COVID-19 and vaccines in Africa: a descriptive and thematic analysis of Twitter content [version 1; peer review: awaiting peer review]

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Abstract
Introduction: As coronavirus disease 2019 (COVID-19) vaccines become available, it becomes important to understand public perceptions of the vaccines and implementation plans. The social media platform Twitter™, which publicly shares information, serves as an important source of content related to COVID-19 vaccines. This study employed a qualitative descriptive design to examine content related to COVID-19 vaccines posted by Twitter users located in Africa.

Methods: Data were collected from Twitter between the 11th and the 16th of December 2020 using the NCapture tool. We searched Twitter using the terms 'coronavirus', 'COVID-19 vaccine' and 'Africa' to identify the nature and content of tweets related to COVID-19 and vaccines shared by Twitter users from the African region. Descriptive statistics were used to describe the characteristics of Twitter accounts and thematic analysis helped determine, analyse, and clarify patterns of meaning (themes) emerging from the tweets.

Results: The study found n=208 Twitter accounts, the majority (n=69; 33%) from South Africa and most (42%; n=87) from news agencies. The final dataset included n=212 tweets. The most used hashtag was #Covid19vaccine(s). Four themes were identified: i) capacity for vaccine production, ii) vaccine procurement, iii) vaccine logistics, and iv) perceived safety and efficacy of vaccines. The capacity of countries in Africa to manufacture a COVID-19 vaccine was deemed minimal and most tweets questioned Africa's ability to procure vaccines based on the costs. Tweets also centred around the distribution of vaccines, storage and roll-out and the need to leverage existing solar-powered technologies to enhance the cold supply chain in Africa's remote locations. Questions about the safety and efficacy of vaccines developed in under one year were also raised.

Conclusions: Concerns about vaccine procurement and readiness for
distribution were dominant topics. These public concerns can be important in informing policymakers in preparation for the roll-out of vaccines in these contexts.

**Keywords**
Africa, coronavirus, COVID-19, vaccine, vaccination

This article is included in the Coronavirus (COVID-19) collection.
Introduction

On 8th December 2020, the United Kingdom (UK) became the first Western country to approve and roll-out a coronavirus disease 2019 (COVID-19) vaccine: the Pfizer/BioNTech vaccine. The USA and Canada followed soon after. In late December, the Chinese government gave conditional approval for general public use of their COVID-19 vaccine. While Russia announced in August 2020 approval of its COVID-19 vaccine, there were safety concerns voiced about their vaccine. Among the priority groups to receive the Pfizer/BioNTech vaccines were older people (those aged 65 years and over) and front-line (healthcare) workers in these countries. At the time, there was an expectation that other countries would follow suit in licensing and deploying the various vaccines as they become available to halt the spread and impact of the virus.

The approval and subsequent roll-out of a COVID-19 vaccine is more or less a sign that, the world could soon return to ‘normality’. Yet, in many countries, government officials and health professionals have been quick to point out that, until most of the population gets vaccinated (at least 70%), no one country should stop their current public health measures. It is already becoming clear that equity in vaccine distribution within and across countries may not be realised. Notable is the possibility that Africa will be left behind in procuring adequate vaccines to meet demand. The huge logistical challenges involved and the substantial financial investments needed to deliver vaccines to countries in Africa (approximately US$5.7 billion) could jeopardise efforts to tackle the pandemic. The World Health Organization’s (WHO) COVAX program (The COVID-19 Global Vaccine Access facility) is leading the procurement of vaccines to ensure equitable access to African countries.

Africa has had a long-standing history with vaccination programmes, most of which (coupled with other health and social care interventions) have yielded success in reducing morbidity and mortality across age groups. However, like many regions, vaccination programmes in the region have been challenged by poor infrastructure. Especially in rural locations, the lack of cold storage facilities precludes the ability to store temperature-sensitive vaccines for long periods. However, several African countries are making progress by leveraging solar-power technology to enhance the management of a vaccine’s “cold chain”.

In readiness for the roll-out of COVID-19 vaccines, countries put in place distribution management plans and engaged early on with the priority groups to gauge potential factors linked to uptake or hesitancy. However, there have been many reports of vaccine hesitancy and even denial of the coronavirus. Vaccine hesitancy, defined as a delay in acceptance or refusal of vaccination despite the availability of vaccination services, has been a key impediment in the roll-out efforts. Social media platforms, such as Twitter that enable near-instant communication to global audiences, would seem the most suited avenues to offer accurate information amid a pandemic to influence public health behaviour. Yet, most of these platforms have increasingly become inundated with misinformation regarding vaccines’ safety and efficacy, which potentially perpetuates public scepticism and enhances vaccine hesitancy.

This study sought to explore the nature and content of tweets related to COVID-19 and vaccines shared by Twitter users from the African region based on the following research questions.

1) Who is involved in sharing tweets about vaccines or vaccination services in the African region?
2) What hashtags (#) are being used to engage Twitter users on the topic?
3) What is the thematic content of tweets?

Methods

Study design

This study used a qualitative descriptive design by collecting and analysing content on Twitter. Twitter is a micro-blogging site that enables users to post short messages (tweets) up to 280 characters -in the form of facts, opinions, events, personal stories- reply to tweets, share tweets from others’, retweet or simply like tweets. Twitter users can also engage with others through hashtags (#) specific to certain topics, e.g. #COVID19.

Ethics

This paper used publicly available data from Twitter and hence did not require ethical approval.

Data collection and cleaning

Data were collected from Twitter using the search terms ‘coronavirus’, ‘COVID-19 vaccine’ and ‘Africa’ between the 11th and the 16th of December 2020. The search occurred through the Twitter search bar on three random days; the 11th, the 13th and the 16th December and the search resulted in three datasets. The authors chose this time to capture data shared during the first few days following the approval and subsequent administration of the Pfizer and BioNTech vaccine in the UK. Only original tweets (not retweets) were eligible for inclusion.

Data were collected using the tool NCapture offered by the software NVivo 12. NCapture is a free web-browser extension that facilitates data collection from the Internet to import into NVivo, a software used for organising and managing qualitative data. Once captured, results were imported into NVivo for Mac (Version 12) as a dataset. Data cleaning entailed identifying and eliminating duplicates and retweets. All authors then reviewed data to identify potentially relevant tweets in line with the study aim. Tweets had to fulfil the following inclusion criteria to be included in the final dataset; first, the Twitter account had to originate from an African country as classified by the WHO, (location was identified in the Twitter profiles) and second, the tweet had to mention ‘coronavirus vaccine’ or ‘COVID-19 vaccine’ and Africa had to be mentioned in the tweet as well. Twitter accounts without a stated location and those relating to coronavirus or COVID-19 vaccines in contexts other
than Africa were excluded from the final dataset. Only tweets written in the English-language were included in the study.

Data analysis and interpretation
We used descriptive statistics to describe our sample (Twitter accounts, hashtags) and thematic analysis to make sense of tweet contents. We were interested in identifying the characteristics of those sending tweets, for example if these were individuals or organizations, their occupation or type of business, and Twitter accounts by country. Thematic analysis (TA) is a method used within qualitative data to help determine, analyse, and clarify patterns of meaning (‘themes’) emerging in qualitative data\(^2\). We used an inductive analysis approach and hence our analysis was guided by the data. The analysis entailed i) familiarising with the data, ii) initial generation of interpretative codes, iii) identifying relationships between the codes to generate themes and iv) reviewing and redefining themes\(^2\). To ensure our findings’ credibility, all co-authors were involved in data cleaning, analysis, and interpretation of findings.

Results
The Twitter search resulted in a total of n=2,035 tweets, and after n=157 (7.7%) duplicates were identified and eliminated, n=1,878 tweets. The authors were only interested in original tweets (referred to as tweets, henceforth), and hence retweets (n=1,233; 65.7 %) were excluded resulting in n=645 (34.3 %). As the focus was on tweets sent by users situated in Africa, n=260 (40.3%) tweets were excluded for being linked to a location outside of Africa and n=173 (26.8%) were excluded for having no stated location, resulting in a total of n=212 (32.9%) tweets included in the analysis. Most tweets (n=145; 68.3%) included a link that provided additional information to support the tweet.

Research question 1
Who is involved in sharing tweets about COVID-19 vaccines or vaccinations in the WHO African region?
The study comprised n=208 Twitter accounts. The majority were from South Africa (n=69; 33%). About 43% (n=90) of the accounts were from individuals, while about 42% (n=87) were from news agencies. Table 1 presents characteristics of the Twitter accounts.

Research question 2
What hashtags (#) are being used to engage Twitter users on the topic?
The most commonly used hashtag was #Covid19vaccine (s), n=20 (10%) (Figure 1). Others included the combination of #Covid19 and #vaccine (s) (5%), #CovidVaccine (2%), #coronavirus #vaccine (1%) #CoronavirusVaccine (<1%), #covid19vaccines (<1%), #Coronavaccine (<1%), and #C19vaccines (<1%).

Research question 3
What is the thematic content of tweets?
Thematic analysis resulted in four themes and nine sub-themes. The main themes were i) the capacity for vaccine production, ii) vaccine procurement, iii) vaccine logistics and iv) the perceived safety and efficacy of vaccines. Tweets are denoted by the letters TW followed by a number.

Table 1. Characteristics of Twitter accounts.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n=208</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twitter Profile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals</td>
<td>90</td>
<td>43</td>
</tr>
<tr>
<td>Foreign missions</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>News agencies</td>
<td>87</td>
<td>42</td>
</tr>
<tr>
<td>Government ministries</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Financial institutions</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Private businesses</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Academic institutions</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Pan African organizations</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Non-Governmental Organizations</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>User Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Africa (Unspecified country)</td>
<td>38</td>
<td>18</td>
</tr>
<tr>
<td>South Africa</td>
<td>69</td>
<td>33</td>
</tr>
<tr>
<td>Nigeria</td>
<td>45</td>
<td>22</td>
</tr>
<tr>
<td>Mozambique</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Kenya</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>Liberia</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Uganda</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Ghana</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Rwanda</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Congo</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Namibia</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Cameroon</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Zambia</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Djibouti</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Togo</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Followers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 1 million</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>800,001 to 1 million</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>600,001 to 800,000</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>400,001 to 600,000</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>200,001 to 400,000</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>0 to 200,000</td>
<td>177</td>
<td>85</td>
</tr>
</tbody>
</table>
Theme 1: The capacity for vaccine production in Africa
This theme related mainly to the perceived capacity of countries in Africa to manufacture a COVID-19 vaccine. Vaccine development efforts were seen as absent within the region (TW 201). However, a few tweets (TW114; TW199) highlighted South Africa’s capacity to manufacture vaccines, although others were less optimistic (TW212), with some (TW 209) purporting that the country had not produced vaccines locally in 25 years. Some hoped that the pandemic had served as a lesson for Africa to ramp up its vaccine production capacity (TW162). One tweet (TW82) highlighted current ongoing efforts to ensure Africa’s participation in global vaccine efforts. One main challenge to vaccine production by African countries was the high production costs due to patent protections (TW78; TW152; TW 200).

Theme 2: COVID-19 vaccine procurement
Most tweets centred around vaccine procurement, and the sub-themes identified included the availability and accessibility of vaccines for African countries and the cost of vaccines. Some tweets raised questions concerning Africa’s ability to procure COVID-19 vaccines (T90), when vaccines would be available (TW74; TW115), which vaccines African countries would get (TW74) and who would pay for them (TW74; TW115). The expectation was that African countries would get vaccine deliveries in mid-2021 (TW47; TW61; TW62; TW63; TW67; TW68; TW71). There was much less of a focus on what vaccines would be availed to African countries. However, it was suggested that the continent would likely rely on vaccines produced in China and /or Russia in the immediate future (TW107). Overall, most tweets related to this theme suggest that Africa would be last in securing vaccines (TW127; TW182; TW184; TW185).

The cost of vaccines was seen as a potential hindrance to securing vaccines for Africa. The WHO estimates that the continent would require $9bn to fund 1.4 billion doses (TW40; TW 202; TW 206; TW 208; TW 210; TW 211). The question around ‘Who will pay?’ was posed (TW74; TW115), with some claiming that vaccines would be sold to the continent at exorbitant prices (TW70). Others called on pharmaceutical companies to reduce the cost for African countries (TW26; TW27). Tweets highlighted the WHO’s central role in enabling vaccine access in Africa through the COVAX programme (TW36; TW110). Vaccines expected through this programme were deemed inadequate to meet demand (TW33; TW168; TW 200). Notable was potential funding from the international community, for example, the Bill and Melinda Gates Foundation (TW54), the World Bank and the Afreximbank (TW46). And while this support was lauded and encouraged in some tweets (TW68; TW103), some decried the continent’s over-reliance on donors (TW70; TW73; TW185).

Theme 3: COVID-19 vaccine logistics
This theme centred on the distribution of vaccines, storage and roll-out. Questions surrounding who would handle the distribution of vaccines were raised (TW74; TW90; TW138). Besides, Africa’s ability to store the vaccines at extremely low temperatures (minus 70°C/ 94°F) or lower, as would be the case for the Pfizer and BioNTech vaccine, were put into question (TW90).
National airlines were said to be ramping up capacity and improving cold chain air freight for distribution (TW15; TW16; TW81; TW83; TW84; TW86; TW89; TW109). The need to leverage existing solar-powered technologies to enhance the cold supply chain in Africa’s remote locations was reiterated (TW175). The prospects of other potentially efficient and easier to store vaccines coming into the market were viewed as good news for the continent (TW135).

The vaccine roll-out issue was a notable sub-theme (TW5; TW21; TW52; TW98; TW181). There were questions around ‘Who would get vaccinated first?’ The remarks made by Director-General Tedros Adhanom on the importance of countries to vaccinate priority groups, including health workers, older people, marginalised groups at higher risk as well as people with underlying medical conditions was shared in a number of tweets (TW98; TW181). Yet, given the continent’s expected limited supply, it was believed that deciding on priority groups would be difficult and would require making some tough decisions (TW167). The need to develop a vaccine allocation system based on human rights and African values was highlighted in one tweet (TW166).

Theme 4: The perceived safety and efficacy of COVID-19 vaccines

This theme highlighted the misinformation about vaccines’ perceived safety and efficacy, including fake vaccines on the market (TW2; TW3; TW158; TW99). Some questioned the safety and efficacy of vaccines developed in less than one year, citing the complexity and time needed to develop most vaccines (TW106). Some countries, like South Africa, were said to be making concerted efforts to assure people that vaccines approved and deployed would fulfill all safety requirements (TW2; TW3). There was a call on African governments to beware and vigilant of potential fake vaccines during procurement (TW189) and for policymakers to ensure that full consideration had been given to the vaccines before approval and roll out (TW99).

Discussion

The use of Twitter to convey public health messaging has been a growing trend, and the ongoing COVID-19 pandemic has prompted increased discussions on social media. The authors were interested in identifying those involved in sharing tweets on COVID-19 vaccines in Africa and the topics of these tweets. As far as the authors know, this is the first Twitter study about COVID-19 vaccines in Africa.

News agencies posted the majority of tweets and also had the highest number of followers. Even though journalists play a critical role in informing the public on science, especially the development of vaccines, they run the risk of misinforming the public due to shortcomings in their expertise on matters of health.

South Africa ranked as the country with most Twitter users even though only 38.1% of South Africans use Twitter, and the country lags behind others in Africa in the use of Twitter. South Africa is one of the few countries participating in vaccine development trials, and these efforts are being reflected on social media platforms like Twitter.

More tweets than original tweets in our study sample contradict other studies that used Twitter data. In their study, Boyd and colleagues note that the way Twitter users choose to share information on Twitter (through retweets or original tweets) depends on several factors. For example, some prefer to retweet breaking news or information they consider urgent. Given the timing of our study (data collection occurred during the period following the Pfizer/BioNTech vaccine approval), this might explain the high number of retweets. Notable in our study is that n=145 (68.3%) tweets included a link that sought to corroborate the information shared. This may speak to the potential credibility of the tweets shared and is consistent with other studies.

More generally, vaccines have proven effective in reducing mortality and morbidity related to infectious diseases. However, Africa, the continent most impacted by infectious diseases, cannot manufacture these potentially life-saving treatments. Some Twitter users expressed frustration at the continent’s reliance on ‘handouts’ from Western countries, tying this to poor leadership and mismanagement of national health systems in Africa. The need for Africa-led solutions in these efforts was articulated in our study and is a finding supported in other studies.

Tweets highlighting misinformation about the safety of the COVID-19 vaccines were shared in our study sample. Other studies share this finding that notes the extensive presence of anti-vaccine rhetoric on social media. Misinformation can lead to vaccine hesitancy, impacting the willingness to get vaccinated. To add to this potential obstacle are the huge logistical challenges involved in rolling out the vaccines, which have already been experienced by many countries engaged in the roll-out. Consistent with other studies, our study noted the need for countries to work with communities through participatory approaches to ensure acceptability, uptake, and vaccines implementation.

Conclusion and study limitations

This study focused on the nature and content of tweets on COVID-19 and vaccines shared by Twitter users identifying with a location in Africa. The authors were interested in this particular group, given the limited evidence of voices from this geographical location in the Twitter literature. Most of the tweets shared were on procurement, which was linked to the supply and costs. While issues of safety and efficacy were raised, this was not a dominant theme. It is our view that health care professionals, government agencies and other organisations in health ought to be more active in sharing COVID-19 related tweets to ensure that information shared is credible.

A number of factors may influence the findings; First, the data were collected over a short period and may not provide a complete picture in relation to the study’s aim. However, as the data were collected during the period immediately following...
the approval of COVID-19 vaccines in the UK, we believe the most relevant tweets were captured.

Second, the initial dataset included many retweets (n=1,233; 65.7 %), which were excluded from this study. Retweets enable Twitter users to spread information shared by others and may not always reflect critical engagement with the content of a tweet and cannot be seen as endorsements or expressions of opinions by Twitter users. Future research could focus on analysing retweets. Further, this study included tweets published in the English-language only and hence relevant tweets in other languages may have been eliminated.

Data availability
Due to restrictions surrounding this data, data is available on request from the corresponding author (purity.mwendwa@ucd.ie).

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