Analysis of Twitter Conversation on COVID-19 Pandemic in Africa 2019-2020

Sanni Shamsudeen Ademola[1], Neema Rajabu[2], Aliyu Olugbenga Yusuf[3], Ntombikayise Nomsa Mathabela[4], Lasisi Kamoru Alamu[5]

[1]Department of Computer Science, Faculty of Science and Engineering, University of Eswatini
[2]Faculty of Computer Science and Information Technology, Kampala International University
[3]Department of Library and Information Science; Federal University of Lafia,
PMB 146, Lafia, Nasarawa State, Nigeria;
[4]University of Eswatini Library, Private Bag 4, Kwaluseni, The Kingdom of Eswatini.
[5]Department of Telecommunication Engineering, Kampala International University

ABSTRACT

Background: Communication about COVID-19 pandemic has a huge impact on coordination, control and mitigation efforts against the disease. Patterns and trends of COVID-19 pandemic conversations amongst African tweeps between the year 2019 and 2020 was studied. This study aimed to determine the impact of Twitter COVID-19 information dissemination on attitudes, behaviour and decision making during the pandemic.

Subjects and Method: This was a cohort study with combined quantitative and qualitative approach. This study was conducted in Africa, from December 2019 to December 2020. The quantitative approach was founded on data mining and data analytics research approach, applying measurements in terms of counts, numbers and frequencies while qualitative approach was founded on Natural Language Processing (NPL) algorithm to extract themes/topics and further applying sentiment analysis to a body of large textual data.

Results: A total number of 24,251 tweets was recorded, out of which 9, 016 (37.2%) of the tweets were positive, indicating positive attitude towards COVID-19 related information, control, treatment and regulations. A number of 7, 024 (29%) of tweets were considered neutral, indicating a neutral opinion on conversations related to COVID-19, while 8, 211 (33.9%) were considered negative tweets. South Africa is the most frequently used word and frequently used hashtag followed by Nigeria. Result further revealed four clear topics of discussion which are: a) Africa coronavirus, b) First sub-Saharan pandemic variant, c) Total number of confirmed new deaths, and d) COVID-19 cases in Africa. Besides, it was observed that most health authorities and health partners in Africa are not actively participating on Twitter.

Conclusion: Health information dissemination on social media must be moderated through censorship, otherwise fake news and misinformation would persist to aggravate the spread of diseases and cause deaths. In order to protect the public against false information, public health institutions, governments and partners in health should establish an active presence on social media to share factual information, and timely debunk misinformation.

Keywords: Africa, COVID-19, twitter Conversation, social media, sentiment Analysis

Correspondence:
Sanni Shamsudeen Ademola. Department of Computer Science, Faculty of Science and Engineering, University of Eswatini, Private Bag 4, Matsapha, Manzini, Kingdom of Eswatini. Email: sanniade01@gmail.com. Mobile: +26876241155/79241155.

BACKGROUND

The ubiquitous nature of information through digital platforms has resulted in the emergence of new data sources for research and decision making. These data are produced by users often unobtrusively while interacting with digital tools. Digital trace data from social media platforms have become a basis for research in many disciplines, more so in the wake of COVID-19 related health messages and communication. Social media platforms like Twitter serve as a simple, easy, inexpensive and powerful communication asset for individuals, groups and organizations. Twitter currently ranks as one of the leading social networking sites globally based on active users. More than 500 million tweets are sent per day on Twitter and the company boasts of more than 199 million monetizable active users as at July 2021, with a total revenue of $1.04 billion. Twitter is very popular globally amongst millennials who made up 80% of Twitter users. 80% of Twitter users access the platform on a mobile device while 93% of video views are on mobile phones (Aslam, 2021). Registered users can read and post tweets as well as follow other users via update feed. All these daily activities on Twitter generate massive amounts of data useful for research, analysis, marketing and decision making.

Twitter provides an easy way for people to express their feelings, comment on topics of interest and promote themselves. Harris et al. (2014) suggested that social media such as Twitter affords us the opportunity to better disseminate factual information to a larger population on several health-related topics using scientific evidence. This enables us to learn more about the impact of social media as a means to disseminate health messages. Twitter and other social media platforms have become very popular for disseminating health infor-

mation (Nagendran and Dimick, 2014), and has also been used to track breaking news, trends, current affairs and real time self-health reporting. Health related tweets and conversations enables us to understand people perception, beliefs and level of awareness about a subject matter or trending topic. Twitter is a useful data source for infodemiology studies involving public health response monitoring (Xue et al., 2020; Wayne et al., 2015; Zhou et al., 2018).

Twitter conversation on COVID-19 pandemic infection rate, treatment, and vaccination has become a focus for researchers, since it helps to understand public's perception, habits and behavioural intention towards COVID-19 regulations. The use of Twitter to track rapidly evolving sentiments and trending opinion on COVID-19 pandemic has been very significant in the control and mitigation efforts (Xue et al., 2020; Hu et al., 2020; Yang et al., 2021).

Different kinds of information on COVID-19 is spreading on social media which has a significant impact on public opinion; this makes it imperative to study health conversations on social media for proper intervention. Health-related organizations generally use Twitter to communicate health messages, engage the public and promote health literacy (Park et al., 2013; Park et al., 2016; Gallotti et al., 2020). Twitter was effective in communicating public health messages on COVID-19, in debunking fake news and misinformation and disseminating timely health messages (Rufai and Bunce, 2020). Twitter posts, comments, replies, retweets, and likes have become the basis for research data collection, analysis and reporting. Beyond conversational data, Twitter data are also useful for location information to study and monitor online health information,

communication, and interventions (Burton et al., 2012).

As a result of the COVID-19 pandemic, social media became the main platform for public expression, opinions and reactions against different events or public health practices regarding COVID-19 (Pérez-Escoda et al., 2020). Social media is now a vital communication phenomenon for governments, organizations or institutions, and universities for information dissemination to the public. Social media, Twitter in particular, is used to explore multi-facet of public health research. A systematic review recognized that health research can make use of Twitter for six different categories, namely: content, analysis, surveillance, engagement, recruitment, as part of an intervention, and network analysis (Sinnenberg et al., 2017).

Communicable diseases, like COVID-19, nearly resulted in making social media the only means of disseminating health information of all forms to the general public. Hence, social media play a vital role in public perception of disease exposure, eventual decision making, and risk behaviours (Giustini et al., 2018; Al-Dmour et al., 2020). Lots of research efforts have gone into studying the impact of health messages on social media. Moorhead et al. (2013) and Moon et al. (2019) discovered that online health information aids health communication. Hazzam and Lahrech (2018), observed that health communication through social media platforms can be helpful to both healthcare workers and the general public. As social media become a very important healthcare tool, health workers are expected to become very active on social media and communicate professionally with colleagues, patients, and the entire medical community (Mishori et al., 2014).

The ubiquity and easy access make social media an important complement against the traditional methods of disseminating information (Fox et al., 2016). New media platforms have made information exchange seamless and stress-free. The degree of individual awareness about the deadly COVID-19 pandemic determines the reaction of individuals to the transmission of the disease, the awareness of the disease makes people take quick and adequate preventive measures so as to guide against infection. It was revealed through research that the reports of media platforms about a pandemic determine how people form their opinion about the disease prevention and proper health behavioural practices (Collinson et al., 2015).

The great benefits of social media include connecting people together irrespective of the location and information sharing among the people simultaneously. Social media platforms like Twitter, Facebook and WeChat enable sharing of the guidelines for COVID-19 as they are immediately being published by health managements. In response to the COVID-19 pandemic, the population enjoys real-time news and instructions on personal guidance against the deadly virus. Subsequently, health information shared from different social media accounts have a substantial impact on the behavioural attitude of the people, especially when the information is disseminated in real-time and in different forms (Yang and Shiwen, 2021).

People expressed their love and appreciation either by liking an article or by following an account. It was found that there was a great change in the number of followers on so many official accounts within a week of the COVID-19 pandemic (Hu et al., 2020). YouTube also played an important role in disseminating information about COVID-19 concerning the con-

trol of the virus. However, various studies revealed that most YouTube videos were of unpleasant quality because they have few recommended precautions from governments or public health institutions (Tsao et al., 2021). Since the information on social media is mostly generated by users, therefore, such information may be subjective or inaccurate, and can frequently imbibe false information and conspiracy theories (Bridgman et al., 2020). It is then imperative that information is disseminated to the general public in real-time in order to beat misinformation (Pérez-Escoda et al., 2020). Kouzy et al. (2020) studied the rate of misinformation related to COVID-19 pandemic on Twitter by studying 673 English tweets. The researchers observed that false information made up 24.8% of the tweets, while 17.4% of the tweets were unverifiable information. In a similar study by Boon and Skunkan (2020), analysis of 107 990 English tweets showed that negative feeling for the COVID-19 pandemic dominated the conversation, while topic modelling revealed three major themes of discuss: COVID-19 pandemic emergency; ways of controlling COVID-19; reporting cases of COVID-19.

Therefore, social media platforms such as Twitter affords us the opportunity to study health information interaction on social media in order to better disseminate factual information to a larger population on several health-related topics. Meanwhile, Twitter conversation on COVID-19 pandemic situation in Africa remains understudied, and the goal of our study is to address this gap. Therefore, this study aimed to analysed twitter conversation related to COVID-19 pandemic situation in Africa in order to explore the implication of these interactions and to better design health communication strategies for the future. This will also enable us to learn more about the impact of social media as means to disseminate health messages.

SUBJECTS AND METHOD

1. Study Design
This was cohort study with combined quantitative and qualitative approach. This study was conducted in Africa from December 2019 to December 2020.

2. Population and Sample
The population studied was all Twitter accounts that posted or commented on COVID-19 virus related to Africa. The search term was "COVID-19 in Africa OR COVID-19 vaccine in Africa OR Coronavirus in Africa OR Coronavirus vaccine in Africa OR Corona virus in Africa OR Corona virus vaccine in Africa", between 31st of December 2019 and 31st of December 2020.

3. Inclusion and Exclusion Criteria
Inclusion criteria in this study were all tweets, replies, comments, posts, likes related to COVID-19 situation in Africa between the period studied was part of the inclusion criteria.

Exclusion criteria included all tweets, replies, comments, posts, likes unrelated to COVID-19 situation in Africa between or beyond the period studied.

4. Instruments
The data is in the form of primary data. Primary data were obtained using Twint package an advanced open-source python library useful to extract data from Twitter. It is used to scrape tweets using different parameters such as: hashtags, usernames, topics, sentiment analysis etc.

5. Data Analysis
Data was cleaned and managed in CSV format to Dataframe which presents several parameters useful for scientific analysis in table formats including: Tweet id, conversation id, date, time, timezone, user_id, name, place, tweet, language, mentions,

urls, photos, replies count, retweets count likes_count, hashtags, cashtags, likes, retweet, quotes, videos, reply to, amongst others. Besides, it generates useful information for sentiment analysis of tweets which reveals the polarity, neutrality and negatevity score for every single tweet.

RESULTS

1. Sample Characteristics

The first result generated for African Twitter conversation on COVID-19 between the 31st of December 2019 and 31st of December 2020 is a descriptive analysis of the number of tweets. A total of 24, 251 tweets were recorded during the period under study. The study applied a sentiment analyser tool to analyse the tweets and the result is presented in Figure 1.

Sentiment analysis as depicted in Figure 1 indicates that 9, 016 (37.2%) of the tweets were positive 7,024 (29%) were neutral, while 8,211 (33.9%) were considered negative tweets. The frequency of words and phrases is presented as a word cloud graph in Figure 2.

Figure 3 shows that the month of March 2020 saw the highest rate of tweets related to COVID-19 in the African Twitter Conversation. This is not surprising since according to Reuters COVID-19 tracker, March 2020 witnessed the enforcement of pandemic lockdown in many African countries including South Africa, Nigeria, Egypt, Ethiopia, Cameroun, Republic of the Congo, Ghana, Zimbabwe, Uganda, Ivory Coast, Eswatini, Sudan, Gambia, Madagascar, Namibia, Tunisia among others (Reuters, 2021). The analysis of word counts and phrases is presented in Figure 4:
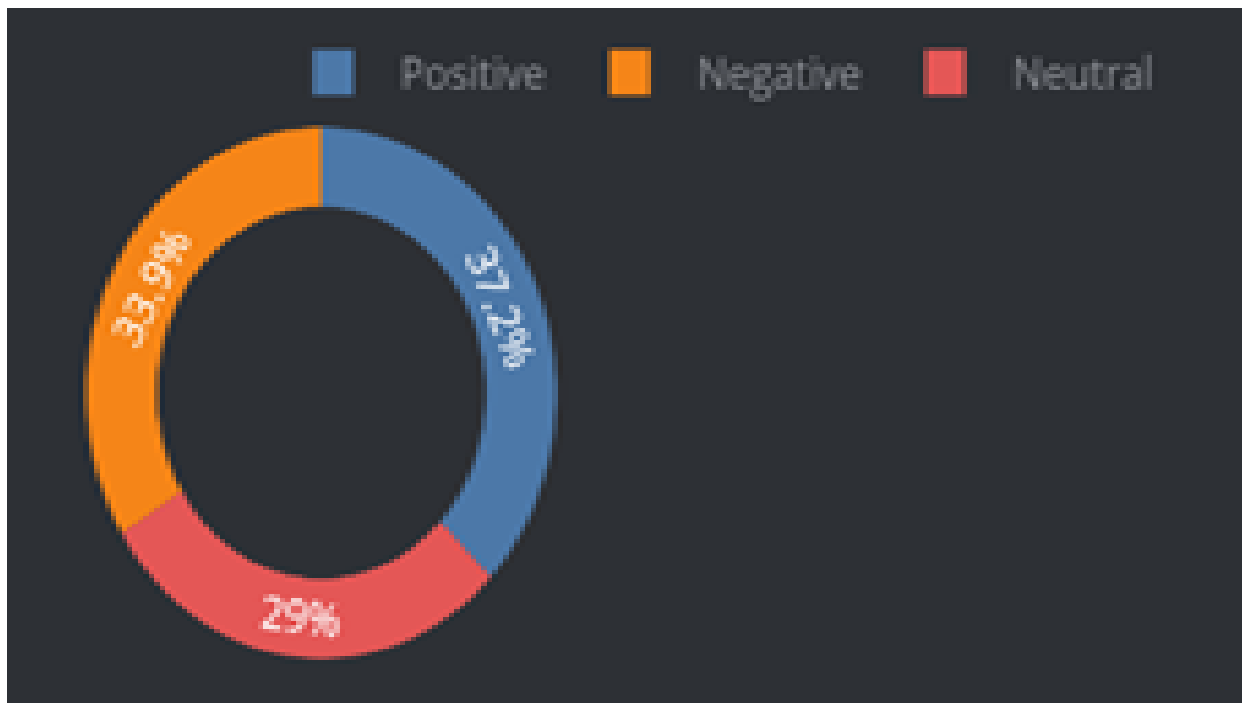

Figure 1: Plotted distribution of sentiment analysis in African COVID-19 Twitter conversation (December 2019 - December 2020)

Figure 2: Word cloud graph in African COVID-19 Twitter conversation (December 2019 - December 2020)

Figure 3: Frequency of tweets by dates in African COVID-19 Twitter conversation (December 2019 - December 2020).

Figure 4 indicates that South Africa is the most frequently used word in COVID-19 Africa Twitter conversation. This is not a surprise as well since South Africa was the epicenter of COVID-19 related infections and deaths in Africa. South Africa, Morocco, Tunisia and Ethiopia are among the countries with the most cases in the continent. In terms of the caseloads, southern Africa is the most affected region, followed by the northern and eastern parts of the continent, while central Africa is the least affected region in the continent (Africa CDC, 2021). Results from topic modeling

indicate four clear topics which are: a) Africa coronavirus, b) First sub-Saharan pandemic variant, c) Total number of confirmed new deaths, and d) COVID-19 cases in Africa. Furthermore, the study extracted hashtags and handles from the tweets to collect their frequency distribution as presented in Figure 5.
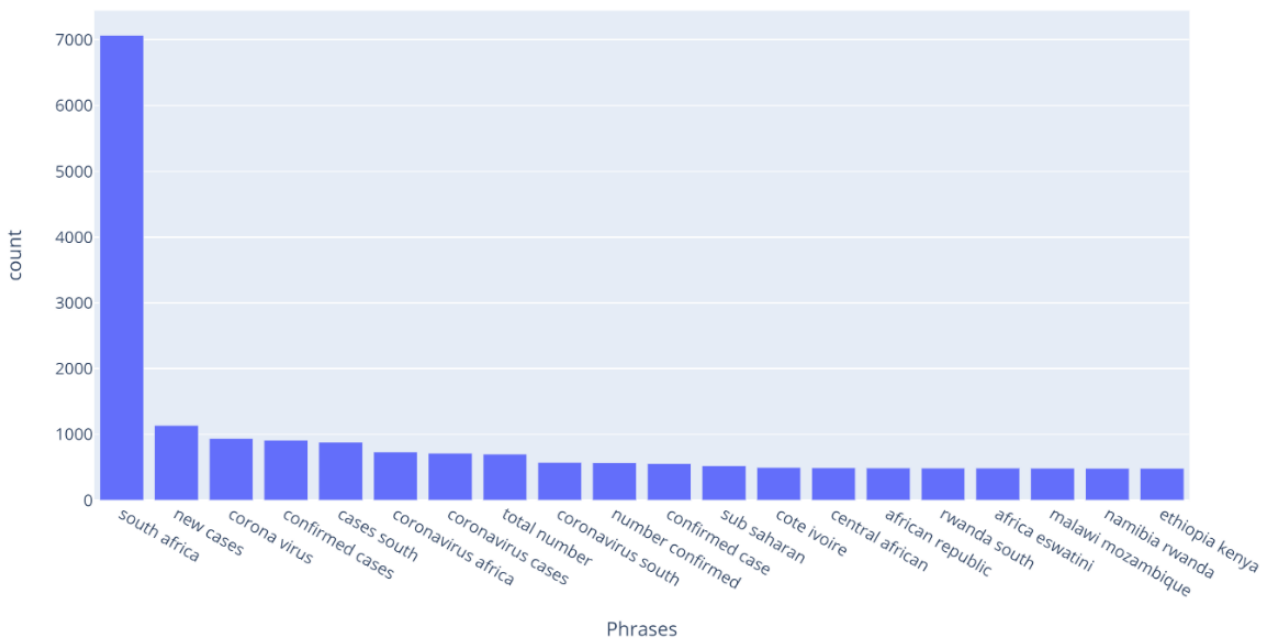

Figure 4: Top 20 occurrences of phrases in African COVID-19 Twitter conversation (December 2019 - December 2020).
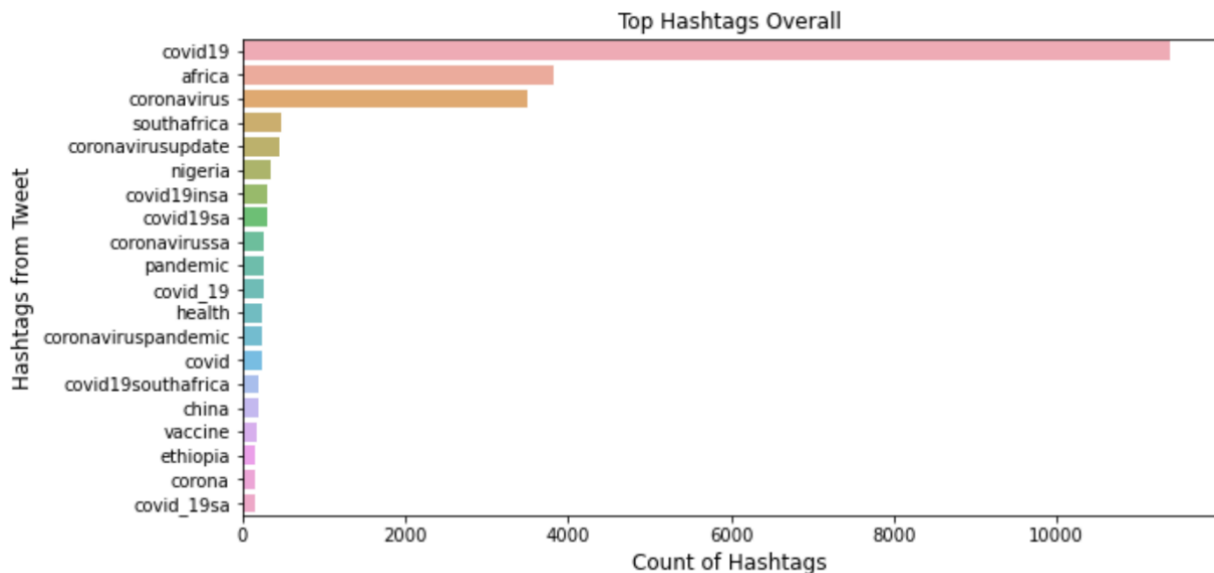

Figure 5: Top Hashtags from tweets in African COVID-19 Twitter conversation (December 2019 - December 2020).

Result from the analysis of hashtags indicates that 'covid-19' is the most popular hashtag followed by 'africa', 'coronavirus', 'southafrica', 'coronavirusupdate', 'nigeria',

'covid19insa', 'covid19sa', 'coronavirussa'. This finding shows that most of the conversation going on Twitter concerning COVID-19 situation in Africans is centered on the pandemic situation in South Africa, and it was the main focus of discussion. Furthermore, it was observed that the conversation was mainly between Twitter handles of individuals from different parts of Africa. Figure 6 and Table 1 shows the top five handles posting information and engaging in COVID-19 discussion during the period under review.

   Table 1. revealed that the top five twitter handles posting information related to COVID-19 situation in Africa are: *@COVID19_bot, followed by @COVID-Live, @HealthZA, @Simacoder, and @APO_source.* @COVID19_bot is a Twitter account that periodically post the most up-to-date data regarding COVID-19 pandemic using data from Worldometer, Johns Hopkins University CSSE and Wikipedia, @COVIDLive shares current news and statistics on COVID-19 on a day to day basis using data from Worldometer, @HealthZA is the official Twitter account of the National Department of Health South Africa, @Simacoder is a Photojournalist who is very active in posting COVID-19 information, while @APO_source is a Pan-African communications and press release distribution service.
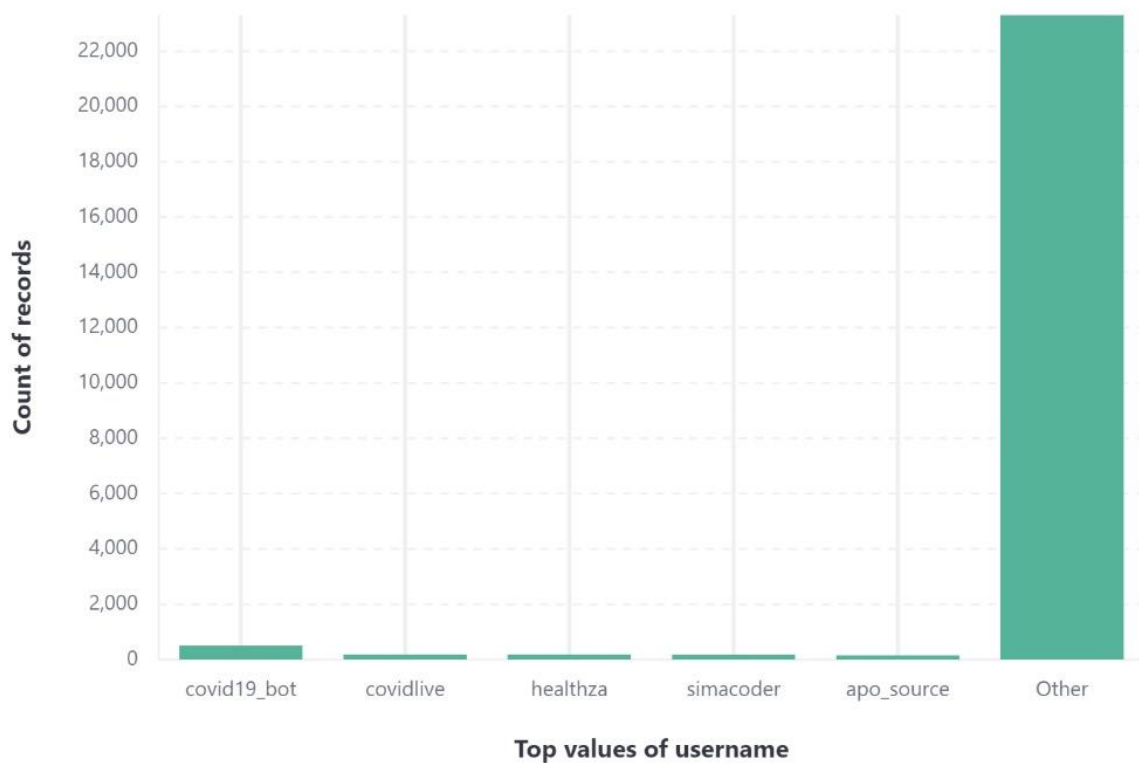

Figure 6: Top 5 Twitter handles in African COVID-19 Twitter conversation (December 2019 - December 2020).

The most interesting finding from Table 1 is the fact that most health authorities and partners in Africa are not active on Twitter except for @HealthZA which is the official

Twitter account of the National Department of Health South Africa, @Crowdfrica which engages in sourcing funding for healthcare

in Africa and @AfricaCDC which is a technical institution of the African Union.

Table 1: Top Twitter handles in African COVID-19 Twitter conversation (December 2019 - December 2020).

Twitter handles	Frequency (n)	Percentage (%)
covid19_bot	507	
covidlive	188	0.81
healthza	185	0.80
simacoder	183	0.79
apo_source	149	0.64
laudiumtoday	134	0.58
herbicrafts	128	0.55
sabcnews	71	0.31
exantedata	71	0.31
crowdfrica	65	0.28
theafricamentor	64	0.28
coronaspread	62	0.27
allafrica	55	0.24
africacdc	46	0.20
zeinobia	45	0.19
nkosi_milton	45	0.19
knowcovid19	43	0.19
covid_africa	42	0.18
bsctza	38	0.16
whthome	37	0.16

DISCUSSION

This study on Twitter conversation related to COVID-19 situation in Africa reflect the pattern of communication amongst African tweeps between the year 2019 and 2020. The period under study was the epic period of the pandemic in Africa and the rest of the world. A total number of 24, 251 tweets was recorded, out of which 9, 016 (37.2%) of the tweets were positive, indicating positive attitude towards COVID-19 infections, control, mitigation, and regulations. A number of 7, 024 (29%) of tweets were considered neutral, indicating a neutral opinion on conversations related to COVID-19, while 8, 211 (33.9%) were considered negative tweets.

The high rate of negative tweets is quite alarming and negatively affects pandemic control and mitigation. Similar findings were reported by Kouzy et al. (2020), Boon-Itt and Skunkan (2020). Kouzy et al. (2020) found that 24.8% of the tweets they analysed included misinformation, while most of the tweets analysed by Boon-Itt and Skunkan (2020) were filled with negative comments. Hence, information interaction on health-related topics especially during a pandemic or epidemic can instigate extreme self-relevant emotions and eventually raise personal-level risk perception and preventive behaviours (Oh et al., 2020). Meanwhile, the month of March 2020 saw the highest numbers of tweets related to COVID-19 in the African Twitter Conversation which was the period when pandemic lockdown was announced in most African countries. Announcement of lockdown leads to people having to make changes in behaviour and to seek more clarifications on the pandemic through social media interactions.

The analysis of word counts and phrases revealed that South Africa is the most frequently used word in COVID-19 Africa Twitter conversation and many of the con-

versations were cantered upon the critical COVID-19 situation in South Africa. Findings from topic modelling generated four clear topics, which were: a) Africa coronavirus, b) First sub-Saharan pandemic variant, c) Total number of confirmed new deaths, and d) COVID-19 cases in Africa. Results from topic modelling revealed that African tweeps were very much concerned about the growing number of infections and this was the major topic of discussion. The top five twitter handles posting information related to COVID-19 situation in Africa are: @COVID19_bot, followed by @COVIDLive, @HealthZA, @Simacoder, and @APO_source. @COVID19_bot is a Twitter account that periodically post the most up-to-date data regarding COVID-19 pandemic using data from Worldometer, Johns Hopkins University CSSE and Wikipedia, @COVIDLive shares current news and statistics on COVID-19 on a day to day basis using data from Worldometer, @HealthZA is the official Twitter account of the National Department of Health South Africa, @Simacoder is a Photojournalist who is very active in posting COVID-19 information, while @APO_source is a Pan-African communications and press release distribution service. What is of concern in this particular finding is the fact that most government health ministry and subsidiaries in Africa are not active on Twitter excepb t for @HealthZA which is the official Twitter account of the National Department of Health South Africa, @Crowdfrica which engages in sourcing funding for healthcare in Africa and @AfricaCDC which is a technical institution of the African Union.

The World Health Organization recognizes the danger of misinformation during a pandemic; infodemic is fast and widely circulated information which could be a blend of accurate, inaccurate and misinformation. The effect of Infodemic on healthy behavioural practices can be so damaging and can raise the risk of contracting the disease. Social media platforms like Twitter offer great benefits with regards to information dissemination, sharing, exchange of ideas. However, the dangers of these free and easy to use platforms should be critically addressed. Health information dissemination on social media must be scrutinized or moderated, otherwise false information would continue to aggravate the spread of diseases leading to deaths. In order to protect the public against false information, public health institutions, governments and partners in health should establish an active presence on social media to share factual information, and debunk misinformation in real-time.

AUTHORS CONTRIBUTION

Sanni Shamsudeen Ademola conceptualized and designed the research idea, he coordinated the study and was involved in co-writing the entire paper. Neemah Rajabu wrote all the Python code for the Twitter data retrieval, processing, analysis and visualization. Aliyu Olugbenga Yusuf was actively involved in data cleaning, processing and analysis. Ntombikayise Nomsa Mathabela participated in the critical review of literature. Lasisi Kamoru Alamu likewise collaborated in reviewing relevant literature for the study, identifying gaps in research, data collection, data processing, data analysis and interpretation of results.

FUNDING AND SPONSORSHIP

This study is self-funded.

CONFLICT OF INTEREST

There is no conflict of interest in this study.

REFERENCES

Al-Dmour H, Amer SMA, Al-Dmour R (2020). Influence of social media platforms on public health protection against the COVID-19 pandemic via the mediating effects of public health awareness and behavioural changes: integrated model. J. Med. Internet Res. 22(8): 19996. DOI: 10.2196/-19996.

Aslam S (2021). Twitter by the Numbers: Stats, Demographics & Fun Facts, Omnicore. Available at: https://-www.omnicoreagency.com/twitter-statistics/.

Boon-Itt S, Skunkan Y (2020). Public perception of the COVID-19 pandemic on Twitter: Sentiment analysis and topic modeling study. JMIR. Public Health and Surveillance. 6(4): 21978. DOI: 10.2196/21978.

Bridgman A, Merkley E, Loewen PJ, Owen T, Ruths D, Teichmann L, Zhilin O. (2020). The causes and consequences of COVID-19 misperceptions: Understanding the role of news and social media. Harvard Kennedy School Misinformation Review. 1(3). DOI: 10.-31219/osf.io/6tcdn.

Burton SH, Tanner KW, Giraud-carrier CG, West JH (2012). Right Time, Right Place, Health Communication on Twitter: Value and Accuracy of Location Information. 14: 1–11. DOI: 10.37016/mr-2020028.

Collinson S, Khan K, Heffernan JM (2015). The effects of media reports on disease spread and important public health measurements. PloS one. 10(11): 0141423. https://doi.org/10.1371/-journal.pone.0141423.

Gallotti R, Valle F, Castaldo N, Sacco P, Domenico M. (2020). COVID-19 epidemics, Nature Human Behaviour. Springer US. DOI: 10.1038/s41562-020-00994-6.

Giustini D, Ali SM, Fraser M, Boulos MNK (2018). Effective uses of social media in public health and medicine: a systematic review of systematic reviews. Online J. Public Health Inform. 10(2): 215. DOI: 10.5210/ojp-hi.v10i2.8270.

Hazzam J, Abdelmounaim L. (2011) Health care professionals' social media behaviour and the underlying factors of social media adoption and use: quantitative study. J. Med. Internet Res. 20(18): 12035. DOI: 10.2196/12035.

Hu Z, Yang Z, Li Q, Zhang A (2020). The COVID-19 Infodemic: Infodemiology study analysing stigmatizing search terms. J. Med Internet Res. 22(11).

Kouzy R, Abi JJ, Kraitem A, El-Alam MB, Karam B, Adib E, Zarka J, et al., (2020). Coronavirus Goes Viral: Quantifying the COVID-19 Misinformation Epidemic on Twitter. Cureus, 12(3), e7255. DOI: 10.7759/cureus.-7255

Mishori R, Singh LO, Brendan L, Calvin N (2014). Mapping physician Twitter networks: describing how they work as a first step in understanding connectivity, information flow, and message diffusion. J. Med. Internet Res. 16(4): 107. DOI: 10.2196/jmir.3006.

Moorhead SA, Hazlett DE, Harrison L, Carroll JK, Irwin A, Hoving C (2013). A new dimension of health care: systematic review of the uses, benefits, and limitations of social media for health communication. J. Med. Internet Res. 15(4): 1933. DOI: 10.2196/-jmir.1933.

Nagendran M, Dimick JB. (2014). Disseminating research findings preparing for generation. JAMA Surg. 49(7): 629–630. DOI: 10.1001/jamasurg.2013.-5019.

Park H, Reber BH, Chon MG, Park H, Reber BH, Chon MG. (2016). Tweeting as Health Communication: Health organizations use of twitter for health promotion and public engagement tweeting as health communication: health organizations. Use of Twitter for Health Promotion and Public Engagement. 21(2):188–198. DOI: 10.1080/10810730.2015.1058435.

Park H, Rodgers S, Stemmle J. (2013). Analysing health organizations' use of Twitter for promoting health literacy. J. Health Commun. 18(4):410-25. https://doi.org/10.1080/10810730.-2012.727956.

Pérez-Escoda A, Jiménez-Narros C, Perlado-Lamo-de-Espinosa Marta, Pedrero-Esteban LM (2020). Social networks engagement during the COVID-19 pandemic in Spain: health media vs. healthcare professionals. Int. J. Environ. Res. Public Health. 17(4): 5261. DOI: https://doi.org/10.-3390/ijerph17145261.

Reuters (2021). COVID-19 Global tracker, Reuters research. Available at: https:-//graphics.reuters.com/worldcoronavirus-tracker-and-maps/.

Rufai SR, Bunce C. (2020). World leaders' usage of twitter in response to the COVID-19 pandemic: A content analysis. J Public Health. 42(3): 510–516. DOI: 10.1093/pubmed/fdaa049.

Sinnenberg L, Buttenheim AM, Padrez K,

Mancheno C, Ungar L, Merchant RM (2017). Twitter as a tool for health research: a systematic review. Am J Public Health. 107(1): 1–8. DOI: 10.-2105/AJPH.2016.303512.

Wayne W, Chiu XI, Chen Y, Mukherjee T. (2015). Twitter hashtags for health : applying network and content analyses to understand the health knowledge sharing in a Twitter-based community of practice. Quality Quantity. Springer Netherlands. 1361–1380. doi: 10.1007/s11135-014-0051-6.

Xue J, Chen J, Hu R, Chen C, Zheng C, Su Y (2020). Twitter Discussions and Emotions about the COVID-19 Pandemic: Machine Learning Approach. J. Med. Internet Res. 22(11): 1–14. doi: 10.21-96/20550.

Yang Q, Shiwen W (2021). How social media exposure to health information influences Chinese people's health protective behaviour during air pollution: a theory of planned behaviour perspective. Health communication. 36(3): 324–333. doi: 10.1080/10410-236.2019.1692486.

Zhou J, Liu F, Zhou H (2018). Understanding health food messages on Twitter for health literacy promotion. Perspectives in Public Health: 138(3): 173–179. doi: 10.1177/1757913918760-359.