Assessing role of infodemics through mHealth, social media, and electronic media on COVID-19 and its vaccination among caregivers and healthcare providers in Pakistan: A qualitative exploratory study

Abdul Momin Kazi, Nazia Ahsan, Rawshan Jabeen, Raheel Allana, Saima Jamal, Muhammad Ayub Khan Mughal, Kathryn L Hopkins, Fauzia Aman Malik

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Abstract

Background: The COVID-19 pandemic has had a significant impact on different countries due to which various health and safety measures were implemented with digital media playing a pivotal role. However, digital media also poses significant concerns, such as misinformation and lack of direction.

Objective: We aimed to explore the role of digital and social media during the COVID-19 pandemic and its vaccines to understand the nature of the infodemic among caregivers and healthcare providers in an LMIC.

Methods: This study employed a qualitative exploratory study design with purposive sampling strategies, conducted at three primary healthcare facilities in the province of Sindh, Pakistan. Seven focus group discussions with healthcare providers and 60 in-depth interviews with caregivers were conducted using semi-structured interviews through virtual platforms (Connect on Call and Zoom). Transcripts were analyzed through thematic analysis.

Results: Our study revealed the pivotal role of electronic media, mHealth and social media during the pandemic. Four major themes were identified which include (1) sources of information about COVID-19 and its vaccination, (2) electronic media value and misleading communication, (3) mHealth leveraging and limitations during COVID-19 and (4) social media influence and barriers during COVID-19. Healthcare providers and caregivers shared that common sources of information were electronic media and mHealth, followed by social media. Some participants also used global media for more reliable information related to COVID-19. mHealth solutions such as public awareness messages, videos, call ringtones, and helplines promoted COVID-19 prevention techniques and vaccine registration. However, overwhelming influx of news, social-political narratives including misinformation/disinformation through social media such as WhatsApp, Facebook and Twitter were found to be the primary enablers of vaccine-related infodemics. Electronic media and mHealth were utilized more widely to promote the COVID-19 pandemic and vaccine-related information and communication. However, social, and electronic media-driven infodemics were identified as major factors for misinformation related to the COVID-19 pandemic and vaccine hesitancy. Further, this study also found a digital divide between the urban and rural populations, with the use of electronic media in rural, and social media in urban settings respectively.

Conclusions: In conclusion this study found that in a resource-constrained setting like Pakistan the usage of mHealth, social media and electronic media on information spread (both factual and mis- and disinformation) relating to COVID-19 and its vaccination had a significant impact on vaccination attitudes. Based on qualitative findings, this study generated a model of digital communications and information dissemination ‘to increase knowledge about COVID-19 and its prevention measures, including vaccination which can be replicated in similar settings for other disease burdens and related infodemics. Further to

mitigate infodemics, both digital and non-digital interventions are needed at a larger scale.

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Background

The COVID-19 pandemic has had a significant impact on different countries due to which various health and safety measures were implemented with digital media playing a pivotal role. However, digital media also poses significant concerns, such as misinformation and lack of direction.

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were electronic media and mHealth, followed by social media. Some participants also used global media for more reliable information related to COVID-19. mHealth solutions such as public awareness messages, videos, call ringtones, and helplines promoted COVID-19 prevention techniques and vaccine registration. However, overwhelming influx of news, social-political narratives including misinformation/disinformation through social media such as WhatsApp, Facebook and Twitter were found to be the primary enablers of vaccine-related infodemics. Electronic media and mHealth were utilized more widely to promote the COVID-19 pandemic and vaccine-related information and communication. However, social, and electronic media-driven infodemics were identified as major factors for misinformation related to the COVID-19 pandemic and vaccine hesitancy. Further, this study also found a digital divide between the urban and rural populations, with the use of electronic media in rural, and social media in urban settings respectively.

Conclusion

In conclusion this study found that in a resource-constrained setting like Pakistan the usage of mHealth, social media and electronic media on information spread (both factual and mis- and disinformation) relating to COVID-19 and its vaccination had a significant impact on vaccination attitudes. Based on qualitative findings, this study generated a model of digital communications and information dissemination ‘to increase knowledge about COVID-19 and its prevention measures, including vaccination which can be replicated in similar settings for other disease burdens and related infodemics. Further to mitigate infodemics, both digital and non-digital interventions are needed at a larger scale.

Funding

Sabin Vaccine Institute (Agreement number: 050110-00)

Introduction

The COVID-19 pandemic has had a deleterious impact on healthcare systems, economies, and societies, globally [1]. This impact has been exacerbated by the resulting COVID-19 “infodemic” or accompaniment of too much information, including false or misleading information, also occurring in the new, digital age of information sharing. With more than three billion digital media users globally, digital media became the key source of information and communication, particularly during a crisis, creating a ‘digital pandemic’ of information disseminated in multiple forms regardless of the legitimacy of the sources [2-4]. Downstream effects are confusion, low vaccine confidence, vaccination refusal, and other poorly informed health behavior-related decision-making [5,6]. The most severe consequences are evident in LMICs and among marginalized communities [7], where trust in and exposure to official health information sources is comparatively low [8] and there are lower health literacy levels, poor health infrastructure and resources [9].

Amidst experienced disruptions to healthcare associated with the COVID-19 pandemic and

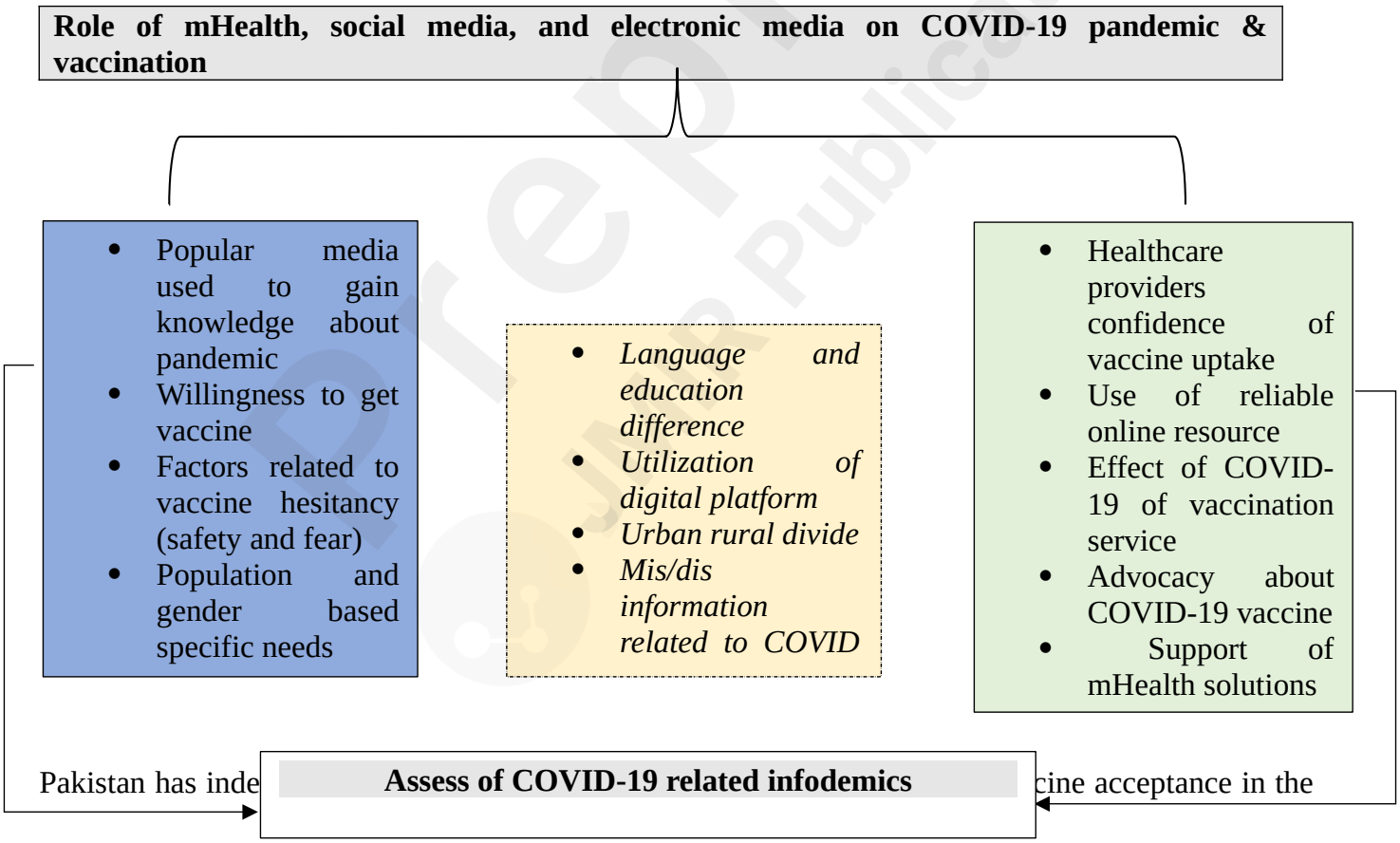
infodemic, an opportunity also arose. With the advancement of information and technology, digital health played a critical role in COVID-19 response, advocacy, and mobilization [10]. Specifically, digital media assisted in disseminating correct information through mobile health (mHealth)—mobile wireless technologies for public health. These innovations are an integral part of eHealth, which include the cost-effective and secure use of information and communication technologies in support of health and health-related fields, social media promoted public health initiatives, and electronic media-raised awareness of and encouraged preventative measures (e.g., hand hygiene and vaccination uptake) [11].

During the COVID-19 pandemic, many countries developed mHealth applications to assist with identifying of prevalent symptoms for self-assessment, implementing contact tracing, disseminating information, and minimizing exposure and reducing face-to-face interaction between patients and health workers [12]. A WhatsApp chatbot application in South Africa used machine learning technology to provide free, automated responses to user queries on COVID-19, relating to travel advice, recent statistics, symptoms, and debunking of myths and misinformation [13]. Facebook groups were utilized by most of the healthcare professionals during the pandemic to discuss and integrate real-time experiences in illness treatment [14]. Data visualization dashboards enabled data-driven infographics representing global-to-local pandemic-related statistics, which allowed for the public and researchers to comprehend and track the pandemic in real-time [15]. Lastly, social media channels were used to inform citizens about pandemic-related government response efforts and updates, such as the National WhatsApp channel established in Singapore during the COVID-19 surge [16].

Based on the described initiatives during the COVID-19 pandemic, we have developed a comprehensive framework highlighting the key roles of various digital platforms. This framework highlights how digital tools played diverse and complementary roles in pandemic management, from disseminating information and assessing symptoms to real-time data tracking and communication.

These tools were pivotal in proactive intervention, personalized guidance, knowledge exchange among experts, data-driven decision-making, and fostering community resilience through amplified public health messaging and grassroots initiatives **(figure 1).**

Figure 1: Role of mHealth, social media and electronic media during covid-19



Pakistan has inde cine acceptance in the past. The country has a history of vaccine-preventable disease outbreaks due to various factors, including misinformation, cultural beliefs, lack of awareness, and mistrust in vaccines. One notable example is the polio eradication efforts in Pakistan. Despite considerable progress made globally,

Pakistan has remained one of the few countries where polio cases continue to be reported [17]. Further Pakistan is a country with diverse cultural and linguistic backgrounds, where different regions may have unique sociodemographic factors that influence vaccine acceptance and hesitancy [18]. Moreover, the COVID-19 pandemic has brought about new challenges and concerns regarding vaccine acceptance globally. It is essential to examine the role of digital media and mHealth interventions on vaccine acceptance and uptake differs across regions in Pakistan. Factors such as regional beliefs, levels of trust in digital media sources, and access to healthcare information may vary, leading to different outcomes in vaccine-related decision-making. By exploring these regional differences, the study can provide valuable insights into the role of digital health interventions in addressing vaccine hesitancy in diverse settings. Thus, it is vital that these digital health interventions continue to be developed to harness social media for public good and increase trust in vaccines and vaccination, especially within LMICs like Pakistan. Thus, we explored the role of mHealth, social media (e.g., Facebook, Twitter, Instagram etc.), and electronic media (i.e., Television and radio) during the COVID-19 pandemic and its association with COVID-19 vaccination and childhood routine immunization acceptance and uptake amongst parents and child caregivers and healthcare providers in a resource-constrained setting in Pakistan.

Methods

Study Design, Setting and Population

The exploratory qualitative research was employed to assess the role of infodemics through mHealth, electronic and social media in Pakistan to explore the unique experiences and insights of population which may be overlooked in quantitative studies [19, 20]. This study was implemented between May 2020 – August 2021 at three sites in Pakistan: the peri-urban Aga Khan University (AKU) Health Demographic Surveillance System (HDSS) Primary Healthcare Centers (PHC) of Ali Akbar Shah Goth and Bhains Colony, the rural Sindhi district of Matiari, and the Community Health Center (CHC) vaccination clinic at the Aga Khan University Hospital (AKUH) in urban Karachi. The three

selected sites in Pakistan were chosen to represent diverse populations and capture unique socio-economic and cultural factors influencing vaccine acceptance and hesitancy. The vaccination center at peri-urban sites targeted low-middle to low-income individuals, the rural area represented a low-income population, and the vaccination center at Aga Khan University Hospital (urban site) encompassed both high-income and low-middle-income backgrounds. This approach ensured a comprehensive understanding of vaccination behaviors across different socio-economic contexts aimed to understand the role and impact of mHealth, social media, and electronic media on vaccine-related attitudes and behaviors across different socio-economic contexts. Focus group discussions (FGDs) were implemented amongst HWs (doctors, nurses, pharmacists, Lady Health Visitors (LHVs), Vaccinators, Lady Health Workers (LHWs), and Community Health Workers (CHWs) in Karachi and Matiari who worked in the selected centers and in-depth interviews (IDIs) were conducted with parents/caregivers of children < 1 year of age. **Figure 2** illustrates a flow chart showing from where participants were recruited.

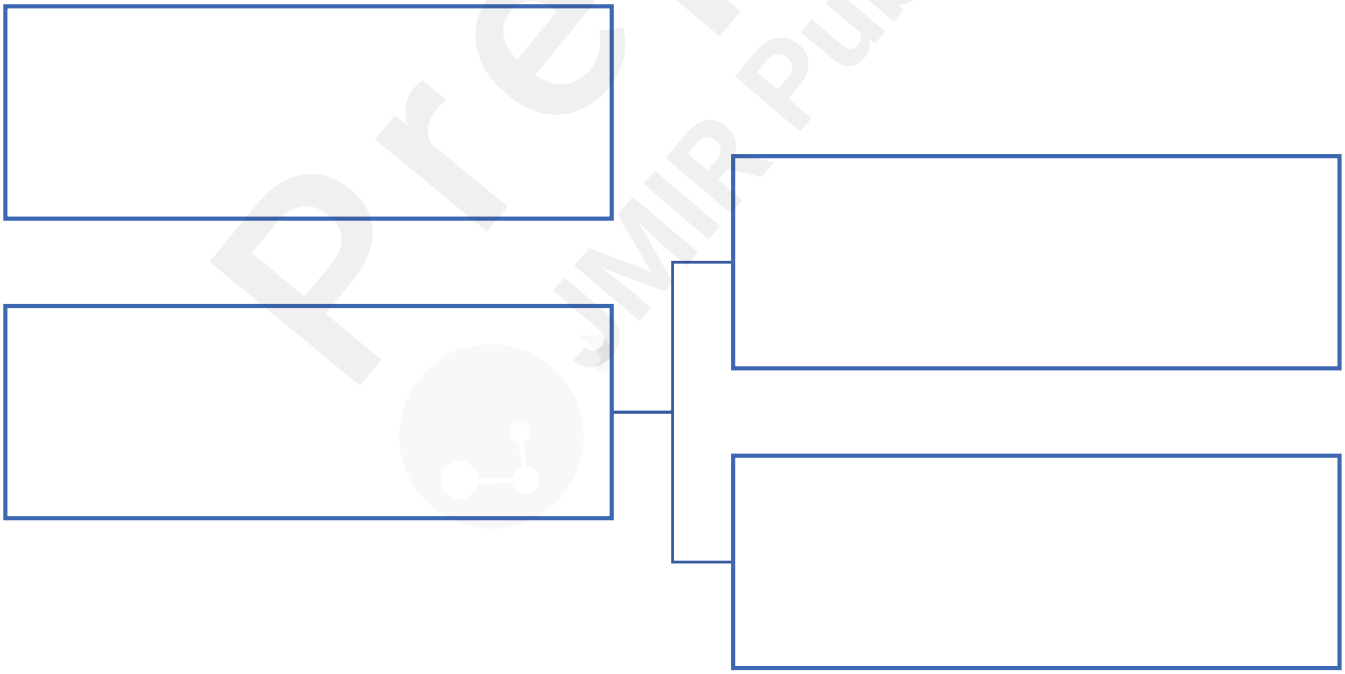


Figure 2: *Flow chart depicting participants enrollment.*

Ethical Approval

The study received the approval from the ethical review committee of Aga Khan University (2020-5316-14620).

Inclusion criteria and sampling approach

We used purposive sampling technique for recruiting health care providers and convenient sampling was applied on parent's selection. Parents or child caregivers were eligible as IDI participants if (i) they have at least one child under one year of age (ii) their telephonic contact number was listed in either the registry maintained by AKU Hospital and its associated centers at the study sites or provided by a community health workers (CHWs) affiliated with the study sites. The IDIs were conducted with one caregiver at a time. Healthcare providers such as doctors, nurses, pharmacists, lady health visitors (LHVs), vaccinators, and CHWs at each of the three study sites were eligible as FGD participants. However, 6-8 participants were included in the FGDs. The parents/ caregivers and healthcare providers who did not provided consent were excluded from the study.

Study frameworks and tool

Semi-structured qualitative interview guides were developed for both IDI and FGD data collection in English and local Urdu language with the help of literature review [21-23]. The main topic discussed were access of electronic and social media among diverse population, barriers and perceived challenges, caregivers/parental concerns about vaccine safety, understanding of content available on digital media and word of mouth within the community. Moreover, HCPs were more focused on associated factors with COVID-19 fear and content created dis/mis information which may lead to vaccine hesitancy. We used the process defined in figure 2 to gather data.

Data collection and Management

A team of researchers from AKU designed and piloted the research tools and trained qualitative research staff for conducting FGDs and IDIs. Due to the ongoing pandemic, all data collection was

conducted remotely as per COVID-19 standard operating procedures. Seven focus group discussions with healthcare providers and 60 in-depth interviews with caregivers were conducted using semi-structured interviews through virtual platforms (Connect on Call and Zoom) till the point of saturation. Two alternative methods were employed to acquire data: 40-60 minutes IDIs were conducted telephonically, while 60–90-minute FGDs with healthcare providers were conducted using the Zoom video conferencing platform. After obtaining verbal informed consent for participation, the respondents affiliated with all three study sites were given an overview of the study objectives and parents/caregivers were provided training or guidance on how to conduct virtual interviews on a phone which can be helpful for individuals who may not be tech-savvy or have limited experience with virtual communication and healthcare providers were debriefed about the Zoom platform and its related features to avoid any hindrances while interviews were being conducted. Data was recorded on the phone and Zoom password protected device.

Data Analysis

Thematic analyses were adopted as part of qualitative study. Each audio recorded Sindhi and/or Urdu-spoken IDIs and FGDs were transcribed and translated to English. The English transcripts were then assessed and coded separately and connected to text fragments that reflected crucial user perspectives. The data were subsequently organized into thematic categories by looking for topics and then reviewed, defined, and named. We ensured trustworthiness of the data analysis by using Lincoln Guba guidance e.g., to reduce researcher biasness two team members analyzed. Further all discrepancies were resolved after team discussion, the finalize codes to generate major themes coming out through the FGDs and in-depth interviews. The team then contrasted themes before more targeted coding, focusing on ideas linked to mHealth, social media, and electronic media.

RESULTS

Table 1 below summarizes the key findings.

	Sub-theme	Key findings
COVID -19 related Infodemics	**Electronic media infodemics**	• Overselling of news • Both factual and false information • Fabricated news around COVID-19 and vaccination • Influence of negative political narrative • Anxiety due to exaggerated breaking news
	Social media infodemics	• Negative impact of videos (burial process) • Overhype of content creating fear of getting infection • Sharing of conflicting post (audios, videos) • False information through nonmedical professionals • Myths about adverse effects of COVID -19 vaccine, brain damage, infertility, and death)
	mHealth infodemics	• Lack of pandemic related information in rural population • Limited access of mobile phone • Parents were unable to understand information about COVID-19 information through ring tones • Reluctant about sharing personal identification number required for vaccination registration

The subsections below further explain the results.

1. **Access to information through print, electronic and digital media**

Healthcare providers (HCPs) and caregivers shared that COVID-19-related information was commonly disseminated through print media, mHealth, and social and electronic media. The HCPs of the urban site reflected their beliefs about the use of the medium as authentic, as mobile phones (WhatsApp) were easily accessible and conveniently used. Moreover, HCPs also used Facebook to access information from official pages of World Health Organization, Centers for Disease Control, and other international websites. While a few caregivers also used international media for more reliable information related to COVID-19, caregivers in rural areas showed concern about media could not reach and who had limited services on mobile networks.

“I get credible information from Google. We also access COVID-related information from Facebook

pages of WHO, CDC and other international health organizations and they [healthcare workers] received official updated information through WhatsApp by senior management" (FGD- Healthcare provider from Karachi).

"Women do not own mobile phones. Usually, they are used by males in our community" (FGD-Healthcare provider from Matiari).

"COVID-19 related SMS is important in those areas where there are not many ways of information like small cities and villages, where there is no internet available" (IDI-Parent/caregiver from CHC).

mHealth:

2. Perceived mHealth solution usefulness and challenges during COVID -19

During Pandemic, SMS-based mobile interventions were used to promote COVID-19 prevention techniques and register the general population for COVID-19 vaccination at both urban and rural sites. These messages tried to influence public behaviors, such as standard operating procedures (SOPs) related to COVID-19 prevention, follow-up appointments and immunization advantages. Caregivers endorsed these government services. Caregivers shared that they received messages for the registration for COVID-19 vaccination of people over 60 years of age. HCPs stated that conducting vaccination registration using national identity card (CNIC) numbers was a good initiative and felt an automated system that shared reminder messages would help to reduce the defaulters.

"Public service -SMS are beneficial in spreading awareness about COVID-19 pandemic, SOPs, and getting vaccinated against COVID -19" (FGD-Healthcare provider from Matiari).

"The public service -SMS is about COVID-19 vaccine registration, if your age is above 60 then you can get your vaccines, for registration send your CNIC number to 1166" (IDI-Parent/caregiver from CHC).

Urban caregivers felt more suspicious whenever CNIC was asked for vaccination or other treatment, as a circulating rumor via Twitter stated this local data was being gathered for use by foreign

agencies, such as the United States or China.

"They ask for your NIC number when you go to get your COVID-19 test done. There were such gossips making rounds that your data will be sold to China or USA or on Twitter, like China and USA will control the world" (IDI-Parent/caregiver from CHC).

Social media

a. Community access to social media and information

HCPs perceived that social media, including WhatsApp, YouTube and Facebook were used as a positive medium for circulating updated information during this pandemic. However, they also shared that vaccine hesitancy increased amongst the general population, because of the social media infodemic. Caregivers in urban areas reported using social media such as Facebook and the internet to learn about COVID-19 prevalence and news updates, but those in rural areas reported that they have never used social media.

"Social media (Facebook, WhatsApp, Instagram, YouTube) is the first source of information about COVID" (FGD-Healthcare providers from CHC Karachi).

b. **Conflicting news related to COVID-19 and its spread through social media**

Caregivers shared that the news circulating via social media was largely negative and fabricated, creating fear among the general population in both the settings. Participants felt social media was full of opinionated people who deliberately post to impose their personal beliefs on the public.

"Things shared on social media are completely meaningless. Everyone became a doctor and began to demonstrate their competence. Social media is rife with stories about people becoming unwell after receiving their first dose of vaccination. People are skeptical of the COVID-19 vaccine" (IDI-Parent/caregiver from Matiari).

"We get awareness through these messages, but sometimes rumors are being spread through social media posts, so we need to check the information being shared and look at its sources and determine if the messages are credible and true or false" (FGD-Healthcare provider from Karachi).

c. COVID-19 pandemic and vaccine rumors spread through social media

According to these caregivers, the news about vaccine-related adverse events was shared by trusted community members such as friends and relatives on platforms like WhatsApp and Facebook. This information spread quickly, leading to skepticism about the safety and efficacy of COVID-19 vaccines. A few caregivers reported that the news on social media shared COVID-19 immunizations caused brain stroke/clotting and that this news led to vaccine hesitancy.

"People got hesitant to receive the COVID-19 vaccination after reading on social media that it causes brain coagulation" (IDI-Parent/caregiver from CHC).

"Then there were rumors that so many people died or got infected after getting the vaccine" (FGD-Healthcare provider from Matiari)

One of the significant challenges regarding news was the uncertainty on delivery of accurate information and its understanding among the population. Caregivers shared multiple rumors regarding COVID-19 immunization such as it caused infertility in unmarried people and congenital malformations in children of vaccinated pregnant women, and increased mortality rate amongst vaccinated people.

"After getting COVID-19 vaccine, you might become infertile and unable to conceive. There were rumors that many people died or got infected after COVID-19 vaccine" (FGD-Healthcare provider from Matiari).

Electronic Media

a. Role of electronic media platforms during the COVID-19 pandemic

Electronic media was the main source of information for the rural population. The caregivers suggested that electronic media has a significant impact on communities sharing that international media like BBC never fabricated information as compared to the national news channels. Further, COVID-19 news about morbidity and mortality was telecast as a sensational issue. According to the healthcare providers, there were many erroneous calls and SMS messages with incorrect information

circulating among the caregivers. Nonetheless, the information was validated by healthcare providers before passing it to others. Further, they double-checked every news item from official sources before sending it to others.

"In my opinion, news that is broadcasted on BBC is not fabricated. So, media should encourage more programs and talk shows on COVID-19 prevention and its vaccination rather than sensational news on morbidities and mortalities" (IDI-Parent/caregiver from CHC).

"Public service messages are important in creating awareness about COVID-19 pandemic only if they are sent from a relevant source like official government websites or numbers, then you know that this is a credible bit of information" (FGD-Healthcare providers from CHC Karachi).

b. COVID-19 vaccine hesitancy and misleading information spread through electronic media

HCPs expressed that sometimes non-medical personalities shared their opinions on the news, which may confuse the population and negatively influence other individuals' vaccination behavior. One of the caregivers in the urban site expressed that he felt worried and stressed after receiving COVID-19 related news. The rural population expressed comparable concerns about news-related anxiety. Caregivers believed that both positive and negative news broadcasted on television and other media influenced the population's mental health.

"I heard Provincial Government's statement on television that if you want to get this vaccine then get it at your own risk. If government officials continue to talk like this, it will create a negative impact regarding vaccines in the minds of the people. Educational people will also have uncertainties and concerns because of it" (FGD-Healthcare provider from Matiari).

DISCUSSION

The COVID-19 pandemic has had both health and societal implications which were not comparable to any recent event in global history. The influence of social distancing had a great impact which has led to an increase in the widespread use of digital platforms for acquiring the latest updates and communication. This qualitative study highlighted many critical issues based on the usage of mHealth, social and electronic media related to the COVID-19 pandemic and vaccine coverage. According to healthcare providers and caregivers, the primary findings of our study indicated that electronic media and mHealth were being used more broadly to promote COVID-19 pandemic related information and communication. However, the social and electronic media-driven infodemics and urban-rural divide posed major obstacles. Further, it not only enabled individuals to quickly access and share information on disease spread and emerging health policy changes, but also provided access to resources, community engagement and misinformation.

Our study showed electronic media as the most effective tool for communicating health-related messages such as awareness of COVID-19 SOPs and vaccination to reduce the general population's fear of acquiring infection. Electronic media provided the most reliable information related to the pandemic and hence became the most dependable medium from which to get information, especially for the rural population. Electronic media was the primary source for filling the information gap amongst the general population in Pakistan. However, there was an element of misinformation and disinformation in the news broadcasts related to the COVID-19 pandemic and hence created confusion and mislead the general population. This was similar to findings in Korea demonstrating that using electronic media to access vaccine-related information had a positive impact on the population's vaccination-related decision-making, as well as higher perceived benefits of the COVID-19 vaccine and greater trust in the government to address vaccine hesitancy [24]. Further, an Italian study highlighted the importance of health information transmitted to raise awareness among individuals through radio, television, and journalistic communications [25]. However, despite motivating the population to reduce their fear and stress related to the COVID-19 pandemic,

television broadcasts commonly used complicated language, technical jargon, and disseminated debates; and therefore, created more confusion about the situation [26].

Our study explored the usefulness of mHealth as a communication media to disseminate and support the population and healthcare providers during the pandemic. Participants in our study reported that mHealth strategies such as ringtone messages disseminated COVID-related awareness and preventive strategies and were actively used as a communication media about public health awareness messages during different phases of the pandemic in the overall population. Most people could understand the ringtone because it was played in local languages. A similar strategy has been recommended to replace entertainment and religious ringtones with health promotion, particularly for low and middle-income countries [27]. Our findings also revealed that healthcare providers approached the COVID-19 dashboard and national and international resources for credible sources of information which motivated them to deliver services and enabled vaccination uptake. SMS also played an essential role in the online registration of the COVID-19 vaccine moreover, reminders were automatically forwarded to the general population for missing doses of COVID-19 vaccine. Another study revealed that sending SMS, email, and postal messages enhanced influenza vaccination appointments [28]. According to our study participants, SMS-based vaccine registration was significantly accepted by the population and could potentially be further expanded to other adult and child vaccinations in Pakistan and other LMICs.

During the pandemic, the role of social media was widespread in providing information about COVID-19 and its vaccine through Facebook, Twitter, and WhatsApp. However, social media also propagated misinformation and disinformation related to COVID -19, hence introducing phenomena of infodemics. In Pakistan, WhatsApp was widely used for disseminating pandemic-related information. Similarly, a study conducted in the United Arab Emirates reported WhatsApp as being mostly used to acquire COVID-19-related information [29].

Our study explored that social media news and its content contributed to increasing COVID-19-

related anxiety and stress among the population, as stated by HCPs. In our study, political tweets received more engagement, as leaders' tweets had an enormous influence on the public creating confusion and misconception. Another study showed that leaders' tweets had higher interaction in high-income nations like the United Kingdom, as well, and it was discovered that the leader's tweets have a stronger impact on the general population; creating misinterpretation which ultimately impacted vaccine uptake [30].

During the pandemic, information regarding vaccine adverse effects and misinformation was circulating on television and social media, adding fear and uncertainty among the population, and leading to a decline in vaccine acceptance. Our study participants also reported infertility, brain stroke, and death-related misinformation. Our findings are consistent with a US-based study which reported similar misinformation falsely correlating COVID-19 vaccination with infertility and population growth control, electronic tattooing or microchipping individuals for global surveillance, and autism, which resulted in low vaccine uptake by the general population, overall [31]. Thus, our HCPs participants emphasized that lack of news verification and monitoring, and incorrect information dissemination, resulted in confusion and vaccine hesitancy among caregivers. This qualitative study provided insights that lack of technological literacy in the rural population was a hindrance in adopting mHealth interventions in the rural setting. Our study participants were not aware of or did not report about the official COVID-19 Government of Pakistan website. Besides that, the rural population especially women did not own personal mobile phones and were unfamiliar with its usage due to a lack of technological literacy. However, in a rural setting in India, where literacy rate of women is 40.35%. nearly 85% of the rural illiterate women studied were found to be using a mobile phone without necessarily owning it. It was their quickest means of communication and receiving information [32].

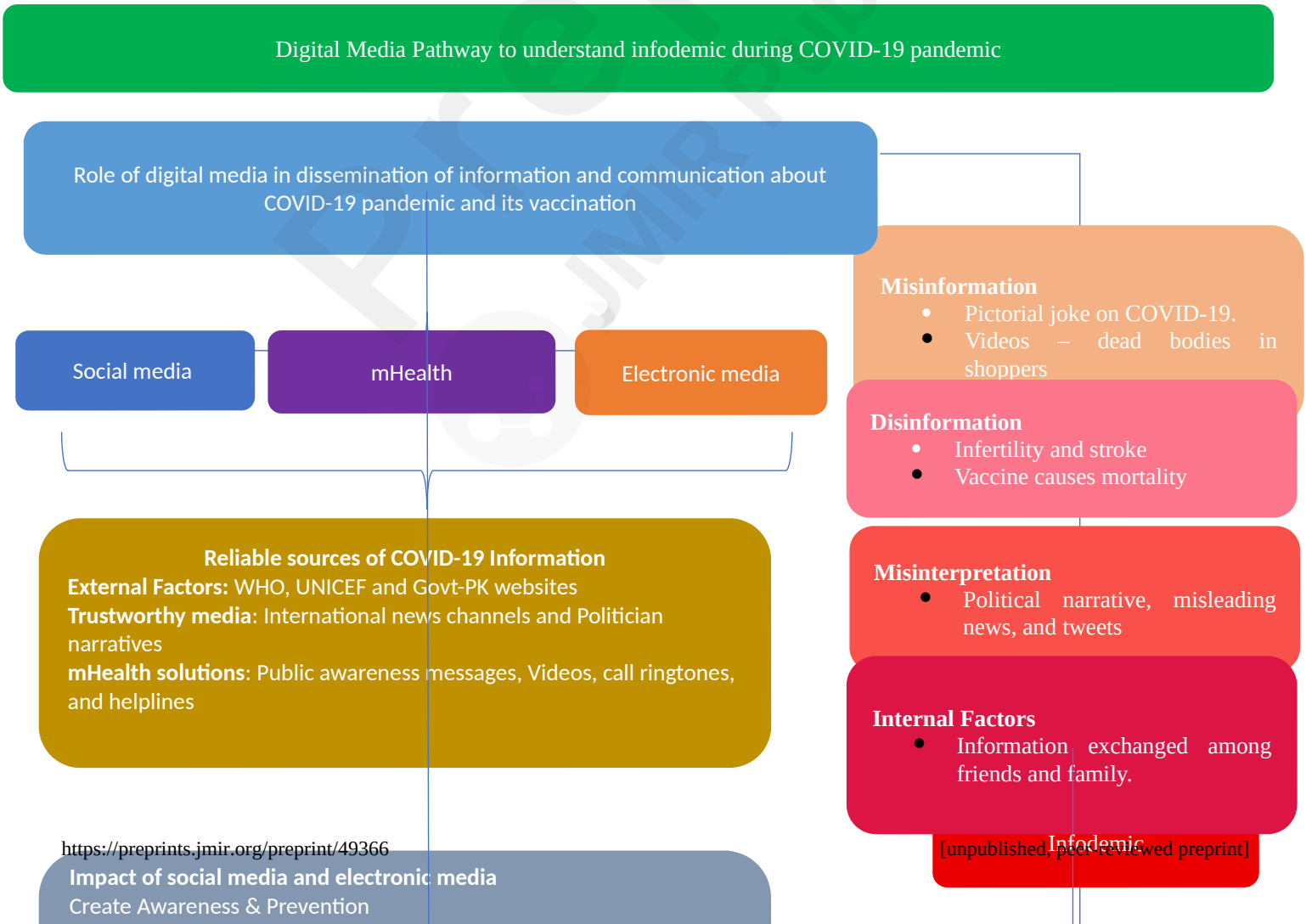
The digital pathway model that we conceptualized is based on national policy interventions (SMS based interventions, caller tunes, vaccine registration through SMS) and the responses of our

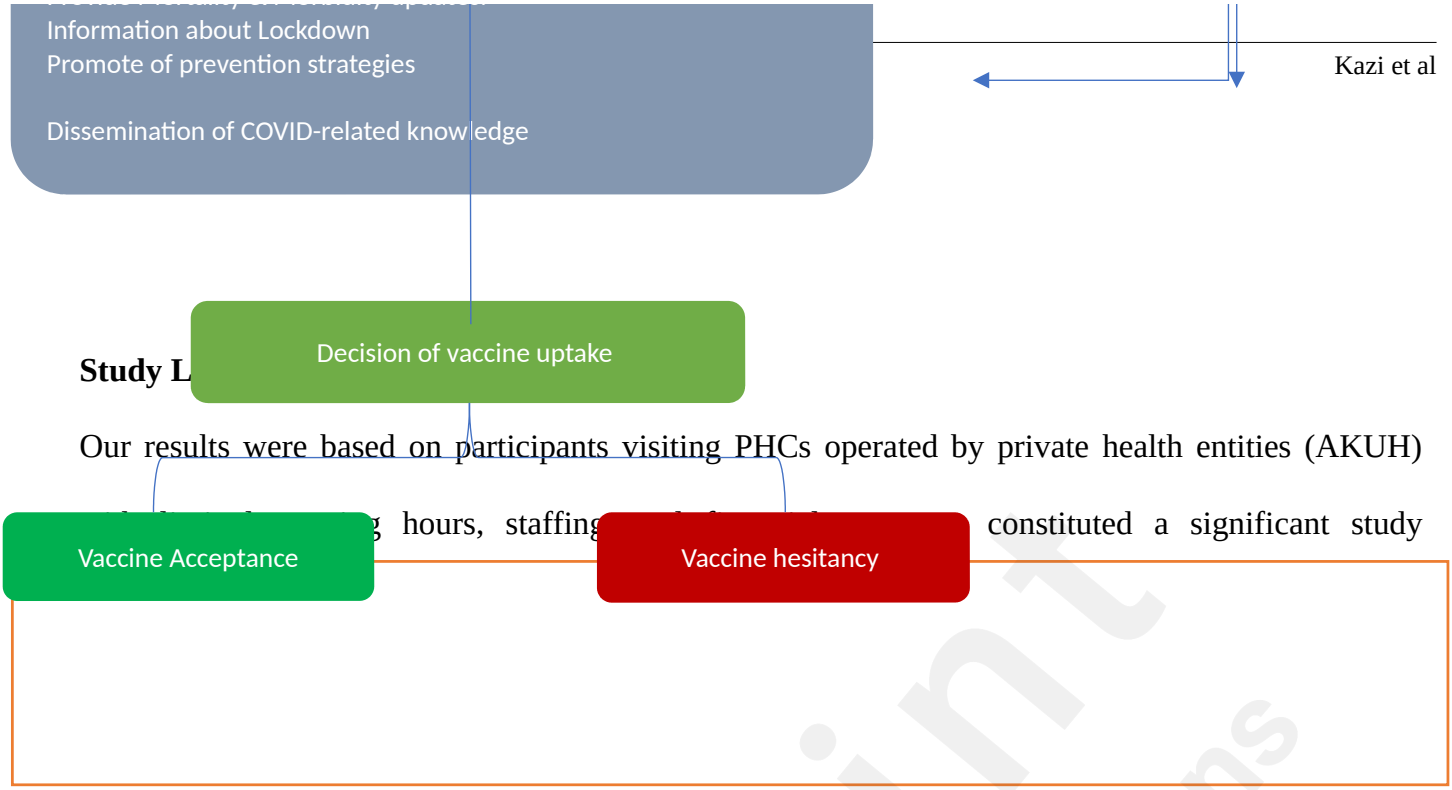
research participants, which enabled them to communicate and disseminate information during the COVID-19 pandemic and assisted them in the fight against pandemic-related infodemics **(Figure 3)**. We have discussed the diversity of interventions and their usage along this pathway. This framework is required to understand how digital methods might be integrated into COVID-19 control efforts and to aid in future pandemic preparedness.

- Electronic media provided coverage to the overall population through advertisements, news, and broadcasts, minimizing digital communication among the urban and rural population.
- mHealth-based initiatives like SMS, calls, helplines, and caller ringtones were the sources of public awareness and information, which were enhanced by using local languages. Other external media like WHO websites and news channels were used as reliable resources.
- Social media enabled wide access to information, particularly in the urban population, and dissemination of misinformation and disinformation about vaccines and pandemics.
- Electronic media, mHealth, and social media were the major modes of communication and dissemination during the pandemic which promoted COVID-related SOPs and vaccine acceptance. However, these same mediums also became the source of infodemics leading to misguided information and vaccine hesitancy.

We examined platforms commonly used in misinformation campaigns in our setting such as mHealth, and social and electronic media. The flowchart's development revealed a critical insight into how different mediums play distinct roles in supporting the spread of misinformation via different paths. Our model has crucial information for policymakers who want to combat the phenomena of infodemics and the digital divide. Policymakers at the government level across the world need to strategize social and legal regulatory frameworks to curb the spread of misinformation and disinformation on digital media.

Figure 3: Infodemic pathway of digital media





Study L

Our results were based on participants visiting PHCs operated by private health entities (AKUH) hours, staffing constituted a significant study

Implications and Recommendations

The COVID-19 pandemic has necessitated the use of digital platforms for communication and information dissemination, with electronic media, mHealth, and social media playing crucial roles. Electronic media emerged as an effective tool for promoting COVID-19-related information and reducing fear among the general population. However, it also became a source of confusion causing mis/disinformation. Further to improve public health interventions, precise and accurate information that pertains to WHO or CDC guidelines should be allowed to be aired on televisions and media can function as a bridge for people to connect with health officials and local government for assistance, and collaborations between government and media outlets can establish guidelines for responsible reporting [33]. mHealth strategies, such as SMS notifications, ringtone messages and mobile phone applications proved useful in raising public awareness, especially in rural areas. Policymakers should invest in user-friendly mHealth platforms to ensure timely and accurate information reaches individuals, particularly in low-income settings. Lastly social media platforms also played a pivotal role in providing pandemic related information which was not previously seen on that scale and unfortunately also contributing towards infodemics. Regulatory bodies should develop frameworks to mitigate misinformation on social media, including collaboration with social media companies,

monitoring mechanisms, and awareness campaigns. These frameworks should include collaboration with platforms for fact-checking and prioritizing authoritative sources, real-time monitoring using AI, public awareness campaigns promoting critical thinking, and regulatory oversight ensuring transparency and accountability [34]. Addressing the challenges posed by infodemics and the digital divide requires enhancing information verification, promoting digital media literacy in rural areas, and strengthening public health communication through partnerships with influencers and healthcare providers. By implementing these strategies, policymakers can improve information dissemination, mitigate misinformation, and enhance future pandemic preparedness efforts.

Conclusion

In conclusion, this study proposes the implementation of a communication pathway focused on diseases and pandemics to be integrated into a national digital policy in resource constraint setups including Pakistan. This would enhance the country's readiness to respond to health crises and boost public awareness and comprehension of these matters. However, digital media emerged as the primary source of information during the pandemic, yet it also contributed to misinformation and disinformation, causing infodemics. It is therefore essential to comprehend the sources and content of information within each digital medium element that triggers infodemics. LMICs are more vulnerable to infodemics because they have limited access, awareness, and lower literacy levels to comprehend and evaluate health-related information. Our research findings further revealed a digital divide between urban and rural populations, resulting in digital inequalities. To address these challenges, both digital and non-digital solutions must play a vital role. Moreover, credible information must be widely disseminated from trustworthy sources, verified by subject matter experts, and tailored to fit the local context. Lastly, training programs on the usage of digital media, dissemination strategies, and information reliability need to be conducted, particularly for healthcare providers and different settings, especially to reach rural communities.

Contributors

Conceptualization, A.M.K., F.A.M., and N.A.; methodology, A.M.K., N.A., F.A.M., and R.J.; thematic analysis, N.A. and R.J.; investigation, N.A. and S.J.; resources, S.J. and W.M.; data curation, N.A. and R.J.; technology use, A.K.; writing—original draft preparation, N.A., R.J., and R.A.; writing—review and editing, K.L.H, N.A., W.M., R.J., and R.A.; supervision, A.M.K., and F.A.M.; project administration, A.M.K., N.A.; funding acquisition, K.L.H,. All authors have read and agreed to the published version of the manuscript.

Declaration Of Interest

We declare no competing interests.

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