Inaccuracies in Google's Health-Based Knowledge Panels Perpetuate Widespread Misconceptions Involving Infectious Disease Transmission

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Abstract. Google health-based Knowledge Panels were designed to provide users with high-quality basic medical information on a specific condition. However, any errors contained within Knowledge Panels could result in the widespread distribution of inaccurate health information. We explored the potential for inaccuracies to exist within Google's health-based Knowledge Panels by focusing on a single well-studied pathogen, Ebola virus (EBOV). We then evaluated the accuracy of those transmission modes listed within the Google Ebola Knowledge Panel and investigated the pervasiveness of any misconceptions associated with inaccurate transmission modes among persons living in Africa. We found that the Google Ebola Knowledge Panel inaccurately listed insect bites or stings as modes of EBOV transmission. Our scoping review found 27 articles and reports that revealed that 9 of 11 countries where misconceptions regarding insect transmission of EBOV have been reported are locations of current (i.e., Democratic Republic of Congo and Guinea) or previous EBOV outbreaks. We found reports that up to 26.6% (155/582) of study respondents in Democratic Republic of Congo believed mosquito bite avoidance would prevent EBOV; in other locations of previous large-scale EBOV outbreaks (e.g., Guinea), up to 61.0% (304/498) of respondents believed insects were involved in EBOV transmission. Our findings highlight the potential for errors to exist within the health information contained in Google's health-based Knowledge Panels. Such errors could perpetuate misconceptions or misinformation, leading to mistrust of health workers and aid agencies and in turn undermining public health education or outbreak response efforts.

INTRODUCTION

Due to the widespread use of Google for health-related searches, Google unveiled their health information-based "Knowledge Graphs" in 2015.¹ Although general topic Knowledge Graphs, also known as Knowledge Panels, have existed for years,² health-based Knowledge Panels were designed to provide users with basic medical information on a specific condition. These Knowledge Panels feature prominently on search engine results pages and appear as the first entry when using mobile devices for Web searches, substantially increasing the likelihood that users will use them for information when scanning their search results.³

To generate a health-based Knowledge Panel, Google selects and analyzes information from websites determined to be of high quality; then, teams of doctors review and edit the information for accuracy.⁴ Following a Google search for a specific medical condition, the resulting Knowledge Panel (when available) is conspicuously displayed at the top of the search results. This Knowledge Panel provides a summary or overview of the medical condition and may include transmission modes, symptoms, treatments, and whether the condition requires diagnosis and treatment by a medical professional (Figure 1).

In 2018, a study focusing on Ebola virus (EBOV) knowledge, attitudes, and practices in the Democratic Republic of Congo (DR Congo) reported that 26.6% of respondents believed the virus could be transmitted via mosquito bite (Michael Hawkes, personal communication).⁵ That report, and the substantial increase in the peer-reviewed and grey literature covering

EBOV transmission in the years following the 2013–2016 West African Ebola virus disease (EVD) outbreak, indicated the potential for inaccuracies relating to EBOV transmission modes to exist on the Internet. Such inaccuracies, combined with poor eLiteracy skills, could lead to an overestimation of risk; create fear, mistrust, and rumors; perpetuate misinformation; and ultimately require labor-intensive public health education efforts to dispel misconceptions.

Herein, we evaluated the accuracy of information pertaining to the EBOV transmission modes listed in the associated Google Knowledge Panel. We then carried out a scoping review of the knowledge and attitudes of persons living in Africa regarding those inaccurate transmission modes we found were listed in the Google Ebola Knowledge Panel.

METHODS

Assessment of accuracy. We carried out a search in Google on March 8, 2021 using the terms: "Ebola," "Ebola virus," "Ebola hemorrhagic fever," and "Ebola virus disease." All search terms resulted in the same Knowledge Panel (Figure 1). Transmission modes listed in the Google Ebola Knowledge Panel were then cross-checked against those transmission modes listed on the WHO⁶ and the CDC⁷ EBOV webpages for accuracy (Supplemental Figure 1).

Scoping review search strategies and selection criteria. After we determined inaccuracies existed within the Google Ebola Knowledge Panel relating to EBOV transmission by insects or stings (Supplemental Figure 2), we carried out a scoping review to determine the knowledge and attitudes of persons living in Africa as related to these transmission modes.

Literature searches were performed on March 8, 2021 using the platforms PubMed and Web of Science, in addition to the database African Index Medicus. Keywords were identified and searched by the authors to identify literature addressing EBOV knowledge and attitudes in African countries as related

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Ebola
Also called: ebola hemorrhagic fever

OVERVIEW SYMPTOMS TREATMENTS SPECIALISTS

A virus that causes severe bleeding, organ failure, and can lead to death.

Humans may spread the virus to other humans through contact with bodily fluids such as blood.
Initial symptoms include fever, headache, muscle pain, and chills. Later, a person may experience internal bleeding resulting in vomiting or coughing blood.
Treatment is supportive hospital care.

Extremely rare
Fewer than 1,000 US cases per year

- Treatable by a medical professional
- Spreads by animals or **insects**
- Requires a medical diagnosis
- Lab tests or imaging always required
- Critical: needs emergency care

HOW IT SPREADS

By blood products (unclean needles or unscreened blood).
By animal or **insect bites or stings**.
By touching a contaminated surface (blanket or doorknob).
By saliva (kissing or shared drinks).

For informational purposes only. Consult your local medical authority for advice.
Sources: [Mayo Clinic](#) and others. [Learn more](#)

Feedback

FIGURE 1. Google Knowledge Panel, sometimes referred to as a Knowledge Graph or Infobox, for searches using the terms: “Ebola,” “Ebola virus,” “Ebola hemorrhagic fever,” and “Ebola virus disease.” Searches were carried out on January 12, 2021. All three searches resulted in the same Knowledge Panel. This figure appears in color at www.ajtmh.org.

to the transmission of EBOV by either insects or stings. The following keywords were used in conjunction with Boolean operators to form search statements for PubMed and Web of Science: arthropod, attitude, bite, Culicidae, Ebola, flies, fly, housefly, insect, knowledge, mosquito, Muscidae, and sting. The African Index Medicus was searched more broadly. Search strategies can be found in the Supplemental Methods. Search statements were designed to retrieve literature mentioning Ebola and virus transmission via insects or stings or articles focused on knowledge and attitudes surrounding EBOV or EVD. Database searches were supplemented by citation pearl searching or by screening reference lists of inclusion literature and grey literature to produce additional publications for review. Bibliographic records, including abstracts, were exported from the search results into EndNote X8 (Clarivate Analytics, Philadelphia, PA). In EndNote X8, the Find Duplication function was used, followed by further manual deduplication.

Abstracts available in English were screened for information regarding African knowledge, attitudes, and/or misconceptions related to EBOV transmission via insects or stings. Retracted articles were excluded. Full-text articles were then read to determine eligibility, including all articles that specifically stated “knowledge” and “attitudes” in the title due to the potential of in-scope criteria in figures. Literature was excluded if it did not report knowledge, attitudes, and/or misconceptions as related to EBOV transmission by insects or stings. Full-text literature was also excluded if the full text of the article or report was in a non-English language. However, non-English articles with a translated abstract were included if they met our selection criteria.

RESULTS

Transmission mode inaccuracies. We determined that the Google Ebola Knowledge Panel (Figure 1) incorrectly listed “[Ebola virus] spreads by . . . insects” and “How it [Ebola virus] spreads: By . . . insect bites or stings” as modes of virus transmission.

Attitudes and misconceptions. A total of 27 articles or reports met the inclusion criteria for our scoping review (Supplemental Figure 3). We found widespread misconceptions existed in those regions with previous EVD outbreaks as well as in regions in proximity to previous outbreaks (e.g., EBOV is transmitted by insects) (Table 1). Importantly, 9 of the 11 countries where misconceptions regarding insect transmission of EBOV were reported are locations of current (i.e., DR Congo and Guinea) or previous EVD outbreaks. Alarmingly, two recent reports from DR Congo indicated that 24.8% and 26.6% of respondents felt that EBOV transmission to people could be prevented by avoiding mosquito bites. In other locations of previous large-scale EVD outbreaks, up to 61.0% of interviewees/respondents in some surveys felt insects were involved in the transmission of EBOV. One study carried out in the DR Congo and another study carried out in Ghana that combined multiple variables, including knowledge, attitudes, or misconceptions involving EBOV insect transmission, among others, were not included in Table 1.^{8,9} Our scoping review did not find any reports indicating persons believed EBOV transmission occurred by “stings.”

DISCUSSION

We determined that inaccuracies exist within the Google Ebola Knowledge Panel relating to virus transmission by insects or stings (Figure 1). To date, peer-reviewed research does not support the role of insects in the transmission of EBOV to humans.^{10–13} Additionally, our searches did not find any peer-reviewed evidence suggesting EBOV is transmitted to humans by “stings.” The Knowledge Panel indicates the information contained was sourced from the “Mayo Clinic and others.” However, the Mayo Clinic EBOV linked webpage states: “There’s no evidence that Ebola virus or Marburg virus can be spread via insect bites.”¹⁴ It therefore remains unclear how the incorrect EBOV transmission modes ended up in the Knowledge Panel as the information contained within undergoes expert review prior to publication⁴ or how long this information has been publicly available. Google’s Knowledge Panels allow users to submit feedback, which the authors submitted on May 31, 2019 to alert Google to the inaccurate

TABLE 1
Studies carried out in Africa reporting misconceptions associated with Ebola virus transmission via insects

Location	Population interviewed/surveyed	Year of interview/survey	Summarized findings related to insect transmission*
Democratic Republic of Congo†‡	Public (≥ 14 yr old)	August 2018	"Can protect self from Ebola by avoiding mosquito bites [No. 155/582 (26.6%)]§" ¹⁵
	Public (≥ 18 yr old)	August 2018	"Ebola can be prevented by avoiding mosquito bites [No. 71/286 (24.8%)]" ²⁵
Ethiopia	Health care providers working in a hospital setting (≥ 20 yr old)	August–October 2015	"But many believed that EVD can be transmitted through . . . or [other insects] mosquitoes (24.3%) [No. 52/211]" ²⁶
Gabon‡	Public and some health care providers	≤ 2001	" . . . others responded the mosquitoes . . . were the cause [of the EBOV outbreak]" ²⁷
Ghana	Public and some health care providers (≥ 20 yr old)	February–March 2015	"there was a firm belief that Ebola . . . could also be transmitted through air, mosquito bites and houseflies" ²⁸
Guinea†¶	Public (preference given to head-of-household, ≥ 18 yr old)	December 2014–January 2015	" . . . major misconceptions that need to be rejected include perceptions that EVD is transmitted by . . . mosquito [No. 94/345 (27.3%)]" ²⁹
	Public (head-of-household and an adult woman or young person 15–24 yr old)	August 2015	" . . . in Forécariah 61% [No. 304/498] of respondents believed Ebola can be transmitted through mosquito bites . . . " ³⁰
	Public (head-of-household and an adult woman ≥ 25 yr old or young person 15–24 yr old)	August 2015	" . . . [No. 2,795/5,705] 49% believed they could protect themselves from Ebola by avoiding mosquito bites" ³¹
	Public (head-of-household and an adult woman ≥ 25 yr old or young person 15–24 yr old)	August 2015	"Reported mosquito bites as [sic] cause of Ebola (57%) [No. 3268/5733]" ¹⁶
Liberia¶	Public and some health care providers	August 2014	" . . . at the onset of the emergency phase of the epidemic [EBOV], the Government of Liberia launched a public health campaign that enjoyed [sic] people to . . . protect themselves from insect bites (a carryover from antimalarial campaigns) . . . " ¹⁹ "As a result, local populations initially believed that a number of non-Ebola sources of infection, like insects . . . were primary sources for Ebola." ¹⁹
	Head-of-household or designated individuals when the head-of-household was unavailable (≥ 18 yr old)	December 2014	" . . . 33% [No. 387/1,190] of respondents believed Ebola could be spread by mosquito bites . . . " ²⁰
	EVD actively monitored or quarantined households (head-of-household)	April 2015	"However, interviewees sometimes incorrectly identified mosquito bites [No. 67/115 (58.3%)], as a mode of EBOV transmission . . . " ³²
Nigeria‡	Public and healthcare providers (≥ 18 yr old)	2014	" . . . 26% [of respondents] think it [EBOV] could be spread by mosquito bite . . . " ³³
	Clinicians	August–September 2014	"Transmission through mosquito bite [No. 80/398 (20.1%)]" ³⁴
	Hospital clinic (≥ 20 yr old)	October–December 2014	" . . . believed. . . [No. 32/400] (8.0%) from mosquito bites . . . " ³⁵
	Public (≥ 18 yr old)	2014–2015	"How is Ebola spread? . . . Through insect bites [No. 62/438 (14.2%)]" ³⁶
	Medical and nursing students	August–September 2015	"[Routes of transmission of EVD are] . . . by mosquito bites [No. 57/423 (13.5%)]" ³⁷
Senegal‡	Vaccine trial participants (≥ 18 yr old)	August–November 2015	"The others [sic] transmission mode identified by interviewees: mosquito bites [No. 109/249 (43.8%)] . . . " ³⁸
Sierra Leone¶	Public (head-of-household and an adult woman ≥ 25 yr old or a young person 15–24 yr old)	August 2014	"Ebola can be transmitted by mosquito bites (30%) [No. 424/1413]" ³⁹
	Public (head-of-household and an adult woman ≥ 25 yr old or a young person 15–24 yr old)	August 2014	" . . . [EBOV is] transmitted through: mosquito bites (29.6%) [No. 403/1360]" ⁴⁰
	Healthcare providers	February 2017	Prior to training: "Ebola is transmitted through mosquito bites [No. 9/99 (9.1%)]" ²¹ Post training: "Ebola is transmitted through mosquito bites [No. 4/93 (4.3%)]" ²¹
Sudan‡	Health care providers (≥ 20 yr old)	November–December 2014	" . . . [No. 52/258 (20.2%)] identified insects as a mode of EVD transmission" ⁴¹
	Public (≥ 18 yr old)	May 2015	"[Respondents reporting transmission was] vector born [sic] 12.9% [No. 85/655]. . . " ⁴²
Uganda‡	Public areas of previous EVD/MVD outbreaks (≥ 18 yr old)	January–February 2015	" . . . 11.3% [No. 60/530] thought that EVD/MVD could be transmitted through biting mosquitoes . . . " ⁴³
West Africa and South Africa#, **	Academicians (scientific fields) with degrees or those without degrees (18–45 yr old)	2014–2015	" . . . 23% [No. 23/100] believed that insects and mosquitoes can help [sic] in transmitting Ebola Virus Disease. . . " ⁴⁴

EBOV = Ebola virus; EVD = Ebola virus disease; MVD = Marburg virus disease.

* Frequency data are reported as number (%) whenever possible. Some articles reported the percentage without the denominator from which the percentage was derived, the percentage including the denominator from which the percentage was derived, the percentage without the numerator and denominator from which the percentage was derived, the percentage including the numerator and denominator from which the percentage was derived, or the numerator or denominator in the text from which the percentage was derived was unclear.

† Current or recent Ebola virus transmission.

‡ Countries reporting previous Ebola virus outbreaks.

§ Michael Hawkes, personal communication, September 4, 2019.

^{||} This publication was written in Japanese; therefore, we used the available English translation of the abstract for the associated information. The year the interviews were conducted was not available in the abstract.

¶ Countries with widespread Ebola virus transmission or cases during the 2013–2016 outbreak in West Africa.

Countries reporting limited Ebola virus cases (≤ 2 cases).

** Reported response results from West African and South African participants were not separated by region or country but were combined.

content. Surprisingly, the Knowledge Panel also lacked information on other important transmission modes (e.g., sexual transmission).

We found numerous articles reporting widespread misconceptions among populations in countries with previous EVD outbreaks that the virus was transmitted by insects. Notably, of the 11 countries in Africa that reported EVD outbreaks since 1976, including those involving the Sudan, Taï Forest, or Bundibugyo viruses, nine countries had populations that believed EBOV was transmitted by insects at the time of the questionnaires/surveys. These findings underscore that reliable information from publicly accessible sources is critical to preventing misconceptions and rumors in regions with active EBOV transmission. Inaccuracies regarding health information might be exacerbated in regions experiencing civil unrest, such as the DR Congo, where there is already substantial mistrust and active public health disinformation campaigns being carried out by violent non-state actors.^{15–18}

Inaccuracies in the Google Ebola Knowledge Panel could also have the unintended consequence of perpetuating inaccurate public health information leading to additional confusion regarding EBOV transmission modes. In 2015, during the EVD outbreak, the Liberian government launched a “one-stop shop” campaign to provide preventative disease information.¹⁹ The circulating messages encouraged several tips for preventing EVD, including protection against insect bites (previously part of antimalarial efforts). Although this message would have had the benefit of potentially reducing malaria and arbovirus transmission, it caused confusion among local populations because it indicated that insects (e.g., mosquitoes) were involved in the transmission of EBOV.¹⁹ One report even stated, “. . . common misconceptions, especially about mosquitoes need to be addressed.”²⁰ Of note, training of health care workers focused on EBOV transmission modes has been shown to have a positive effect in reducing the perception that mosquitoes are involved in virus transmission.²¹

There are limitations to our study. Although 41.0% of online persons living in sub-Saharan Africa use the internet to get health information²² and Google accounts for 97.3% of the African search engine market share (as of February 2021),²³ it is possible those individuals seeking information on EBOV or EVD use search engines other than Google or use sources other than the internet for health information (e.g., radio, television, and/or community meetings). Even so, Google Trends search interest data from Google “Ebola” searches made within DR Congo from 2017 to 2020 (during EVD outbreaks) showed above-average interest in this topic,²⁴ with spikes of tremendous interest (when compared with all other Google searches made within DR Congo) coinciding with public health announcements regarding new outbreaks or case reports. PubMed and Web of Science do not allow for the full text of an article to be searched; therefore, literature containing keywords in the body of the text may have been missed. Additionally, African health and medical journals are often unindexed in international bibliographic databases, so locating knowledge, attitude, and practice research from Africa cannot be accomplished exclusively by searching PubMed and Web of Science. To mitigate this, we also searched African Index Medicus. Finally, some of the studies included in our table may have inadvertently used the same data set, and the survey response rates in some reports were unclear.

Although Google is a cost-efficient and timely source for health information easily accessible to anyone with internet access, users must use eLiteracy skills to understand and appraise online information when addressing health concerns because errors in even “trusted sources” are likely commonplace. For example, we carried out a quick preliminary search of several other Google health-based Knowledge Panels, which we found also contained inaccuracies associated with pathogen transmission modes. These inaccurate Knowledge Panels include rabies and incorrectly state that rabies “. . . spreads by insect bites or stings,” and that transmission of several vector-borne pathogens (e.g., Zika, dengue, chikungunya, yellow fever, malaria, and Lyme disease) may also occur through “stings,” which is a misnomer.

Our results highlight the need for health-related “Knowledge Panels, Knowledge Graphs, or Infoboxes” provided by various Web search engines to provide accurate information and use rigorous fact checking prior to publishing. Errors found within Knowledge Panels could perpetuate misconceptions, misinformation, and/or rumors involving infectious diseases and could potentially lead to further mistrust of health workers and aid agencies, severely undermining public health education and outbreak response efforts.

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