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Changing Health Information on COVID-19 Vaccination in Asia

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Abstract: The informational domain related to COVID-19 reflects the degree of uncertainty and pace of evolution of the pandemic. This places a burden on peoples' searches for information to guide their choices, importantly including for COVID-19 vaccines. Thus, it is important for health communications that support vaccination campaigns to attenuate vaccine hesitancy to be accessible, including in terms of readability, and adapted to the evolving pandemic. This paper aims to understand internet searches on COVID-19 vaccination, specifically the mix of sources and readability of the sources over a two-year period (2021–2023) in Singapore, Hong Kong, and the Philippines, for search results in English, as English is a main language for each of these locations. The sources accessed through online searches in June 2021 and May 2023 were categorized by type of source and whether they were from one of the focal locations or elsewhere. The readability of information from web-search results was assessed using a set of readability tests (Flesch–Kincaid Reading Ease, Flesch–Kincaid Grade Level, Gunning Fog Index, Coleman–Liau Index, and Simple Measure of Gobbledygook Grade level). Over the two-year period there was an increase in government sources and reduction in mass media sources with distinct local patterns. Local government sources increased in Singapore whereas foreign government and multi-lateral organization sources increased in Hong Kong, with the Philippines being an intermediate pattern. In contrast to the changing mix of sources, the readability tests indicate a low proportion of URLs scoring within recommended readability thresholds across locations and types of sources over the two years. Information on COVID-19 vaccine development and deployment is an important part of health communications that includes internet search. The paper contributes to understanding health communications during a pandemic, including mix of local and non-local sources and contingency on local social and health context.

Keywords: health communications; readability; COVID-19; vaccine; internet media; Asia

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1. Introduction

Throughout the COVID-19 pandemic, a central issue has been the flow of information and disinformation about the disease including, importantly, regarding vaccinations. Such health communications have evolved over the course of the pandemic, such as through successive waves of infection and evolving priorities, as evidenced by research papers' keywords changing over time with vaccinations coming to the fore in 2021 (de las Heras-Pedrosa et al. 2022). With evolving vaccination campaigns and other government policies, there have been corresponding shifts in public sentiment (Lwin et al. 2022), trust in government policies and healthcare systems (Mihelj et al. 2022; Turhan et al. 2022), and attitudes towards vaccination (Xiao et al. 2022; Yuen 2022). Thus, the informational domain related to COVID-19 has been fast evolving, which is necessary given the degree of uncertainty and pace of evolution of the pandemic but places a burden on peoples' searches for information to guide their choices. An important topic has been to understand the benefits and risks related to the efficacy, safety, and availability

of COVID-19 vaccines, which highlights the importance of health communications to support vaccination campaigns and attenuate vaccine hesitancy (Costantini 2021; Dubé et al. 2013; Michel and Goldberg 2021).

An important part of the overall information flow stems from peoples' searches for information, which is an integral part of deciding about their health (Nongo et al. 2020; Vandensande 2020). With regard to vaccinations, evidence points to greater acceptance of vaccines by those with greater health literacy (Turhan et al. 2022), which encompasses accessing relevant information and determining an appropriate course of action (Nutbeam 2000). Access to information needs to be complemented by peoples' abilities to understand the information. For health information not related to COVID-19, however, the evidence is that English-language information is harder to read than recommended readings levels allow for (Abdi et al. 2020; Bould and Forshaw 2023; Calo et al. 2018; Jo et al. 2020), although with the scope for reading levels to be eased (Kim et al. 2020). For information on COVID-19, the evidence on readability for websites accessed in the U.S. consistently points to readability as being more difficult than recommended to reach a wide audience (Basch et al. 2020; Szmuda et al. 2020), including in a follow-up study (Garcia et al. 2021). Furthermore, studies considering particular sources of information also document relatively difficult readability, including patient education materials from academic medical centres (Kruse et al. 2021) and COVID-19 vaccines (Bothun et al. 2022). A comparison across four English-speaking countries, the U.S., the United Kingdom, Canada, and Ireland, while not finding differences in readability on average across countries, did find material from public health and government organizations somewhat easier to read than media sources (Worrall et al. 2020). Thus, the overall pattern is toward relatively difficult readability, although with some differences by types of sources. While there is some evidence of readability remaining difficult as the pandemic evolved, this is in contrast to a need for information provision to evolve with the unfolding of the pandemic (Lim et al. 2021), thus calling for a study of the adaptation of health communications to local conditions and over time.

This study contributes to understanding how information about COVID-19 vaccinations changed over a period of two years in Singapore, Hong Kong, and the Philippines. English is one of the main languages spoken in these regions. While research on the readability of English-language health information in English-speaking countries, such as the U.S. and the United Kingdom (Basch et al. 2020; Bould and Forshaw 2023), and for immigrants in English-speaking countries and foreign residents in non-English-speaking host countries (Miller et al. 2021; Peters and Kruger 2021) is more prevalent, English in multi-lingual societies, such as three locations in South-East Asia, has received less attention. The specific focus is on online searches, comparing the top-ranked search results based on a Google online search, across locations and over the time period, which spanned from June 2021 to May 2023. For June 2021, this study takes our prior study (Costantini and Fuse 2022) as a comparison point and thus the same data collection approach was followed to enable comparison. The search was conducted in English to enable comparability across locations, while recognizing that, in each location, English is one of multiple languages in use, including Chinese and Tagalog. Over the period from June 2021 to May 2023, the two points of data collection, the COVID-19 pandemic evolved substantially in the three focal locations. In Singapore, there were close to zero cases in June 2021, with subsequently four main waves of daily cases between late 2021 and late 2022, with the largest peak in early 2022. In Hong Kong, there were close to zero cases until a substantial spike in daily cases around March 2022, with subsequently much smaller waves. In the Philippines, there were four main waves of cases, the first in mid-2020, two in 2021, and one in early 2022, with each subsequent wave having a generally higher peak of shorter duration. In all three locations, daily cases were relatively low, as of May 2023. Thus, this study provides a comparison of information provision though online searches across two timeframes: the first, relatively early in the pandemic, and the second, subsequent to major waves of infections. Overall, this study contributes to the understanding of evolving health communications across different locations in South-East Asia.

2. Materials and Methods

2.1. Data

The data collection comprised a cross-sectional web search across the three locations for two time periods. The data collection procedure was as in (Costantini and Fuse 2022), for which the first data collection in June 2021 occurred. The subsequent data collection was in May 2023. In each case, the web search was using a Google Chrome browser. The browser history, cookies, and cache were first cleared, then Google location choice was set to the relevant location in turn: Singapore, Hong Kong, and the Philippines. The search term used was "COVID-19 vaccine". The search results are ranked URLs, with each URL being a link to the content of the associated website. For each location, the first 50 URLs in the search results were recorded, with sponsored and advertising links excluded. For each time period, the URLs across the locations were compared to identify the list of unique URLs, which were 105 in June 2021 and 109 in May 2023. The URLs were classified to identify the type of source, which included the following: government or multilateral organisations; mass media such as a news organization; medical information or medical service providers such as hospitals; and a residual other category. Also, the URLs were classified as to whether the source was from Singapore, Hong Kong, the Philippines, or elsewhere.

2.2. Measures of Readability

A set of five readability tests was used to assess each of the URLs, which included the following: Flesch–Kincaid Reading Ease (FRE), Flesch–Kincaid Grade Level, (FKGL), Gunning Fog Index (GFI), Coleman–Liau Index (CLI), and Simple Measure of Gobbledygook (SMOG) Grade level (Added Bytes 2021). The readability assessment focused on the main text of the website corresponding to the URL, not including headers, footers, and navigational elements. The FRE scores are on a 0–100 scale, with a higher score indicating increased readability and a score above 80 taken to indicate 'easy' reading. The other four provide a score based on U.S. school grades, so lower scores correspond to text that is easier to read, with age correspondence as follows: ages 6–7 for grade 1 through to ages 17–18 for grade 12. In the U.S., overall guidance is to achieve readability below grade 7, which corresponds to ages 12–13 (McKenzie et al. 2017; U.S. Department of Health and Human Services 2010). A set of tests was used as these place weight on different aspects that affect readability: sentence length (FRE, FKGL, GFI, CLI), number of syllables per word (FRE and FKGL), proportion of difficult words (GFI), number of letters per word (CLI), and proportion of words with three or more syllables (SMOG). Thus, to assess readability the scores on the various measures and the proportion of URLs scoring below the U.S. thresholds (i.e., the proportion that are relatively easier to read) was used in the analysis.

2.3. Statistical Analysis

The data were analysed using STATA (Statistics Data Analysis, Version MP-13.1 for Windows, StataCorp LP, Texas, TX, USA). A p-value less than 0.05 was considered to indicate statistical significance for all analyses.

3. Results

The 50 URLs collected for each location comprise some that are common across two or three locations as well as just for one location. The resulting number of unique URLs was 109 in 2023 versus 105 in 2021. For 2023, the number of URLs retrieved for one, two or all three locations (Figure 1a) has the most URLs accessed in just one location for Singapore and the highest overlap in URLs between Hong Kong and the Philippines. In contrast, in 2021 the highest overlap was between Singapore and the Philippines, and the most in just one location being Hong Kong. The main changes in the distribution of URLs across locations (Figure 1b) are the increase in URLs retrieved only in Singapore (+9) and the decreases in URLs retrieved in both Singapore and the Philippines (−7) and in Singapore and Hong Kong (−4).

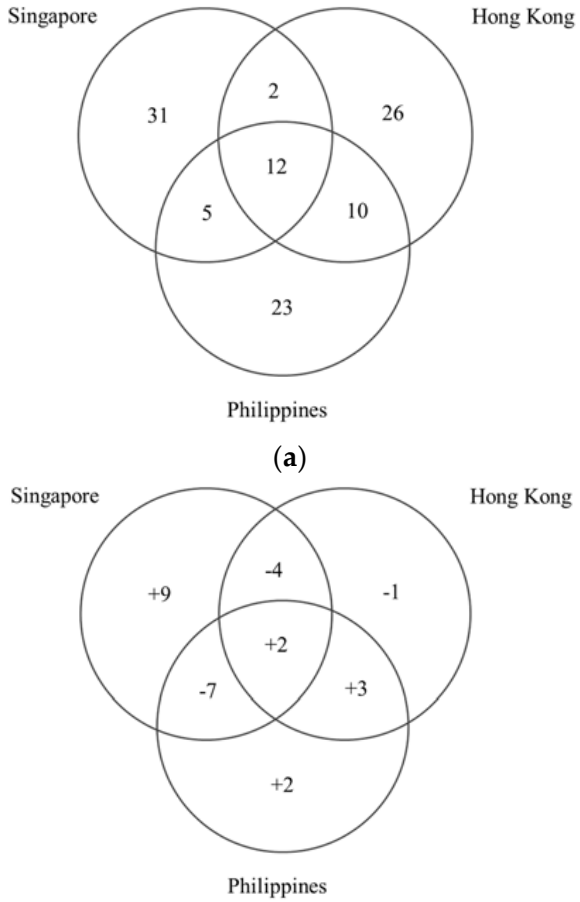

Figure 1. Distribution of 50 URLs retrieved across locations. (**a**) **May 2023**: number of URLs retrieved for one, two, or all three locations, which leads to a total of 118 unique URLs; (**b**) **Difference between May 2023 versus June 2021**: Difference in number of URLs retrieved for one, two, or all three locations.

To understand the pattern in types of sources and how this changed over time, the URLs were classified into five categories of sources (Table 1): governments of Singapore, Hong Kong, or the Philippines; other governments (e.g., United States, Canada, and Australia) and multilateral agencies (e.g., WHO); mass media, such as newspapers and international news sites (e.g., CNN); medical information sites (e.g., WebMD) and healthcare providers (e.g., hospitals); and other sources, including general information sites (e.g., Wikipedia), non-profit organizations, and corporate websites (e.g., of vaccine producers).

Over the course of the two years, the proportion of URLs from the first two categories comprising governments and multilateral agencies increased from an average across locations of 52% to 69% (Table 1). Within this, the patterns across the three locations were distinctive. The proportion of local government URLs increased in all three locations: Singapore +8%; Hong Kong +6%; and the Philippines +4%. More marked were the differences in proportion of other governments and multilateral agencies: Singapore −4%; Hong Kong +26%; and the Philippines +12%. In 2023, the 55 URLs of other governments and multilateral agencies included 23 from the United States (including federal and state governments), and Centers for Disease Control and Prevention (CDC), 6 from Canada (federal and provinces governments), 6 from Australia (federal and state governments), and 6 from the United Kingdom including the National Health Service (NHS), with the rest from New Zealand, India, Ireland, Japan and the WHO, UNICEF, European Medical Authority (EMA), African Union's Centres for Disease Control and Prevention, and the International Monetary Fund (IMF).

Table 1. The proportion of URLs by category of source for each location.

(a) June 2021				
	Singapore	Hong Kong	Philippines	Average
	%	%	%	%
Governments of Singapore, Hong Kong, or Philippines	10	2	4	5.3
Other governments and multilateral agencies	44	50	46	46.7
Mass media sources	14	24	18	18.7
Medical information and healthcare services	18	12	20	16.7
Other	14	12	12	12.7
(b) May 2023				
	Singapore	Hong Kong	Philippines	Average
	%	%	%	%
Governments of Singapore, Hong Kong, or Philippines	18	8	8	11.3
Other governments and multilateral agencies	40	76	58	58.0
Mass media sources	6	4	0	3.3
Medical information and healthcare services	24	10	22	18.7
Other	12	2	12	8.7
(c) Difference between June 2021 and May 2023				
	Singapore	Hong Kong	Philippines	Average
	%	%	%	%
Governments of Singapore, Hong Kong, or Philippines	8	6	4	6.0
Other governments and multilateral agencies	−4	26	12	11.3
Mass media sources	−8	−20	−18	−15.3
Medical information and healthcare services	6	−2	2	2.0
Other	−2	−10	0	−4.0

The main decrease was in the proportion of mass media sites, declining from an average of 19% in 2021 to 3% in 2023, which included zero in the Philippines. Medical information and healthcare services changed the most in Singapore (+6%) and the residual other category changed most in Hong Kong (−10%).

The readability of the URLs is first considered for each location's 50 URLs. Across the locations, in May 2023 the mean readability of the respective 50 URLs (Table 2) was between grades 8.8 and 12.6 for the FKGL, GFI, CLI, and SMOG and between 42 and 44 ('difficult') for the FRE, all statistically different from the ease of reading threshold ($p < 0.001$). In June 2021, the mean readability was between grades 8.8 and 11.9 for the FKGL, GFI, CLI, and SMOG and between 43 and 47 ('difficult') for the FRE. Indeed, the difference in mean readability (Table 3) indicates more difficult to read URLs for 9 out of 15 indicators (of which 2 with statistically significant differences, GFI and CLI for Singapore), and easier to read for 6 out of 15 indicators (of which none with statistically significant differences): FRE decreases (i.e., becomes harder), and FKGL and CLI increase (i.e., become harder)

in all three locations, whereas GFI and SMOG score harder in Singapore and easier in Hong Kong and the Philippines. These patterns compare the 50 URLs for each location: given the substantial changes in the proportion of types of sources within each location, the readability for each type of source is addressed next.

Table 2. Readability test scores by location of search in May 2023.

Readability Test *:	**FRE**	**FKGL**	**GFI**	**CLI**	**SMOG**
(a) Singapore					
Mean	42.1	10.3	10.3	12.6	11.9
Standard deviation	11.3	2.3	3.4	2.0	2.2
Readability easier (% of URLs) **	0%	0%	12%	0%	0%
p-value ***	<0.001	<0.001	<0.001	<0.001	<0.001
(b) Hong Kong					
Mean	43.8	9.6	9.0	11.9	10.9
Standard deviation	11.5	2.3	3.3	2.0	2.1
Readability easier (% of URLs) **	0%	8%	24%	0%	0%
p-value ***	<0.001	<0.001	<0.001	<0.001	<0.001
(c) Philippines					
Mean	42.1	9.9	8.9	12.3	11.2
Standard deviation	11.0	1.8	3.1	2.2	1.9
Readability easier (% of URLs) **	0%	2%	22%	2%	0%
p-value ***	<0.001	<0.001	<0.001	<0.001	<0.001

* Flesch–Kincaid Reading Ease (FRE), Flesch–Kincaid Grade Level, (FKGL), Gunning Fog Index (GFI), Coleman–Liau Index (CLI), and Simple Measure of Gobbledygook (SMOG) Grade level. ** Readability rated as easier if score is 80 or more for FRE, 'easy', or below grade 7 for other tests. *** Test of difference of mean from threshold for easier readability.

Table 3. Difference between June 2021 and May 2023 in mean readability test scores by location of search.

Readability Test *:	**FRE**	**FKGL**	**GFI**	**CLI**	**SMOG**
(a) Singapore	−1.2	0.6	1.4	1.0	0.8
(b) Hong Kong	−3.0	0.2	−0.3	0.2	−0.2
(c) Philippines	−3.2	0.0	−0.8	0.4	−0.5

* Flesch–Kincaid Reading Ease (FRE), Flesch–Kincaid Grade Level, (FKGL), Gunning Fog Index (GFI), Coleman–Liau Index (CLI), and Simple Measure of Gobbledygook (SMOG) Grade level.

Considering four different types of sources, combining the governments of Singapore, Hong Kong, and the Philippines with other governments and multilateral agencies, and the five readability tests, 19 out of 20 had a degree of difficulty statistically significantly above the easy readability thresholds ($p < 0.001$) in May 2023 as well as in June 2021. Also, there were limited differences between the average readability across categories: in May 2023, the difference between the highest and lowest scores across categories was 9.3 points for FRE, 0.9 for FKGL, 1.9 for GFI, 1.0 for CLI, and 1.3 for SMOG (Table 4). The differences between the two years indicated for 18 out of 20 measures more difficult to read sources, though none with statistically significant increases in difficulty, and just 2 out of 20 measures indicating easier to read, neither statistically significant difference: overall, no improvement in readability (Table 5). For the largest set of sources, governments and multilateral agencies, the difference over time was modest: FRE became harder by 2.7 points, and for the other measures changed from −0.2 to 0.5, depending on the measure, so less than one grade level.

Table 4. May 2023 readability test scores by category of source.

Readability Test *:	**FRE**	**FKGL**	**GFI**	**CLI**	**SMOG**
(a) Governments and multilateral agencies (N = 69)					
Mean	42.1	9.8	9.1	12.3	11.1
Standard deviation	11.7	2.2	3.3	2.4	2.2
Readability easier (% of URLs) **	0%	4%	20%	1%	0%
p-value ***	<0.001	<0.001	<0.001	<0.001	<0.001
(b) Mass media (N = 5)					
Mean	47.2	10.3	11.0	11.8	12.3
Standard deviation	10.3	3.1	4.1	1.8	2.7
Readability easier (% of URLs) **	0%	20%	20%	0%	0%
p-value ***	<0.001	<0.001	<0.001	<0.001	<0.001
(c) Medical information and healthcare services (N = 24)					
Mean	41.4	10.7	10.7	12.8	12.4
Standard deviation	11.6	2.4	3.9	1.8	2.3
Readability easier (% of URLs) **	0%	0%	13%	0%	0%
p-value ***	<0.001	<0.001	<0.001	<0.001	<0.001
(d) Other sources (N = 11)					
Mean	37.9	10.7	10.2	12.7	12.0
Standard deviation	8.9	1.5	3.0	1.3	1.9
Readability easier (% of URLs) **	0%	0%	9%	0%	0%
p-value ***	<0.001	<0.001	0.31	<0.001	<0.001

* Flesch–Kincaid Reading Ease (FRE), Flesch–Kincaid Grade Level, (FKGL), Gunning Fog Index (GFI), Coleman–Liau Index (CLI), and Simple Measure of Gobbledygook (SMOG) Grade level. ** Readability rated as easier if score: 80 or more for FRE, 'easy'; or below grade 7 for other tests. *** Test of difference of mean from threshold for easier readability.

Table 5. Difference between June 2021 and May 2023 in mean readability test scores by category of source.

Readability Test *:	**FRE**	**FKGL**	**GFI**	**CLI**	**SMOG**
(a) Governments and multilateral agencies	−2.7	0.2	−0.2	0.5	0.0
(b) Mass media	−1.3	0.8	1.3	0.3	0.5
(c) Medical information and healthcare services	−5.6	0.7	0.1	0.9	0.3
(d) Other sources	0.9	0.1	1.9	1.4	0.8

* Flesch–Kincaid Reading Ease (FRE), Flesch–Kincaid Grade Level, (FKGL), Gunning Fog Index (GFI), Coleman–Liau Index (CLI), and Simple Measure of Gobbledygook (SMOG) Grade level.

In comparing across locations, in addition to considering which URLs occur in one or more locations of search a separate issue is which URLs are from sources within one of the three locations or from elsewhere. In May 2023, the 109 unique URLs comprised 27 URLs from sources within the three locations and 82 URLs from elsewhere (Table 6), whereas in June 2021 there were, respectively, 21 URLs from within and 84 URLs from elsewhere. As noted above, a main difference over the two years was the increase in 9 URLs accessed only in Singapore, which comprised an increase in 5 local URLs (from 10 to 15 URLs) and in 4 URLs from elsewhere (from 12 to 16 URLs). Indeed, for both June 2021 and May 2023, Singapore had at least as many local sources as the number of local sources for Hong Kong and the Philippines combined.

Table 6. Number of URLs and mean readability scores by presence of URL across locations and by origin of source.

Number of URLs and Readability Tests *:	Number	FRE	FKGL	GFI	CLI	SMOG
(a) Sources from within Singapore, Hong Kong, or the Philippines						
Twenty-seven URLs from sources within the three locations, which were available in the following:						
Singapore, Hong Kong, and Philippines	1	38.2	10.1	7.9	13.8	11.6
Singapore and Hong Kong	0	n/a	n/a	n/a	n/a	n/a
Singapore and Philippines	0	n/a	n/a	n/a	n/a	n/a
Hong Kong and Philippines	1	34.8	10.1	8.5	14.0	10.6
Singapore only	15	42.8	10.6	11.2	13.0	12.5
Hong Kong only	6	36.4	11.0	9.2	12.6	11.7
Philippines only	4	30.4	10.7	4.4	11.6	10.7
(b) Sources from elsewhere						
Eighty-two URLs from sources elsewhere than three locations, which were available in the following:						
Singapore, Hong Kong, and Philippines	11	48.6	8.9	8.6	11.2	10.6
Singapore and Hong Kong	2	42.7	9.8	10.6	13.0	11.2
Singapore and Philippines	5	34.4	11.2	9.2	12.9	12.0
Hong Kong and Philippines	9	45.3	9.1	8.3	12.0	10.5
Singapore only	16	39.7	10.8	11.0	13.0	12.3
Hong Kong only	20	43.6	9.7	9.5	11.7	11.0
Philippines only	19	41.8	10.3	10.3	12.8	11.9

* Flesch–Kincaid Reading Ease (FRE), Flesch–Kincaid Grade Level, (FKGL), Gunning Fog Index (GFI), Coleman–Liau Index (CLI), and Simple Measure of Gobbledygook (SMOG) Grade level.

In terms of the readability of local and non-local sources, comparing the average readability of the 27 URLs from within the three locations to the 82 other URLs yields in May 2023 small differences in readability scores: 3.62 points harder for FRE, and −0.3 to 0.7 grades harder for the other measures (and with slightly tighter range for June 2021). Comparing across the two years indicates a modest increase in difficulty of reading: for local sources FRE was harder by seven points, and other measures increased by 0.1 to 1.0 grades; and for non-local sources the increase in difficulty was smaller, with FRE harder by two points, and other measures increasing by 0 to 0.7 grades. Overall, limited changes in readability across types of sources and locations of sources over the two years.

4. Discussion and Conclusions

An important issue is how health communications adapt to evolving conditions and local context (Lim et al. 2021; Lwin et al. 2022). Regarding COVID-19 vaccinations, this study provides evidence for how one important information source, web searches, changes over a two-year period across three locations in South-East Asia, namely Singapore, Hong Kong, and the Philippines. The results evidence for Singapore an increase in search results unique to Singapore, which includes a notable increase in sources from the Singapore government and a decline from non-local governments and multilateral agencies. This is consistent with evidence of trust in the Singapore government in the context of the pandemic (Lwin et al. 2022; Tan et al. 2022). For Hong Kong and the Philippines, the pattern is different: the sources from the respective local governments increase but less than for Singapore, and from non-local governments and multilateral agencies markedly increase, in particular for Hong Kong as accounting for three-quarters of the URLs in May 2023. Also, for Singapore there is a marked increase in sources from expert medical sources, medical information, and healthcare service providers, whereas a small increase for the Philippines and a decline for Hong Kong. Given evidence from other settings for how trust in experts depends on local context (Mihelj et al. 2022), and how for Hong Kong trust affects vaccine hesitancy (Xiao et al. 2022; Yuen 2022), the results indicate the potential for future research to consider how local social context affects information search and, more broadly, health communications.

Also, the overall pattern is for search results to feature established, known sources, such as mass media and government sources. Thus, internet searches may be less subject to the concerns about misinformation (Cuan-Baltazar et al. 2020) as compared to other media and communications channels, so long as the featured sources are trusted.

During the two years, for all three locations the share of mass media URLs substantially drops. As of June 2021, between 14% and 24% of sources in each location were mass media, dropping to 0% to 6% as of May 2023. In the latter period, the straightforward explanation is that COVID-19 and related aspects such as vaccinations are less news stories, as the local situations are relatively stable, less uncertain, and more understood as compared to June 2021. Thus, mass media sources fulfil a very dynamic role within the landscape of sources encompassing health communications: based on this evidence, the role of mass media is contingent on circumstances. Also, overall, across the two years there a shift in sources from mass media to government sources, though with substantial differences across locations as to the importance of local versus non-local government sources.

In contrast to the changes in sources and mix of sources featuring in the top search results, the readability of these sources remains mostly similar across the two time periods or becomes slightly more difficult to read whether considered for all sources for a location or by type of source. The readability scores are, in general, above the thresholds recommended in the U.S.: that is, the sources are more difficult to understand than recommended. Whether these U.S.-based standards are appropriate across the locations is for future research. That said, to interpret the readability scores, the main issue would be if the U.S. standard were deemed too low for the locations analysed. While the U.S.-based standards reflect aspects such as prevalence of immigrants for whom English may not be the first language and schooling (Peters and Kruger 2021), this would seem unlikely to lead to standards far below those likely to be relevant to the locations analysed. For the locations in Asia in the study, the sources analysed are in English whereas each location has other languages in use. There could be a selection effect whereby those with better English access English-language sources (and equivalently for other local languages), which could mean higher readability levels may still be compatible with wide reach; alternatively, a significant proportion of those searching in English do not have English as their first language and thus would benefit from greater ease of reading. Notwithstanding such a selection effect, there is no marked improvement in ease of readability over the two years. One potential reason is a shift in topics covered and information about the topics: for example, as of May 2023, versus June 2021, for topics such as the effect of COVID-19 vaccinations and access to these vaccinations, more is known and there is less uncertainty. This could trace through to easier readability (e.g., reduced ambiguity enabling simpler expositions) or harder readability (e.g., communication of complex understanding). In any case, the evidence does not indicate a priority for simple-to-read communications, given the lack of improvement in readability. The findings and the multi-lingual aspects of each local context suggest the importance in health communications during events such as the pandemic to address accessibility of information, including through readability.

These considerations on the study results need to be tempered by limitations of the research. The focus is on English language in three locations in South-East Asia, which are multi-lingual societies, and on comparability across locations. Also, as the contribution stems from comparing two time periods, the results potentially depend on when the data were collected though mitigated by both data collection periods being during relatively stable moments of the pandemic. Thus, an interesting extension for future research is to understand the evolution over phases of the pandemic in a more fine-grained manner. Within the broader media and communications landscape, this study is limited to internet searches: nonetheless, this enables documenting an interesting change in the mix of sources, such as the shrinking share of mass media and more stable share of medical information providers, and comparison across locations and over time.

Indeed, in conclusion, the study provides evidence through the focused perspective provided by internet search results of the dynamic changes in health communications as the COVID-19 pandemic and the understanding and access to vaccines unfolded. This points to how notions of health, such as attitudes towards COVID-19 vaccines, are also the result of the interplay between the local and broader contexts and adapt over time: in turn, this places emphasis on understanding health communications contingent on the evolving broader social and health context.

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