English language YouTube videos as a source of lead poisoning-related information: a cross-sectional study

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ABSTRACT

Exposure to lead is detrimental to children's development. YouTube is a form of social media through which people may learn about lead poisoning. The aim of this cross-sectional study was to analyze the variation in lead poisoning-related YouTube contents between different video sources. The 100 most viewed lead poisoning-related videos were manually coded, among which, 50 were consumer-generated, 19 were created by health care professionals, and 31 were news. The 100 videos had a total of more than 8.9 million views, with news videos accounting for 63% of those views. The odds of mentioning what lead poisoning is, how to remove lead, and specifically mentioning the danger in ages 1–5 because of rapid growth among videos created by health care professionals were 7.28 times (Odds ratio, OR = 7.28, 95% CI, 2.09, 25.37, $p = 0.002$); 6.83 times (OR = 6.83, 95% CI, 2.05, 22.75, $p = 0.002$) and 9.14 times (OR = 9.14, CI, 2.05, 40.70, $p = 0.004$) that of consumer-generated videos, respectively. In this study, professional videos had more accurate information regarding lead but their videos were less likely to be viewed compared to consumer-generated videos and news videos. If professional videos about lead poisoning can attract more viewers, more people would be better informed and could possibly influence policy agendas, thereby helping communities being affected by lead exposure.

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Introduction

Lead is a metal that is naturally found in the environment. People are exposed to lead through human activities, such as lead-based paints in homes, plumbing, and gasoline [1]. Lead-based paints were banned in 1978 but almost 4 million households built before 1978 still contain this hazardous element [2]. Although lead exposure is harmful for anyone, it is especially harmful for children [3]. Lead poisoning caused by exposure to lead can damage a child's brain and nervous system, hinder their growth and development, and cause learning and behavioral problems, as well as hearing and speech problems. This environmental health challenge has not been fully overcome. Many children remain at risk.

The issue of lead poisoning has been highlighted by the recent public health crisis in Flint, Michigan. In 2014, the state decided to switch the source of water from the Detroit water system to the Flint River. Chemical reactions between the river's water and the lead piping resulted in water contamination and the concomitant rising incidence of lead poisoning in the community. This crisis was brought to light two years ago and President

Obama declared a State of Emergency for Michigan in January of 2016. One year later, Flint still does not have clean drinking water [4]. Such a crisis creates a demand for information, as consumers and professionals alike aim to rectify or prevent health issues related to lead poisoning. In the advent of the digital age, many use the Internet as a source of information.

YouTube™ is a social media site that allows billions of people to watch and share videos [5]. Videos may be posted by stand-alone individuals known as consumers, by professionals, such as medical doctors and registered nurses, or by news broadcasts from Internet sources or television networks, such as HBO and CNN. Each time a video is clicked on by the viewers, one unit is added to the continuing measure of views. If the viewers like the video, they may press the “thumbs up” icon; likewise, the “thumbs down” icon can be pressed if viewers dislike the video [5]. Many YouTube™ videos are posted as inspirations to others or they may be informative or persuasive for the viewer [5]. There are a plethora of different videos containing many topics or contents. Video meta-data such as count of views and “thumbs up” and “thumbs down”, information about the user who posted

the video, as well as categorization of video contents can be analyzed to provide YouTube™ users with insights.

In recent years, YouTube™ has been used for dissemination of different kinds of health-related information [6], such as skin cancer [7], diabetic retinopathy [8], immunization [9], and Zika virus [10]. Given its popularity, we anticipate that YouTube™ is a platform through which people can learn about lead poisoning and how to remove lead from their homes if it is present. Therefore, the aim of this study was to describe characteristics of YouTube™ videos relating to lead and to analyze how video contents vary by video sources.

Methods

Data retrieval

We selected our sample by searching for “Lead poisoning” on YouTube.com on 30 August 2016. All videos in English were sorted by number of views and examined for specific content. We included the 100 most watched videos. The title, URL, date of upload, length of the video, number of thumbs up and thumbs down, and number of views were recorded. Only English language videos were manually coded.

Coding of video sources

We manually categorized the source of uploads into three categories: Consumer; Professional; and News (both television-based and internet-based). Consumers were non-health care professional individuals, who uploaded their own content, such as informative messages, information regarding what to do if lead poisoning is suspected, or recent events surrounding lead. This category also included verified accounts. Professionals included individuals and organizations with a background in health care, such as a physician, an academic health center, and federal and state agencies. News videos included any news network and any type of news from online sources. All the 100 videos fell into one of these mutually exclusive categories.

Coding of video contents

It was determined if the video mentioned the following information: what lead poisoning is; how to remove lead; explains danger; testing for lead; smelting; specifically mentions the danger among children of years one to five because of the rapid growth in children; that there is no safe level of lead; specific dangers to human body; there may not be any symptoms; treatment; prevention; death; traditional medicines as potential source of lead; toys and jewelry as potential source of lead; bullets as potential source of lead; paint potential source of lead poisoning; candies as a potential source of lead poisoning; water as potential source of lead poisoning; poisoning

of animals; race; social class or wealth. Additional categories included: highlights cases in the US; discusses the need for resources abroad; discusses the need for parents’ awareness; discusses need for training of health care personnel; discusses need for coordination between local, state, and federal governments.

Inter-rater reliability

To assess the inter-rater reliability of the manual coding, i.e. to determine whether the manual coding of the videos from the rater of this study is valid, another independent rater (C.H.B.) selected a random sample of 10 videos from the 100 most watched videos and double coded it. Comparing the manually coded results between the two raters, almost all of the manually coded variables reached 100% agreement with kappa values equal to one except for one variable (i.e. Mentions specific dangers to body) with one video miscoded with kappa = 0.8 and agreement = 90%. This suggests that the manual coding of the rater of this study is reliable and valid.

Statistical analysis

Analysis was conducted in R (version 3.3.1) [11] via RStudio interface (version 0.99.903) [12]. For the length of videos, number of views, views per day, given that the distributions of these types of variables were generally rather skewed, they were analyzed using non-parametric methods (Table 1). The Kruskal–Wallis H Test was used across the three source categories and if the overall test suggested there is a difference, we continued to compare pairwise using Nemenyi test. The correlations between the length of videos, number of views, and views per day were analyzed based on Spearman’s rho. Univariate logistic regression was performed with the source of the video as the predictor variable and the manually coded content variables as the binary outcome variables. The odds ratio of a specific category of video source (Professional; News) showing a specific type of content as compared with the reference category (Consumer-generated videos) was calculated. For better interpretation in application, the relative risk and corresponding confidence limits based on the estimated odds ratio values were computed [13] and were presented in Table 2.

Ethical approval

The study was determined to be not human subjects research by the institutional review board at William Paterson University.

Results

The 100 most watched lead-related YouTube™ videos were all in English. Among them, there were 50 consumer-created videos, 19 news videos created by a health

Table 1. Number of views, views per day, and video length (in minutes) of the most widely viewed 100 lead-related videos in English by their sources.

	Consumer (N = 50)	Professional (N = 19)	News (N = 31)	Overall (N = 100)
<i>Number of views</i>				
Mean [SE]	62,470 [32,935]	9,805 [1433]	182,500 [154,971]	89,680 [50,671]
Median	9274	6758	8875	8821
Range	4447 – 1,515,000	4537 – 27,650	4563 – 4,825,000	4537 – 4,825,000
95% CI	–3716 – 128,657	6794 – 12,817	–133,977 – 499,008	–10,864 – 190,220
Total (%)	3,123,514 (34.8)	186,301 (2.1)	5,657,979 (63.1)	8,967,794 (100)
<i>Views per day</i>				
Mean [SE]	98.04 [35.73]	8.21 [4.05]	1264.26 [1132.90]	442.50 [352.08]
Median	14	3	28	12
Range	2 – 1526	1 – 80	1 – 35,220	1 – 35,220
95% CI	26.2 – 169.9	–0.3 – 16.7	–1049.4 – 3577.9	–256.1 – 1141.1
Total (%)	4902 (11)	156 (0.40)	39,192 (88.6)	44,250 (100)
<i>Length of videos</i>				
Mean [SE]	7.86 [1.37]	7.81 [2.21]	5.25 [0.86]	7.04 [0.85]
Median	5.18	6	3.57	5.03
Range	0.88 – 56.78	0.52 – 45.12	0.25 – 18.53	0.25 – 56.78
95% CI	5.11 – 10.60	3.17 – 12.45	3.50 – 7.01	5.36 – 8.72
Total (%)	392.77 (55.79)	148.42 (21.1)	162.85 (23.13)	704.03 (100)

Note: CI, confidence interval, SE, standard error.

care professional, and 31 news videos from a television network or an Internet source.

In total, these 100 videos were viewed more than 8.9 million times (Table 1). News videos attracted 5.7 million views (63.1% of the total views), followed by consumer-created videos (3.1 million, 34.8%) and professional videos (186,301, 2.1%). The distributions of number of views of videos were not statistically different from each other (Kruskal–Wallis $\chi^2 = 3.03$, $p = 0.220$). Collectively, the 100 videos attracted approximately 44,250 views per day. The median number of views per day was 12 per video (Consumer: 14; Professional: 3; News: 28). The differences in number of views per day between the three categories were statistically significant (Kruskal–Wallis $\chi^2 = 16.17$, $p < 0.01$). Pairwise comparisons using Nemenyi test found that there was a statistically significant difference in number of views per day between professional-generated videos and news videos ($p = 0.01$). However, there was no correlation between the views and the length of videos (spearman's $\rho = 0.1225$, $p = 0.114$). Lengths of videos ranged from 0.25 to 56.78 min among the 100 videos (Table 1). The differences in length of videos between the three categories were not statistically significant (Kruskal–Wallis $\chi^2 = 3.0552$, $p = 0.217$).

Table 2 presents the frequency of lead-related YouTube™ videos by their content and source categories. Forty-seven out of 100 videos mentioned what lead poisoning is. Only 18 (18/100) videos mentioned how to remove lead. Two-thirds of the videos explained danger (67/100). Approximately a half of the videos mentioned paint as a potential source of lead poisoning (46/100),

mentioned testing (51/100), and specific dangers to the body (54/100).

Using consumer-generated videos as the reference category, Table 2 presents the odds ratios of professional videos and that of news videos. The odds of professional videos mentioning what lead poisoning is, of mentioning how to remove lead, and of specifically mentioning the danger in ages 1–5 because of rapid growth were 7.28 times (Odds ratio, OR = 7.28, 95% CI, 2.09, 25.37, $p = 0.002$), 6.83 times (OR = 6.83, 95% CI, 2.05, 22.75, $p = 0.002$), and 9.14 times (OR = 9.14, 95% CI, 2.05, 40.70, $p = 0.004$) that of consumer-generated videos, respectively. Compared to consumer-generated videos, the odds of explaining danger and mentioning testing are higher among both professional (OR = 4.92, 95% CI, 1.27, 19.03, $p = 0.021$; OR = 4.98, 95% CI, 1.54, 16.09, $p = 0.007$) and news videos (OR = 3.85, 95% CI, 1.35, 10.99, $p = 0.012$; OR = 2.81, 95% CI, 1.12, 7.10, $p = 0.028$). Interestingly, the odds of mentioning that there is no safe level of lead (OR = 11.08, 95% CI, 2.00, 61.45, $p = 0.006$), mentioning that there may not be symptoms (OR = 13.07, 95% CI, 1.35, 126.01, $p = 0.026$), mentioning prevention (OR = 6.55, 95% CI, 1.79, 23.95, $p = 0.005$), and mentioning paint as a potential source of lead poisoning (OR = 9.48, 95% CI, 2.43, 37.00, $p = 0.001$) are all higher among professional-based videos compared to consumer-generated videos. The only other odds ratio that was significant was for content that mentions social class or wealth among news videos compared to consumer-generated videos (OR = 3.49, CI, 1.12, 10.90, $p = 0.031$) (Table 2).

Table 2. Frequency count, odds ratio, and relative risk of the most widely viewed 100 lead-related videos in English; compared by source.

Content category	Yes	No	Odds ratio (95% CI)	Relative risk (95% CI)	P-value
Mentioned what lead poisoning is?	47	53			
Consumer	17	33	Reference	Reference	
Professional	15	4	7.28 (2.09, 25.37)	4.34 (1.60, 11.74)	0.002*
News	15	16	1.82 (0.73, 4.55)	1.44 (0.83, 2.48)	0.200
Mentioned how to remove lead?	18	82			
Consumer	7	43	Reference	Reference	
Professional	10	9	6.83 (2.05, 22.75)	3.40 (1.66, 6.95)	0.002*
News	1	30	0.20 (0.02, 1.75)	0.30 (0.05, 1.94)	0.148
Explained danger?	67	33			
Consumer	26	24	Reference	Reference	
Professional	16	3	4.92 (1.27, 19.03)	3.43 (1.10, 10.66)	0.021*
News	25	6	3.85 (1.35, 10.99)	2.45 (1.14, 5.29)	0.012*
Mentioned testing?	51	49			
Consumer	18	32	Reference	Reference	
Professional	14	5	4.98 (1.54, 16.09)	3.24 (1.31, 8.00)	0.007*
News	3	28	2.81 (1.12, 7.10)	1.88 (1.06, 3.35)	0.028*
Mentioned smelting?	6	94			
Consumer	3	47	Reference	Reference	
Professional	0	19	—	—	—
News	3	28	1.68 (0.32, 8.89)	1.34 (0.57, 3.14)	0.543
Specifically mentioned the danger in age 1–5 years because of rapid growth?	13	87			
Consumer	3	47	Reference	Reference	
Professional	7	12	9.14 (2.05, 40.70)	3.44 (1.80, 6.58)	0.004*
News	3	28	1.68 (0.32, 8.89)	1.34 (0.57, 3.14)	0.543
Mentioned that there is no safe level of lead?	12	88			
Consumer	2	48	Reference	Reference	
Professional	6	13	11.08 (2.00, 61.45)	3.51 (1.88, 6.59)	0.006*
News	4	27	3.56 (0.61, 20.69)	1.85 (0.98, 3.52)	0.158
Mentioned specific dangers to body?	54	46			
Consumer	21	29	Reference	Reference	
Professional	13	6	3.00 (0.98, 9.16)	2.23 (0.95, 5.19)	0.055
News	20	11	2.51 (1.00, 6.34)	1.77 (0.98, 3.21)	0.051
Mentioned that there may not be symptoms?	6	94			
Consumer	1	49	Reference	Reference	
Professional	4	15	13.07 (1.35, 126.01)	3.41 (1.83, 6.36)	0.026*
News	1	30	1.63 (0.10, 27.10)	1.31 (0.32, 5.42)	0.732
Treatment mentioned?	15	85			
Consumer	10	40	Reference	Reference	
Professional	4	15	1.07 (0.29, 3.92)	1.04 (0.41, 2.67)	0.923
News	1	30	0.13 (0.02, 1.10)	0.21 (0.03, 1.40)	0.061
Prevention mentioned?	17	83			
Consumer	5	45	Reference	Reference	
Professional	8	11	6.55 (1.79, 23.95)	3.13 (1.58, 6.20)	0.005*
News	4	27	1.33 (0.33, 5.40)	1.19 (0.54, 2.61)	0.687
Mentioned death?	22	78			
Consumer	9	41	Reference	Reference	
Professional	3	16	0.85 (0.20, 3.56)	0.89 (0.31, 2.58)	0.829
News	10	21	2.17 (0.76, 6.16)	1.55 (0.90, 2.69)	0.146
Mentioned traditional medicines as potential sources of lead?	1	99			
Consumer	1	49	Reference	Reference	
Professional	0	19	—	—	—
News	0	31	—	—	—
Mentioned toys and/or jewelry as potential sources of lead?	15	85			
Consumer	8	42	Reference	Reference	
Professional	5	14	1.88 (0.53, 6.68)	1.54 (0.68, 3.51)	0.332
News	2	29	0.36 (0.07, 1.83)	0.49 (0.14, 1.75)	0.219
Mentioned bullets as potential sources of lead?	13	87			
Consumer	11	39	Reference	Reference	
Professional	2	17	0.42 (0.08, 2.09)	0.51 (0.13, 1.93)	0.287
News	0	31	—	—	—
Mentioned paint as a potential source of lead poisoning?	46	54			
Consumer	18	32	Reference	Reference	
Professional	16	3	9.48 (2.43, 37.00)	5.49 (1.76, 17.15)	0.001*
News	12	19	1.12 (0.45, 2.83)	1.07 (0.61, 1.89)	0.806
Mentioned candies as potential sources of lead poisoning?	2	98			
Consumer	2	48	Reference	Reference	
Professional	0	19	—	—	—
News	0	31	—	—	—
Mentioned water as a potential source of lead poisoning?	30	70			
Consumer	13	37	Reference	Reference	
Professional	4	15	0.76 (0.21, 2.71)	0.82 (0.31, 2.12)	0.671
News	13	18	2.06 (0.79, 5.33)	1.53 (0.89, 2.62)	0.138
Mentioned poisoning of animals?	11	89			
Consumer	7	43	Reference	Reference	
Professional	2	17	0.72 (0.14, 3.83)	0.78 (0.22, 2.84)	0.703

(Continued)

Table 2. (Continued).

Content category	Yes	No	Odds ratio (95% CI)	Relative risk (95% CI)	P-value
News	2	29	0.42 (0.08, 2.19)	0.55 (0.16, 1.93)	0.305
Mentioned race?	7	93			
Consumer	2	48	Reference	Reference	
Professional	1	18	1.33 (0.11, 15.62)	1.22 (0.24, 6.35)	0.819
News	4	27	3.56 (0.61, 20.70)	1.85 (.98, 3.52)	0.158
Mentioned social class or wealth?	20	80			
Consumer	6	44	Reference	Reference	
Professional	4	15	1.96 (0.48, 7.89)	1.57 (0.66, 3.78)	0.346
News	10	21	3.49 (1.12, 10.90)	1.93 (1.15, 3.25)	0.031*
Highlighted cases in the US?	14	86			
Consumer	5	45	Reference	Reference	
Professional	2	17	1.05 (0.19, 5.98)	1.04 (0.30, 3.60)	0.948
News	7	24	2.63 (0.75, 9.16)	1.68 (0.94, 2.99)	0.130
Highlighted cases abroad?	6	94			
Consumer	3	47	Reference	Reference	
Professional	0	19	–	–	–
News	3	28	1.68 (0.32, 8.89)	1.34 (0.57, 3.14)	0.543
Discussed the need for medical help and medical resources in US?	1	99			
Consumer	0	50	Reference	Reference	
Professional	0	19	–	–	–
News	1	30	–	–	–
Discussed the need for resources abroad?	1	99			
Consumer	1	49	Reference	Reference	
Professional	0	19	–	–	–
News	0	31	–	–	–
Discussed the need for parents' awareness?	1	99			
Consumer	1	49	Reference	Reference	
Professional	0	19	–	–	–
News	0	31	–	–	–
Discussed the need for training of health care personnel?	0	100			
Consumer	0	50	Reference	Reference	
Professional	0	19	–	–	–
News	0	31	–	–	–
Discussed the need for coordination between local, state, and federal governments?	1	99			
Consumer	0	50	Reference	Reference	
Professional	0	19	–	–	–
News	1	30	–	–	–

* $p < 0.05$

Discussion

While videos created by health care professionals may present more accurate information regarding lead poisoning, they were less likely to be viewed compared to consumer-generated videos and news videos. As compared to consumer-generated videos, professional videos were found to be significantly different in prevalence of informational contents in 12 out of 29 content categories. It is worthy to note that news videos had the most views. While we acknowledge that health care professionals might have a different purpose to create and upload a video about lead poisoning from that of a news organizations, our findings suggest that it would be beneficial for health care professionals to learn from the production of news videos to attract greater attention for their videos. For example, health care professionals could tailor their videos for the target audience and avoid jargon in their presentation. Addressing the concerns of the target audience raised by current events, for example, water contamination in Flint, Michigan, may also attract a higher number of views and ensure that professional information has a higher chance of reaching the target audience.

This paper has a few limitations. As a cross-sectional study, we did not have the data on how the meta-data of the videos changed over time. Our study is limited to English language videos given the language barrier of the

coders. No coding was conducted for misinformation as this is beyond the scope of this descriptive study. Future studies with experimental designs can potentially address the issue pertinent to causal relationships between user categories and video contents. Different YouTube users create and upload videos for a variety of purposes. One cannot speculate on the motivation or intention of these YouTube users; our study can only report the observed relationship between contents and user categories.

Our study provides health professionals, law makers, and the general public with information regarding how well lead poisoning-related videos are being disseminated. Gaps in educational information provision may prompt health care professionals to consider the creation of YouTube videos with educational components on the potential after-effects of lead poisoning. For examples, adequate awareness of parents about protecting their child from lead exposure (by regularly washing hands and toys, creating barriers between play areas and lead sources, or feeding their child healthy foods with calcium, iron, and vitamin C, which may help keep lead out of the body) and promoting communications between parents or affected workers with state or local health department (about testing paint and dust from their homes or work environments) should be incorporated in these videos.

If professional videos about lead poisoning can attract more viewers, more social media users would become aware of scientific information pertinent to lead poisoning. In turn, they could possibly push for policies that would provide people with funding to reduce lead exposure in their residences and in other environments, and thus provide children with lead-free environments that are conducive to their growth and development. Furthermore, if more accurate information was accessible to the public, more people could advocate and possibly influence the agenda of their elected officials and representatives. This in turn may prevent other public health issues like that which is occurring in Flint, Michigan.

Contributions

CHB conceived and designed the study. RNH was the first coder and CHB the second coder. AMJ did the statistical analysis under JY's supervision. JY double-checked AMJ's statistics. AMJ wrote the first draft of the manuscript under ICHF's supervision. CHB, AMJ, JY, AA, and ICHF edited the manuscript.

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