stop 'modern' diseases? *The Telegraph* 2014 March 10.

20. Bolland MJ, Grey A, Gamble GD, et al. The effect of vitamin D supplementation on skeletal, vascular, or cancer outcomes: a trial sequential meta-analysis. *Lancet Diabetes Endocrinol* 2014;2: 307-320.
21. Theodoratou E, Tzoulaki I, Zgaga L, et al. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. *BMJ* 2014; 348:g2035.
22. Chowdhury R, Kunutsor S, Vitezova A, Oliver-Williams C, et al. Vitamin D and risk of cause specific death: systematic review and meta-analysis of observational cohort and randomised intervention studies. *BMJ* 2014;348:g1903.
23. Vitamin D use increased 52% in past two years [Internet]. 2011 Feb 1 [cited 2014 March 9]. Available from: http://www.consumerlab.com/news/Vitamin_Supplement_Use_Survey_Report/01_31_2011
24. Feldman M. Is the market for vitamin D supplements at risk of decline? 2011 April 7 [cited 2014 March 9] In: Euromonitor International Blog. [Internet]. London: Euromonitor International Ltd. Available from: http://blog.euromonitor.com/2011/04/vitamin-d-supplements-losing-their-star.html
25. Montague-Jones G. Markets: global vitamin D boom remains elusive [Internet]. 2010 March 25 [cited 2014 March 9] Available from: http://www.nutraingredients.com/content/view/print/283513
26. Anonymous. Vitamin D: chasing a myth? (Editorial). *Lancet Diabetes Endocrinol* (2014); 2(1):1.
27. Mariani LH, White MT, Shults J, et al. Increasing use of vitamin D supplementation in the Chronic Renal Insufficiency Cohort study. *Journal of Renal Nutrition* 2014; 24:186-193.
28. Kupferschmidt K. Uncertain verdict as vitamin D goes on trial. *Science* 2012;337(6101):1476-1478.
29. IOM. Dietary reference intakes for calcium and vitamin D. Report Brief 2011. http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-calcium-and-vitamin-D.aspx
30. Ross AC, Manson JE, Abrams SA, et al. The 2011 report on dietary reference intakes for calcium and vitamin D from the Institute of Medicine: what clinicians need to know. *J Clin Endocrinol Metab* 2011;96: 53-58.
31. Vimaleswaran KS, Berry DJ, Lu C, et al. Causal relationship between obesity and vitamin D status: bi-directional Mendelian randomization analysis of multiple cohorts. *PLoS Med* 2013;10(2):e1001383.
32. Verbrugge FH, Gielen E, Milisen K, et al. Who should receive calcium and vitamin D supplementation? *Age Ageing* 2012;41: 576-580.
33. Alliance for Audited Media [Internet]. 2013 [cited 2013 December 15]. http://www.auditedmedia.com/news/research-and-data/top-25-us-newspapers-for-march-2013.asp.
34. The Audit Bureau of Circulation [Internet]. 2013 [cited 2013 December 15]. http://www.abc.org.uk/Certificates-Reports/Our-Reports/.
35. Alliance for Audited Media [Internet]. 2013 [cited 2013 December 15]. http://abcas3.auditedmedia.com/ecirc/magtitlesearch.asp.

36. Pöttker, H. News and its communicative quality: the inverted pyramid – when and why did it appear? *Journalism Studies* 2003;4:501–511.
37. Health Canada. Vitamin D and calcium: updated dietary reference intakes. [Internet]. n.d. [cited 2014 July 24]. Available from: http://www.hc-sc.gc.ca/fn-an/nutrition/vitamin/vita-d-eng.php.
38. Cassels A, Hughes MA, Cole C, et al. Drugs in the news: an analysis of Canadian newspaper coverage of new prescription drugs. *CMAJ* 2003;168: 1133-1137.
39. Schwitzer G. Addressing tensions when popular media and evidence-based care collide. *BMC Medical Informatics and Decision Making* 2013;13(Suppl 3):S3.
40. Bennett K, Frisby BN, Young LE, et al. Vitamin D: an examination of physician and patient management of health and uncertainty. *Qual Health Res* 2014;24: 375-386.
41. Begley A, Coveney J. Wonder vitamin or mass medication? Media and academic representation of folate fortification as a policy problem in Australia and New Zealand. *Aust N Z J Public Health* 2010;34: 466-471.
42. Caulfield T, Bubela T, Murdoch CJ. Myriad and the mass media: the covering of a gene patent controversy. *Genetics in Medicine* 2007;9: 850–855.
43. Logsdon CM, Mittelberg M, Myers J. Use of social media and Internet to obtain health information by rural adolescent mothers. *Appl Nurs Res* [Internet]. 2014 [cited 2014 July 20]. EPub 2014 June 7. Available from: http://www.appliednursingresearch.org/article/S0897-1897(14)00087-1/pdf.
44. Scanfeld D, Scanfelt V, Larson EL. Dissemination of health information through social networks: Twitter and antiobiotics. *Am J Infect Control* 2010;38: 182-188.
45. Vance K, Howe W, Dellavalle RP. Social Internet sites as a source of public health information. *Dermatol Clin* 2009;27:133-136.

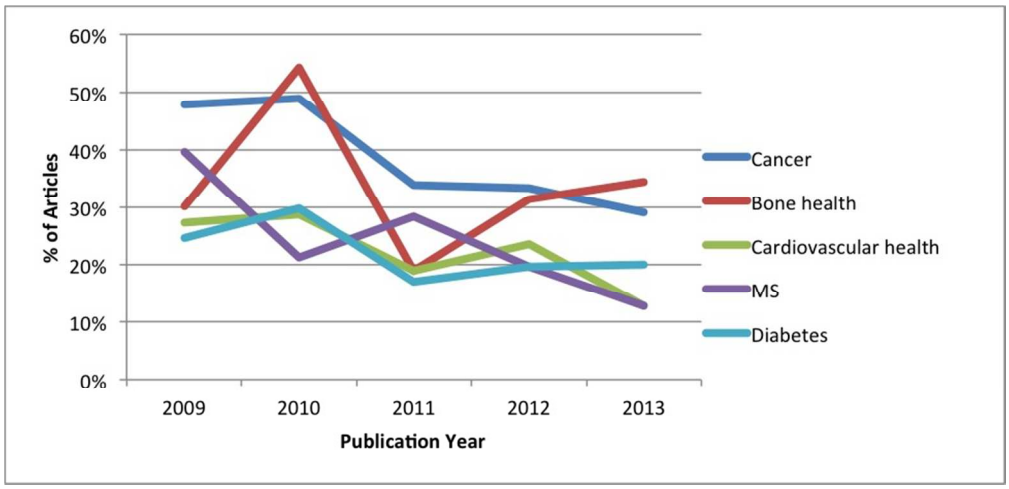

Figure 1. Most frequently named health conditions discussed in relationship to vitamin D in newspapers over 5 years.
164x78mm (150 x 150 DPI)

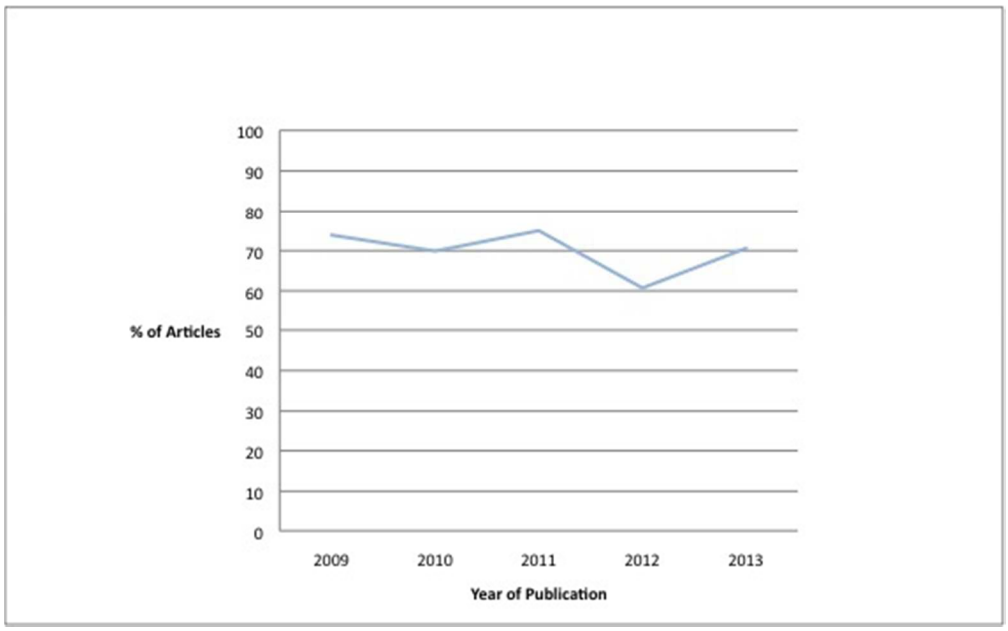

Figure 2. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year.

201x124mm (72 x 72 DPI)

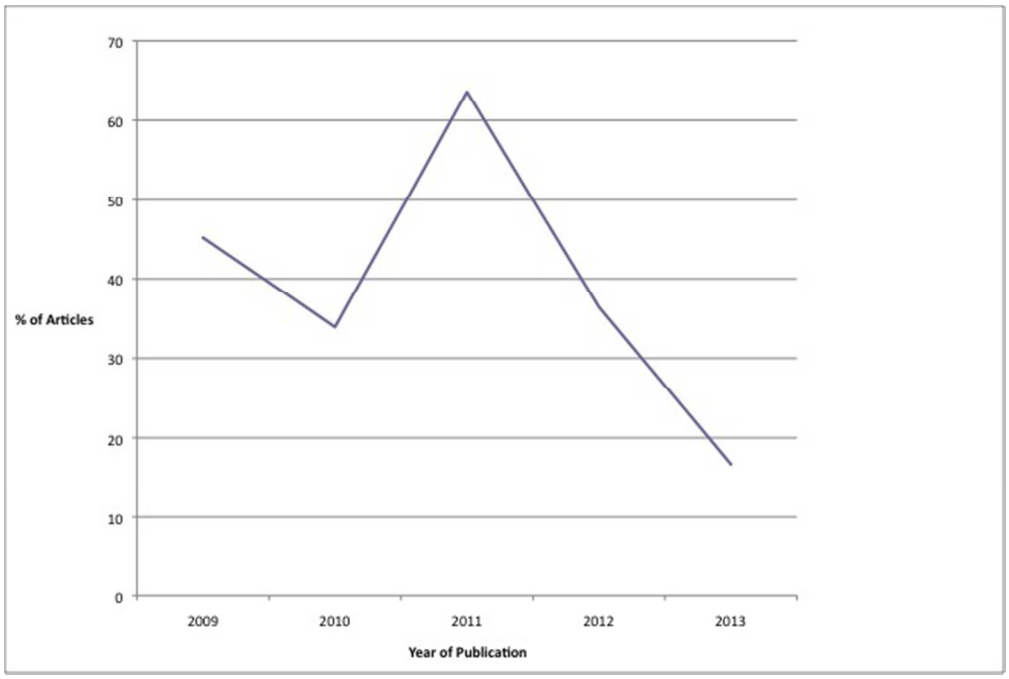

Figure 3. Percentage of articles citing research about vitamin D that interpreted research as endorsement of supplementation by year.

231x154mm (72 x 72 DPI)

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Representations of the Health Value of Vitamin D Supplementation in Newspapers: media content analysis

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Representations of the Health Value of Vitamin D Supplementation in Newspapers : media content analysis

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Representations of the Health Value of Vitamin D Supplementation in Newspapers

ABSTRACT

Objective: To examine the nature of media coverage of vitamin D in relation to its role in health and the need for supplements.

Design: Media content analysis

Setting: Print articles from elite newspapers in the UK, USA, and Canada.

Participants: 294 print newspaper articles appearing over five years (2009-2014)

Results: Newspaper coverage of vitamin D generally supported supplementation. The most common framing of vitamin D in print articles was "adequate vitamin D is necessary for good heath." Articles also framed vitamin D as difficult to obtain from food supply and framed vitamin D deficiency as a widespread concern. In discussions of supplementation, 80% articles suggested supplementation is or may be necessary for the general population, yet almost none of the articles discussed the potential harms of vitamin D supplementation in any detail.
Print articles named 40 different health conditions in relationship to vitamin D. The most commonly cited conditions included bone health, cancer, and cardiovascular health. Although print articles referred to a wide range of scholarly research on vitamin D with varying degrees of endorsement for supplementation, a general tone of support for vitamin D supplementation in media coverage persisted.

Conclusions: Newspaper articles conveyed overall support for vitamin D supplementation. News articles linked vitamin D to a wide range of health conditions for which there is no conclusive scientific evidence. Media coverage downplayed the limitations of existing science and overlooked any potential risks associated with supplementation.

Strengths and limitations of this study

This study examines a large sample of print media articles from venues with high circulation rates.

This study demonstrates that media coverage links Vitamin D to a wide range of health conditions for which there exists no conclusive evidence.

This study does not examine internet-based news sources, which are becomingly an increasingly important source of health information.

Introduction

Despite numerous studies and policy recommendations that have questioned the health value of dietary supplementation,[1, 2] the sale of supplements is a vast multi-billion dollar industry. Research has shown that between 35-50% of the Canadian and US population, including children, take some form of dietary supplements,[3-6] primarily because they believe the food supply is not sufficient to meet their needs and that supplements will improve health and offer protection against a range of diseases. However, little evidence exists to suggest that supplementation in addition to a healthy diet provides these benefits[5, 7, 8, 9] and in some cases it may in fact be harmful.[10]

The reasons people take supplements are undoubtedly complex and multi-factorial[11] and are set within the current cultural context that emphasizes the importance of actively taking personal responsibility for one's health.[12,13] In order to successfully manage one's health, the "citizen-come-consumer"[12(p356)] is compelled, it has been suggested, to make consumer choices that both demonstrate one's commitment to improving one's health and promise to minimize health risks.

Given this cultural and temporal imperative to take responsibility for one's health, it may be important to examine how supplements are framed in the popular press as such framing may inform decisions to purchase and consume vitamins and supplements.[14,15] News frames, or the central organizing ideas, can highlight certain aspects of an issue or topic over others and affect readers' resonance with a story.[16] Examining news framing is particularly important in this context given that the public continues to get much of its information about health and science from the popular press.[17] Studies have also shown that media coverage, in addition to aggressive marketing strategies[18] can have an impact on perceived health beliefs and utilization patterns.[19] While the recursive relationship between the media, science, and public opinion is complex[20] – for example, the media

both shapes and reflects public perceptions – research has consistently indicated that news media, including newspapers, comprise one of the most important sources of health information for the adult general public,[21, 22] although the influence of the internet as a source of news and information is growing.[23]

Given the popularity and health implications of vitamins and supplements, an analysis of news media representations may provide valuable insights that could inform future approaches to public, patient and health professional education. While researchers have previously examined and critiqued the misrepresentation of health-related issues in the popular media[24,25] and some research has been conducted on portrayals of dietary supplements in magazines[26] and advertisements[27], there has, to date, been little analysis of news media coverage related to the value of vitamins or supplements. As such, this study provides a systematic analysis of how one of the most widely consumed supplements, vitamin D, has been portrayed in the popular press and identifies the dominant messages conveyed around vitamin D, health, and the need for supplementation.

The Evidence Surrounding the Need For Vitamin D Supplementation

Vitamin D has received a great deal of attention in the popular press over the past few years. Headlines have, for example, declared a "'Plethora' of diseases caused by vitamin D"[28] and that increased vitamin D supplementation/fortification "could stop 'modern' diseases."[29] However, the state of the existing evidence around the health benefits of vitamin D supplementation is best described as unsettled.[30,31] A recent trial sequential meta-analysis[32] reported on the results from 40 RCT's (roughly 100,000 patients) of vitamin D supplementation alone or vitamin D plus calcium. Most studies followed subjects for at least one year and in some cases for up to 5-7 years. When looking at the important clinical endpoints of myocardial infarction or ischemic heart disease, stroke or cerebrovascular disease, cancer, and mortality, vitamin D supplementation did not significantly reduce risk of these outcomes. Vitamin D supplementation combined with calcium did show a statistically significant reduction in total fractures (8% relative reduction).There were also no reported negative outcomes associated with supplementation in these studies. The authors concluded, "Available evidence does not lend support to vitamin D supplementation and it is very unlikely that the results of a future single randomised clinical trial will materially alter the results from current meta-analyses."[32(p318)] These findings provide some support for vitamin D combined with calcium for reducing fracture risk, but suggest other health claims associated with vitamin D supplementation are not currently supported by the literature.

To address dietary requirements and assessment of vitamin D levels, a comprehensive report was recently completed by the Institute of Medicine (IOM).[33,34] The IOM committee tasked with determining the North American population needs of vitamin D and calcium concluded that higher concentrations of vitamin D "were not consistently associated with greater benefit, and for some outcomes U-shaped associations were observed, with risks at both low and high levels"[34(p53)] and "the prevalence of vitamin D inadequacy in North America has been overestimated."[34(p53)] For some conditions, such as obesity, the causal relation might actually run counter to conventional wisdom – that is,

the condition (increase in adipose tissue) results in lower vitamin D concentrations and not the other way around.[35] Another recent meta-analysis concluded "[d]espite a few hundred systematic reviews and meta-analyses, highly convincing evidence of a clear role of vitamin D does not exist for any outcome"[36(abstract)]. This umbrella review examined over 200 meta-analyses and systematic reviews and reported a probable evidence of association between vitamin D concentrations and birth weight, maternal vitamin D status at term, dental caries in children, and parathyroid hormone concentration in patients experiencing chronic kidney disease requiring dialysis. However, the authors concluded there was no convincing evidence to support universal vitamin D supplementation – a conclusion that fits with the work of others.[32,36,37]

While these conclusions are somewhat definitive in tone, others in the scientific community have been more cautious, emphasizing the equivocal nature of the research surrounding the health value of population wide vitamin D supplementation.[30,31]

Given the equivocal and evolving nature of the vitamin D research,[32,36,37] definitive news headlines and their accompanying stories and testimonies may not provide the public with an accurate picture of the relevant science. Furthermore, such stories may – for better or worse – help to drive the market for vitamin D, which some industry reports suggest has grown significantly over the past few years.[38-40] Indeed, some have suggested that market growth for the sale of vitamin D supplements has reached triple digits and is worth hundreds of millions of dollars.[40]

For the purposes of our study, we do not need to take a stand on the value of vitamin D supplementation; as this is a complex issue (involving biomarkers and the multiple functions of vitamin D in the body and through the lifecycle). We also do not address the use of vitamin D for specific, vulnerable populations[41] or those that clearly have vitamin D status that would be associated with important health outcomes like rickets. Instead, we merely seek to highlight that even a cursory review of the relevant academic literature reveals the science around the evidence that the population requires vitamin D supplementation for optimal health and prevention of diseases is far from conclusive.

The evolving and conflicting nature of the relevant scientific research, outlined briefly above, the absence of research that examines media representation of vitamins and supplements, and the substantial media coverage on vitamin D presents a timely opportunity to explore the nature and tone of the media attention paid to this popular vitamin supplement.

Methods

Our study sought to understand how the news media framed Vitamin D supplementation and whether the framing changed over a 5-year period. Our study was modeled after previous studies that took an inductive approach to analysing the content of print news media,[24,25] we conducted a content analysis of print articles appearing in elite newspapers that addressed vitamin D over a five-year period (2009 – 2014). Search terms included: 'vitamin D' and 'health'. The Factiva database was used to collect newspaper articles about vitamin D in elite newspapers in Canada, the United States, and the United

Kingdom. The search was limited to the top five daily newspapers in a broadsheet format in each country based on recent circulation reports.[42, 43] Our initial search yielded 408 results. Articles were excluded from analysis if vitamin D was not linked to discussions of health or supplementation, or if vitamin D was not a general focus of the article. Our final data set consisted of 294 newspaper articles published between January 2009 and January 2014.

Exploratory qualitative coding was initially conducted on a random sample of 40 articles (approximately 10%) from the entire sample.[44] Based on recurring themes that emerged during initial qualitative coding, a coding instrument was developed which was organized into three sections. The first section included general, descriptive information about the publication. The second section captured the health conditions discussed in relation to vitamin D, whether vitamin D supplementation was mentioned and/or recommended, whether the article referred to a specific research study about vitamin D and the extent of the information provided, and whether the potential harms of vitamin D supplementation were discussed. Finally, each article was coded as being overall supportive of, skeptical of, merely descriptive, or as presenting multiple perspectives on vitamin D supplementation. For the purposes of this study, these items were considered important elements in the framing, or central organizing ideas, of representations of vitamin D supplementation in news media.

Two researchers each coded half of the data set. All articles were coded in Excel and data were tallied using SPSS v.22. A random sample of 20% of the articles was then coded by a third coder who was previously uninvolved in the project. Inter-rater reliability was then calculated on SPSS v.22 using Cohen's Kappa. The results of inter-rater reliability for all items ranged between k=0.644 and 0.86 with an average score of k=0.724, indicating substantial to almost perfect agreement.[45]

Results

Our results suggest that vitamin D garnered considerable media attention over the five-year period of interest. Vitamin D coverage peaked in 2010 (which may have been influenced by the release of the revised vitamin D recommendations by the Institute of Medicine in November 2010[33]), and showed only a slight decline in subsequent years. While newspaper coverage was most prominent in Canada, media attention was fairly evenly distributed between all three countries, as shown in Table 1. The largest number of newspaper articles were featured in health and lifestyle sections (48%), followed by the news and front-page sections (31%).

Table 1. Newspapers Included in Sample

Newspaper Title	Country	Number of Articles
Globe and Mail	Canada	45
Montreal Gazette	Canada	9
National Post	Canada	12
Toronto Star	Canada	19

Vancouver Sun	Canada	18
The Los Angeles Times	US	11
The New York Times	US	15
USA Today	US	11
The Wall Street Journal	US	24
The Washington Post	US	26
The Daily Telegraph	UK	9
Financial Times	UK	8
The Guardian	UK	19
The Independent	UK	11
The Times (London)	UK	57
TOTAL		294

What's the Big Deal About D*?*

Our content analysis revealed the major themes used in media coverage of vitamin D. In general, articles frequently identified and exalted vitamin D's role in maintaining or promoting good health and in preventing chronic disease. The most common theme overall was: "adequate vitamin D is necessary for good health" (57% articles). Most articles contained several themes. Other major themes included, "vitamin D supplements may be necessary for good health and the prevention of chronic disease" (36 % articles), "it is impossible or difficult to get vitamin D from natural sources" (28% articles), and "vitamin D deficiency is widespread and cause for concern" (30% articles). Overall, the themes in news articles positioned vitamin D as important for good health, but also suggested it is difficult to achieve sufficient vitamin D levels without supplementation, and that deficiency is a widespread concern.

Articles were also coded to identify the specific health conditions linked to vitamin D. In total, newspaper articles named 40 different health conditions associated with vitamin D. Overall, cancer was mentioned most frequently (43%), followed by bone health (39%). After cancer and bone health, newspaper articles cited MS (28%), cardiovascular health (25%), and diabetes (24%) most frequently. Interestingly, these conditions varied slightly by year, as shown in **Figure 1**, but cancer and bone health remained relatively steady.

Figure 1. Most frequently named health conditions discussed in relationship to vitamin D in newspapers over 5 years.

Although these were the most frequently mentioned health concerns, vitamin D was credited for preventing or decreasing the risk of a vast array of health conditions ranging from hair loss, influenza, the common cold, Parkinson's disease, and for assisting with muscle recovery. Furthermore, the majority of articles (88%) listed more than one health concern in connection to poor vitamin D status. As a result, an overarching narrative emerged that celebrated vitamin D as a wonder drug that is 'good for everything.'

To Supplement or Not to Supplement?

In light of the zeal with which the North American population purchases and consumes vitamin supplements, and given the media's emphasis on vitamin D's role in a wide range of health conditions, we examined how media coverage addressed the specific issue of vitamin D supplementation. Our analysis revealed 86% of newspaper articles explicitly referred to vitamin D supplementation. Of these, 59% of newspaper articles suggested 'supplementation may be necessary for good health' while 21% more assertively declared 'supplementation is necessary for good health'. In other words, 80% of newspaper articles suggest supplementation is or may be necessary.

Figure 2. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year.

It is important to note, however, some newspaper articles, although supportive of vitamin D supplementation overall, were moderate in their approach. For example, 25% of articles suggested that more research is needed before unequivocal guidance around supplementation is possible. Some articles (8%) also made mention of the potential harms of too much vitamin D.

Importantly, many newspaper articles utilized the inverted pyramid style,[46] which often puts more detailed information, such as the potential for harm further down in the article. We coded for the tone of the entire article, but it may be that if audiences read only the first part of the article, they may not read the more nuanced, detailed pieces of information included in the article.

We also sought to identify if vitamin D daily intake recommendations for the general public were attributed to any expert, professional or governing body, and if so, which one. Of the newspaper articles (53%) that provided these recommendations for the general public, 58% of articles failed to attribute the recommended intake to any expert body. Of those articles that did provide recommendations and attributed them to a professional body, IOM was the most frequently cited (13%), followed by Health Canada and the Cancer Society of Canada (10%).

Many articles suggested that obtaining vitamin D through dietary means and sun exposure was preferable to supplementation. And, 57% of articles identified one or more dietary sources of vitamin D such as fortified milk and some fish. However, articles simultaneously reminded readers that sufficient vitamin D is difficult to obtain through these non-supplementary means; indeed, this was one of the primary themes about vitamin D mentioned above. Therefore, although articles often acknowledged that non-supplementary sources of vitamin D were preferable, they also indicated that this approach would likely fail to meet recommendations. As a result we interpreted these discussions as contributing to general support for supplementation.

Deciphering the Science: Accurate Messages in the News?

The ongoing scientific research on vitamin D was reflected and, at times, explicitly noted in the news media coverage. Of the articles that discussed supplementation, 40% of

newspaper articles referred to one or more specific scientific research studies (i.e., a peer-reviewed journal article) on vitamin D. These studies were positioned as 'evidence' around vitamin D supplementation and vitamin D's role in specific health conditions.. In addition, 35% of newspaper articles provided detail that extended beyond the study's overall conclusions (i.e., type of study, sample population and size).

We also coded articles to assess whether news articles interpreted the research as an endorsement of vitamin D supplementation. Our results showed 56% of those newspaper articles that mentioned research did not interpret the research as taking an explicit stand one way or the other on supplementation. However, 22% of the articles that mentioned research did interpret the research as an endorsement of supplementation.

Given the ongoing scholarly debate surrounding vitamin D, we analyzed this data to identify any potential change in how the science was positioned over the 5-year sample period. We found the interpretation of research as endorsement of vitamin D supplementation dropped noticeably in 2012 as seen in **Figure 3.** This may reflect the increasing number of research studies that do not call for or support supplementation, or a more cautious approach to interpretation on part of the news media. However, despite this decline in referencing scientific support for supplementation, articles maintained a supportive tone in favor of supplementation overall.

Figure 3.
Percentage of articles citing research about vitamin D that interpreted research as endorsement of supplementation by year.

Discussion

Our results found several consistencies in newspaper coverage of vitamin D. First, the content analysis revealed that newspaper coverage represented vitamin D in a favorable light and suggested it was positively linked to good health and the prevention of chronic diseases. We suggest this is a fair reflection of the science as adequate levels of vitamin D are, obviously, required for good health. Most of the controversy in the literature is not about whether vitamin D is needed, but about the amount we should get, whether natural sources are sufficient, and the need for supplementation. Second, newspapers conveyed overall support for vitamin D supplementation. Given the equivocal nature of the relevant evidence, this is not an appropriate representation of the science nor consistent with existing policy recommendations.[33, 47]

Third, despite the equivocal nature of scientific evidence, even on frequently studied outcomes such as cancer, fractures, cardiovascular health, and all-cause mortality,[32,36,37] media coverage overall suggested an established link between vitamin D and multiple health conditions beyond these. However, potential harm of excessive vitamin D levels and supplementation was very rarely discussed. Therefore, vitamin D supplementation was constructed as risk-free and as providing myriad potential health benefits.

This study is one of few to study media representations of vitamins or supplements. Our

findings are consistent with other research of media coverage of health issues, which has shown that news stories about medicine and health emphasize potential benefits and downplay potential harms and limitations.[48, 49] Our results also indicate that media coverage was inconsistent and at times contradictory – which, given the state of the science, is not surprising. For example, articles reported inconsistent daily intake recommendations, which may create confusion among readers.[19] Recent research has also shown both health professionals and the general public are uncertain about many aspects of vitamin D, including how much is needed per day and how much can be easily obtained through natural sources.[50]

Overall, results of the content analysis demonstrate that the print news media often frame vitamin D and supplementation in terms of the health benefits of vitamin D for everything. While some articles did include qualifying details regarding potential risks and the need for additional research, the positive framing of vitamin D in news articles draws readers' attention towards supplementation while downplaying these risks.[15] This framing may resonate particularly with readers who were already inclined towards vitamin supplementation, thus providing them little reason to not supplement.[14]

We know the media is a powerful, persuasive source of health information.[51, 52] Given our findings that the popular press have been consistently endorsing supplementation, it seems reasonable to conclude the popular press is, at least in part, helping to fuel the demand for vitamin D supplements and to the confusion about its value. This framing of vitamin D supplementation may be interacting with salient ideas about the need to take responsibility for one's health, which is often demonstrated through consumer behavior and other health-related decisions.[12,13] However, the actual impact of media on public perceptions was beyond the scope of this study and could be the subject of future research. Our study also highlights the need for good, independent and reliable sources of health information that present a more nuanced and contextualized picture of the relevant science.

Implications for Future Research

This study examined a large number of print news articles but it is important to note potential limitations. For example, we did not examine the content or influence of popular vitamin D information websites such as www.vitamindcouncil.org or of social media outlets such as Facebook, YouTube, and Twitter. However, social media are becoming an increasingly important source of health information for the general public.[53-55]

Therefore, future research should examine how vitamin D is represented in social media and on popular health-related information websites to determine how the general public integrates and makes sense of these diverse sources of information. It would also be important to examine the public's perceptions of the relationship between vitamin D and health and their beliefs about supplementation. Bennett and colleagues[40] provide an important starting point and future research could examine more explicitly what messages the general public takes home from media coverage of vitamin D. Finally, future research that captured the perspectives of health professionals would be important.

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Contributions

TC conceptualized study and assisted with analysis. MC collected, coded, and contributed to analysis. CR contributed to analysis. . TC, MC, JPM, CR and CJF reviewed data and contributed to writing the manuscript.

Competing Interest Declaration

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pd (available upon request from the corresponding author) and declare that (1) All authors report no support from any organisation for the submitted work (2) All authors have no relationships with companies that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) all authors have not non-financial interests that may be relevant to submitted work.

Data Sharing

Dataset consisting of coded articles available upon request from corresponding author Marianne Clark mclark1@ualberta.ca

Funding and Independence

The authors confirm they are independent from their funders and that the funders of this work did not play a role in study design, collection, analysis or interpretation of the data, in the writing of the article, or in the decision to submit the article for publication.

Transparency

The authors affirm that the manuscript is an honest, accurate, and transparent account of the study being reported. No important data or aspects of the study have been intentionally omitted

References

1. Fortmann SP, Burda BU, Senger CA, et al. Vitamin and mineral supplements in the primary prevention of cardiovascular disease and cancer: an updated systematic evidence review for the U.S. Preventive Services Task Force. *Ann Intern Med* 2013;159: 824-834.
2. Lamas GA, Boineau R, Goertz C, et al. Oral high-dose multivitamins and minerals after myocardial infarction: a randomized trial. *Ann Intern Med* 2013;159: 797-805.
3. Community Health Survey [2004] Statistics Canada. Available from: http://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htmhttp://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htm
4. Bailey RL, Fulgoni VL, Keast DR, et al. Examination of vitamin intakes among US adults by dietary supplement use. *J Acad Nutr Diet* 2012;112: 657-663.
5. Blendon RJ, Benson JM, Botta MD, et al. Users' views of dietary supplements. *JAMA Intern Med* 2013;173: 74-76.
6. Dwyer J, Nahin RL, Rogers GT, et al. Prevalence and predictors of children's dietary supplement use: the 2007 National Health Interview Survey. *Am J Clin Nutr* 2013;97: 1331-1337.
7. Bailey RL, Gahche JJ, Miller PE, et al. Why US adults use dietary supplements. *JAMA Intern Med* 2013;173: 355-361.
8. Martínez ME, Jacobs ET, Baron JA, et al. Dietary supplements and cancer prevention: balancing potential benefits against proven harms. *JNCI J Natl Cancer Ist* 2012;104: 732-739.
9. Fan X, Lee KS, Frazier SK, et al. The use of, and perceptions about, dietary supplements among patients with heart failure. *Eur J Cardiovasc Nurs* [Internet]. 2014 [cited 2014 July 20];13: 311-319. EPub 2013 June 19. Available from: http://cnu.sagepub.com/content/13/4/311
10. Bjelakovic G, Nikolova D, Gluud LL, et al. Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases. *Cochrane Database Syst Rev* 2012; 3:CD007176.
11. Nichter M, Thompson JJ. For my wellness, not just my illness: North Americans' use of dietary supplements. *Cult Med Psychiatry* 2006 Jun; 30:175-222.
12. Fries CJ. Governing the health of the hybrid self: Integrative medicine, neoliberalism and the shifting biopolitics of subjectivity. *Health Soc Review* 2008; 17(4): 353-367.
13. Petersen A, Lupton D. The new public health: Discourses, knowledges, strategies. Thousand Oaks: Sage; 1996.
14. Nisbet MC. Communicating climate change: why frames matter for public engagement. *Environ* 2009; 51:12–23. doi:10.3200/ENVT.51.2.12-23 CrossRef
15. Scheufele DA. Framing as a theory of media effects. *Journal of Communication* 1999; 49: 103-122.
16. Gamson WA, Modigliani A. Media discourse and public opinion on nuclear power: A constructionist approach. *American Journal of Sociology* 1989;95: 1-37.

17. Geller G, Bernhardt BA, Holtzman NA. The media and public reaction to genetic research. *JAMA* 2002; 287:773.
18. Story M, French S. Food advertising and marketing directed at children and adolescents in the U.S. *Int J Behav Nutr Phys Act* 2004;1: 3-17.
19. Nagler RH. Adverse outcomes associated with media exposure to contradictory nutrition messages. *J Health Commun* 2014;19: 24-40.
20. Fahnestock J. Accommodating science: The rhetorical life of scientific facts. *Written Comm* 1998;15: 330-350.
21. Percheski C, Hargittai, E. Health information-seeking in the digital age. *J Am Coll Health* 2011;59: 379-386.
22. Dutta-Bergman, MJ. Primary sources of health information: comparisons in the domain of health attitudes, health cognitions, and health behaviors. *Health Communication* 2004;16: 273-288.
23. Internet gains on television as public's main news source. [Internet] 2011 Jan 4 [cited 2014 June 18]. Available from: http://www.peoplepress.org/2011/01/04/internet-gains-on-television-as-publics-main-news-source/
24. Zarzeczny A, Rachul C, Nisbet MC, et al. Stem cell clinics in the news. *Nature Biotechnology* 2010; 28: 1243-1246.
25. Kamenova K, Reshef A, Caulfield T. Angelina Jolie's faulty gene: newspaper coverage of a celebrity's preventive bilateral mastectomy in Canada, the United States, and the United Kingdom. *Genetics in Medicine* 2013; 16: 522-528.
26. Kava R. Meister KA, Whelan EM, et al. Dietary supplement safety information popular among older readers. *Journal of Health Comm: Int Perspectives* 2002;7: 13-23.
27. DeLorme DE, Huh J, Reid LN, et al. Dietary supplement advertising in the US. *Int Journal of Advertising* 2012;31 (3): 547-577.
28. Smith R. 'Plethora' of diseases caused by low vitamin D. *The Telegraph* 2012 Dec 12.
29. Gillie O. Vitamin D – could it stop 'modern' diseases? *The Telegraph* 2014 March 10.
30. Anonymous. Vitamin D: chasing a myth? (Editorial). *Lancet Diabetes Endocrinol* 2014; 2(1):1.
31. Kupferschmidt K. Uncertain verdict as vitamin D goes on trial. *Science* 2012;337(6101):1476-1478.
32. Bolland MJ, Grey A, Gamble GD, et al. The effect of vitamin D supplementation on skeletal, vascular, or cancer outcomes: a trial sequential meta-analysis. *Lancet Diabetes Endocrinol* 2014;2: 307-320.
33. IOM. Dietary reference intakes for calcium and vitamin D. Report Brief 2011. http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-calcium-and-vitamin-D.aspx
34. Ross AC, Manson JE, Abrams SA, et al. The 2011 report on dietary reference intakes for calcium and vitamin D from the Institute of Medicine: what clinicians need to know. *J Clin Endocrinol Metab* 2011;96: 53-58.

35. Vimaleswaran KS, Berry DJ, Lu C, et al. Causal relationship between obesity and vitamin D status: bi-directional Mendelian randomization analysis of multiple cohorts. *PLoS Med* 2013;10(2):e1001383.
36. Theodoratou E, Tzoulaki I, Zgaga L, et al. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. *BMJ* 2014; 348:g2035.
37. Chowdhury R, Kunutsor S, Vitezova A, Oliver-Williams C, et al. Vitamin D and risk of cause specific death: systematic review and meta-analysis of observational cohort and randomised intervention studies. *BMJ* 2014;348:g1903.
38. Vitamin D use increased 52% in past two years [Internet]. 2011 Feb 1 [cited 2014 March 9]. Available from: http://www.consumerlab.com/news/Vitamin_Supplement_Use_Survey_Report/01_31_2011
39. Feldman M. Is the market for vitamin D supplements at risk of decline? 2011 April 7 [cited 2014 March 9] In: Euromonitor International Blog. [Internet]. London: Euromonitor International Ltd. Available from: http://blog.euromonitor.com/2011/04/vitamin-d-supplements-losing-their-star.html
40. Montague-Jones G. Markets: global vitamin D boom remains elusive [Internet]. 2010 March 25 [cited 2014 March 9] Available from: http://www.nutraingredients.com/content/view/print/283513
41. Verbrugge FH, Gielen E, Milisen K, et al. Who should receive calcium and vitamin D supplementation? *Age Ageing* 2012;41: 576-580.
42. Alliance for Audited Media [Internet]. 2013 [cited 2013 December 15]. http://www.auditedmedia.com/news/research-and-data/top-25-us-newspapers-for-march-2013.asp.
43. The Audit Bureau of Circulation [Internet]. 2013 [cited 2013 December 15]. http://www.abc.org.uk/Certificates-Reports/Our-Reports/.
44. Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Los Angeles: Sage.
45. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33: 159-174.
46. Pöttker, H. News and its communicative quality: the inverted pyramid – when and why did it appear? *Journalism Studies* 2003;4:501–511.
47. Health Canada. Vitamin D and calcium: updated dietary reference intakes. [Internet]. n.d. [cited 2014 July 24]. Available from: http://www.hc-sc.gc.ca/fn-an/nutrition/vitamin/vita-d-eng.php.
48. Cassels A, Hughes MA, Cole C, et al. Drugs in the news: an analysis of Canadian newspaper coverage of new prescription drugs. *CMAJ* 2003;168: 1133-1137.
49. Schwitzer G. Addressing tensions when popular media and evidence-based care collide. *BMC Medical Informatics and Decision Making* 2013;13(Suppl 3):S3.
50. Bennett K, Frisby BN, Young LE, et al. Vitamin D: an examination of physician and patient management of health and uncertainty. *Qual Health Res* 2014;24: 375-386.
51. Begley A, Coveney J. Wonder vitamin or mass medication? Media and academic representation of folate fortification as a policy problem in Australia and New

Zealand. *Aust N Z J Public Health* 2010;34: 466-471.
52. Caulfield T, Bubela T, Murdoch CJ. Myriad and the mass media: the covering of a gene patent controversy. *Genetics in Medicine* 2007;9: 850–855.
53. Logsdon CM, Mittelberg M, Myers J. Use of social media and Internet to obtain health information by rural adolescent mothers. *Appl Nurs Res* [Internet]. 2014 [cited 2014 July 20]. EPub 2014 June 7. Available from: http://www.appliednursingresearch.org/article/S0897-1897(14)00087-1/pdf.
54. Scanfeld D, Scanfelt V, Larson EL. Dissemination of health information through social networks: Twitter and antiobiotics. *Am J Infect Control* 2010;38: 182-188.
55. Vance K, Howe W, Dellavalle RP. Social Internet sites as a source of public health information. *Dermatol Clin* 2009;27:133-136.

Representations of the Health Value of Vitamin D Supplementation in Newspapers : media content analysis

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Representations of the Health Value of Vitamin D Supplementation in Newspapers

ABSTRACT

Objective: To examine the nature of media coverage of vitamin D in relation to its role in health and the need for supplements.

Design: Media content analysis

Setting: Print articles from elite newspapers in the UK, USA, and Canada.

Participants: 294 print newspaper articles appearing over five years (2009-2014)

Results: Newspaper coverage of vitamin D generally supported supplementation. The most common framing of vitamin D in print articles was "adequate vitamin D is necessary for good heath." Articles also framed vitamin D as difficult to obtain from food supply and framed vitamin D deficiency as a widespread concern. In discussions of supplementation, 80% articles suggested supplementation is or may be necessary for the general population, yet almost none of the articles discussed the potential harms of vitamin D supplementation in any detail.
Print articles named 40 different health conditions in relationship to vitamin D. The most commonly cited conditions included bone health, cancer, and cardiovascular health. Although print articles referred to a wide range of scholarly research on vitamin D with varying degrees of endorsement for supplementation, a general tone of support for vitamin D supplementation in media coverage persisted.

Conclusions: Newspaper articles conveyed overall support for vitamin D supplementation. News articles linked vitamin D to a wide range of health conditions for which there is no conclusive scientific evidence. Media coverage downplayed the limitations of existing science and overlooked any potential risks associated with supplementation.

Strengths and limitations of this study

This study examines a large sample of print media articles from venues with high circulation rates.

This study demonstrates that media coverage links Vitamin D to a wide range of health conditions for which there exists no conclusive evidence.

This study does not examine internet-based news sources, which are becomingly an increasingly important source of health information.

Introduction

Despite numerous studies and policy recommendations that have questioned the health value of dietary supplementation,[1, 2] the sale of supplements is a vast multi-billion dollar industry. Research has shown that between 35-50% of the Canadian and US population, including children, take some form of dietary supplements,[3-6] primarily because they believe the food supply is not sufficient to meet their needs and that supplements will improve health and offer protection against a range of diseases. However, little evidence exists to suggest that supplementation in addition to a healthy diet provides these benefits[5, 7, 8, 9] and in some cases it may in fact be harmful.[10]

The reasons people take supplements are undoubtedly complex and multi-factorial[11] and are set within the current cultural context that emphasizes the importance of actively taking personal responsibility for one's health.[12,13] In order to successfully manage one's health, the "citizen-come-consumer"[12(p356)] is compelled, it has been suggested, to make consumer choices that both demonstrate one's commitment to improving one's health and promise to minimize health risks.

Given ~~Within~~ this cultural and temporal imperative to take responsibility for one's health ~~context~~, it may be important to examine ~~understanding~~ how supplements are framed in the popular press as such framing may inform~~may provide insight into the nature of the representation that are informing~~ decisions to purchase and consume vitamins and supplements.[14,15] News frames, or the central organizing ideas, can highlight certain aspects of an issue or topic over others and affect readers' resonance with a story.[16] Examining news framing is particularly important in this context given that the public continues to get much of its information about health and science from the popular

press.[17] Studies have also shown that media coverage, in addition to aggressive marketing strategies[18] can have an impact on perceived health beliefs and utilization patterns.[19] While the recursive relationship between the media, science, and public opinion is complex[20] – for example, the media both shapes and reflects public perceptions – research has consistently indicated that news media, including newspapers, comprise one of the most important sources of health information for the adult general public,[21, 22] although the influence of the internet as a source of news and information is growing.[23]

Given the popularity and health implications of vitamins and supplements, an analysis of news media representations may provide valuable insights that could inform future approaches to public, patient and health professional education. While researchers have previously examined and critiqued the misrepresentation of health-related issues in the popular media[24,25] and some research has been conducted on portrayals of dietary supplements in magazines[26] and advertisements[27], there has, to date, been little analysis of news media coverage related to the value of vitamins or supplements. As such, this study provides a systematic analysis of how one of the most widely consumed supplements, vitamin D, has been portrayed in the popular press and identifies the dominant messages conveyed around vitamin D, health, and the need for supplementation.

The Evidence Surrounding the Need For Vitamin D Supplementation

Vitamin D has received a great deal of attention in the popular press over the past few years. Headlines have, for example, declared a "'Plethora' of diseases caused by vitamin D"[28] and that increased vitamin D supplementation/fortification "could stop 'modern' diseases."[29] However, the state of the existing evidence around the health benefits of vitamin D supplementation is best described as unsettled.[30,31] A recent trial sequential meta-analysis[32] reported on the results from 40 RCT's (roughly 100,000 patients) of vitamin D supplementation alone or vitamin D plus calcium. Most studies followed subjects for at least one year and in some cases for up to 5-7 years. When looking at the important clinical endpoints of myocardial infarction or ischemic heart disease, stroke or cerebrovascular disease, cancer, and mortality, vitamin D supplementation did not significantly reduce risk of these outcomes. Vitamin D supplementation combined with calcium did show a statistically significant reduction in total fractures (8% relative reduction).There were also no reported negative outcomes associated with supplementation in these studies. The authors concluded, "Available evidence does not lend support to vitamin D supplementation and it is very unlikely that the results of a future single randomised clinical trial will materially alter the results from current meta-analyses."[32(p318)] These findings provide some support for vitamin D combined with calcium for reducing fracture risk, but suggest other health claims associated with vitamin D supplementation are not currently supported by the literature.

To address dietary requirements and assessment of vitamin D levels, a comprehensive report was recently completed by the Institute of Medicine (IOM).[33,34] The IOM committee tasked with determining the North American population needs of vitamin D and calcium concluded that higher concentrations of vitamin D "were not consistently associated with greater benefit, and for some outcomes U-shaped associations were

observed, with risks at both low and high levels"[34(p53)] and "the prevalence of vitamin D inadequacy in North America has been overestimated."[34(p53)] For some conditions, such as obesity, the causal relation might actually run counter to conventional wisdom – that is, the condition (increase in adipose tissue) results in lower vitamin D concentrations and not the other way around.[35] Another recent meta-analysis concluded "[d]espite a few hundred systematic reviews and meta-analyses, highly convincing evidence of a clear role of vitamin D does not exist for any outcome"[36(abstract)]. This umbrella review examined over 200 meta-analyses and systematic reviews and reported a probable evidence of association between vitamin D concentrations and birth weight, maternal vitamin D status at term, dental caries in children, and parathyroid hormone concentration in patients experiencing chronic kidney disease requiring dialysis. However, the authors concluded there was no convincing evidence to support universal vitamin D supplementation – a conclusion that fits with the work of others.[32,36,37]

While these conclusions are somewhat definitive in tone, others in the scientific community have been more cautious, emphasizing the equivocal nature of the research surrounding the health value of population wide vitamin D supplementation.[30,31]

Given the equivocal and evolving nature of the vitamin D research,[32,36,37] definitive news headlines and their accompanying stories and testimonies may not provide the public with an accurate picture of the relevant science. Furthermore, such stories may – for better or worse – help to drive the market for vitamin D, which some industry reports suggest has grown significantly over the past few years.[38-40] Indeed, some have suggested that market growth for the sale of vitamin D supplements has reached triple digits and is worth hundreds of millions of dollars.[40]

For the purposes of our study, we do not need to take a stand on the value of vitamin D supplementation; as this is a complex issue (involving biomarkers and the multiple functions of vitamin D in the body and through the lifecycle). We also do not address the use of vitamin D for specific, vulnerable populations[41] or those that clearly have vitamin D status that would be associated with important health outcomes like rickets. Instead, we merely seek to highlight that even a cursory review of the relevant academic literature reveals the science around the evidence that the population requires vitamin D supplementation for optimal health and prevention of diseases is far from conclusive.

The evolving and conflicting nature of the relevant scientific research, outlined briefly above, the absence of research that examines media representation of vitamins and supplements, and the substantial media coverage on vitamin D presents a timely opportunity to explore the nature and tone of the media attention paid to this popular vitamin supplement.

Methods

Our study sought to understand how the news media framed Vitamin D supplementation and whether the framing changed over a 5-year period. Our study was modeled after previous studies that took an inductive approach to analysing the content of print news media,[24,25] we conducted a content analysis of print articles appearing in elite newspapers

that addressed vitamin D over a five-year period (2009 – 2014). Search terms included: 'vitamin D' and 'health'. The Factiva database was used to collect newspaper articles about vitamin D in elite newspapers in Canada, the United States, and the United Kingdom. The search was limited to the top five daily newspapers in a broadsheet format in each country based on recent circulation reports.[42, 43] Our initial search yielded 408 results. Articles were excluded from analysis if vitamin D was not linked to discussions of health or supplementation, or if vitamin D was not a general focus of the article. Our final data set consisted of 294 newspaper articles published between January 2009 and January 2014.

Exploratory qualitative coding was initially conducted on a random sample of 40 articles (approximately 10%) from the entire sample.[44] Based on recurring themes that emerged during initial qualitative coding, a coding instrument was developed which was organized into three sections. The first section included general, descriptive information about the publication. The second section captured the health conditions discussed in relation to vitamin D, whether vitamin D supplementation was mentioned and/or recommended, whether the article referred to a specific research study about vitamin D and the extent of the information provided, and whether the potential harms of vitamin D supplementation were discussed. Finally, each article was coded as being overall supportive of, skeptical of, merely descriptive, or as presenting multiple perspectives on vitamin D supplementation. For the purposes of this study, these items were considered important elements in the framing, or central organizing ideas, of representations of vitamin D supplementation in news media.

Two researchers each coded half of the data set. All articles were coded in Excel and data were tallied using SPSS v.22. A random sample of 20% of the articles was then coded by a third coder who was previously uninvolved in the project. Inter-rater reliability was then calculated on SPSS v.22 using Cohen's Kappa. The results of inter-rater reliability for all items ranged between k=0.644 and 0.86 with an average score of k=0.724, indicating substantial to almost perfect agreement.[45]

Results

Our results suggest that vitamin D garnered considerable media attention over the five-year period of interest. Vitamin D coverage peaked in 2010 (which may have been influenced by the release of the revised vitamin D recommendations by the Institute of Medicine in November 2010[33]), and showed only a slight decline in subsequent years. While newspaper coverage was most prominent in Canada, media attention was fairly evenly distributed between all three countries, as shown in Table 1. The largest number of newspaper articles were featured in health and lifestyle sections (48%), followed by the news and front-page sections (31%).

Table 1. Newspapers Included in Sample

Newspaper Title	Country	Number of Articles
Globe and Mail	Canada	45

Montreal Gazette	Canada	9
National Post	Canada	12
Toronto Star	Canada	19
Vancouver Sun	Canada	18
The Los Angeles Times	US	11
The New York Times	US	15
USA Today	US	11
The Wall Street Journal	US	24
The Washington Post	US	26
The Daily Telegraph	UK	9
Financial Times	UK	8
The Guardian	UK	19
The Independent	UK	11
The Times (London)	UK	57
TOTAL		294

What's the Big Deal About D*?*

Our content analysis revealed the major themes used in media coverage of vitamin D. In general, articles frequently identified and exalted vitamin D's role in maintaining or promoting good health and in preventing chronic disease. The most common theme overall was: "adequate vitamin D is necessary for good health" (57% articles). Most articles contained several themes. Other major themes included, "vitamin D supplements may be necessary for good health and the prevention of chronic disease" (36 % articles), "it is impossible or difficult to get vitamin D from natural sources" (28% articles), and "vitamin D deficiency is widespread and cause for concern" (30% articles). Overall, the themes in news articles positioned vitamin D as important for good health, but also suggested it is difficult to achieve sufficient vitamin D levels without supplementation, and that deficiency is a widespread concern.

Articles were also coded to identify the specific health conditions linked to vitamin D. In total, newspaper articles named 40 different health conditions associated with vitamin D. Overall, cancer was mentioned most frequently (43%), followed by bone health (39%). After cancer and bone health, newspaper articles cited MS (28%), cardiovascular health (25%), and diabetes (24%) most frequently. Interestingly, these conditions varied slightly by year, as shown in **Figure 1**, but cancer and bone health remained relatively steady.

Figure 1. Most frequently named health conditions discussed in relationship to vitamin D in newspapers over 5 years.

Although these were the most frequently mentioned health concerns, vitamin D was credited for preventing or decreasing the risk of a vast array of health conditions ranging from hair loss, influenza, the common cold, Parkinson's disease, and for assisting with muscle recovery. Furthermore, the majority of articles (88%) listed more than one health concern in connection to poor vitamin D status. As a result, an overarching narrative emerged that celebrated vitamin D as a wonder drug that is 'good for everything.'

To Supplement or Not to Supplement?

In light of the zeal with which the North American population purchases and consumes vitamin supplements, and given the media's emphasis on vitamin D's role in a wide range of health conditions, we examined how media coverage addressed the specific issue of vitamin D supplementation. Our analysis revealed 86% of newspaper articles explicitly referred to vitamin D supplementation. Of these, 59% of newspaper articles suggested 'supplementation may be necessary for good health' while 21% more assertively declared 'supplementation is necessary for good health'. In other words, 80% of newspaper articles suggest supplementation is or may be necessary.

Figure 2. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year.

It is important to note, however, some newspaper articles, although supportive of vitamin D supplementation overall, were moderate in their approach. For example, 25% of articles suggested that more research is needed before unequivocal guidance around supplementation is possible. Some articles (8%) also made mention of the potential harms of too much vitamin D.

Importantly, many newspaper articles utilized the inverted pyramid style,[46] which often puts more detailed information, such as the potential for harm further down in the article. We coded for the tone of the entire article, but it may be that if audiences read only the first part of the article, they may not read the more nuanced, detailed pieces of information included in the article.

We also sought to identify if vitamin D daily intake recommendations for the general public were attributed to any expert, professional or governing body, and if so, which one. Of the newspaper articles (53%) that provided these recommendations for the general public, 58% of articles failed to attribute the recommended intake to any expert body. Of those articles that did provide recommendations and attributed them to a professional body, IOM was the most frequently cited (13%), followed by Health Canada and the Cancer Society of Canada (10%).

Many articles suggested that obtaining vitamin D through dietary means and sun exposure was preferable to supplementation. And, 57% of articles identified one or more dietary sources of vitamin D such as fortified milk and some fish. However, articles simultaneously reminded readers that sufficient vitamin D is difficult to obtain through these non-supplementary means; indeed, this was one of the primary themes about vitamin D mentioned above. Therefore, although articles often acknowledged that non-supplementary sources of vitamin D were preferable, they also indicated that this approach would likely fail to meet recommendations. As a result we interpreted these discussions as contributing to general support for supplementation.

Deciphering the Science: Accurate Messages in the News?

The ongoing scientific research on vitamin D was reflected and, at times, explicitly noted in the news media coverage. Of the articles that discussed supplementation, 40% of newspaper articles referred to one or more specific scientific research studies (i.e., a peer-reviewed journal article) on vitamin D. These studies were positioned as 'evidence' around vitamin D supplementation and vitamin D's role in specific health conditions.. In addition, 35% of newspaper articles provided detail that extended beyond the study's overall conclusions (i.e., type of study, sample population and size).

We also coded articles to assess whether news articles interpreted the research as an endorsement of vitamin D supplementation. Our results showed 56% of those newspaper articles that mentioned research did not interpret the research as taking an explicit stand one way or the other on supplementation. However, 22% of the articles that mentioned research did interpret the research as an endorsement of supplementation.

Given the ongoing scholarly debate surrounding vitamin D, we analyzed this data to identify any potential change in how the science was positioned over the 5-year sample period. We found the interpretation of research as endorsement of vitamin D supplementation dropped noticeably in 2012 as seen in **Figure 3.** This may reflect the increasing number of research studies that do not call for or support supplementation, or a more cautious approach to interpretation on part of the news media. However, despite this decline in referencing scientific support for supplementation, articles maintained a supportive tone in favor of supplementation overall.

Figure 3.
Percentage of articles citing research about vitamin D that interpreted research as endorsement of supplementation by year.

Discussion

Our results found several consistencies in newspaper coverage of vitamin D. First, the content analysis revealed that newspaper coverage represented vitamin D in a favorable light and suggested it was positively linked to good health and the prevention of chronic diseases. We suggest this is a fair reflection of the science as adequate levels of vitamin D are, obviously, required for good health. Most of the controversy in the literature is not about whether vitamin D is needed, but about the amount we should get, whether natural sources are sufficient, and the need for supplementation. Second, newspapers conveyed overall support for vitamin D supplementation. Given the equivocal nature of the relevant evidence, this is not an appropriate representation of the science nor consistent with existing policy recommendations.[33, 47]

Third, despite the equivocal nature of scientific evidence, even on frequently studied outcomes such as cancer, fractures, cardiovascular health, and all-cause mortality,[32,36,37] media coverage overall suggested an established link between vitamin D and multiple health conditions beyond these. However, potential harm of excessive vitamin D levels and supplementation was very rarely discussed. Therefore, vitamin D supplementation

was constructed as risk-free and as providing myriad potential health benefits.

This study is one of few to study media representations of vitamins or supplements. Our findings are consistent with other research of media coverage of health issues, which has shown that news stories about medicine and health emphasize potential benefits and downplay potential harms and limitations.[48, 49] Our results also indicate that media coverage was inconsistent and at times contradictory – which, given the state of the science, is not surprising. For example, articles reported inconsistent daily intake recommendations, which may create confusion among readers.[19] Recent research has also shown both health professionals and the general public are uncertain about many aspects of vitamin D, including how much is needed per day and how much can be easily obtained through natural sources.[50]

Overall, results of the content analysis demonstrate that the print news media often frame vitamin D and supplementation in terms of the health benefits of vitamin D for everything. While some articles did include qualifying details regarding potential risks and the need for additional research, the positive framing of vitamin D in news articles draws readers' attention towards supplementation while downplaying these risks.[15] This framing may resonate particularly with readers who were already inclined towards vitamin supplementation, thus providing them little reason to not supplement.[14]

We know the media is a powerful, persuasive source of health information.[51, 52] Given our findings that the popular press have been consistently endorsing supplementation, it seems reasonable to conclude the popular press is, at least in part, helping to fuel the demand for vitamin D supplements and to the confusion about its value. This framing of vitamin D supplementation may be interacting with salient ideas about the need to take responsibility for one's health, which is often demonstrated through consumer behavior and other health-related decisions.[12,13] However, the actual impact of media on public perceptions was beyond the scope of this study and could be the subject of future research. Our study also highlights the need for good, independent and reliable sources of health information that present a more nuanced and contextualized picture of the relevant science.

Implications for Future Research

This study examined a large number of print news articles but it is important to note potential limitations. For example, we did not examine the content or influence of popular vitamin D information websites such as www.vitamindcouncil.org or of social media outlets such as Facebook, YouTube, and Twitter. However, social media are becoming an increasingly important source of health information for the general public.[53-55]

Therefore, future research should examine how vitamin D is represented in social media and on popular health-related information websites to determine how the general public integrates and makes sense of these diverse sources of information. It would also be important to examine the public's perceptions of the relationship between vitamin D and health and their beliefs about supplementation. Bennett and colleagues[40] provide an

important starting point and future research could examine more explicitly what messages the general public takes home from media coverage of vitamin D. Finally, future research that captured the perspectives of health professionals would be important.

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Contributions

TC conceptualized study and assisted with analysis. MC collected, coded, and contributed to analysis. CR contributed to analysis. . TC, MC, JPM, CR and CJF reviewed data and contributed to writing the manuscript.

Competing Interest Declaration

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pd (available upon request from the corresponding author) and declare that (1) All authors report no support from any organisation for the submitted work (2) All authors have no relationships with companies that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) all authors have not non-financial interests that may be relevant to submitted work.

Data Sharing

Dataset consisting of coded articles available upon request from corresponding author Marianne Clark mclark1@ualberta.ca

Funding and Independence

The authors confirm they are independent from their funders and that the funders of this work did not play a role in study design, collection, analysis or interpretation of the data, in the writing of the article, or in the decision to submit the article for publication.

Transparency

The authors affirm that the manuscript is an honest, accurate, and transparent account of the study being reported. No important data or aspects of the study have been intentionally omitted

References

1. Fortmann SP, Burda BU, Senger CA, et al. Vitamin and mineral supplements in the primary prevention of cardiovascular disease and cancer: an updated systematic evidence review for the U.S. Preventive Services Task Force. *Ann Intern Med* 2013;159: 824-834.
2. Lamas GA, Boineau R, Goertz C, et al. Oral high-dose multivitamins and minerals after myocardial infarction: a randomized trial. *Ann Intern Med* 2013;159: 797-805.
3. Community Health Survey [2004] Statistics Canada. Available from: http://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htmhttp://www.statcan.gc.ca/pub/82-003-x/2010004/article/11349/findings-resultats-eng.htm
4. Bailey RL, Fulgoni VL, Keast DR, et al. Examination of vitamin intakes among US adults by dietary supplement use. *J Acad Nutr Diet* 2012;112: 657-663.
5. Blendon RJ, Benson JM, Botta MD, et al. Users' views of dietary supplements. *JAMA Intern Med* 2013;173: 74-76.
6. Dwyer J, Nahin RL, Rogers GT, et al. Prevalence and predictors of children's dietary supplement use: the 2007 National Health Interview Survey. *Am J Clin Nutr* 2013;97: 1331-1337.
7. Bailey RL, Gahche JJ, Miller PE, et al. Why US adults use dietary supplements. *JAMA Intern Med* 2013;173: 355-361.
8. Martínez ME, Jacobs ET, Baron JA, et al. Dietary supplements and cancer prevention: balancing potential benefits against proven harms. *JNCI J Natl Cancer Ist* 2012;104: 732-739.
9. Fan X, Lee KS, Frazier SK, et al. The use of, and perceptions about, dietary supplements among patients with heart failure. *Eur J Cardiovasc Nurs* [Internet]. 2014 [cited 2014 July 20];13: 311-319. EPub 2013 June 19. Available from: http://cnu.sagepub.com/content/13/4/311
10. Bjelakovic G, Nikolova D, Gluud LL, et al. Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases. *Cochrane Database Syst Rev* 2012; 3:CD007176.
11. Nichter M, Thompson JJ. For my wellness, not just my illness: North Americans' use of dietary supplements. *Cult Med Psychiatry* 2006 Jun; 30:175-222.
12. Fries CJ. Governing the health of the hybrid self: Integrative medicine, neoliberalism and the shifting biopolitics of subjectivity. *Health Soc Review* 2008; 17(4): 353-367.
13. Petersen A, Lupton D. The new public health: Discourses, knowledges, strategies. Thousand Oaks: Sage; 1996.
14. Nisbet MC. Communicating climate change: why frames matter for public engagement. *Environ* 2009; 51:12–23. doi:10.3200/ENVT.51.2.12-23 CrossRef
15. Scheufele DA. Framing as a theory of media effects. *Journal of Communication* 1999; 49: 103-122.

16. Gamson WA, Modigliani A. Media discourse and public opinion on nuclear power: A constructionist approach. *American Journal of Sociology* 1989;95: 1-37.
17. Geller G, Bernhardt BA, Holtzman NA. The media and public reaction to genetic research. *JAMA* 2002; 287:773.
18. Story M, French S. Food advertising and marketing directed at children and adolescents in the U.S. *Int J Behav Nutr Phys Act* 2004;1: 3-17.
19. Nagler RH. Adverse outcomes associated with media exposure to contradictory nutrition messages. *J Health Commun* 2014;19: 24-40.
20. Fahnestock J. Accommodating science: The rhetorical life of scientific facts. *Written Comm* 1998;15: 330-350.
21. Percheski C, Hargittai, E. Health information-seeking in the digital age. *J Am Coll Health* 2011;59: 379-386.
22. Dutta-Bergman, MJ. Primary sources of health information: comparisons in the domain of health attitudes, health cognitions, and health behaviors. *Health Communication* 2004;16: 273-288.
23. Internet gains on television as public's main news source. [Internet] 2011 Jan 4 [cited 2014 June 18]. Available from: http://www.peoplepress.org/2011/01/04/internet-gains-on-television-as-publics-main-news-source/
24. Zarzeczny A, Rachul C, Nisbet MC, et al. Stem cell clinics in the news. *Nature Biotechnology* 2010; 28: 1243-1246.
25. Kamenova K, Reshef A, Caulfield T. Angelina Jolie's faulty gene: newspaper coverage of a celebrity's preventive bilateral mastectomy in Canada, the United States, and the United Kingdom. *Genetics in Medicine* 2013; 16: 522-528.
26. Kava R. Meister KA, Whelan EM, et al. Dietary supplement safety information popular among older readers. *Journal of Health Comm: Int Perspectives* 2002;7: 13-23.
27. DeLorme DE, Huh J, Reid LN, et al. Dietary supplement advertising in the US. *Int Journal of Advertising* 2012;31 (3): 547-577.
28. Smith R. 'Plethora' of diseases caused by low vitamin D. *The Telegraph* 2012 Dec 12.
29. Gillie O. Vitamin D – could it stop 'modern' diseases? *The Telegraph* 2014 March 10.
30. Anonymous. Vitamin D: chasing a myth? (Editorial). *Lancet Diabetes Endocrinol* 2014; 2(1):1.
31. Kupferschmidt K. Uncertain verdict as vitamin D goes on trial. *Science* 2012;337(6101):1476-1478.
32. Bolland MJ, Grey A, Gamble GD, et al. The effect of vitamin D supplementation on skeletal, vascular, or cancer outcomes: a trial sequential meta-analysis. *Lancet Diabetes Endocrinol* 2014;2: 307-320.
33. IOM. Dietary reference intakes for calcium and vitamin D. Report Brief 2011. http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-calcium-and-vitamin-D.aspx
34. Ross AC, Manson JE, Abrams SA, et al. The 2011 report on dietary reference intakes for calcium and vitamin D from the Institute of Medicine: what clinicians need to know. *J Clin Endocrinol Metab* 2011;96: 53-58.

35. Vimaleswaran KS, Berry DJ, Lu C, et al. Causal relationship between obesity and vitamin D status: bi-directional Mendelian randomization analysis of multiple cohorts. *PLoS Med* 2013;10(2):e1001383.
36. Theodoratou E, Tzoulaki I, Zgaga L, et al. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. *BMJ* 2014; 348:g2035.
37. Chowdhury R, Kunutsor S, Vitezova A, Oliver-Williams C, et al. Vitamin D and risk of cause specific death: systematic review and meta-analysis of observational cohort and randomised intervention studies. *BMJ* 2014;348:g1903.
38. Vitamin D use increased 52% in past two years [Internet]. 2011 Feb 1 [cited 2014 March 9]. Available from: http://www.consumerlab.com/news/Vitamin_Supplement_Use_Survey_Report/01_31_2011
39. Feldman M. Is the market for vitamin D supplements at risk of decline? 2011 April 7 [cited 2014 March 9] In: Euromonitor International Blog. [Internet]. London: Euromonitor International Ltd. Available from: http://blog.euromonitor.com/2011/04/vitamin-d-supplements-losing-their-star.html
40. Montague-Jones G. Markets: global vitamin D boom remains elusive [Internet]. 2010 March 25 [cited 2014 March 9] Available from: http://www.nutraingredients.com/content/view/print/283513
41. Verbrugge FH, Gielen E, Milisen K, et al. Who should receive calcium and vitamin D supplementation? *Age Ageing* 2012;41: 576-580.
42. Alliance for Audited Media [Internet]. 2013 [cited 2013 December 15]. http://www.auditedmedia.com/news/research-and-data/top-25-us-newspapers-for-march-2013.asp.
43. The Audit Bureau of Circulation [Internet]. 2013 [cited 2013 December 15]. http://www.abc.org.uk/Certificates-Reports/Our-Reports/.
44. Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Los Angeles: Sage.
45. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33: 159-174.
46. Pöttker, H. News and its communicative quality: the inverted pyramid – when and why did it appear? *Journalism Studies* 2003;4:501–511.
47. Health Canada. Vitamin D and calcium: updated dietary reference intakes. [Internet]. n.d. [cited 2014 July 24]. Available from: http://www.hc-sc.gc.ca/fn-an/nutrition/vitamin/vita-d-eng.php.
48. Cassels A, Hughes MA, Cole C, et al. Drugs in the news: an analysis of Canadian newspaper coverage of new prescription drugs. *CMAJ* 2003;168: 1133-1137.
49. Schwitzer G. Addressing tensions when popular media and evidence-based care collide. *BMC Medical Informatics and Decision Making* 2013;13(Suppl 3):S3.
50. Bennett K, Frisby BN, Young LE, et al. Vitamin D: an examination of physician and patient management of health and uncertainty. *Qual Health Res* 2014;24: 375-386.
51. Begley A, Coveney J. Wonder vitamin or mass medication? Media and academic representation of folate fortification as a policy problem in Australia and New

Zealand. *Aust N Z J Public Health* 2010;34: 466-471.
52. Caulfield T, Bubela T, Murdoch CJ. Myriad and the mass media: the covering of a gene patent controversy. *Genetics in Medicine* 2007;9: 850–855.
53. Logsdon CM, Mittelberg M, Myers J. Use of social media and Internet to obtain health information by rural adolescent mothers. *Appl Nurs Res* [Internet]. 2014 [cited 2014 July 20]. EPub 2014 June 7. Available from: http://www.appliednursingresearch.org/article/S0897-1897(14)00087-1/pdf.
54. Scanfeld D, Scanfelt V, Larson EL. Dissemination of health information through social networks: Twitter and antiobiotics. *Am J Infect Control* 2010;38: 182-188.
55. Vance K, Howe W, Dellavalle RP. Social Internet sites as a source of public health information. *Dermatol Clin* 2009;27:133-136.

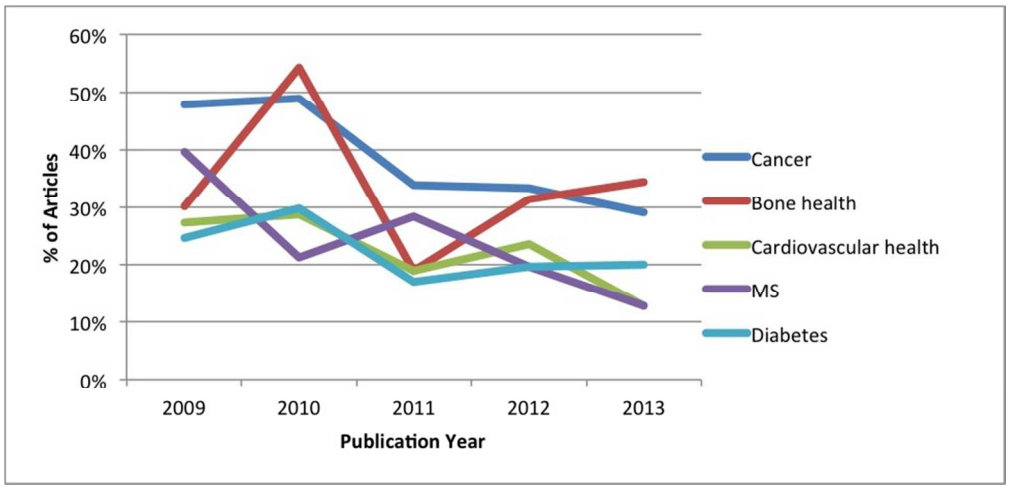

Figure 1. Most frequently named health conditions discussed in relationship to vitamin D in newspapers over 5 years.
164x78mm (150 x 150 DPI)

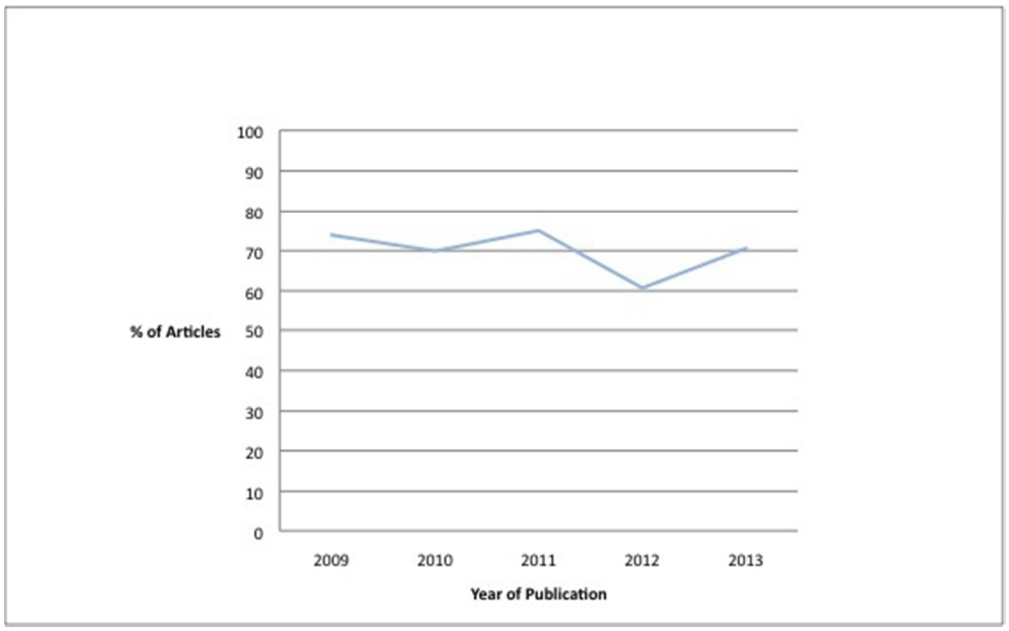

Figure 2. Percentage of articles that utilized one or both of the frames 'supplementation may be beneficial' and/or 'supplementation is necessary' by year.

201x124mm (72 x 72 DPI)

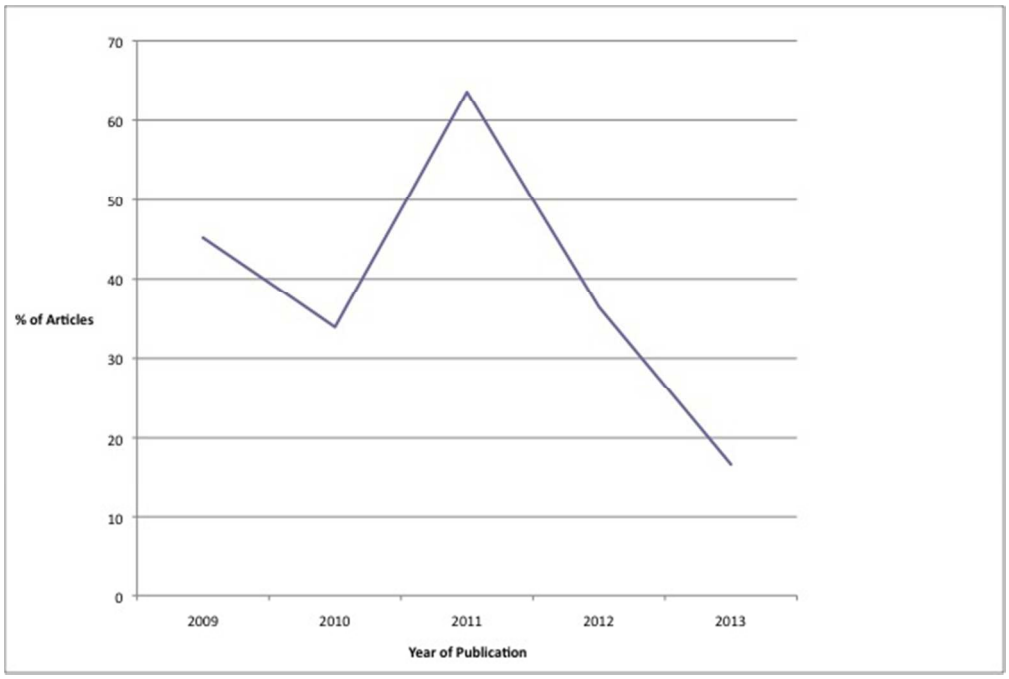

Figure 3. Percentage of articles citing research about vitamin D that interpreted research as endorsement of supplementation by year.

231x154mm (72 x 72 DPI)