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The kiss of death – Unearthing conversations surrounding Chagas disease on YouTube

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Abstract: This study employed Uses and Gratification Theory (UGT), Health Belief Model (HBM) and a mix of techniques to highlight the important role of social media in health communication. A total of 602 comments posted by YouTube users as they interacted with news items reporting on Chagas disease were thus analysed. A web-based software called Netlytic was used to capture and conduct text analytics. The sentiment of user comments on each of the five videos selected for this analysis was measured using SentiStrength. This study, therefore, achieved four objectives. First, it determined the most engaging comments amongst YouTube users as they interacted with Chagas disease news information. Second, it identified the most common issues or concerns discussed by YouTube users. Third, it analyzed the extent to which YouTube users commenting about Chagas disease conveyed information related to (a) prevention benefits, (b) barriers, (c) susceptibility to Chagas disease, (d) severity of Chagas and (e) self-efficacy as part of the Health Belief Model. And finally, it measured the levels of positive and negative sentiment in the comments made by YouTube users. Study findings, limitations, and implications for future research have been discussed as well.



A. W. Otieno

ABOUT THE AUTHOR

Aggrey has over 17 years in resource mobilization, program management, monitoring and evaluation and conducting research on health, politics and child protection. He also has 2 years' experience in teaching undergraduate level mass communication courses. Aggrey has academic interests in making use of big data and analytics in understanding the effects of new media on society and organizations. Specifically, his research endeavors are on user engagement in online environments and how user generated content influence change in attitude, opinions, perceptions and behavior in child protection, health and politics. The findings generated by this study plays an important role in informing health communication practitioners not only about the importance of targeting YouTube users in various health communication campaigns such as those against neglected tropical diseases like Chagas, but also highlights the motivation YouTube users have that can be taken advantage of as well as the best message appeals to be utilized.
Research interest

PUBLIC INTEREST STATEMENT

Health communication practitioners have been the go-to source for health information, especially of neglected tropical diseases such as Chagas. However, due to the current digital age and concomitant proliferation of social media platforms such as YouTube, social media users affected or living within disease prone environments have turned to social media including YouTube to seek as well as share information about diseases. This change of information landscape necessitates the use of YouTube by health communication professionals as a channel for health communication campaigns. This study discussed the motivations that attract social media users to YouTube as well as their health belief towards Chagas disease, and how health communication experts can take advantage of various message appeals in their campaigns.

Subjects: American Studies; Latin American & Hispanic Studies; Communication Research Methods; Development Communication; Health Communication; Health & Development;; Population & Development; Human Geography; Health Conditions; Public Health Policy and Practice;

Keywords: Chagas disease information; kiss of death; health communication; kissing bugs; neglected tropical diseases

1. Introduction

While the world is gripped by the Coronavirus (COVID-19) pandemic, other emerging infectious diseases also remain public health threats having the potential to disrupt daily lives. Globalization, climate change, and other factors seem to have increased the intensity and pervasiveness of a variety of infectious diseases such as Chagas. In recent years, Chagas disease, traditionally endemic in Latin America (Bennett et al., 2018), especially in rural areas where there is high poverty (Maguire et al., 1986), has made its way to the United States. Most Chagas disease patients in the U.S. were reported infected with a parasite called *Trypanosoma cruzi* or *T. cruzi* (Eggers et al., 2018). In the eastern and southern U.S., *T. cruzi* is transmitted to human beings by an insect vector identified as *Triatoma sanguisuga*, which is also widely known as “kissing bug” (Howard & Kounang, 2019, April 25). The *T. cruzi* is transmitted through the feces of the “kissing bugs” deposited during and after a blood meal around victims’ eyes and the bite site and causes Chagas disease. Infected victims show “serious cardiac and gastrointestinal complications” in the later stages of the disease (Grijalva et al., 2015).

In 2018, the U.S. Centers for Disease Control and Prevention (CDC) reported that about 300,000 people were estimated to live with Chagas disease in the United States (Eggers et al., 2018). The source of infection was already identified in seven states of the U.S. between 2008 and 2013 (Bennett et al., 2018). A “kissing bug” case recently occurred in Delaware, United States, raising concerns about the issue (Eggers et al., 2018). However, Chagas disease as a public health problem in the U.S. has a relatively low level of awareness (Bennett et al., 2018). This could partly be attributed to the seasonal nature of the spread of the bug carrying the parasite during summer months when the kissing bug becomes more active as the temperature goes up (Howard & Kounang, 2019, April 25). Moreover, at a global level, it was reported that there were an estimated 65,000,000 people at risk of Chagas disease and most patients had “no access to diagnosis and comprehensive treatment in each phase of the disease (World Heart Federation, 2019).”

Effective health communication campaigns that utilize a range of communication platforms are as a result important in understanding message diffusion and the spread of diseases such as Chagas amongst the public. In the last ten years, the advent of social media such as YouTube, Facebook, and Twitter is challenging the traditional health communication campaigns that were characterized by top-down dissemination of health messages through television, radio, and newspapers. News, opinions, and stories about Chagas disease can now be shared with millions of social media users by a click of a button. For example, according to Chew and Eysenbach (2010), there were two million tweets that were shared about H1N1 in 2009. On video-sharing platforms such as YouTube, such active (likes, dislikes, comments, shares) and passive (video views, comment reads) user engagement (Khan, 2017) creates further awareness and possibly a better understanding and preparedness for such diseases. To take advantage of the affordances provided by social media channels, traditional media such as television have turned to sharing their news items through social media platforms such as YouTube. Realizing the interactive potential of social media, especially in the form of videos, many media houses thus have dedicated active YouTube presence.

Utilization of social media platforms such as YouTube for health communication has been well documented (Chew & Eysenbach, 2010; Freberg et al., 2013; Liu & Kim, 2011; Signorini et al., 2011). Little focus has however been made to understand how YouTube users might influence risk perceptions during Chagas disease outbreak through comments made on YouTube news channels,

the most active YouTube users who are engaging with Chagas disease news information and the sentiments in comments shared by YouTube users regarding news information about Chagas disease that they have interacted with on YouTube.

1.1. Neglected tropical diseases

The World Health Organization identifies tropical diseases as any number of infectious diseases that thrive either solely or primarily in hot, humid climates (WHO, 2015, August 18). Of these diseases, many are classified as neglected tropical diseases (NTDs). Diseases included in this classification are dengue, rabies, blinding trachoma, Buruli ulcer, endemic treponematoses (yaws), leprosy (Hansen disease), Chagas disease, human African trypanosomiasis (sleeping sickness), leishmaniasis, cysticercosis, dracunculiasis (guinea-worm disease), echinococcosis, foodborne trematode infections, lymphatic filariasis, onchocerciasis (river blindness), schistosomiasis (bilharziasis), soil-transmitted helminthiasis (intestinal worms) (WHO, 2012, January 17).

In a 2015 study funded by the Bill and Melinda Gates Foundation, researchers discovered that the global death toll of Malaria and the NTDs combined were well over 800,000 (Wang et al., 2016). While some tropical diseases, such as malaria, receive attention and funding for prevention and vaccine development, NTDs are under represented in these regards. The populations most likely to be affected by NTDs are in poor and remote regions (“Why are some tropical diseases called ‘neglected?’” 2012). The lower socio-economic status of these populations gives them very little political influence and places them low on the list of public health priorities.

The artifacts of poverty—poor sanitation, lack of access to clean water, and inadequate housing—all contribute to the spread of these diseases (Rojas-de-Arias, 2001). In the research domain, funding for basic research on NTD pathogens represents a fraction of the total global investment in infectious disease research. This indicates that basic research related to halting the spread of these diseases, research that could promote innovations and workable solutions, is not highly valued (Hotez, 2017).

1.2. Chagas disease

Chagas disease—also referred to as American trypanosomiasis—was discovered in 1909 by Brazilian physician Carlos Chagas (Perez-Molina & Molina, 2018). It is a potentially life-threatening illness found primarily in over 20 Latin American countries (What is Chagas Disease?, 2016). The World Health Organization (2016) estimates that 8 million people worldwide are infected with the disease and over 10,000 people die every year from health conditions brought on by Chagas (cardiovascular and gastrointestinal muscles are damaged by the disease). Chagas is spread by the feces of the triatomine bug, also called the kissing bug, which is deposited near the bite site during and immediately after blood feeding. These insects thrive in the nooks and crevices of the poorly constructed, mud-thatch homes of poorer communities where the disease is found (Grijalva et al., 2015; De Maio et al., 2014).

Chagas disease mostly affects people residing in resource-restrained communities with deficient housing, low visibility, and little political voice (Bern et al., 2011; Peérez-Molina & Molina, 2018; Rojas-de-Arias, 2001). The disease creates a cycle fueled by poverty and sickness. Inadequate sanitation and living conditions, caused by poverty, leave the victims susceptible to Chagas disease. Once Chagas disease is contracted it can lead to a lifetime of disability and pain, lowering the individual’s ability to improve their socio-economic conditions (De Maio et al., 2014). Thus, perpetuating the stigma and discrimination associated with people living in poor housing conditions that favor infestation (Bern et al., 2011; Rojas-de-Arias, 2001). Due to the stigma associated with Chagas disease as a poverty disease, many people in endemic areas are reluctant to seek diagnosis or treatment (Peérez-Molina & Molina, 2018). Moreover, in many regions, people lack access to diagnosis and treatment (Dumontel et al., 2016).

Also, Chagas disease has had negative ramifications on the economies of the countries hosting infected people. Peérez-Molina and Molina (2018) estimate that over 750,000 working hours have

been lost due to premature deaths caused by Chagas, and over US\$1 billion has been lost in productivity because of the disease. The estimated annual global burden of Chagas disease is at least 627 USD million in health-care costs (Pe  rez-Molina & Molina, 2018). Furthermore, Hotez et al. (2014), argue that the expected cost of treatment per patient in a year is 1,028, USD with lifetime costs averaging 11,619 USD per patient. Martins-Melo et al. (2019) has estimated that 75% of people infected with Chagas disease are living in urban areas, increasing the demand for medical and social assistance, in addition to increasing the risk of congenital transmission. According to Martins-Melo et al. (2019), currently more than 70 million people worldwide are at risk of infection.

Chagas disease remains a neglected tropical disease (Hotez et al., 2014; Pe  rez-Molina & Molina, 2018) even though it is becoming a global health challenge. Chagas disease, initially associated with Latin American countries is now spreading beyond its natural geographical boundaries since infected individuals are migrating from Latin American endemic countries to non-endemic areas such as the United States, Canada, Europe, and some Western Pacific countries (Martins-Melo et al., 2019). Also affected are Australia and Japan (Stanaway & Roth, 2015). The international community is still faced with numerous challenges when it comes to combating Chagas disease. First, the disease's extreme spatial heterogeneity, faster evolving temporal trends marked with a decades-long lag between infection and symptomatic disease have led to biased prevalence data, and a near-total absence of data outside of endemic countries (Stanaway & Roth, 2015). Also, there are many undetected *T. cruzi* infections which sustain the risk of transmission through blood and organ donation and from mother to child. The doctors who could have the biggest impact on slowing the spread of the disease, obstetricians, have limited knowledge of congenital *T. cruzi* transmission risk, and almost no screening of at-risk women is carried out (Bern et al., 2011). This inadequate knowledge by obstetricians leads to under-diagnosis and under-reporting. So far only two drugs—Nifurtimox and Benznidazole—have proven efficacy against Chagas' disease. Unfortunately, Nifurtimox of the two drugs has not yet been approved by the U.S. FDA (Bern et al., 2011; Montgomery et al., 2014; Yoshioka et al., 2020) and Benznidazole has only partial approval from the U.S. FDA (Yoshioka, 2020).

1.3. Uses and gratification theory (UGT) in engagement with videos on Chagas disease

According to YouTube (2020), there are over 2 billion logged-in users who visit YouTube every month, resulting in over a billion hours of video watch time and views every day. YouTube interactive properties have transformed YouTube users from passive observers of content to active participants who create vast quantities of user-generated content through their online comments, interactions, and behavior.

UGT has been applied to understand why and how people seek out and use certain media to satisfy their individual needs and thus experiencing gratifications such as knowledge enhancement, entertainment and relaxation, social interaction, reward, and personal identity (Dolan, et al 2015). Reasons such as information seeking and sharing, entertainment, social and relational interactions, affirmation, and monetary rewards have been identified as some of the key motivations that drive individuals into using certain social media platforms (Dola, et al., 2015). These motivations have been found to influence social media user attitudes, perceptions, and satisfaction towards online content they have engaged with (Khan, 2017). Khan (2017), documented the following seven engagement predictors amongst YouTube users: (a) the strongest predictor for liking and disliking videos was the relaxing entertainment motive; (b) commenting and uploading being strongly predicted by social interaction motive; (c) sharing being strongly predicted by information giving motive; (d) passive content consumption in the form of video viewing was most strongly predicted by relaxing entertainment motive; (e) reading comments predicted by information-seeking motive, (f) greater YouTube experience predicted positive liking, and (g) anonymity played a role in sharing and uploading videos. Whereas there are a vast number of studies on user engagement with marketing content generated by profit-making firms, very few studies have focused on users' engagement with disease information such as Chagas disease as

well as the resultant sentiments generated by social media users while engaging with health information.

1.4. Health belief model

This study also uses the lens of the Health Belief Model (HBM) to determine the potential of YouTube users in participating in Chagas disease prevention programs. According to Patterson et al. (2018), HBM has several factors that can be employed to determine reasons that inspire individuals to act towards disease prevention, screening for, or controlling a disease. As explained by Patterson et al. (2018), the first factor, perceived susceptibility is all about how an individual believes that he/she is susceptible to a particular health problem. This is because an individual is less likely to act on the desired behavior if they don't feel threatened by the health problem (Briones et al., 2012). Perceived severity is the second factor that deals with a person's belief that not acting on preventing the health problem leads to severe consequences on them (Patterson et al., 2018). Susceptibility and severity in HBM as a result indicate people's perception of the disease (Briones et al., 2012). In addition, perceived benefits and barriers in HBM are more concerned with the individual's perceptions that the proposed behavior will work to reduce the likelihood of the negative health outcome occurring (Patterson et al., 2018). As argued by Briones et al. (2012), perceived benefits indicate that a given individual must trust that participating in preventive behavior leads to threat reduction or enhances positive outcomes. On the other hand, perceived barriers are concerned with whether individuals are less likely to adopt the desired preventive behavior or not if the costs are too great to them (Briones et al., 2012). The fifth HBM factor is perceived self-efficacy which is considered as an important determinant of motivation to adopt a recommended health behavior (Briones et al., 2012). Due to self-efficacy, a person is confident that he/she can take action (Patterson et al., 2018).

This study therefore aimed at answering four research questions:

RQ1: How do YouTube users show their desire to perform social and relational interactions as they engaged with Chagas disease news information?

RQ2: How do the comments posted by YouTube users portray their motivations to engage with the news information about Chagas disease?

RQ3: What are the level of positive and negative sentiment in comments shared by YouTube users regarding news information about Chagas disease that they interacted with on YouTube?

RQ4: To what extent do YouTube users commenting about Chagas disease convey information related to (a) prevention benefits, (b) barriers, (c) susceptibility to Chagas disease, (d) severity of Chagas, and (e) self-efficacy—the five HBM factors?

2. Method

2.1. Data collection

This study analyzed 602 comments posted by YouTube users from five YouTube videos. The selection criteria for the five videos were (a) news videos about Chagas disease, (b) videos with comments, and (c) videos with the highest number of views. Table 1 details the YouTube videos that were selected.

YouTube comments posted under each of the videos listed in Table 1 were collected using Netlytic, a cloud-based text and social network analysis tool that allows researchers to gather and import data from social media platforms such as YouTube, in order to find, explore, and visualize emerging themes of discussions (Grudz et al., 2016). The analysis was then conducted, also using Netlytic, to answer research question one.

Table 1. YouTube videos from news media houses that were analyzed

News Media House	Video Title	Number of views	Number of comments	Likes	Dislikes
News Channel 5	CDC warns TN of Kissing bug, Chagas disease	595, 206	106	311	27
Sci Show	3 deadly diseases you've probably never heard of	371, 200	700	12,000	124
NBC News	Health officials warn deadly kissing bugs spreading North in US	50, 726	89	225	29
Al Jazeera	Chagas: A silent killer I witness	19, 315	18	108	8
Tomo News US	How kissing bug bites can lead to Chagas disease	12, 441	46	201	10
Total		1,048,888	959	12, 845	198

2.2. Data cleaning

Netlytic was used to collect user comments. To prepare the data for analysis, the researchers removed any comments that were not in English, which resulted in the loss of just three comments. Some comments used only punctuation or emojis and were removed from the data set as well. In addition, comments that replied to other comments rather than the video itself were also removed from the data set. One video (“3 deadly diseases you’ve probably never heard of”) contained references to two diseases other than Chagas. When the comments for this video were coded references to diseases other than Chagas were ignored for the purposes of this study.

2.3. Data analysis

Netlytic, content analysis, and SentiStrength software analysis were conducted on the cleaned comments. Netlytic was used to answer research question 1 that determined the most engaging YouTube comments about Chagas disease. On the other hand, to answer research questions 2, 3, and 4, a total of 602 were manually coded by two independent coders to identify the most commonly discussed issues or concerns raised by YouTube users as they engaged with the news information about Chagas disease. As depicted in [Tables 2 and 3](#), the content analysis coding scheme fell into 16 variables. An hour of discussion about the coding scheme was carried out by the two coders. When disagreements occurred, the item codes were reviewed and discussed for maximum clarity. The two coders made use of YouTube comments from two videos about Chagas disease, separate from those analyzed in this study, to examine rater reliability using Kappa Alpha. The coefficients for all analyzed variables were above the acceptable level or the minimum bound of .65 suggested by McHugh (2012).

In addition to determining the sentiments raised by YouTube users through manual coding, the cleaned data was saved as a text file, with one comment contained per line, and loaded into SentiStrength for analysis. Sentiment polarity for user comments on each of the five videos selected for this analysis was therefore measured using SentiStrength. SentiStrength is a sentiment strength detection program that analyzes sentiments expressed in social web texts including YouTube comments (Thelwall, 2017). This software is designed to perform automatic analysis of short, informal texts in English using a pre-defined lexicon. Sentiment analysis in communication is important in understanding how messages are conveyed and the audience’s reactions to these messages (Thelwall, 2017). To measure the sentiment of the comments for each individual video the average positive and average negative score of each video was calculated.

Table 2. Variables, reliabilities, number of YouTube comments & percentages

	Variables	Reliabilities	Number of comments	Percentages
1	Sentiments by YouTube users	0.67		
	Positive		60	10%
	Negative		121	20%
	Neutral		329	55%
	Mixed		92	15%
2	Personal experience with Kissing bug	0.70		
	Yes		65	11%
	No		537	89%
3	Humor	0.66		
	Yes		79	13%
	No		523	87%
4	Information giving	0.68		
	Yes		110	18%
	No		492	82%
5	Information seeking	0.70		
	Yes		122	20%
	No		480	80%
6	Criticism	0.68		
	Yes		58	8%
	No		554	92%
7	Intention to act in the campaign against Chagas disease	0.66		
	Yes		132	22%
	No		470	78%
8	Fear	0.73		
	Yes		151	25%
	No		451	75%
9	Support/ appreciation	0.70		
	Yes		144	24%
	No		548	76%
10	Lack of knowledge before watching videos	0.70		
	Yes		117	19%
	No		485	81%
11	Xenophobia	0.72		
	Yes		18	3%
	No		584	93%

Table 3. Examples of comments left by YouTube users

Positive	Neutral	Negative	Mixed
<i>"Thank you for spreading awareness!"</i>	<i>"I live in Pennsylvania. I've seen those kissing bugs outside before."</i>	<i>"Is there a specific test to see if we have it? Can you see the bite mark? Not enough info here to help ..."</i>	<i>"before video: i really want to travel the globe, it would be so much fun! after video: you can't make me leave my house. i refuse to go swimming ever again"</i>
<i>"Really appreciate this episode! I help run our universities Invertebrate Biology course and we teach about these early in the semester! It's great to see you guys putting out information on these kinds of issues to remind us all!"</i>	<i>"I've heard about all these and know about them all:D"</i>	<i>"I cringed when Hank said Tsetse fly! It's Tseh-tsee, not tsee—tsee"</i>	<i>"Before watching this I'm going to state that this cannot be good for my particular phobia and OCD. Edit: Now that I watched it ... okay hasn't messed with my too much ..."</i>
<i>"I have heard of all 3 of these diseases. I'm glad something is finally being done about them."</i>	<i>"They have been in central ny for years."</i>	<i>"What? No dengue?"</i>	<i>"SciShow you make great videos that I enjoy and I believe what you have to say, but do you have a college degree in some kind of science or are you just transferring information off the internet to us."</i>

Then, the negative and positive average of all scores for each video was calculated. In the SentiStrength measurements, the positive sentiment could range from 1 (neutral) to 5 (strong). Likewise, the negative sentiment could be measured from -1 (neutral) to -5 (strong).

3. Results

3.1. The most engaging YouTube comments about Chagas disease

RQ1: This study aimed at identifying how YouTube users showed their desire to perform social and relational interactions as they engaged with Chagas disease news information. As earlier indicated, the selection criteria for the five videos were (a) news videos about Chagas disease, (b) videos with comments, and (c) videos with the highest number of views. A total of 1,048, 888 views, 959 comments, 12, 845 likes as well as 198 dislikes are indications of the kind of engagements YouTube users had as they engaged with Chagas disease news information as shown in Table 1. Further textual analysis as summarized in Appendix 1 showed the most active YouTube users whose comments received the most likes and replies such as: Specialkman (1,100 likes and 9 replies); MFizzle777 (60 likes and 11 replies); Ginger Aira (53 likes and 2 replies); Christopher Sabionski (35 likes and 6 replies); Guilherme Betolini (23 likes and 2 replies); Coochie Cult (19 likes); PhillieD XO (11 likes and 4 replies); Jayden The Asian (11 likes and 1 reply); Tessamersus (8 likes and 7 replies) and finally, John Skowronski (8 likes).

YouTube comments associated with Chagas disease news information that elicited active engagement amongst YouTube users were appreciative, had an element of sympathy or emotional appeal, or were entertaining (see the Appendix 1). As is commonly the norm on YouTube, most commenters had anonymous pseudonyms, and names that camouflaged their real identities.

3.2. Motivations for engaging with information about Chagas disease

The second research question aimed at explaining how the comments posted by YouTube users portrayed their motivations to engage with the news information about Chagas disease. Reasons

Table 4. HBM factors amongst YouTube users

HBM factor	Level of perception	Reliabilities	Number of comments	Percentages
Benefits	Highly effective	0.66	35	6%
	Low effectiveness		20	3%
	No information provided		547	91%
Barriers	High risk	0.70	24	4%
	Low risk		17	3%
	No information provided		561	93%
Susceptibility	Highly susceptible	0.70	92	15%
	Low susceptibility		17	3%
	No information provided		492	82%
Severity	Yes	0.70	174	29%
	No		428	71%
Self-efficacy	Yes	0.70	124	21%
	No		478	79%

such as information giving and sharing, entertainment and humor, provision of criticism and disapproval, and exhibition of xenophobic tendencies against certain people were unearthed by this study. The key motivations that drove YouTube users into interacting with the videos with news information about Chagas disease has been summarized in [Table 2](#).

The study found that only 19% of the YouTube users indicated that they have known about the existence of Chagas disease before engaging with the YouTube videos. Several YouTube users decried the lack of Chagas disease coverage by traditional news. Lack of public understanding about Chagas disease necessitated 20% of YouTube users to seek additional information on how to diagnose, prevent, and cure Chagas disease after watching the YouTube videos. In addition, 11% of YouTube users have had personal experiences with the deadly kissing bugs as noted by one YouTube user, “my great-grandmother died from Chagas and my grandmother is currently battling with it. Its weird because we are Brazilians but my grandmother caught the disease here in Texas.”

Due to the personal experiences that YouTube users have had with the Kissing bugs, 18% ended up sharing more information about the Kissing bugs and Chagas disease with other YouTube users beyond the information provided in the analyzed videos as in the below comment:

“So I grew up in Bolivia where the kissing bug is fairly prevalent. They usually bite around the face and then drop feces onto the bite. The bacteria which gives people Chagas is inside the feces. These bacteria will remain pretty much dormant for about 15 to 20 years, then boom, they start to multiply and shut down organs until your body dies. The bite can be confused with a large mosquito bite but it hurts more. Seriously my family had a dear friend die because he was bitten when he was younger and then about 20 years later he went to the hospital with a stomach pain then died the next day. This bug is like something out of a nightmare.”

In as much as 24% of the YouTube comments were supportive and appreciative of the information about Chagas disease disseminated through the videos, 8% were highly critical of the videos. Unfortunately, 3% of the comments had xenophobic sentiments. This is because 18 YouTube comments indicated that Kissing bugs should be used as a biological weapon to kill Muslims,

immigrants, and gay communities. Most importantly, 22% of the comments indicated the intention by the YouTube users to be part of the Chagas disease prevention and cure initiatives. Even though 13% of the comments had a sense of humor in their comments about Chagas disease, 25% of the coded comments indicated a sense of fear that emerged after watching the videos as a YouTube user indicated that he cannot fall asleep after watching the videos. As summarized by one YouTube user, Kissing bugs do not have “a sweet kiss, but a kiss of death!”

3.3. Sentiments shared by social media users regarding Chagas disease

The third research question aimed at measuring the sentiments shared by YouTube users regarding news information about Chagas disease that they interacted with on YouTube. To answer this question a sentiment analysis was first performed using SentiStrength. The average sentiment scores for each of the videos hovered around neutral as defined by SentiStrength (-1,0,1), with a slight inclination toward negative sentiment. The mean of the positive sentiments for the videos was 1.037 and the mean of the negative sentiments was -1.335. As the result would indicate, strong sentiment was rare and the results of any strong sentiments were moderated by an overabundance of neutrality in the comments. Video #2 entitled, “3 deadly diseases you’ve probably never heard of” showed the smallest gap between the positive and negative sentiment scores (2.159) despite having the highest number of comments. This suggests that an increase in engagement does not necessarily indicate an increase in sentiment strength. On the other hand, Video #4 (entitled, “Chagas: A silent killer”) having the lowest number of comments of the five videos analyzed, displayed the highest point gap between the positive and negative sentiment scores (2.511). It is possible that the lower number of comments allowed individual comments with higher sentiment scores to greatly affect the average. Whereas the videos with larger numbers of comments will exhibit a more moderate sentiment score as the positive and negative sentiments average out.

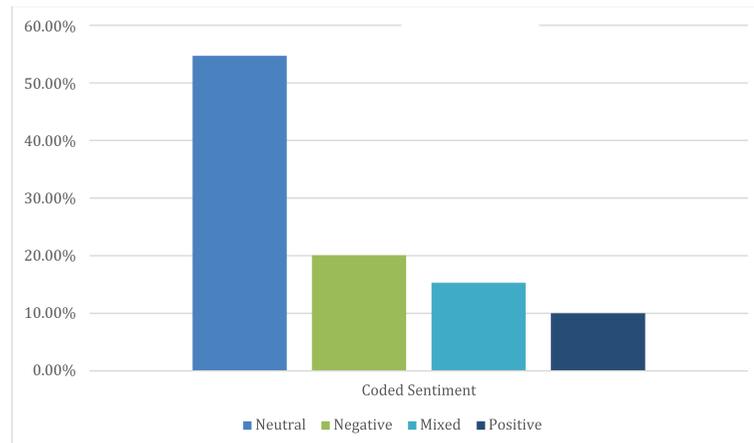
Sentiment was also measured via manual coding by two independent coders. Comments were coded as positive, negative, neutral, or mixed. Comments found to be generally supportive of the messaging in the videos was coded as positive. Comments found to be primarily critical of the messaging in the videos was coded as negative. Comments were coded as mixed when they had an approximate equal amount of positive and negative sentiment, and comments that expressed information without being critical or supportive were coded as neutral (see [Table 3](#) for examples of each of these categories). Of the 602 comments coded, it was found that more than half of the comments were neutral (54.7%), agreeing with the overall finding of the SentiStrength analysis. The remaining comments were coded as either negative (20.1%), mixed (15.3%), or positive (10%) as indicated in [Table 2](#). This finding suggests that a large number of neutral sentiments is indeed overwhelming the negative, mixed, or positive sentiments as was indicated in the SentiStrength analysis, as a result increasing the face validity to the findings of the sentiment detection software.

3.4. HBM factors amongst the YouTube users

Finally, the fourth research question aimed at determining the extent to which YouTube users commenting about Chagas disease conveyed information related to a) prevention benefits, b) barriers, c) susceptibility to Chagas disease, d) severity of Chagas and e) self-efficacy as stipulated in the Health Belief Model.

Concerning benefits, 35 of YouTube comments (6 %) included information indicating that prevention of Chagas disease by controlling the spread of Kissing bugs was highly effective, whereas 20 comments (3 %) indicated low effectiveness, and 547 comments (91%) included no information about effectiveness. In terms of barriers, our results indicated that 24 comments (4%) mentioned high risks associated with the prevention of the spread of Kissing bugs through methods such as the use of insecticides, 17 comments (3%) indicated low risks while 561 comments (93%) didn’t. In terms of susceptibility, 92 comments (15%) indicated that YouTube users were highly susceptible to Chagas disease, 17 comments (3%) indicated low susceptibility, and 492 comments (82%) included no information about susceptibility. Analysis of severity revealed that 174 comments

Figure 1. Manually coded sentiment analysis.



(29%) reported a link between Kissing bugs and Chagas disease, while 428 comments (71%) did not discuss the link between Kissing bugs and Chagas disease. Finally, concerning self-efficacy, 124 comments (21%) discussed steps to prevent the spread of Kissing bugs while 478 comments (79%) did not discuss these issues. The results are shown in [Table 3](#).

4. Discussion

In this study, we conducted content, textual, and sentiment analysis to better understand influential topics amongst YouTube users surrounding the Chagas disease outbreak. We have synthesized these findings in [Table 1](#), [2](#), [3](#) and [4](#), as well as [Figure 1](#) and the [Appendix 1](#).

This study under scores the need for health communication professionals to consider making use of YouTube in disseminating information about Chagas disease. Central to this argument is the concept of online engagement that appreciates the role of YouTube users in co-creation of value, strategy, and collaboration in health communication campaigns such as those targeting Chagas disease. In order to make this possible, the study findings unearthed some of the engagement predictors amongst YouTube users that were documented by Khan (2017). For instance, the analyzed videos represented the top five most viewed videos on YouTube with information about Chagas disease. The 1,048, 888 views generated by all the five videos is an indicator of the relaxing entertainment motive. However, there was passive content consumption of the Chagas disease information as only 959 comments were posted by the over a million YouTube users who viewed the videos with Chagas disease information. The 959 comments nevertheless predict the social interaction potential that social media users may have while engaging with disease information such as Chagas. The study findings also confirmed that Chagas disease information provided greater YouTube experience amongst the social media users as a total of 12, 845 liked the five videos. In addition, the analysis of the comments posted by the most active YouTube users who engaged with the videos on Chagas disease indicated the kind of messages that may generate more engagement amongst YouTube users. As a result, three types of messages were established to be important while developing social media content that has the potential to go viral, namely: appreciative posts, posts with a fear appeal, and those that were entertaining. These engagement predictors have been found to influence the attitudes, perceptions, and satisfaction of social media users towards online content they have engaged with (Khan, 2017; Towers et al., 2015). This is also in line with Khan's (2017) assertion that social media engagement is a multidimensional concept that comprises not only behavioral (actions) but also cognitive (thoughts), and emotional (feelings) aspects.

A total of 1,048, 888 views, 959 comments, 12, 845 likes as well as 198 dislikes are indications of the kind of engagements YouTube users had as they engaged with Chagas disease news

information. The level of engagements observed in this study are in tandem with the seven engagement predictors and motives that Khan (2017) had documented, namely: (a) relaxing entertainment motive shown through likes and dislikes about Chagas disease information as well as passive content consumption through the high number of YouTube users who viewed the five videos; (b) social interactions motive with content on Chagas disease was characterized with the comments and the video uploads that were posted; (c) information giving motive about Chagas disease was exemplified through the information that YouTube users shared; (d) information seeking motive was shown by the act of reading comments about Chagas disease; and (f) greater YouTube experience while interacting with Chagas disease information was observed through positive liking of the videos and posts made by YouTube users.

Previous studies have indicated that Chagas disease mostly affects populations residing in low-income areas. This could explain why Chagas disease remains neglected by policymakers as the infected populations are frequently stigmatized, have low visibility, and little political voice (Bern et al., 2011; Peérez-Molina & Molina, 2018; Towers, et al., 2015). Scholars such as Di Girolamo et al. (2011) have also argued that infected populations usually have low public health priority, they do not generate much scientific interest, nor do they attract disease control and management-related investments by the international community. In this study, a YouTube user named Christopher Sabionski indicated that Chagas disease is on top of the list of things that he fears most. This kind of fear has negative ramifications on people infected with Chagas disease. This fear can lead to stigmatization of Chagas disease patients (Peérez-Molina & Molina, 2018). The stigma associated with Chagas disease keeps many infected individuals from seeking support. There are therefore many people infected with chronic Chagas disease that are unaware of their condition. The situation in the United States is even more complex since populations infected with Chagas disease are largely confined to immigrants from Latin American countries such as Brazil, Bolivia, and Ecuador. Thus, as argued by Montgomery et al. (2014), immigrants are usually reluctant to accept that they are at risk of being infected with Chagas disease due to stigma associated with Chagas disease.

Most YouTube users documented by this study indicated that they have low awareness levels about Chagas disease. This is in tandem with studies conducted by Montgomery et al. (2014) that concluded that both endemic and non-endemic countries are grappling with the challenge of how to increase disease awareness without increasing stigma as a disease primarily affecting the poor. Increasing awareness of Chagas disease amongst at-risk populations without increasing stigma and improving knowledge of Chagas disease management amongst already infected populations will not only lead to Chagas disease prevention but also better case detection and receipt of appropriate care by the infected ((Alonso-Padilla et al., 2019).

Garcia et al. (2013), argued that greater knowledge of Chagas disease leads to the acquisition of new health-related behaviors amongst the targeted communities. Public health practitioners have therefore resorted to health communication campaigns aimed at triatomine vector control through housing improvements, encouragement of insecticide spraying, improvement of hygienic habits, reduction of household clutter, and cohabitation with domesticated animals. In the past, only traditional mass media played a key role in influencing the diffusion of public health information (Shein et al., 2010), serving as a conduit for the flow of information from official stakeholders to the public. Now, the proliferation of the internet and the adoption of social media platforms have led to enhanced dissemination of health-related messages (Sharma et al., 2016; Shein et al., 2010). The adoption of social media platforms such as YouTube augments the efficient, effective, and targeted flow of health information in resource-constrained settings.

A few noteworthy facts concerning the Health Belief Model and its key constructs have also been revealed by this study. First, almost 91% of YouTube comments indicated either low effectiveness or provided no information about the effectiveness of the prevention strategies

employed to prevent the spread of the Kissing bug, and consequently, Chagas disease. This is further compounded by the perception of 97% of the analyzed YouTube comments that there are high risks, or had no indication of the risks associated with the techniques used in curtailing the spread of Kissing bugs such as the use of insecticides. In addition, 82% of YouTube comments had no information about the susceptibility to Chagas disease and thus failed to indicate that Chagas disease is also a threat to residents of the United States. More than half of the analyzed YouTube comments did not mention the link between Kissing bug and Chagas disease, and thus fell short of relaying that the Kissing bugs can cause serious health problems. As argued by Patterson et al. (2018), both severity and susceptibility are two significant determinants of protection motivation. The study findings concerning HBM factors mirror those that were documented by Patterson et al. (2018) which noted that in as much as individuals believe they are susceptible to bites from kissing bugs, their perceived threat is low because the consequences of these bites were minimal and not quickly recognizable in comparison to other diseases.

Finally, lack of public understanding about Chagas disease necessitated 20% of YouTube users to seek additional information on how to diagnose, prevent, and cure Chagas disease after watching the YouTube videos. In as much as 24% of the YouTube comments were supportive and appreciative of the information about Chagas disease disseminated through the videos, 8% were highly critical of the videos. Unfortunately, 3% of the comments had xenophobic sentiments. This is because 18 YouTube comments indicated that Kissing bugs should be used as a biological weapon to either kill Muslims, immigrants, or gay communities. Most importantly, 22% of the comments indicated the intention by the YouTube users to be part of the Chagas disease prevention and cure initiatives. Even though 13% of the comments had a sense of humor in their comments about Chagas disease, 25% of the coded comments indicated a sense of fear that emerged after watching the videos like in the case of a YouTube user who indicated that he cannot fall asleep after watching the videos.

This study hence highlighted the great potential for YouTube as a tool for health communication. As documented by Prybutok (2013), YouTube's interactive nature is vital not only for the viewing audience but also health communicators who can utilize YouTube comments to distribute health messages as well as evaluate audience response to such messages. From the study findings, besides fear, emotional and appreciative appeals; humorous and entertaining comments that were embedded with information about Chagas disease attracted most engagement from other YouTube users. This underscores the important Entertainment Education value that health communication practitioners may take advantage of. In as much as the health communication practitioners should be cautious of the risk of messages becoming trivial due to the application of humor, humorous messages has the potential of enhancing viewer attention, are more persuasive and can provoke positive viewer response (Prybutok, 2013).

5. Conclusion

This study determined the important role that YouTube plays in health communication. Motivations such as information seeking and sharing, entertainment, social interactions and affirmation were identified as some of the key motivations that drive YouTube users into engaging with disease information like in the case of Chagas disease. Public health practitioners therefore need to take advantage of these engagement predictors to target social media users with health communication campaigns that are aimed at triatomine vector control through housing improvements, encouragement of insecticide spraying, improvement of hygienic habits, reduction of household clutter, and cohabitation with domesticated animals as a way of preventing the spread of Chagas disease. Significant number of YouTube users in this study had low awareness about the effectiveness of the prevention strategies employed to prevent the spread of the Kissing bug as well as their susceptibility to Chagas

disease. This calls for more sustained awareness-raising activities since Chagas disease is also a threat to residents of the United States.

Moreover, sustained health communication campaigns that target policymakers will lead to improvement of the implementation, coverage, access, and quality of health care for Chagas disease patients, including early diagnosis and treatment interventions (Martins-Melo et al., 2019). In such a context, an effective health communication campaigns should have the ability to cross disciplinary boundaries and bridge the gap between health services and communities, as well as between health and social issues (Di Girolamo et al., 2011). Health communication campaigns should also focus on messages that discourage sleeping in hovels or mud dwellings that are vulnerable to infestations of disease-carrying insects. In addition, the preventive health communication campaigns also need to encourage the use of insect repellent and bed nets, and avoidance of potentially contaminated fruit or cane juices such as those from street vendors, as well as making a call to action to the policymakers and international community to draw their attention to Chagas disease which has so far been neglected. Surveillance of the disease is important to the U.S., as travelers from countries where Chagas is endemic frequently enter the country (Bennett et al., 2018). Public health organizations, such as the World Health Organization (WHO), health professionals, and physicians are expected to provide reliable knowledge about the disease and recommendations to prevent the infection to the public.

5.1. Limitations

Although the findings of this study give anecdotal evidence regarding social media conversations by YouTube users on Chagas disease, there are still some limitations. First, all the five analyzed videos and comments posted by YouTube users were in English except for the three comments that were not in English, and were therefore removed from the analysis. This could have been influenced by the search queries made by the researchers using English. This means that there are videos with Chagas disease information that are in Spanish. It will be great to analyze videos that targets Spanish-speaking population. Second, we focused on the comments made by YouTube users on videos that were uploaded in 2013, 2015, 2017, and 2019. Out of the five videos, only two were uploaded in April 2019. This means that very few media outlets focused on broadcasting news about Chagas disease. It would have been helpful if social media conversations conducted on Twitter and Facebook were also analyzed to observe trends over time and across different social media platforms. Third, the sentiment analysis conducted by this study did not show any significant variance as most sentiments made by YouTube users were trending towards 1.0. This indicates that most YouTube users were neutral on their sentiments. Though the researchers also deployed manual content analysis to gauge the kind of sentiments towards Chagas disease by YouTube users, perhaps analyzing data using SentiStrength from a larger number of videos would have shown some kind of variations.

Despite the aforementioned limitations, this study advances understanding of social media conversations held by YouTube users regarding Chagas disease. As such, this study helps to identify YouTube comments that elicited most engagements, the commonly discussed issues and concerns held by YouTube users, and the sentiments expressed by YouTube users. In addition, this study provides an empirical foundation for future social media analytics research. As found in this study, YouTube is mainly an entertainment channel where health communicators and organizations can disseminate Entertainment Education messages aimed at preventing Chagas disease. This study as a result highlighted the enormous YouTube potential to be deployed as a health communication channel in the current digital era. Health communication practitioners can therefore take advantage of the motivations and user message appeal preferences documented by this study as well as the health beliefs that YouTuber users have about Chagas disease to design health communication campaigns.

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Appendix 1. Most engaging YouTube Comments & their significance

#	Comment made	Like count	Reply count	Significance to Chagas disease health campaign on YouTube
1	I like that this video was sponsored by Bill Gates. “Who sponsored this video?” “Bill Gates” “You mean the Bill & Melinda Gates Foundation?” “No. Just Bill Gates.”	1,100	9	His comment was the most liked by other YouTube users. He had a positive comment that appreciated the sponsorship Bill Gates made that supported the production of one of the videos. Lesson: Appreciative comment Health messages that are appreciative of the support given by others in addressing the disease may lead to more engagement on YouTube
2	Much respect to Bill Gates, I so wish many more million and Billionaires would stop being so self centered and help the world. Like Roman Abramovich always building Mega yachts and these wealthy Muslim countries like the United Arab Emirates (UAE) never giving aid! Has anyone heard of them helping? Nope!	60	11	This YouTube user also gave a positive comment that appreciated the support Bill Gates gave in the production of one of the videos. Lesson: Appreciative comment Health messages that are appreciative of the support given by others in addressing the disease may lead to more engagement on YouTube

(Continued)

(Continued)				
#	Comment made	Like count	Reply count	Significance to Chagas disease health campaign on YouTube
3	That moment when you live in the tropical zone.	53	2	His comment elicited fear that is associated with living in tropical zones since they are more vulnerable to Chagas disease transmission. Lesson: Emotional appeal Messages that elicit fear amongst the audience may lead to more engagement with the content.
4	I'll add this to my list of things to "fear."	35	6	His comment elicited fear that he had regarding the kissing bug. It seems the other YouTube users agreed as they also shared the same fear. Lesson: Fear appeal Sometimes health messaging that elicit fear from the targeted audience may elicit more engagement

(Continued)

#	Comment made	Like count	Reply count	Significance to Chagas disease health campaign on YouTube
5	Chagas is really well known here in Brazil but it's not a common thing anymore ... if the kissing bug is trying to bite you, it's unnoticeable but the actual bite doesn't infect u, they suck your blood for about 5 to even 45 minutes (usually when u sleepin') and, before they go, the bug defecates near the bite when u wake up you'll feel that the local is a lil itchy so u gonna scratch it and the feces (only blood) will get to the place where the bite was and get to ur blood system ... pretty fucked up right?	23	2	He gave an in-depth explanation of how the kissing bugs are lethal bloodsuckers that need to be feared. The user explained how a kissing bug can suck blood for almost 45 minutes Lesson: Messages that elicit fear amongst YouTube users may lead to more engagements.
6	if that's what a kissing bug looks like then I've almost died a thousand times when I was a toddler	19	0	His comment was hilarious but indicated how most people would be scared to death by just coming across a kissing bug. Lesson: Entertaining Hilarious health messages that many people can relate with may lead to more engagement

(Continued)

<i>(Continued)</i>				
#	Comment made	Like count	Reply count	Significance to Chagas disease health campaign on YouTube
7	who else let Facebook bring them here?	11	4	This comment was entertaining as the YouTube user never made any comment related to Chagas disease but found it funny that YouTube users such as himself found themselves watching videos about Chagas disease after getting the video links from Facebook. Other YouTube users who may have heard about Chagas disease through Facebook engaged with him as a result. Lesson: Entertaining Hilarious health messages that many people can relate with may lead to more engagement.
8	I'm gonna get my flame thrower	11	1	His comment was hilarious but indicated how most people would deal with the kissing bug by throwing them in flames. Lesson: Entertaining Hilarious health messages that many people can relate to may lead to more engagement

(Continued)

#	Comment made	Like count	Reply count	Significance to Chagas disease health campaign on YouTube
9	<p>This is no joke. I found out that I was deathly allergic to the cone nose beetle, aka kissing bug, the hard way ... twice. Both times I was bitten I had to be transported to the ER. Its deadly to some of us, no problem to others. Strange. They almost always bite you on the face (thus the kissing bug name) around the mouth because the tissue is easier to pierce. It was bitch getting stung. My tongue and lips swelled up so much I couldn't swallow! I had blotchy red splotches all over my body, it drove my heartbeat into a rate so fast that I kept passing out. BEWARE of this insect!!! If you live in Arizona, that's where I am, so watch out. It resides with packrats and mice in the dirt outside but can also get into the walls of your home, which is what happened to me. Very, very bad two nights of my life where I almost died.</p>	8	7	<p>He is a survivor of Chagas disease. His comment explained how he got bitten by the kissing bug, and how deadly it is since he had to be transported to the ER. Lesson: Fear appeal Where possible, work with content creators who have survived from the disease being addressed as other social media users may find them to be more authentic</p>

(Continued)

<i>(Continued)</i>				
#	Comment made	Like count	Reply count	Significance to Chagas disease health campaign on YouTube
10	Thanks can you do the science of a dog-human affection?	8	0	His comment was on whether dogs could be infected with Chagas disease. His question generated some engagement even though no one responded to the question. Lesson: Entertaining Messages that elicit fear amongst YouTube users may lead to more engagements.



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