Going viral: the Zika virus in the media

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1 Introduction

The rapid rise of a new infectious disease to epidemic proportions will always spur heightened and prolonged public and academic interest. The period following the initial outbreak is marked by an increase in scientific investigation, a surge in directed public funding, and intensive media attention. The current Zika virus epidemic (2015-2016) is no exception.

In May 2015, the Pan American Health Organisation (PAHO) issued an alert regarding the first confirmed Zika virus infections in Brazil. Cases excalated and by 1 February 2016, the World Health Organisation (WHO) declared a public health emergency of international concern. Since then the Zika virus has spread throughout Latin America and to other parts of the world. As of June 2016, the Zika virus had been reported in 61 countries, of which 47 were experiencing their first outbreak in history. In August 2016, Singapore reported cases of the Zika virus and this marked the beginning of concern about Zika in Asia. The Zika epidemic is ongoing at the time of writing.

Any news and information about current epidemics provided to the public can produce one of three reactions: it may have no effect on public opinion; it may reassure anxieties present in the public psyche; or it may incite fear and heighten anxiety within public opinion. For example, in the United States (U.S.), both the mainstream media response and social media response during the last Ebola epidemic (2014) had been accused of the latter whereby an increase in public anxiety was provoked, despite the threat of epidemic in the U.S. being negligible (Fung et al., 2014). There was a similar incitement of anxiety within the U.S. during the early stages of the current Zika epidemic, despite the relatively low risk of a Zika epidemic emerging in the same rapid fashion as has been found in Latin America (Gyawali et al., 2016). However, the extent to which media coverage impacts on public opinion over health issues such as Zika remains to be well-established. Moreover, it has not been previously studied to what extent the different forms of media, such as mass media, social media and academic media, correlate with each other and the effect this might have on how public health information is portrayed.

Mass media, such as newspapers and online news sites, is a communication channel by which information stemming from various fields can be selectively packaged and delivered to the public, including those within and outside a field, to keep them appraised of key ideas and progressions (Livesey, 2011). This is a one-to-many form of communication, whereby information from a single source (a newspaper, radio show, etc) is distributed to multiple people. Social media, such as Facebook, differs firstly because it is a many-to-many form of communication whereby multiple sites/people distribute news to multiple others; and secondly because these sites do not have a primary news function. They are online social networking tools that are used extensively for multiple purposes, of which only one is news production (Solis, 2007). The receiver of news can also directly decide the level

of importance attributed to a news piece as well as retain the ability to selectively share and attach their own opinion to the piece. Academic media, such as editorials and reports in journals, are again different. These news pieces tend to be more formal, include more technical or scientific detail, and are aimed towards a smaller, academic community, rather than the general public.

This report aims to investigate the extent to which academic, social, and mass media correlate with each other when reporting on public health issues, and to what extent this can work to influence public opinion, using examples from the current Zika epidemic. As the recent Zika outbreak started in Brazil, the most extensive media reporting of Zika has been in Latin America and the U.S. (WHO, 2016a). This report focuses on U.S. media reporting to illustrate the correlation between different media sources, since the U.S. is a large English-speaking country geographically close to the epicentre of the Zika epidemic. The findings have been used to accumulate and provide key public health policy recommendations as to how the media could best utilised by public health officials during the outbreak of an infectious disease, as well as what policy-makers should attempt to avoid in this regard.

The structure of this report is as follows. Firstly, Section 2 presents a brief background on the Zika virus. Section 3 inivestigates the representation of the Zika epidemic by the mass media, focusing on online newspapers in the U.S.. The translation of academic media into mass media is presented, followed by two longitudinal Zika-related topics that have continually appeared in the mainstream media. In Section 4, a literature review illustrates the additional information that social media can provide when assessing how public opinion is shaped by the media. This section also discusses key differences between social and mass media that are important for policy makers to understand. Finally, a summary and policy recommendations are provided in Section 5.

Figure 1: *Microcephaly, an underdeveloped brain and therefore small head, is the most common consequence of the Zika virus that has been talked about during the 2015-2016 Zika epidemic. Powerful images, like this two-week-old baby with microcephaly (Grande, Brazil) have become the face of Zika. Source: Felipe Dana/Washington Post (Sun, 2016)*

2 About the Zika virus

Scientific investigation of Zika

Zika was first identified in 1947 in the Zika Forest of Uganda, and isolated cases have occurred sporadically in Africa and South East Asia since the 1960s (Dick et al., 1952; Campos et al., 2015). For a long time, Zika was little more than a scientific curiosity, as the infection itself is self-limiting, mild and requires little more than supportive care. Interest spiked in 2007, when there was an outbreak of Zika in the Yap Islands of the Federated States of Micronesia, and then again later between 2013-2014 in French Polynesia. During these outbreaks, the knowledge of the disease was refined and its characteristics better defined. It was suspected that Zika could be sexually transmitted and blood/serum diagnostic tests were established early on (Musso et al., 2015). Before the current outbreak, there was already a growing concern that Zika might cause more than just mild fever and rash, and associations had beguan to be drawn between Zika and rare neurological diseases, such as microcephaly (an abnormally small head arising from incomplete brain development, see Figure 1) and Guillain-Barre Syndrome (GBS).

The current Zika outbreak, of a much larger scale than previous outbreaks, has consolidated these findings and confirmed the neurological associations (Mlakar et al., 2016). Newborn babies, who become infected via mother-to-child transmission, are most susceptible to these neurological indications. As the virus can lie dormant for prolonged periods of

time, it is thought transmission can occur in women that become pregnant within 2 years of being exposed to the virus. Currently there is no treatment available for Zika and the WHO recommendations point solely to prevention through the use of mosquito nets and the full range of contraceptive methods (to avoid both sexual transmission and conception), or avoidance of Zika-infected areas if possible (WHO, 2016b).

Ecology of the Zika virus

Zika is an arbovirus, a primarily RNA based virus transmitted by mosquito vectors, spread in particular by the species *Aedes aegypti*. Other arbovirus diseases transmitted by mosquitos in the same manner to Zika include West Nile Fever, Chikungunya and Dengue fever (Fauci and Morens, 2016). For most of its existence, the enzootic cycle of Zika was maintained between wild primates and mosquitos with only occasional infection of humans (Gyawali et al., 2016). It has been hypothesised that the massive spillover into human infections has been caused by an adaptation of the virus or *A. aegypti* mosquito to exploit human habitats to increase breeding success. Since the explosive spread of the virus from the African continent to the Pacific Islands and South America, it has been observed that inner city crowding and poor sanitation in large urban areas has provided an ideal breeding ground for *A. aegypti* and thus facilitates the epidemic of the Zika virus (Fauci and Morens, 2016). Transcontinental spread of the virus is attributed to the mass migration of people throughout the modern world. Specifically, spread to Brazil from Pacific Islands has been attributed to one or more infected persons being associated with a mass gathering like a carnival or a sporting event (Gyawali et al., 2016). As the virus can remain in the bloodstream of an infected individual for up to 1 month, the transcontinental migration of a mosquito vector is not required to spread the virus, rather just the infection of a mosquito by a human carrier of the virus. Thus, the ever increasing movement of people globally and the lack of ubiquitous sanitation within large urban areas as well as an already well-established population of *A. aegypti* within continental South America has provided an answer to how the current epidemic of Zika originated (Gyawali et al., 2016).

It is in this close symbiotic relationship between the *A. aegypti* mosquito and large urban populations that novel solutions to the epidemic can be found, particularly as traditional solutions have not proven very effective in other similar epidemics. Previous public health measures set out to combat the spread of West Nile virus, Dengue fever and Chikungunya has not been adequate to control breeding of the *A. aegypti* mosquito, and spraying of pesticides from truck mounted spray machines has also do little to combat the presence of the mosquito given their breeding sites being in close proximity to houses (Goddard, 2016). Simply increasing insecticide use is also dangerous since resistance has and will become more commonplace in mosquito populations (Yakob and Walker, 2016). A more coordinated effort by homeowners and the local council in removing mosquito breeding sites, like

standing water, is more likely to result in a significant decrease in the mosquito population in areas with a large human presence. Furthermore, significant improvements to the quality of urban housing in South American cities could both help reduce the spread of Zika and therefore prevent new epidemics in the future, as well as inevitably increase the quality of life for residents. Specific recommendations for preventative measures include house screens, air conditioning and removal of house and yard debris which currently are luxuries largely unavailable to impoverished residents of the crowded urban areas where mosquito breeding and infection is most rife (Fauci and Morens, 2016). The current Zika virus epidemic is highlighting social inequalities which persist within affected South American countries and thus the disproportionate impact of the epidemic on those living within the lowest socioeconomic strata of urban populations. Currently, several academics have picked up on how preventative measures can be formed into public health policies with Reiter (2016) commenting that treatment campaign for cleaning up the human peri-domestic environment exploited by *A. aegypti* combined with an effective vaccine campaign can help end the epidemic; while Yakob and Walker (2016) note the impracticality of city-wide breeding site removal and rather proposes preventative measures through genetic control of mosquitos.

3 Zika reporting in mainstream media

The mass media provides an important role in communicating information to the public. This section investigates what information the mass media has reported about the Zika virus, and common themes in how this information is presented that appears to make news reporting an effective dissemination of important information. This section is presented in two parts: firstly four examples are presented of how mass media have reported medical research about the Zika virus. Secondly two controversial stories related to the Zika virus are followed in the media over several months. Common themes from the media's reporting of the Zika epidemic are then discussed.

3.1 Methodological note

Online U.S. newspaper articles have been examined as an example of mass media. Recent research has suggested that Americans turn to newspapers, whether in print or online, more than any other news source (Media Insight Project, 2014). For health and medicine related news, Americans mainly go to newspapers or a TV station. Online news is still relevant despite the rise in social media, as research suggests that social media appears to be largely adding to, rather than replacing, other ways that people get news. More than 80% of Americans say they that in addition to social media, they also get their news by going directly to a news organisation (online, print or TV), a trend that is consistent across generations (Media Insight Project, 2014).

Zika-related newspaper articles were identified through daily news briefings such as Global Health NOW[1] (produced by the John Hopkins Bloomberg School of Public Health) and the Kaiser Family Foundation[2]. News articles were also identified through key word searches ("zika", "zika and olympics", and "microcephaly") of three popular U.S. newspapers: the New York Times, The Wall Street Journal, and The Washington Post. Links in online news articles were followed to identify even more relevant articles and scientific publications.

To determine whether newspaper coverage of the Zika virus in the U.S. had been consistent, the number of hits returned from the newspaper key word searches were tracked each week (Monday to Sunday). Figure 2 shows the timeline of the number of hits returned for the key word "zika" since the WHO declared the Zika virus an international emergency on 1 February 2016. This shows that Zika has remained in the U.S. news with an small increase in reporting around the time of the Olympic and Paralympic Games in August.

[1] `http://www.globalhealthnow.org/`
[2] `http://kff.org/`

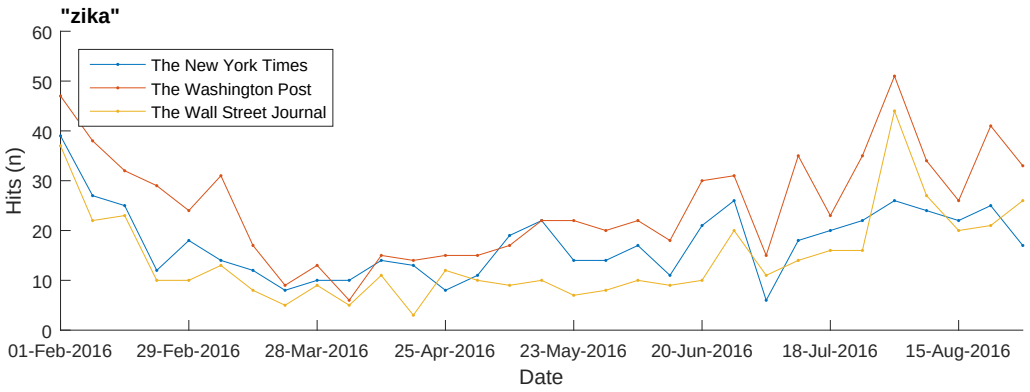

Figure 2: *Number of hits for keyword "zika" for three major U.S. newspapers from the start of the Zika epidemic.*

3.2 Medical effects of Zika

As previously mentioned, during the current Zika epidemic scientists have been working hard to understand the Zika virus and how it affects humans, particularly the developing foetus. Here, four examples are presented of research about the Zika virus (academic media) that has been reported by mass media.

Zika and microcephaly

The link between Zika and microcephaly (abnormal smallness of the head, see Figure 1) was confirmed on 13 April 2016 by scientists at the CDC. The official review paper was published in the New England Journal of Medicine, an esteemed medical journal (Rasmussen et al., 2016). Several newspapers disseminated this information, including the New York Times and The Washington Post.

The review conducted by the CDC describes the criteria for assessing causation between an infection and virus ("Shepard's criteria") and systematically explains which points have been met, citing individual studies where appropriate. Two high-quality epidemiologic studies were of particular importance in supporting the Zika-microcephaly association. These were independent studies from French Polynesia (Lancet, 2016), and Rio de Janeiro (New England Journal of Medicine, 2016). The paper concluded that after a review of the available evidence, sufficient evidence had accumulated to infer a causal relationship between prenatal Zika virus infection and microcephaly and other severe brain anomalies. The public implications of this conclusion were also stated, namely that the risk of microcephaly from the Zika virus could now be directly communicated both in clinical care settings and in public health guidance; and prevention efforts could now be focused.

Both the New York Times (McNeil Jr., 2016) and The Washington Post (Sun, 2016) articles clearly explained the main points of the original journal article. The former summarised the main reasons for confirmation of the link between microcephaly and the Zika

virus into six points, which is easy to read and links to individual studies that were reported by the review and so guides the reader to links for further information. The Washington Post article included a video and schematic that contrasted the foetal development process by showing a foetus developing normally and a foetus developing with microcephaly. It also provided links to the original review paper and correctly emphasised that the review focused only on evidence linking Zika and foetal anomalies and thus cannot be extrapolated to other neurological problems in adults. Readers were also guided to the current expert advice about the Zika virus. Microcephaly is the medical outcome that causes the most reason for concern with the Zika virus, and continues to be discussed in the media.

Zika and eye damage

Eye damage has previously been associated with microcephaly. In February 2016, an original research article in JAMA Ophthalmology examined whether eye damage was also prevalent in those affected with the Zika virus (de Paula Freitas et al., 2016). Image data collected from 29 infants with microcephaly were examined (for example, see Figure 3. Most of the mothers had signs and symptoms of the Zika infection during pregnancy. Vision-threatening abnormalities were present in the eyes of 35% of the infants (see Figure 3). The authors conclude a likely association between microcephaly from exposure to the Zika virus and eye abnormalities.

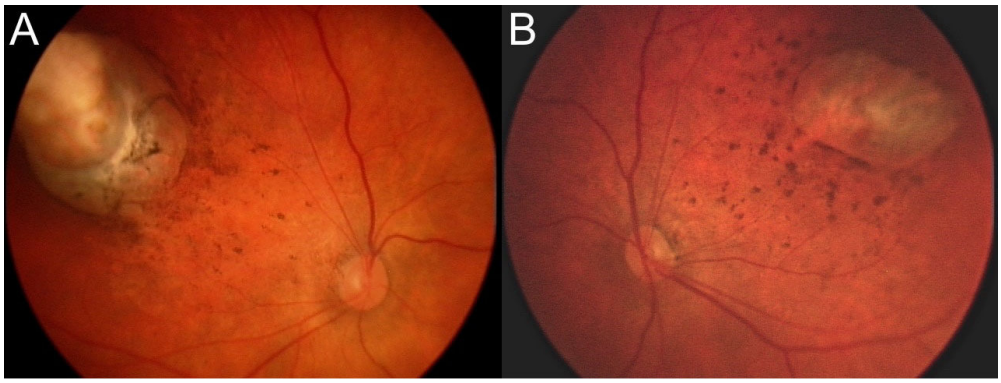

Figure 3: *The most common ocular abnormalities in infants infected with the Zika virus were black speckled lesions in the back of the eye and retinal damage. Credit: American Medical Association (Louis, 2016)*

Alongside the research article, JAMA Ophthalmology published an invited commentary on the Zika Virus infection and the eye (Jampol and Goldstein, 2016), which summarises the main findings of the aforementioned study and puts it in context. This is more readable than the original research article. Other comments in response to the article have also since been published.

A New York Times article reported on the findings of this paper (Louis, 2016). It linked to the original JAMA ophthalmology paper, and reported details about the study such as sample size, how many infants had eye damage and limitations of the study. The newspaper

article notably translated technical jargon into everyday language, for example the "macular and perimacular lesions" that were one of the most common eye abnormalities identified, was explained as "black speckled lesions". Furthermore, the newspaper quoted an expert to explain the impact of these eye lesions, "based on my experience, I would say a large number of these kids will be blind." Readers were also referred to the CDC recommendation that pregnant women get tested for the Zika virus and if positive, free ophthalmologic evaluation would be provided.

At the end of May 2016, two further studies were published that suggested more severe eye damage in babies with microcephaly than originally thought. Over 40% of the confirmed Zika cases had severe lesions in the eye. One of the articles was published in Ophthalmology, journal of the American Association of Opthamology (AAO). The AAO highlighted this research in a news release on their website (Dang, 2016). No further newspaper articles about Zika and eye damage have been identified.

Zika and joint deformities

A study published in the British Medical Journal (BMJ) in August suggested an association between joint deformities at birth and microcephaly in newborns presumed to have congenital Zika virus infection. The BMJ also published a press release, and Reuters published an article on the paper. We could not identify any articles relating to this research publication in mainstream newspapers.

The BMJ research article presents seven case studies of newborns with arthrogryposis, characterised by joint deformities at birth (*arthrogryposis* is derived from the Greek words *arthro*, meaning joint, and *gryposis*, meaning crooked) (van der Linden et al., 2016). The newborns all had diagnosis of congenital infection presumably caused by the Zika virus. Two previous studies had been published since the Zika virus outbreak that suggested such an association, but they did not describe the deformities in detail. Arthrogryposis is considered a sign rather than a specific disease, so it may be associated with several disorders. The researchers found in their case studies that the arthrogryposis did not result from abnormalities of the joints themselves, but was likely to be of neurogenic origin.

The BMJ press release explains the research study in non-technical terms (such as providing a definition for arthrogryposis), and summarises the main findings (bmj, 2016). Similar non-technical language is used by the Reuters article (Helland, 2016). It explains that joint deformities "could be a result of Zika's effect on the developing baby's motor neurons, cells that control the contraction or relaxation of muscles". The article does not make assumptions about the association, but emphasises this is only a possible link and the need for further research with a larger sample.

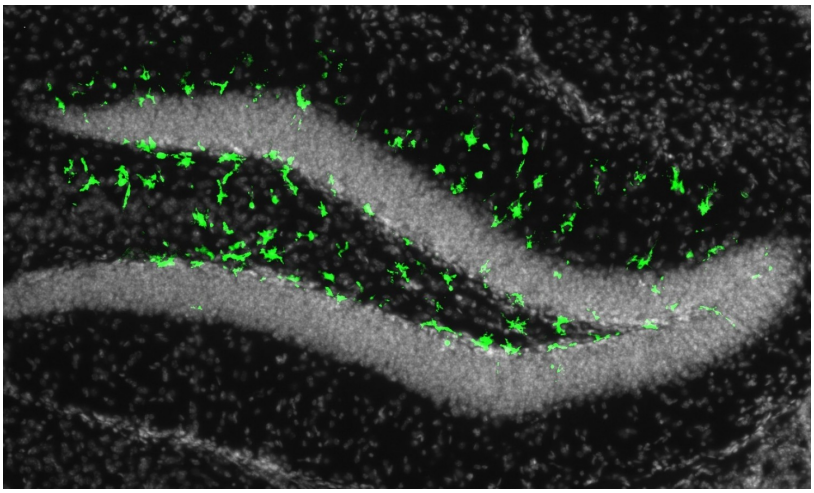

Figure 4: *Illumination of the fluorescent biomarker in green reveals that the adult mouse brain could be infected by Zika in a region called the subgranular zone of the hippocampus. This part of the brain is important in learning and memory. Source: Laboratory of Pediatric Brain Disease at Rockefeller University / Cell Stem Cell (Dennis, 2016)*

Zika and brain damage

Zika has previously been associated with Guillain-Barre syndrome (BGS) in adults, a sickness of the nervous system which causes muscle weakness and sometimes paralysis (CDC fact sheet, 2016). Current CDC research suggests a strong association between Zika and GBS, but only a small proportion infected with the Zika virus get GBS. In August 2016, new research suggested the mechanism by which Zika may affect adult brain cells.

The original research article was published in Cell Stem Cell (Li et al., 2016). They screened brain images from Zika-infected and mock-treated (placebo) mice and described which biomarkers and regions of the brain were most affected (see Figure 4). The article used technical terms to describe the research, referencing areas of the brain by the name of the biomarker. They concluded that the Zika virus was able to infect some neurons more than others. In particular, proliferative neural progenitor cells and immature neurons were most affected (cells that are still adapting to their final role, only found in some parts of the adult brain) whereas the terminal-differentiated cells were relatively unaffected. This mechanism may explain the emergent cases of Zika-linked GBS. This research was performed in mice, but is thought to be representative of the action of the virus in mammals.

The Washington Post covered this research in an article that uses non-technical words (Dennis, 2016). The article explains that most adult neurons are believed to be resistant to Zika and that is why the Zika virus in adults has not been as much of a concern so far. However, some neural progenitor cells (which are affected in the foetus) remain in adults, where they replenish the brain's neurons over a lifetime. It is these neurons which are vital for learning and memory, so these areas are at the most risk from a Zika infection. The new article also quotes the author of the research paper and discusses the limitations of the study.

Public polling

To further understand the impact of mass media reporting, it is necessary to understand what the public know about the Zika virus and current epidemic. Two polls about the Zika virus and epidemic were identified: a monthly poll by the Kaiser Family Foundation (KFF); and a March poll conducted by the Associated Press-NORC Centre for Public Affairs Research (APNORC). Each poll surveyed approximately 1000 people using a mixture of online and phone surveys. Social media data allows for a richer understanding of public opinion, as discussed in Section 4, however currently there is limited data for the Zika epidemic since it is so current.

In March, the spread of the Zika virus was the 6th most closely followed health story by Americans in the past 12 months (KFF). Most Americans (90%, KFF August) have heard or read at least a little about the Zika virus, yet only 60% (KFF August) have been closely following the news about the Zika virus outbreak. These numbers have remained consistent since February. A smaller proportion of the younger generation (less than 40 years of age) have been following the Zika outbreak compared to the older generation (APNORC). Those that are aware of Zika express low concerns of being infected with the virus themselves. Between 31% (APNORC) and 34% (KFF July) are moderately or very worried about the Zika virus affecting them or someone they know. Most Americans are aware that Zika can be spread by mosquitos (90% APNORC; 88% KFF August). A lesser proportion are aware the Zika virus can be spread through sexual intercourse (57% APNORC; 59% KFF August).

These polls assessed public knowledge of two of the four medical research examples presented. Firstly, the link between the Zika virus and microcephaly (and other birth defects) is well known (75% APNORC; 59% KFF June). Microcephaly has appeared repeatedly in the mass media, especially since the CDC and WHO recommendations for pregnant women are based on the available evidence of the link between Zika and microcephaly. In contrast, only a small percentage (13% KFF June) are aware that Zika is linked to adult brain damage. This is understandable since the risk of adult brain damage is small compared to that of microcephaly and fetal brain damage. Overall, the polls indicate that the majority of the public have an accurate understanding and awareness of the Zika virus.

3.3 Longitudinal stories about the Zika virus

Zika at the Olympics

In August and September 2016, the summer Olympics and Paralympics were held in Rio de Janeiro, Brazil. However, since the recent Zika virus outbreak also occured in Brazil, concerns about whether the Olympics should go ahead or not were continually discussed in the months leading up to the Games (see Figure 5). Concerns were particularly about

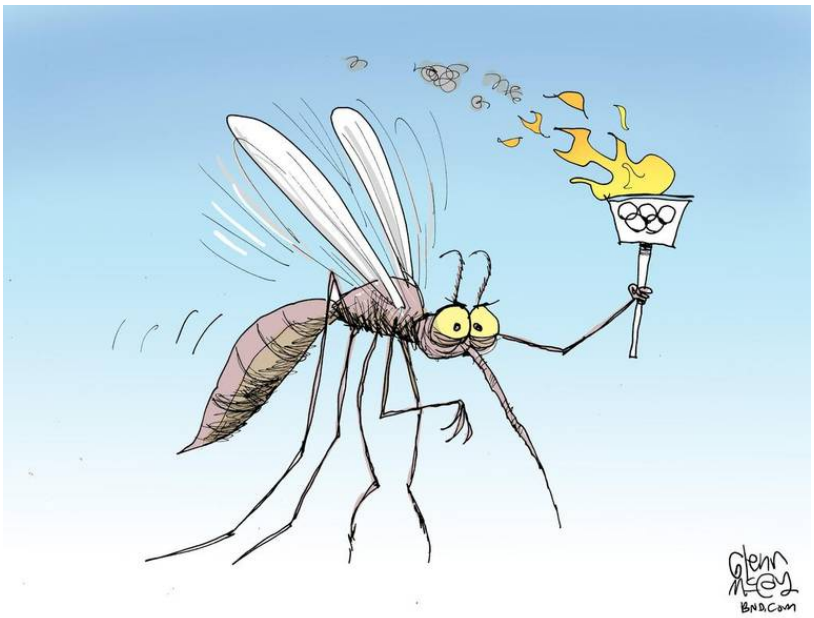

Figure 5: *One of the many cartoons circulated about the concerns of the Zika virus at the Olympic Games. Source: Belleville news-democrat. Cartoon by Glenn McCoy: "Zika Olympics".*

women who were pregnant, or couples who wanted to get pregnant in the next two years, due to risk of microcephaly associated with the Zika virus. The U.S. media has continually provided updates on WHO travel advice, expert opinions, and those Olympians who had decided not to attend the Olympics due to concerns about the Zika virus.

The WHO published a formal statement about the Zika virus and the Olympic and Paralympic Games on 12 May 2016 (WHO, 2016c). The statement reiterated the general advice for people traveling to areas where the Zika virus is circulating, such as how to protect against mosquito bites, and that pregnant women were recommended not to travel to Rio de Janerio. The statement recommended that pregnant women should not travel to Rio de Janeiro, but restricting travel for other people would not affect the existing spread of the Zika virus. A month later (28 May), the WHO reaffirmed their stance in a news release after 150 health experts, mostly bioethicists, called on the WHO to recommend moving the Games, or delaying them until the Zika virus was under control (WHO, 2016a). Yet again, on 14 June, the WHO emergency committee reaffirmed its previous advice that "there should be no general restrictions on travel and trade with countries, areas and/or territories with Zika virus transmission, including the cities in Brazil that will be hosting the Olympic and Paralympic Games." (WHO, 2016b).The WHO remained firm in their position that the summer Olympics was not a threat to the spread of the Zika virus, and travellers would not be at risk.

Early on in the Zika epidemic, U.S. newspapers started to question whether the Olympic and Paralympic Games should go ahead despite the Zika virus being prevalent in Brazil. Such newspaper articles usually reflected both sides of the argument. They explained what the WHO had decided and why, and also quoted from public health experts who doubted

the WHO's decision because they were concerned about the risk of Zika spreading even faster.

Articles written outside mainstream media were more opinionated, and most disagreed with the WHO's position. A New Scientist article set out to argue that the reasons for the WHO recommendation for the Olympics to still go ahead were weak and not epidemiologically meaningful (MacKenzie, 2016). Even if small, there was still a risk of the Zika virus being taken to new countries because of travel to the Olympics, so when is there too much to lose? The article ended with several suggestions as to what governments could do to "Zika-proof" the games. The title of a Harvard Public Health Review (student publication) article reads, "Off the Podium: why public health concerns for global spread of Zika virus means that Rio de Janeiro's 2016 Olympic Games must not proceed" (Attaran, 2016). The article gives five reasons why the Olympics should not go ahead, with the implication that if it weren't for the money and prestige associated with the Olympics, they would be cancelled or postponed. A CNN/ORC poll found that 47% of Americans thought it was very likely or somewhat likely that an outbreak of the Zika virus would occur among athletes at the Olympics (CNN/ORC International, 2016). Public opinion therefore reflected the split opinion of the experts and WHO with regards to the safety of the Olympic and Paralympic Games.

In July, the U.S. National Institutes of Health (NIH) announced funding of a Zika virus study of its Olympics team (National Institutes of Health: News Release, 2016). This came after the two WHO news releases stating that there was no need to cancel the Olympics, yet it was evident that the public were still concerned. The study would monitor up to 1000 athletes, coaches and other U.S. Olympic Committee staff to improve understanding of how the Zika virus persists in the body and to identify potential factors that influence the course of the infection. The USA Today online news represented this announcement as welcome news, thankful that someone was taking the Zika threat seriously and putting measures in place to monitor, if not reduce, the Olympic related impact of Zika (Berkrot, 2016; Axon, 2016).

Two weeks before the Olympic Games were due to start, a study was published in the Journal Annals of Internal Medicine which supported the limited risk of the Olympics further transmitting the Zika virus (Lewnard et al., 2016). The study predicted just 3-37 Olympic attendees would contract the Zika virus and bring it to their home countries. The calculation was largely based on data collected on the dengue virus during the World Cup. This article was welcome relief to the previous concerns about the Olympics, especially as the Games were inevitably going to go ahead by this stage. The focus of the media changed to the athletes and the excitement of the Games. The prediction of the aforementioned study turned out to be correct, as there were no confirmed cases of the Zika virus linked to the Olympic or Paralympic Games.

Funding to fight Zika in the U.S.

The lack of funding available to respond to the Zika virus epidemic has been a controversial topic in the U.S.. Some consider the Zika virus a serious threat that requires urgent funding; while others say the Zika virus is not life threatening (unlike the Ebola virus), and therefore does not require emergency funding. The ongoing debate has been closely reported by the U.S. media.

On 8 Feb 2016, one week after the CDC declared the Zika virus as a national emergency; President Obama announced a request for $1.9 billion in emergency funds to fight Zika. The White House provided a breakdown of the fund allocation, and explained that the primary focus was to accelerate research into a vaccine for Zika and educate populations at risk for disease (The White House, 2016). In order to release this funding, Congress (made up of the Senate and the House) needed to agree on the funding proposal. Several months went by with no movement from Congress. The Senate and the House then each proposed an alternative funding strategy ($1.1 billion and $622 million respectively), both falling short of the originally requested $1.9 billion. On 28 June, four months after initially requested, Congress rejected the request for Zika funding because they couldn't come to a consensus. Thus the summer break began with no emergency funding for the Zika response. After the summer a consensus on the funding issue was reached, avoiding a government shutdown, and the President signed the final funding of $1.1 billion on 29 September 2016, 233 days after originally requested. A policy brief about the Zika response funding story was put together by the KFF (Wexler et al., 2016).

At each stage of the funding story, the media accurately reported the details and summarised the story so far. The content of each proposed bill was presented, and the opinions of experts and officials were communicated. This topic has been one with strong opinions, and most newspapers communicate that the Zika response should have been funded, usually by their choice of expert to quote. For example, after the Senate proposed a $1.1 billion in emergency financing, a big shortfall from the originally requested amount, the New York Times reported Josh Earnest, the White House press secretary, who said "it is woefully insufficient given the significant risk that is posed by Zika" (Herszenhorn, 2016). Furthermore, the length of time Congress was taking to make a decision was frequently mentioned in news articles. Even the Congress blog titled an article, "Clock is ticking on Zika funding" (Caldwell, 2016). A reported interview with the CDC director emphasised his opinion (thought to be representative of scientists in the U.S.) of how "We really need to make sure that congress acts quickly... Congress did the right thing with Ebola [provided timely emergency funding], and I'm hopeful they'll do the right thing in Zika. The sooner they do it, the better it's going to be" (Foody, 2016). Later, when Congress rejected the funding for Zika funding in June, the story was in every major newspaper (Zezima, 2016;

Berman, 2016). Negative opinions from officials were again communicated, such as Senate Minority Leader Harry M. Reid who exclaimed, "I don't remember anything as outrageous, as shameful as this piece of legislation." Opinion pieces communicated concern about the lack of funding, with articles titled: "We're screwed on outbreaks like Zika as long as we have to rely on congress for money" (Belluz, 2016); "CDC and NIH officials: how not to fight the Zika virus" (Frieden and Fauci, 2016); and "Zika is here, and America has no plan to fight it" (Shanker, 2016).

There were also strong opinions about moving money from other sources. While waiting on Congress, the White House moved $589 million from the Ebola fund to the Zika response (April), and $81 million from biomedical research and antipoverty and healthcare programs to pay for the development of a Zika vaccine (August) (Davis, 2016). The Huffington Post quoted Thomas Keyon, President and CEO of Project HOPE who said "[taking funds from Ebola] is a gamble the White House should not have to make. Ebola is not over yet." (Kenyon, 2016). The World Bank estimated the economic damage from Ebola in West Africa at $2.2 billion, which would take years to recover such that diverting resources away from Ebola made little sense.

In May, an article about the "economics of the Zika virus" was published in PLOS (a peer-reviewed open-access medical journal), funded by the NIH (Alfaro-Murillo et al., 2016). This article put numbers and dollars to the impact of the Zika virus in the U.S. and South America, and suggested that the initial funding proposal by the White House in February was likely to be cost-effective. The direct medical costs for caring for cases of microcephaly and GBS as a result of Zika warranted substantial expenditure focused on Zika virus control. This research was overlooked by U.S. newspapers, even though it supported the urgency for funding that had already been presented by the media.

Public polling in August 2016 indicated that 76% (KFF) of the public considered passing new funding for the Zika outbreak in the U.S. an important or top priority for Congress. This largely correlates with the arguments and opinions that have been communicated by the media. It is likely that the media's arguments and choice of quotations influenced the opinions of the public, as has been suggested by previous research. This illustrates the powerful role of the media in directing public interest.

3.4 Discussion

This section has examined four examples of scientific research about the Zika virus, and followed two controversial stories related to the Zika epidemic. These news examples suggest three mechanisms that may enable mass media to be an effective means of informing the public about epidemics.

Firstly, the key details are accurately reproduced by newspapers. When reporting origi-

nal research, media articles include details such as the sample size, context, and setting of the study. Limitations of the study are also often discussed to provide a balanced perspective. In the U.S. funding debate, the key details of the requested funding proposals were accurately reproduced.

Secondly, the information is made accessible to the reader. Most notably, media articles use non-technical language to describe research, compared to specialist jargon that appears in a medical journal article. Information is often presented in many forms, such as in schematics, videos, or a panel of summary points. Information is also made accessible by putting the research into perspective. News articles usually quote experts in the field to communicate the relevance of a discovery, for example the eye damage caused by Zika was put in perspective when an expert said "based on my experience, a large number of these kids will be blind"; or to indicate the opinion of experts, such as in the U.S. funding debate and whether the Olympics should proceed. Research is also put into perspective by comparing it to another well-known disease or situation. The Zika epidemic has been compared with the recent Ebola outbreak, the historical Thalidomide scare which also caused defects in babies, and the virus itself has been com Dengue fever which is similar in transmission and symptoms.

Thirdly, news articles provide extra information that the reader may want to know. Background information is usually presented, such as when the link between microcephaly and Zika was established or why the question of whether the Olympics should go ahead is controversial. Online news articles link to original research articles where relevant, link other Zika-related articles, and current advice by the CDC and WHO. Links appear either in the text or in a side/bottom panel.

The longitudinal stories presented in this section further illustrate the power of the media in directing the public's interest and opinion. The WHO's assertive stance on the risk of Olympic Games contributing to the spread of the Zika virus, is an example of how when there is a clear structure of power from which decisions are made, the media acts more as a release for frustration and discontent rather than a forum to explore potential alternatives (Happer and Philo, 2013). When the WHO continually reaffirmed their position, the media did not discuss whether the Olympic Games could be postponed, held elsewhere, or skipped altogether. The media primarily expressed anger and conern over the decision and the only solution presented was how to 'zika-proof' the Games, acknowledging that the Olympics were going to go ahead. The media can therefore be key in the setting of agendas and focusing public interest on particular topics, which operates to limit the range of arguments and perspectives that inform public debate.

The Zika-funding story illustrates how the media can choose an argument and assumption and use that to underpin a news story. The media assumed that the Zika response needed funding, and argued that the government could and should provide the necessary money.

The tone of news articles, the information quoted, and the selection of images all worked to support this argument. Previous research has shown that reporting in this manner is likely to influence public opinion, as was observed in this funding story described here. 76% of those polled agreed the government should provide money to fund the Zika response. The media thus has an opportunity to direct the public's interest which is particularly key for topics where readers do not posses direct knowledge or experience of what is happening (Happer and Philo, 2013).

To further understand the influence of the mass media's representation of Zika on public opinion, more information about the public's response and opinion is necessary. One such means by which this may be available is from social media data. The differences between mass media and social media and some advantages of the latter, will be discussed in the next section.

4 The contribution of social media

Mass media and social media have differences in reach and pervasion of everyday life. When assessing the media effect on public opinion and public consciousness, it is therefore important to treat these forms of media as separate entities. This section reviews the literature to highlight the difference between mass media and social media in the context of the current Zika epidemic in terms of: how media informs the public of developments in the spread and treatment of the epidemic; and the media's ability to influence public opinion in both a positive or negative way.

Historically, mass media has never been used to gain insight into the public opinion of current affairs, since there it is difficult to determine the relationship between the opinions of the mass media outlets and the public they serve. However, since social media is a many-to-many form of communication, it allows a unique insight into public opinion. Furthermore, the near ubiquitous use of social media throughout most adults around the world allows researchers in all fields to be able to analyse the levels of interest and knowledge the public may have regarding areas of current interest or concern, such as the current Zika epidemic (Wilder-Smith et al., 2016; Glowacki et al., 2016; Dredze et al., 2016).Thus, through analysis on the volume of social media posts (tweets, Facebook posts etc.) it is now possible to gauge how public opinion reacts according to mass media coverage of the epidemic and how much the epidemic captivates public opinion.

To date, most research projects into public opinion regarding the current Zika epidemic have been limited to English speaking social media posts, mostly based in the U.S.. While this does not allow as deep an insight into the public opinion of Latin American populations who are at a greater risk from the epidemic, it does hold interest for public health organisations such as the Centre for Disease Control and Prevention (CDC), a federal agency of the U.S. who protects public health and safety (Glowacki et al., 2016). A study conducted by Southwell et al. (2016) focused on the impact news coverage of the Zika virus by media outlets had on the online behaviour of observers. It was found that news stories, especially those with public health authority announcements, caused a response in online search behaviour and social media interaction after they were shown. This correlation was found in all three countries studied - the U.S., Guatemala and Brazil - where there was found a strong positive correlation between news and related tweets as well as news and Google searches about the epidemic. After the initial peaks of interest, the number of searches and social media response would reduce to pre-news levels regarding the epidemic. Thus, with public engagement the highest during news stories covered by mass media, this 'window of engagement' can be exploited by public health authorities for sharing preventative measures and current developments in cures for the disease. In addition to this, any identified anxieties there may be present in public awareness can also be addressed in these high peaks

of activity by the appropriate public health authorities. Thus, authorities may be able to prevent heightened fear and potential hysteria within a population in a cost effective and efficient manner. The peaks of interest caused by media coverage can be increased by assuring the credibility of news through input by public health authorities in the initial news story. Therefore, with an increase in levels of public engagement observed, efforts to increase communication between public health authorities, such as WHO and CDC, and the general public must take advantage of the role media coverage plays in drawing attention to epidemics such as Zika.

While mass media is able to produce "windows of engagement" within the public, social media both complements the peaks of public interest created by mass media and is also able to maintain a level of engagement and awareness amongst its users away from news coverage. Thus, it does not depend on "newsworthy" coverage of significant events or breakthroughs to be able to deliver timely information and updates from public health authorities to users. Furthermore, as already discussed, the ability for members of the public to express their opinions online in a manner which preserves these opinions allows public health authorities - amongst others interested in public opinion - to be able to quantify the abstract notion of a public opinion. Through analysis of buzzwords in tweets, Facebook posts and Google searches, researchers are able to record the volume of interest there is in a particular topic within a specific timeframe. In addition to this, the content of such social media posts can give insight into the current knowledge held by members of the public regarding the epidemic (Southwell et al., 2016). As public health can be quite an insular sector in many countries and institutes, there is a great possibility for disconnect between public health official's perception of the knowledge held by the general public and the actual knowledge of many people on the epidemic. Using the 'archive of opinions' that social media sites possess, this can allow quick, relatively effortless studies to be conducted on levels of public knowledge. Using information gained through these studies of social media, public health authorities can tailor their public outreach to include all necessary information rather than assume the baseline of knowledge and awareness within a population. This has the ability to increase the success of any public health initiative as understanding of actions, their background and consequences can increase public engagement and reduce opposition.

A further difference between social media and mass media is that the former provides a medium through which individual questions and concerns can be addressed directly by public health authorities. A study conducted by Glowacki et al. (2016) looked at the efficacy of a live twitter question and answer session conducted by the CDC. Based on the premise that social media platforms can cultivate fear and hasten the spread of misinformation, an individualistic approach by public health authorities can help assure individual fears and educate in the hope that knowledge may spread or fear may dissipate. The speed and public nature of replies by public health authorities can also help in the format of a quick question

and answer session. In the aforementioned study, a live chat hosted by the CDC on 12 February 2016 was observed and the content of both questions and answers analysed. It was found that interaction between social media users and public health authorities on a platform like twitter provided a unique forum for the fast distribution of information and answers, with individual responses provided to individual concerns. Compared to other information sharing channels such as advertising or leafleting, short informative responses in the form of tweets can produce a cost-effective and permeating solution to raising public awareness regarding the Zika epidemic. A further benefit to actively asking about the fears of social media users is again being able to gauge areas of concern from topics social media users ask about. In the study conducted by Glowacki et al. (2016), areas of most concern amongst American social media respondents were "how the virus can be spread" and "how to prevent spread". Areas of least concern were identified as how to prevent mosquito breeding sites. Thus, the information being passed on could be tailored to individual concerns as well as providing a larger picture to the queries and worries of the public. In addition to these benefits, the conversational nature of the Q&A session allowed health organisations to spread information without worrying about inciting fear as less personal media broadcasts may. Outwith highlighting primary areas of concern, secondary areas of education may be highlighted such as the discovery that the interactive social media users were less concerned about removing mosquito breeding sites. This may be due to this knowledge already being present and widespread around the U.S., where mosquitos are found, but it may also be indicative of the public being unaware of the correlation between increasing mosquito populations and urban landscapes. While this lack of attention may be attributed to either or both of these reasons, this has highlighted a potential area of research for health organisation to look into and assess the public awareness of preventing mosquito breeding and control of arbovirus spread. To use information gained in this way through social media again will help public health organisations to produce public information that does not assume the level of knowledge and awareness of their target population and therefore allows the public to use it as a supplement to pre-existing knowledge. This can increase the use such information can be put to in public spheres – a response which can vastly help public health initiatives.

4.1 Case study: Social media and spread of misinformation regarding vaccines

Social media platforms can be used both for the spread of information and the spread of misinformation. The former will of course be the responsibility of public health authorities and health departments whereas the latter can be conducted by an informal society of social media users who have similar opinions. The risks of intended spread of misinformation

regarding Zika on social media, whether done maliciously or in a misguided effort to help, has already been identified in studies, especially to do with the development of a Zika vaccine. This has the potential to make an already difficult vaccine campaign even harder for public health authorities to achieve, thus creating further hurdles in a campaign to dissipate the epidemic in Latin America and any possible epidemic in the U.S.

A study conducted by Dredze et al. (2016) is an early indicator of the fear held by some academics in the power of social media and the spread of misinformation. The authors highlight that the uncertainty within all public circles regarding the origin, transmission and health consequences of Zika is a prime breeding ground for conspiracy theorists and pseudo-scientific claims especially within the well-established anti-vaccination community. As has already been discussed, while mass media caused sporadic peaks in public interest regarding Zika, social media provides a platform in which interest and Zika related content can be published all year round. While the aforementioned peaks of public interest can be found on social media related to mass media news, between these windows of interest there is the opportunity to still present opinions on social media. With no contest from official news stories and developments, opinions presented during these lulls will not be mixed with informed news and opinions regarding the virus. It is in this context that Dredze, Broniatowski and Hilyard note that the emergence of pseudoscientific claims regarding a Zika virus by prominent vaccine refusal communities can become influential in shaping people's opinions. In addition to the constant anti-vaccine rhetoric that may be present on social media, the lack of updates or successes in the development of the vaccine can cause scepticism from the public and thus increase negative opinions surrounding the vaccination campaign.

With this report mostly concerning a potential Zika epidemic being present in the U.S., concern over anti-vaccine rhetoric will be greater in U.S. public health authorities than in other countries. A prominent and, at times endangering, anti-vaccination campaign has been present in the U.S. since the early 1980s and persists through to today. As a result of vaccine scepticism 39.8% of U.S. parents have refused or delayed routine vaccinations for their children (Ołpiński, 2012). Anti-vaccination, as a widespread phenomenon, is attributed to a shift in which people forget the threat of the disease a vaccine is preventing against and focus turns to real and imaginary side effects of the vaccines (Ołpiński, 2012). Distance from the reality of the disease therefore causes attention to shift towards the effect of the vaccine on the individual. While this tends to occur in the natural history of most vaccination projects – vaccines become the victims of their own success – the far removed threat of Zika in the U.S. has the threat of causing attention to turn to the potential side-effects of the vaccine on the recipient. The physical distance of the American population from the epicentre of the Zika epidemic may therefore reduce the efficacy of any vaccination programmes in the U.S.. This underlying scepticism in the public opinion will provide a further barrier

to an already challenging vaccination campaign. This is due to the current difficulties faced in vaccination efforts against Chikungunya and West Nile virus, two arboviruses very similar in pathophysiology and epidemiology. The sporadic and unpredictable nature of these epidemics means that pre-emptive vaccination of large populations in anticipation of an epidemic may not be cost effective (Fauci and Morens, 2016). An alternative approach would be rapid deployment of vaccines during an epidemic but the explosive and unpredictable nature of arboviruses may cause this vaccination effort to be unsuccessful. Thus, intricate and long term vaccination plans against the Zika virus would require the full cooperation of the target population in order to ensure a certain level of success. The threat, therefore, of the spread of misinformation across social networks must be taken seriously by public health authorities when considering public opinion and areas of co-operation between the authorities and general public.

5 Summary and Policy recommendations

The 2015-2016 Zika virus epidemic has demanded what may be the most difficult public health response. Concern over the Zika virus has been polarised: some say the public doesn't need to be concerned because the Zika virus doesn't bring death like Ebola; yet others insist the public should be concerned because Zika causes birth defects such as microcephaly, and lifelong therapy and support for this generation will bring a large financial cost. Zika has raised questions about abortion and rights to contraception. Zika has been compared with Dengue, Ebola, Polio and Thalidomide. Vaccine makers have been challenged to include pregnant women, and the consequences of vaccine myths have been exposed. At the heart of the Zika epidemic, the largest sporting event in the world - the Olympic and Paralympic Games - went ahead amid concerns about its impact on the spread of the Zika virus.

Amongst the complicated and confused responses to the Zika epidemic, the media has had an important role in communicating information to the public and guiding public opinion and interest. This report has explored the relationship between academic media and mass media, aspects of mass media reporting which allow communication to be effective, and the differences between mass media and social media including the advantages of social media when gaining insights into public opinion.

The mass media was found to be effective at communicating and spreading information. Academic literature is accurately reproduced and non-technical language used to make information accessible to the reader. Online media also allows readers to be easily directed to further information or related topics. The mass media sometimes chooses an argument and assumption and uses that to underpin a news story, particularly when the topic is controversial or political. This strategy has been observed to influence public opinion, as was illustrated with the story on U.S. funding for the Zika response. Mass media also can dictate the range of arguments that inform public debate and focus public interest on these particular topics.

In contrast, social media provides a forum for users to express their own opinions. There is therefore a wealth of information that can be learned about public opinion that is not available from mass media alone. One study indicated that social media activity on a particular topic was highest immediately after than had been broadcast, providing windows of opportunity.

The key recommendations for how the media can best be used by public health officials during the outbreak of an infectious disease, are listed below:

- Gauge levels of public knowledge by using social media, and therefore produce information appropriate for the level of knowledge and awareness in the target population.
- Maintain a constant social media presence. Individual questions and fears can be

quickly and succinctly addressed using social media, such as by providing individually tailored answers or links to further information. The best time to engage the target audience is immediately after an official news broadcast. A constant presence would also dispel the spread of misinformation during news "lulls", such as would be advantageous in the example of vaccine development.

- Take advantage of the pervasive nature of social media to mobilise community action. For example, in the 2015-2016 Zika epidemic, the cumulative effort of individuals inspecting their own residencies for mosquito breeding sites were likely to bring a more effective and permanent decline in vector breeding compared to city-lead cleaning of neighbourhoods.

- Direct the arguments and opinions communicated by mass media by providing them with the necessary information.

- Trust that academic literature will be communicated accurately and effectively by mass media.

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