1   **TITLE PAGE**

2   **Title**

3   What's Buzzing on your Feed? Health Authorities' Use of Facebook to Combat Zika in
4   Singapore

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26

ABSTRACT

In 2016, Singapore grappled with one of the largest Zika outbreaks in Southeast Asia. This study

examines the use of Facebook for Zika-related outreach and engagement by the Ministry of

Health (MOH) and the National Environmental Agency (NEA) from March 1, 2015 to

September 19, 2016. Despite nearly equivalent outreach, MOH's Facebook posts received more

likes (μ=3.49) and shares (μ=30.11), whereas NEA's posts received more comments (μ=4.55),

with NEA posting mostly on prevention (N=30) and MOH on situational updates (N=24).

Thematic analyses identified prevention-related posts as garnering the most likes (N=1277),

while update-related posts were most shared (N=1,059) and commented upon (N=220). Outreach

briefly ceased for two months after Singapore's first imported case of Zika, but increased

following the outbreak of locally-transmitted cases in August 2016. Public engagement was

significantly higher during Zika, compared with prior Haze and Dengue outbreak. The results

indicate the value of Facebook as a tool for rapid outreach during infectious disease outbreaks,

and as a 'listening' platform for those managing the situation. We discuss implications for public

health communication and research.

<div style="text-align:center">What's Buzzing on your Feed?</div>

<div style="text-align:center">Health Authorities' Use of Facebook to Combat Zika in Singapore</div>

INTRODUCTION

Social media, such as Facebook and Twitter, have grown from being the exception to the norm in pandemic communication strategies, despite their potential to amplify risk perceptions or enable rumors to spread during infectious disease outbreaks (IDOs).[1-3] In a cost-effective and time efficient manner, social media bridge communication gaps between citizens and public officials, creating real-time mechanisms for reporting and feedback loops.[4] Research surrounding social media use for infectious disease surveillance, management, & outreach has largely focused on the West [5, 6] though most epidemics emerge in tropical regions, and pandemics are global phenomena. The existing evidence surrounding social media use during IDOs in tropical countries remains largely anecdotal.[7-9] Understanding Singapore's use of Facebook during Zika offers a valuable opportunity to examine this phenomenon from the perspective of a technology-rich tropical country, which has been lauded for its management of the Zika outbreak.[10]

Singapore: Social Media Landscape & Zika

The first imported case of Zika in Singapore was reported on May 13, 2016 by the Ministry of Health (MOH) and the National Environmental Agency (NEA).[11] This case was referred to Singapore's Centre for Communicable Diseases (CDC) and thereafter resolved, with no further cases being reported. Nearly three months after, on August 27, the first locally transmitted Zika case was reported.[12] As the count swelled to 381 over the following three weeks (September 19)[13], the outbreak triggered a cascade of conversations and rumours on social media, even as

1 the MOH and NEA constantly engaged the public on Facebook.[14] Facebook is the second-

2 most active social media channel in Singapore, a tech-savvy nation-state where nearly 65% of its

3 5.6 million population are active social media users.[15] Despite its wide reach, Facebook's role

4 in outbreak communication has been seldom studied[16] and its use by Singapore's public health

5 agencies during the 2016 Zika outbreak provides an opportunity to address the evidence gap in

6 this area. Our exploratory evaluation examined the public's receptivity (in terms of social media

7 engagement) to Facebook outreach by Singapore's public health agencies and sought to

8 understand the differences in outreach patterns between the preparedness and response stages of

9 an outbreak. We compared the outreach and engagement during the global pandemic Zika, the

10 endemic mosquito-borne disease Dengue[17], and Singapore Haze, a smog arising from regional

11 forest fires which adversely affects respiratory health[18], in order to gain insights into how

12 social media engagement varies in different types of public health emergencies.[19-21]

13 **RESEARCH QUESTIONS**

14 RQ1: To what extent has Facebook been used by Singapore's public health authorities for

15 outreach and engagement related to Zika?

16   RQ1a: What were the primary themes of this outreach?

17 RQ2: How did the use of Facebook by Singapore's public health authorities for outreach differ

18 between the pandemic preparedness (pre-outbreak) and response (post-outbreak) phases?

19 RQ3: How did the engagement (or public response) to Facebook outreach by Singapore's public

20 health agencies differ between Zika, Dengue and the Haze?

21

1 **METHODOLOGY**

2 **Data extraction and coding**

3 Using the Facebook API, data were extracted from public Facebook pages of the MOH and NEA

4 for the period March 1, 2015 to September 19, 2016. The data was extracted for this period as it

5 marked the first case of Zika in Brazil [22] to its' current state in the global pandemic. The

6 extraction yielded 1,057 posts from NEA of which 33 were Zika-related and 520 posts from

7 MOH of which 35 were Zika-related. The data contained no identifiers, as no personal Facebook

8 pages were tracked. The NEA & MOH datasets were cleaned and three keywords were sought,

9 (1) Zika, (2) Dengue & (3) Haze. The Zika posts were then coded into four non-exclusive

10 categories adapted from Biswas [23]: (1) *investigation/diagnosis*: posts pertaining to

11 epidemiological surveillance activities and diagnosis of symptoms, (2) *preventive and safety*

12 *measures*: posts on preventive measures and guidelines, outreach and travel advisories, (3)

13 *treatment*: posts on specific medication that could be used to treat Zika symptoms, and (4)

14 *situation updates*: updates about new cases or overall Dengue case burden and other Zika-related

15 updates. We added an additional category called '*interventions*' which pertained to posts about

16 specific programs or measures taken against Zika (such fogging, community outreach, etc).

17 **Data analysis**

18 Data were pooled to calculate a) *Outreach*: defined as the total number of posts by the MOH and

19 NEA and b) *Engagement*: defined as public response/interaction measured by aggregating likes,

20 shares and comments for each post. Distribution of outreach themes were captured after all posts

21 were coded for one of the five themes by two independent coders, arbitrated by a third. Inter-

22 rater agreement was measured using Cohen's K and revealed substantial congruence (K = 0.74;

1   95% CI, .531 to 1.00, $p < .005$). The NEA & MOH datasets were then combined to measure

2   outreach for Dengue & Zika posts and plotted on a month by month basis for the year of 2016.

3   Finally, outreach and engagement scores for Zika, Haze & Dengue for both Facebook pages

4   were standardized by converting into Z-scores.

5   **RESULTS**

6   **RQ1.** As seen in Table 1, the NEA and MOH posted 33 and 35 Zika-related messages

7   respectively between March 2015 and September 2016. The MOH's posts were liked nearly

8   twice as much (Mean = 35.49), and shared (Mean = 30.11), nearly six times as much as that of

9   NEA's, on average. However, NEA's posts were more commented upon (Mean = 4.55) as

10   compared to those of MOH.

11   *Table 1: Summary of Zika-related Facebook outreach and engagement in Singapore*

Agency	Posts	Likes		Shares		Comments	
		N	Average/Post	N	Average/Post	N	Average/Post
NEA	33	662	20.06	180	5.45	150	4.55
MOH	35	1242	35.49	1054	30.11	127	3.63

12

13   Thematic analyses illustrated in Table 2 shows that the NEA's posts focused mainly on

14   prevention (N=30) followed by interventions (N=25) as compared to MOH's posts that focused

15   mainly on situation updates (N=24) and investigations (N=19). Investigation-related posts

16   received most likes on average (29.19) while situation updates were most shared (N=25.21) and

17   commented upon (N=5.24).

18   **Table 2: Analysis of outreach and engagement by Zika-related themes**

Theme	MOH	Total	Likes	Shares	Comments

	NEA Posts	Posts	Posts	N	Average/ Posts	N	Average /Posts	N	Average/ Posts
Investigation	12	19	31	905	29.19	612	19.74	153	4.94
Prevention	30	17	47	1277	27.17	806	17.15	204	4.34
Treatment	0	0	0	0	0	0	0	0	0
Updates	18	24	42	1100	26.19	1059	25.21	220	5.24
Intervention	25	12	37	627	16.95	448	12.11	168	4.54

RQ2. Figure 2 depicts how Facebook outreach by Singapore's public health agencies evolved in relation to key Zika-related events. The first instances of Facebook outreach occurred in the last week of January, in proximity to the widely covered declaration by the WHO Director General (February 1) categorizing Zika as public health emergency of international concern. The outreach frequency drops in the ensuing months, only to resume briefly in May when the first imported Zika case was found. No instances of Zika-specific outreach were recorded in June and July. On August 27, Singapore announced the first locally transmitted case of Zika, an outbreak that eventually led to 381 recorded cases by September 19, 2016. The outreach resumed with vigor in August, with a steep spike in September. The Dengue outreach scores are plotted to provide a reference point to interpret the Zika data given that they are both borne by a common vector.

RQ3. Figure 3 provides a comparison of citizens' engagement with Facebook outreach posts by the NEA and MOH during Zika, the Haze, and Dengue. Graphical analysis of standardized (*z*) scores demonstrates that the level of engagement consistently follows the level of outreach across all three public health issues. The only exception to this trend occurs from June 2016 – September 2016, when Haze engagement is disproportionately high, compared with the number

1 of outreach posts. Linear regressions assessed the relationship between engagement and

2 outreach. Outreach levels explained 93% of the variance in engagement during Zika (F (1, 17) =

3 221.84, p<.005); 36% during the Haze (F (1, 17) = 9.577, p<0.05); and 40% during Dengue (F

4 (1, 17) = 11.429, p<0.05) respectively.

5 **DISCUSSION**

6 The NEA and MOH actively used Facebook to communicate with members of the public about

7 various issues related to Zika, resulting in active online engagement from the community. The

8 analyses reveal that Facebook outreach by both agencies was strongly associated with

9 engagement, and this association was strongest during Zika when compared with two other

10 public health emergencies that have occurred over the last year. The study was constrained by (a)

11 limited engagement data available from Facebook, (b) lack of triangulation of findings across

12 other social media platforms like Twitter, where both MOH and NEA have a substantial

13 following, and (c) un-weighted analysis of different engagement types driven by lack of

14 empirical consensus.

15 In this study, we discovered that a near-identical number of Zika-related posts were made by the

16 two public health agencies, although MOH posts were more popular and widely shared.[24] The

17 latter could be explained by MOH's emphasis on investigations and situation updates, which

18 informed citizens about the unravelling Zika situation. These communication strategies respond

19 to the WHO's call for transparency in disseminating information about "the incidence, speed and

20 containment of an outbreak" immediately after an initial case or cases has/have been found.[3,

21 25] With respect to the different forms of engagement, the greater number of likes and shares for

22 investigation-related posts and situation updates were likely driven by a desire for constant

23 updates about Zika, coupled with the need to keep one's social network abreast of the situation.

In contrast, information about prevention received a greater number of likes but fewer shares or comments. This may be attributed to the effort required to engage in each type of interaction (where likes < shares < comments)[26] and the intentions underpinning the engagement (obtaining information or disseminating it).

Our results revealed how outreach activity coincided with key Zika-related events, with the initial publicity surrounding the WHO announcement giving way to a temporary lull in communications, followed by a critical resumption in May 2016 after the discovery of the first imported Zika case in Singapore. The absence of Zika-specific outreach in the two months after the May case is noteworthy, as continued communications were warranted to prepare the local population for a potential outbreak; a threat which materialized in August. A possible explanation lies in the accompanying trend-line for Dengue outreach, which prevailed during these months. This suggests that the agencies may have been prioritizing generic outreach about transmission and prevention of mosquito-borne conditions, rather than neglecting Zika. The spike in Facebook outreach when cases spiraled in August nevertheless reflects the reactive nature of outbreak communications whilst also underscoring the need for more proactivity in the preparedness phase in future.

The graphical analysis for RQ3 (Figure 3) demonstrates a direct, positive association between the volume of Facebook outreach posts and the public's engagement with them, across all three public health issues.

Regression analyses further demonstrate that, of the three Singapore outbreaks studied, the association between outreach and engagement was the strongest during Zika. However, it is important to note that the Haze and Dengue, while classified as public health concerns, differ from Zika in important ways. The Haze is chiefly triggered by wind movements bringing

emissions from burning of crops in neighboring countries[18] and affects the entire population

by pervading the airspace, while Dengue is an endemic, seasonal, vector-borne disease.[27]

Consistent with the availability heuristic, Zika might have prompted greater concern because of

its immediate association with frightening imagery and relatively unknown nature, as opposed to

Dengue – a seasonal condition familiar to Singapore. Moreover, the public's anxiety about Zika

– demonstrated by their online engagement – is likely to be higher due to the physical effects on

newborns.[28, 29]

CONCLUSION

This study is among the first to demonstrate the value of Facebook in raising public awareness

and sharing information during public health emergencies. Facebook provides a valuable real-

time interface for public health authorities to disseminate information when an outbreak unravels

and through which to monitor the pulse of social conversations (also called 'social listening') in

real-time. These capabilities might enable them to address public anxiety, quell rumors by

providing frequent updates and information, and bolster trustworthy relationships with

communities during outbreaks that trigger confusion and uncertainty among societies. Our

analysis surfaced findings of practical interest to risk communication experts and global health

informatics scholars seeking to optimize social media use during pandemics. Future research is

warranted to test these observations in other contexts, and with different digital platforms, in

order to generate insights that can inform the development and evaluation of social media

communication strategies in public health emergencies.

COMPETING INTERESTS STATEMENT

FUNDING STATEMENT

CONTRIBUTORSHIP STATEMENT

SV - Conceptualization, analysis, writing and editing

RWM - Conceptualization, analysis, and writing

KJ - Conceptualization and writing

CP - Analysis and editing

YF - Data extraction

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Singapore's Zika Story

First case of locally transm[itted]
virus confirmed
8/27/2016

NEA & MOH report first imported
case of Zika virus
5/13/2016

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t
v
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Jun	Jul	Aug	Sep

- Reported to Singapore CDC
- Resolved, no further cases reported

- Social media activity on Zik[a]
- MOH & NEA Facebook outr[each]

Singapore's Social Media Landscape (as of 2016)
Population: 5.6 million
Mobile connections: 8.22 million
Social Media Users: 3.6 million

Social Platforms Top 10 Ranking (as of 2016)
WhatsApp (46%, #1)
Facebook (43%, #2)
Twitter (13%, #9)

Public Health Agencies' Facebook Audience (as of November 15, 2016)
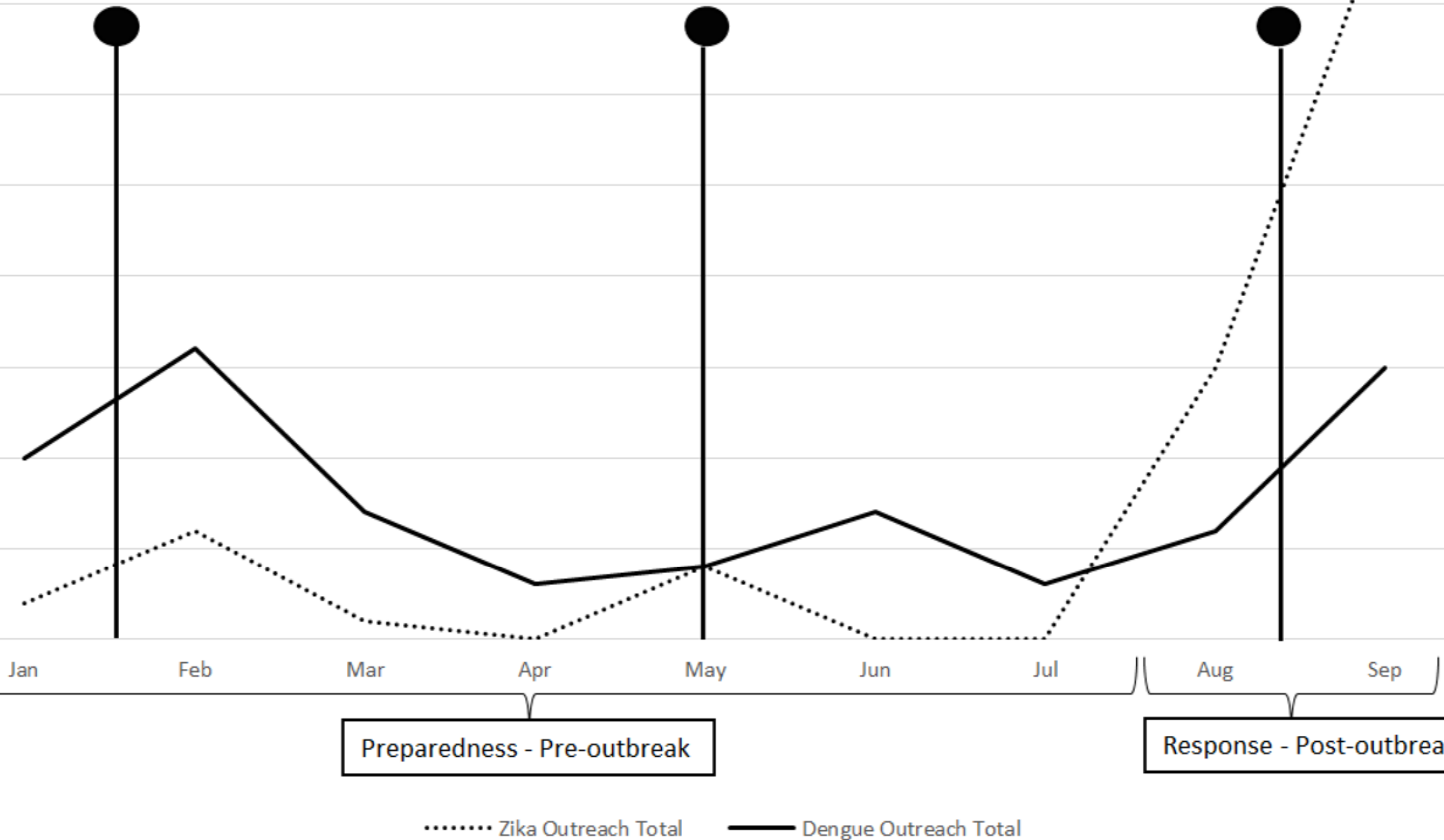NEA Facebook Page Likes: 69,190
MOH Facebook Page Likes: 49, 598

Facebook Outreach in 2016

Feb 1st:
WHO directive of Zika
Outbreak worldwide

May 13th:
First imported Zika
case in Singapore

August 27th:
First locally-transmitted
Zika case in Singapore

Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep

Preparedness - Pre-outbreak

Response - Post-outbreak

.... Zika Outreach Total   —— Dengue Outreach Total

Haze

Jul-16　Aug-16　Sep-16　　Mar-15　Apr-15　May-15　Jun-15　Jul-15　Aug-15　Sep-15　Oct-15　Nov-15　Dec-15　Jan-16　Feb-16　Mar-16　Apr-16　May-16　Jun-16　Jul-16　Aug-16　Sep-16　　Mar-15

- - - - - Haze Outreach ————— Haze Engagement