Vaccinate against COVID- 19 or not? Source of Information and the influence of misinformation on COVID-19 vaccine uptake hesitancy among frontline workers in Dar es Salaam and Dodoma, Tanzania

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Introduction

Since the emergency of the COVID-19 pandemic, there has been an abundance of information, with nearly every media channel covering the latest developments (Kraus et al., 2020). While this abundance supported by internet and Web 2.0 forms the most amazing resources for information the world has yet seen, there is clearly so much misinformation one can expect (Anderson and Rainie, 2017; Barua, 2016; Barua et al., 2020). The world's first social media pandemic COVID-19 (Guynn, 2020), a massive disaster in the 21st century, is not immune to the proliferation of misinformation (Rosenberg et al., 2020; Cuan-Baltazar, 2020).

Misinformation refers to false rumors irrespective of whether it is deliberate or accidental and has already been falsified by credible sources, such as the government, the scientific community, news media, and journals (Tan et al., 2015) or not credible sources such as non-heath expert's including religious leaders, politicians, non-authoritative interpersonal sources; and social media (George (2021). It is defined as claims of fact that is currently false due to a lack of scientific evidence; it can be inaccurate information shared unconsciously by believing that the information is true, or shared consciously for misleading (Scheufele and Krause, 2019; Wardle and Derakhshan, 2017). This is opposed to disinformation which is false information and shared consciously to make harm intentionally (Wardle and Derakhshan, 2017). And it is opposed to mal-information; which is authentic private information shared with the public to cause harm by creating hate speech and harassment (Barua et al., 2020). In regards to COVID 19, misinformation is therefore false information that can be challenged with the best-available evidence pertaining to the COVID-19 (Chou et al., 2018; Krause, 2020). This study borrows the definition by Barua et al. (2020) who considered 'misinformation' as a "mother-term" of both (mis and dis) –(i) inaccurate information shared unconsciously by believing that the information is true, and –(ii) inaccurate information shared consciously.

Evidences (Barua et al., 2020; Rajkumar, 2020; Xiao and Torok, 2020; Zandifar & Badrfam, 2020) indicate that misinformation can have a death-and-life threatening effect amid a pandemic. This is because inaccurate or misinformation or exaggerated information can generate health anxiety amid an infectious disease pandemic (Rajkumar, 2020; Xiao and Torok, 2020). Misinformation can be on the disease itself, how it is spreads, cure against it and aspects related to vaccination. For instance, a resident of Phoenix in the USA, hearing on the news that the chloroquine can cure

COVID-19, died after consuming chloroquine which was commonly used at aquariums to clean fish tanks (Waldrop et al., 2020). Misinformation about COVID-19 can be generated in many forms; such as conspiracy theories such as pro-claiming that the virus being produced in a laboratory for use as a biological weapon (Pennycook et al., 2020); religious fundamentalist who spread misinformation in the way that praying to the almighty will help not to be affected by COVID-19 (Djalante et al., 2020).

While the ground strategy followed by most countries around the world was to reduce the transmissibility of the disease, often by non-pharmaceutical interventions (NPIs), including enforcing masks policy, hands sanitization, social distancing, travel restrictions, schools' closures, and partial or complete lockdowns (Nicola et al., 2020), the most promising strategy to confine the pandemic and providing hope to reduce the mortality and morbidity rates remains within the capacity of medical technology (El-Elimat et al., 2020). Such medical technology includes effective, safe, and affordable antiviral agents and vaccines (El-Elimat et al., 2020). As of December 2020, no antiviral drugs had been approved that were specifically developed against COVID 19 (Kaddoura et al., 2020). According to El-Elimat et al. (2020), and as approved by the WHO, vaccines are effective interventions that can reduce the high burden of diseases globally. Studies (Hajj Hussein et al., 2015; Rodrigues, 2020; Ehreth, 2013) reveal that vaccines are one of the most reliable and cost-effective public health interventions ever implemented that are saving millions of lives each year. Vaccines train one's immune system to create antibodies, just as it does when it's exposed to a disease. According to Sakay (2021) getting vaccinated prevents severe illness, hospitalizations, and death.

Despite widespread recognition that COVID-19 is a critical issue to people all around the globe, and that getting vaccinated prevents severe illness, hospitalizations, and death (Sakay (2021) many remain unwilling to be vaccinated or are choosing to delay vaccination (OECD, 2021). For example, a survey of eleven OECD countries in December 2020 found that on average, only 66% of the population would accept vaccination (IPSOS, 2020). Similarly, recent data from seven OECD countries showed that a quarter of the population in France, Germany and the United States may refuse COVID-19 vaccination, and an even higher proportion among younger population cohorts (Kantar, 2021).

A similar trend is manifested in other parts of the world including Africa. African continent being the lowest in terms of Covid-19 vaccinated populations globally, the countries are also facing increased vaccine hesitancy with the few available doses having no takers in some countries (ALL Global Union, 2021). Cooper et al. (2021) indicated that in all three rounds of the Ipsos surveys, South Africans' willingness to take COVID-19 vaccines was reportedly below global averages. In Kenya, Only 4.8% of Kenya's population had fully vaccinated against COVID-19, slightly lower than Africa's average of 5.2%. Already, the World Health Organization (WHO) has identified COVID- 19 vaccine hesitancy [referred to reluctance or refusal to vaccinate despite vaccines'

availability (WHO, 2019; Lazarus et al., 2020; MacDonald, 2015)] as one of the top ten global health threats (Lazarus et al., 2020).

With the availability of COVID-19 vaccines, there is a lot of ongoing debate of safety and efficacy of the vaccines that are already in the market. According to Menezes et al. (2021), there are multiple drivers of COVID 19 vaccine uptake hesitancy in Africa including concerns about safety, side effects, and effectiveness of the vaccine. Misinformation about novel technologies used against COVID-19, from mRNA technology to cases' tracking applications, has led to concerns about the safety of vaccine developed using the mRNA technology (Sharpe *et al*., 2020; Kwok et al., 2020). This indicates that COVID-19 vaccines hesitancy is also related to the fear of the vaccine's side effects (Mohammad et al., 2021).For example, an August survey famong Kenyans found that 36% of Kenyans were unsure about the shot — and misinformation was a big driver of that (Ravelo & Byatnal, 2021).While previous research has focused on a set of attributes that was relevant at one particular point in time, the evidence and context about the available vaccines has continued to shift in ways that could shape public willingness to accept the vaccine (Kreps et al., 2021).

In Tanzania, the country's President Samia Suluhu Hassan launched the country's vaccination campaign against COVID-19 by receiving her first shot of the Johnson and Johnson vaccine, on 28th July 2021 (Kombe, 2021; Mwai, 2021). Tanzania geared towards vaccination after a team of health experts handed in their report on how to roll out mass inoculation to President Samia Suluhu. The government rolled out a mass vaccination campaign on August 3 with priority given to health workers, the elderly and those with underlying health conditions, and officials involved in COVID 19 related risk assignments (Makoye, 2021). Despite, the president's speech and ongoing health professional's public awareness creation to assure that the vaccine is safe and have required efficacy and that those who are willing to get it have nothing to worry about, a heated debate has continued partly emanating from prior and ongoing misinformation. Like what Piltch-Loeb et al. (2021) reports, the level of vaccine hesitancy in anticipation of vaccine approval by regulatory agencies has become more critical now that the vaccine is available, especially for frontline workers and vulnerable populations[1]. For example, the evangelical preacher Bishop Josephat Gwajima, who is also a member of Tanzania parliamentary assembly, has for some times been one of the loudest critics related to Covid 19 vaccinations (Mwai, 2021). Concerns expressed among ethnic and religious groups have also contributed to vaccine hesitancy (Mohammad et al., 2021). Others include Hon Humphrey Polepole, the then member of parliament of Tanzania, now Ambassador in for Tanzania in Malawi. Critics among others have mainly been on the duration that the scientists have taken to come up with the vaccines, and claims that the vaccines can

[1] Frontline workers include, but are not limited to, healthcare workers, protective service workers (police and EMTs), cashiers in grocery and general merchandise stores, production and food processing workers, janitors and maintenance workers, agricultural workers, truck drivers (Blau et al. (2020) priests and church elder, and academicians in higher learning institutions (HLIs).

interfere with human DNA (Mwai, 2021). There are also claims on a number of side effects like blood clotting and eventual death. This state of the art on emerging skepticism against the vaccine and whether people should be vaccinated or not, need to be quickly defeated and cleared. Consequently, although Tanzania had received only 1,000,000 kits of vaccines by August 2021, there was only 700,000 vaccinations up taken which is equivalent to 1.27% of the whole population. The misinformation issue becomes even more important where it involves the COVID-19 frontline workers in the country.

Like in other parts of the world, frontline worker in Tanzania are prioritized category of persons earmarked for vaccination against the virus to promote their safety. They are groups of workers more likely to be exposed to COVID-19 at work. Evidence indicates that vaccine hesitancy, among frontline workers, remains an important threat to successful rollout of vaccines as there are still a number of them who still have not taken their COVID 19 vaccine shot. Available evidences on the influence of misinformation on whether to vaccinate or not are still inconclusive. For example, Kreps et al. (2021) on public attitudes toward COVID-19 vaccination indicated that those who believe COVID-19 misinformation might have a higher perception of risk of COVID-19. Yet, belief in misinformation about COVID-19 does not appear to be a strong predictor of vaccine hesitancy; yet belief in misinformation and willingness to vaccinate was positively correlated (Kreps et al. (2021). Besides, all available studies are in context of developed countries, with scanty empirical evidences from Africa and Tanzania in particular. According to Aborode et al. (2021) vaccine hesitancy is complex and context-specific, varying across time, places, and disease type. Understanding the influence of misinformation on the vaccination uptake hesitancy in the fight against the pandemic in Africa and Tanzania in particular is of significant importance to fill the existing knowledge gap. It was from this noble reason that this study was formulated to reveal the unknown about the phenomenon.

This study thereof seeks to examine the role of misinformation on COVID-19 vaccine uptake hesitancy among frontline workers in Dar es Salaam and Dodoma, Tanzania. Specifically, the study seeks to assess the sources of COVID 19 misinformation; to assess forms of misinformation and their influence on COVID 19 vaccine uptake hesitancy among frontline workers. The remaining part of this paper comprises of literature review- both theoretical and empirical literature review, methodology, results and discussion and lastly conclusions and implications for the study.

Literature review

The Theory of Informative Fictions (TIF)

The Theory of Informative Fictions **(**TIF) rests on two premises. The first is that the communication is functional, meaning that individuals try to gather the kind of information that would be beneficial to improving decisions (Margolin, 2020). The assumption is not that individuals are perfect maximizers, only that they possess a sufficiently functional inclination to gather and communicate information they believe is valuable.

The theory also assumes that individuals both seek information relevant to their own decisions and communicate information they believe will help others make effective decisions. This communication can be self-interested, such as sharing information to influence political decisions that impact the individual, or altruistic, such as advising a friend (Kümpel, Karnowski, & Keyling, 2015; Yuan, Fulk, & Monge, 2007).

Even so, 'misinformation' as stimuli can generate favorable or unfavorable responses regarding COVID-19. Nonetheless, TIF does not justify the use of misinformation, as the spread and acceptance of inaccurate property information remains dangerous irrespective of the benefits these narratives may provide. Nor does TIF purport to explain all incidences of misinformation. Rather, TIF provides a theoretical framework that synthesizes many findings about misinformation while pointing to additional, testable predictions (Rosenbaum, 2017).

Forms or Types of misinformation and potential sources of COVID 19 misinformation

Debates about how to promote vaccination within the population, and questions about the influence of misinformation have moved quickly (Wood & Schulman, 2021). Examples of considerable discussion topics include whether individuals can distinguish between factual and false information about efforts to combat COVID-19. Despite of some efforts from various stakeholders such as the governments and the responsible ministries keeping on intervening through clarification on any considered to be misleading information, the debate is keeping hot and it is ongoing. According to Safarnejad et al. (2020), there is an emerging need to understand health misinformation from more aspects, including the content, the users who are involved, and the media environment as an interconnected entity.

Misinformation have been classified differently by different authors. For example, Wardle (2019) and Wardle & Derakhshan (2017) document seven type of misinformation. According Wardle (2019) the forms may apply to COVID 19 misinformation and include 1. Satire or parody (no intention to cause harm but has potential to fool) 2. False connection (headlines, visuals or captions don't support the content) 3. Misleading content (misleading use of information to frame an issue or individual, when facts/ information are misrepresented or skewed) 4. False context (genuine content is shared with false contextual information, e.g. real images which have been taken out of context) 5. Imposter content (genuine sources, e.g. news outlets or government agencies, are impersonated) 6. Fabricated content (content is made up and 100% false; designed to deceive and do harm) 7. Manipulated content (genuine information or imagery is manipulated to deceive, e.g. deep fakes or other kinds of manipulation of audio and/or visuals). Analysis by Brennen et al. (2020) recognized three different sub-types of misinformation which are reconfigured, fabricated, and satire form of misinformation. According to Brennen et al. (2020) 59% of misinformation is reconfigured consisting misleading content while 38% consists of fabricated misinformation where 30% of it is fabricated content and 8% is imposter content and satire/parody which carries

3%. Of the reconfigured form of misinformation 29% consist of misleading content, 24% is carried by false content, and 6% is manipulated content. Example of a false content may involve posting images or videos labeled or described as being something other than they are.

There are diverse sources for COVID 19 information that have impacts on the behavior of the general public including their response towards COVID-19 and respective control measures including vaccination. In the context of COVID 19, formal sources include among others health experts; WHO, traditional media such as TVs, radio, newspapers and the related (George, 2021). Information technology advancements and social media enabled by Web 2.0 have not only changed the way we search, receive and share information on various matters it has come with a number of challenges and opportunities including credibility of information they generate. While social media has enhanced ubiquitous access to global information quickly and easily, and to disseminate information to a much wider audience than before, the ease with which media can be produced online has made it possible for rumors, untruths, and disinformation to spread and threaten the credibility of the news media (Wasserman and Benequista, 2017). Characterized by user generated content social media- allows anyone with access to the internet to share information related to COVID 19 including its vaccinations.

According to Volkmer et al. (2021) although social media create opportunities to keep people safe, informed and connected, the same tools also enable and amplify the current infodemic that continues to undermine the global response and jeopardizes measures to control the pandemic. Menezes et al. (2021) asserts that access to social media has facilitated the spread of misinformation and conspiracy theories from international to local. One of the conspiracies at international level is 'the virus being a biological weapon, created either by the US (to destroy Chinese) or China (to destroy Americans)' [Barua et al., 2020]. Menezes et al. (2021), exemplifies further that a small study in Addis Ababa showed that hesitancy was 3.6 times higher among those who received their information from social media compared to those who relied on television and radio. Results by Coninck et al. (2021) indicate that greater exposure to traditional media (television, radio, newspapers) is associated with lower conspiracy and misinformation beliefs while exposure to digital media particularly social media are associated with greater conspiracy. This is also noted by Ferreira and Borges (2020) who evidences that mass media such as television and newspapers, which carry information from authorized sources, played the role of transmitting official information in times of COVID 19 in Portuguese. This study therefore forms its first objective.

H1: Formality of information sources has association with misinformation related to COVID 19 pandemic.

While traditional media such as TVs, radio and newspapers are considered to be credible sources, they are subject to politicization and being used for conspiracies to conceal true information from the public in order to manage crisis, managing present political positions and to keep the economy

alive (Barua, 2020). Aborode et al. (2021) for example observes that politicization of vaccine approval and deployment processes can contribute to public hesitancy or trust. Ongoing conspiracy that Africa will become subjects of experimentation for western vaccines has mark-timed the effort towards promoting vaccination against COVID 19 (Lazarus et al., 2020; Kochhar & Salmon, 2020). Nyalile & Loo (2021) report that the Late Tanzanian president John Pombe Magufuli warned against the Western-developed COVID-19 vaccines in relation to such inconsistencies and concerns of exploitation and experimentation. He made a parallel request of the Ministry of Health to not rush into accepting vaccines without their testing and total satisfaction with the safety and efficacy of said vaccines (Nyalile & Loo, 2021).

The role of religion in influencing people's behavior during disaster, epidemic, or pandemic is also substantial (Barua, 2020; Djalante et al., 2020; Menezes et al. (2021). They can they can simultaneously play both productive and counterproductive roles at the time of pandemics (Djalante et al., 2020). Evidences indicate that religious groups in different countries promoted that their faith in religions would save them from COVID-19. According to a study by Menezes (2020) close to 90% of individuals surveyed in Niger and Liberia said that prayer was more effective than the vaccine. In Bangladesh, a country with a majority of Muslims (more than 90%), an Imam of a mosque in Dhaka city was advising people to visit mosque (BBC-Bangla, 2020) which might generate unfavorable COVID-19 responses. Russonello (2020) noted that one of conservative Pentecostal preachers in Brazil, marked a day as anti-COVID "Day of Abstinence", affirming that fasting would yield a miracle to heal. However, researchers documented that religious fundamentalists are inclined to trust in false information (Bronstein et al., 2018). A recent Geopoll survey in six African countries showed religious beliefs as key determinants of hesitancy.

Studies (Coninck et al., 2021; Humprecht et al., 2020) observe that in most countries, exposure to health experts including physicians, researchers, epidemiologists, and heath information analysts was associated with lower conspiracy beliefs. At the world level WHO is a trusted source for all health and pandemic related information including COVID 19. WHO's Covid-19 dashboard is updated daily, including featuring the number of vaccine doses administered globally, with more detail provided on the dedicated COVID-19 vaccination dashboard (WHO, 2021). At a regional level, there is an AFRO Covid-19 vaccines dashboard and a PAHO COVID-19 vaccines deliveries dashboard (WHO, 2021). This study therefore had its second and third objective as:
H2: Formality of information sources on COVID 19 has influence on COVID 19 vaccine uptake hesitancy.

COVID 19 Misinformation and its impact on COVID 19 vaccine uptake hesitancy

Although any information source can be responsible for misinformation the extent sources are responsible differ. For example, unlike the traditional media that are highly censored, social media-characterized by user generated content allows anyone with access to the internet to share information related to COVID 19 including its vaccinations. Consequently, according to studies

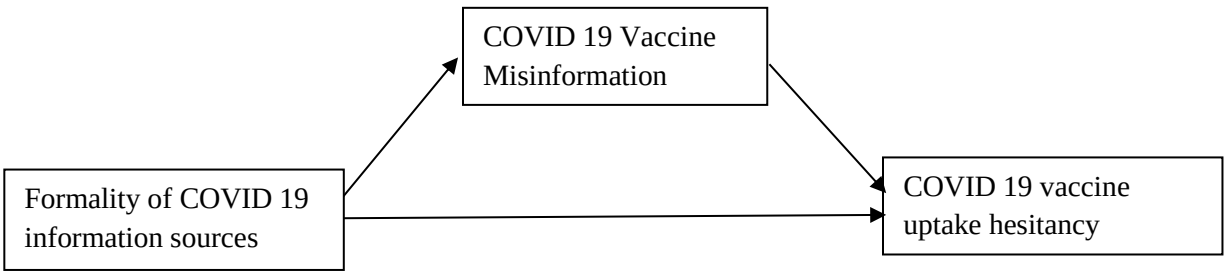
(Silverman, 2016; Venturini, 2019; Gallotti et al., 2020; Garfin et al., 2020) in the social media environment, conspiracy theories, false and fake narratives tend to spread quickly thus outperforming real news in terms of popularity and audience engagements because misinformation is often "preferred" to true information. Consequently, social media have to a large extent been linked to COVID 19 misinformation, generating unnecessary health anxiety amid the pandemic. For example, Li et al. (2020) reported that approximately 23%–26% of YouTube videos disseminating information regarding COVID-19 were misleading. Unfortunately, while false rumors are readily created (Knapp, 1944), false news is often shared more than true news (Vosoughi, Roy, & Aral, 2018), and individuals retain false beliefs even after being corrected (Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Nyhan & Reifler, 2010; Thorson, 2016).

On the other hand, although formal information such as TVs, radio and newspapers could be considered credible enough, their censorship because of whatever reasons including managing potential crises, keep the economy alive or attempts not to lose political positions makes them not credible (Barua, 2020). They can equally be the potential sources for misinformation. For example, the then Health Minister of Bangladesh was quoted saying that "I don't think that COVID-19 is a dangerous disease" simply to keep the situation calm in his country (Barua, 2020). Brima (2021) also noted that given the poor state of media freedom in Burundi and attempts by government to control the narrative on political and health crises local media coverage of COVID-19 was constrained. Others related to that, are the warming made by Late Tanzanian president John Pombe Magufuli to the Ministry of Health to not rush into accepting vaccines without their testing and total satisfaction with the safety and efficacy of said vaccines (Nyalile & Loo, 2021). Consequently, such politicization of vaccine approval and deployment processes can contribute to public hesitancy or trust (Aborode et al., 2021; Coninck et al., 2021).

George (2021) thus urges that in order to determine if a source is credible or not one needs to ask him/herself the following questions: Who is the author? When was the material published? What is the purpose of a source? How is this source proved? What type of audience is this source aimed at? Yet, whether COVID-19 misinformation contributes to vaccine uptake hesitancy or not has not been studied. The study third objective was stated as:
H3: COVID 19 Vaccine misinformation has influence on COVID 19 vaccine uptake hesitancy.

Conceptual model

This study has conceptualized that in a varying degrees, both formal and non-formal sources relating to COVID 19 have potential to influence misinformation relating to COVID 19 vaccine uptake, which in turn influence vaccine uptake hesitancy.



Methodology

This study was conducted in Dar es Salaam and Dodoma, Tanzania. Dar es Salaam is not only the most populated city in Tanzania but also a business city hosting more front line workers as compared to other cities. On the other hand, Dodoma – a national capital of Tanzania, is located in central Tanzania. While since 2019 government ministries as well as major public institutions have their head offices in Dodoma (Mumbere, 2019), a number of important offices and agencies are still in Dar es Salaam. Besides many conferences, workshops, and seminars are still held in Dar es Salaam, and not in Dodoma, the national capital (Kironde, 2021). Indeed, come every Friday afternoon, fleets of buses are seen bringing hundreds of Dodoma residents to Dar es Salaam for the weekend (Kironde, 2021). These include those who live as a split family, with one half in Dodoma and the other in Dar es Salaam. The activities contained therein the two cities make a number of people qualified as frontline workers and therefore suitable for this study. Blau et al. (2020) refers frontline workers to include, but are not limited to, healthcare workers, protective service workers [police and Emergency Medical Technicians (EMTs)], cashiers in grocery and general merchandise stores, production and food processing workers, janitors and maintenance workers, agricultural workers, & truck drivers. This study also considers groups like priests and church elders, and academicians in higher learning institutions (HLIs) to constitute frontline workers. Like in other parts of the world, frontline worker in Tanzania are prioritized category of persons earmarked for vaccination against the virus to promote their safety. They are groups of workers more likely to be exposed to COVID-19 at work. A respondent was given a questionnaire when he/she falls under frontline workers grouping explained above. Before a questionnaire was supplied to a wider scale in actual field, a pilot study was conducted to sample of 20 to sort any ambiguity from the questionnaire. It was from the pilot sample reliability and validity was tested. A Cronbach alpha of more than 0.7 was obtained implying that the instrument was reliable. The refined and standardized questionnaire developed through Google form and the link containing it was distributed conveniently through WhatsApp to respondents residing in Dar es Salaam and Dodoma cities. Till the end of data collection, 164 respondents had successfully responded and submitted the questionnaire with 86 respondents being from Dar es Salaam and other 78 from Dodoma. After data collection data was extracted through Excel, small adjustment done then exported to SPSS Version 22. Frequency and percentage and pie charts were used to present descriptive analysis results. The inferential statistical analysis was done using binary logistic

regression. The binary logistic regression entailed to determine the effect of COVID-19 Vaccine misinformation for Frontline workers on COVID-19 Vaccine uptake hesitancy.

Findings

Respondents' demographic characteristics

The captured respondents' demographic characteristics include region of residence, gender, age, marital status, education level attained, employment status and chronic disease history. From Table 1, it indicates that 52.4% of respondents were from Dar es Salaam city while 47.6% of respondents were from Dodoma city. The data also indicates that 69.5% of respondents were males while 30.5% were females. Age wise 39.6% of respondents were between 31 and 40 years old, followed by 26.8% aged between 21 and 30 years old, 26.2% aged between 41 and 50 years old and 7.3% who were aged above 50 years old. The profile further indicates that 68.3% of respondents were married while 31.7 were single. Education wise, 93.9 of respondents had college/university education level and only 6.1% had secondary education as their highest level of education attainment. Employment wise, 49.4% of respondents were government employees, 32.3% being privately employed and 18.3% as self-employed. Data also indicate 10.4% of respondents had chronic disease history while 89.6% of respondents had no any chronic disease history.

Table1: Demographic profile of respondents

Category	Characteristics	Frequency (N)	Percentage (%)
Region of residence	Dodoma	78	47.6
	Dar es salaam	86	52.4
	Total	***164***	***100***
Sex	Male	114	69.5
	Female	50	30.5
	Total	***164***	***100***
Age	Between 21 and 30	44	26.8
	Between 31 and 40	65	39.6
	Between 41 and 50	43	26.2
	Above 50	12	7.3
	Total	***164***	***100***
Marital status	Married	112	68.3
	Single	52	31.7
	Total	***164***	***100***
Education level	Secondary education	10	6.1
	College/university education	154	93.9
	Total	***164***	***100***
Employment status	Government employed	81	49.4
	Private employed	53	32.3
	Self employed	30	18.3
	Total	***164***	***100***
Chronic disease history	Yes	17	10.4

No	147	89.6
Total	***164***	***100***

Findings based on objectives

This study was established to examine the role of misinformation on COVID-19 vaccine uptake hesitancy among frontline workers in Tanzania. Specifically, the study sought to assess the sources of COVID 19 misinformation; to assess forms of misinformation and their influence on COVID 19 vaccine uptake hesitancy among frontline workers. The analysis results on COVID-19 related source of information, COVID-19 Vaccine Misinformation and COVID-19 Vaccine uptake hesitancy in Tanzania are presented in line with the objectives of the study.

Sources of COVID 19 Information and COVID 19 Hesitancy uptake

The findings presented in Table 2, indicate that both formal and informal sources were used to inform on COVID 19 related issues, and in one way or another may misinform decision on COVID 19 and their related matters. These sources as presented in terms of their frequency and respective usage percentage of respondents include local television 134(81.7%), WhatsApp 123(75%), Local radio 121(73.8%), Ministry of health websites 121(73.8%), Family and friends 120 (73.2%), Health workers 118(72.0%), Top government officials 115(70.1%), Newspapers 114(69.5%), Government websites 104(63.4%), religious leaders 104(63.4%), YouTube 99(60.4%), state health department 97(59.1%), Facebook 93(56.7%), Oversea television 88(53.7%), Hospital websites 79(48.2%), and Oversea television 66(40.2%). The sources are presented as S1 to S16. As per Table 2, the sources respondents relied for their COVID 19 information comprise both formal and informal sources.

Table2: Source of COVID-19 Information

Source	**Yes (N)**	%	Rank	Source formality
Local television (S1)	134	81.7	1	Formal
WhatsApp (S2)	123	75.0	2	informal
Local radio (S3)	121	73.8	3	Formal
Ministry of health websites (S4)	121	73.8	4	Formal
Family and friends (S5)	120	73.2	5	informal
Health workers (S6)	118	72.0	6	Formal
Top government officials (S7)	115	70.1	7	Formal
Newspapers (S8)	114	69.5	8	Formal
Government websites (S9)	104	63.4	9	Formal
Religious leaders (S10)	104	63.4	10	informal
YouTube (S11)	99	60.4	11	informal
State health department (S12)	97	59.1	12	Formal
Facebook (S13)	93	56.7	13	informal
Oversea television (S14)	88	53.7	14	Formal

Hospital websites (S15)	79	48.2	15	Formal
Oversea Radio (S16)	66	40.2	16	Formal

Assessment of the relationship between sources of information and COVID-19 vaccine uptake hesitancy among Frontline Workers was done using logistic regression analysis. The findings reveal that the extent to COVID 19 uptake hesitancy was not a function of formality of the source of information used. The findings presented in Table 3 indicate that the sources of information (formal and informal) had no significant influence on COVID-19 Vaccine Uptake Hesitancy among Frontline Workers.

Table 3: Formality of Sources of information and its influence on COVID-19 Vaccine Uptake Hesitancy among Frontline Workers.

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Formal sources	.081	.065	1.539	1	.215	1.084	.954	1.231
	Informal sources	-.055	.122	.204	1	.651	.947	.746	1.201
	Constant	-.408	.906	.203	1	.652	.665		

a. Variable(s) entered on step 1: Formal sources, Informal sources.

Besides, a cross tabulation to assess the association between sources of information and COVID 19 vaccine uptake hesitancy among frontline workers found that the channel from which respondents relied to receive information related to COVID 19 had no significant relationship with COVID 19 Vaccination uptake hesitancy levels. For example, with local Television (S1) the hesitancy level was more or less similar to those who said Yes as those who said No on TV as their sources. This also applies to the other sources S2 to S16 as presented in Table 3. In fact, the hesitancy level was high with those never used WhatsApp (61%), Local radio (62%), health worker (63%), top government officials (63.3%), Newspapers (62%), government websites (61.7%), religious leaders (63.3%), oversea TVs (60.5%) and oversea radio (61%). The findings also indicate that there was no significance difference on how formal and non-formal sources influenced COVID 19 hesitancy levels. Table 4 and Figure 3 stipulate.

Table 4: COVID-19 Vaccine Uptake Hesitancy among Frontline Workers

Source	**As source**	**Low Hesitancy**	**High Hesitancy**	P-value
Local television (S1)	Yes	43.3%	56.7%	0.584
	No	40.0%	60.0%	
WhatsApp (S2)	Yes	43.9%	56.1%	0.362
	No	39.0%	61.0%	

Local radio (S3)	Yes	44.6%	55.4%	0.810
	No	37.2%	62.8%	
Ministry of health websites (S4)	Yes	41.3%	58.7%	0.392
	No	46.5%	53.5%	
Family and friends (S5)	Yes	41.7%	58.3%	0.422
	No	45.5%	54.5%	
Health workers (S6)	Yes	44.9%	55.1%	0.398
	No	37.0%	63.0%	
Top government officials (S7)	Yes	45.2%	54.8%	0.742
	No	36.7%	63.3%	
Newspapers (S8)	Yes	44.7%	55.3%	0.440
	No	38.0%	62.0%	
Government websites (S9)	Yes	45.2%	54.8%	0.239
	No	38.3%	61.7%	
Religious leaders (S10)	Yes	46.2%	53.8%	0.664
	No	36.7%	63.3%	
YouTube (S11)	Yes	43.4%	56.6%	0.555
	No	41.5%	58.5%	
State health department (S12)	Yes	44.3%	55.7%	0.176
	No	40.3%	59.7%	
Facebook (S13)	Yes	38.7%	61.3%	0.355
	No	47.9%	52.1%	
Oversea television (S14)	Yes	45.5%	54.5%	0.237
	No	39.5%	60.5%	
Hospital websites (S15)	Yes	48.1%	51.9%	0.608
	No	37.6%	62.4%	
Oversea Radio (S16)	Yes	43.9%	56.1%	0.315
	No	39.0%	61.0%	

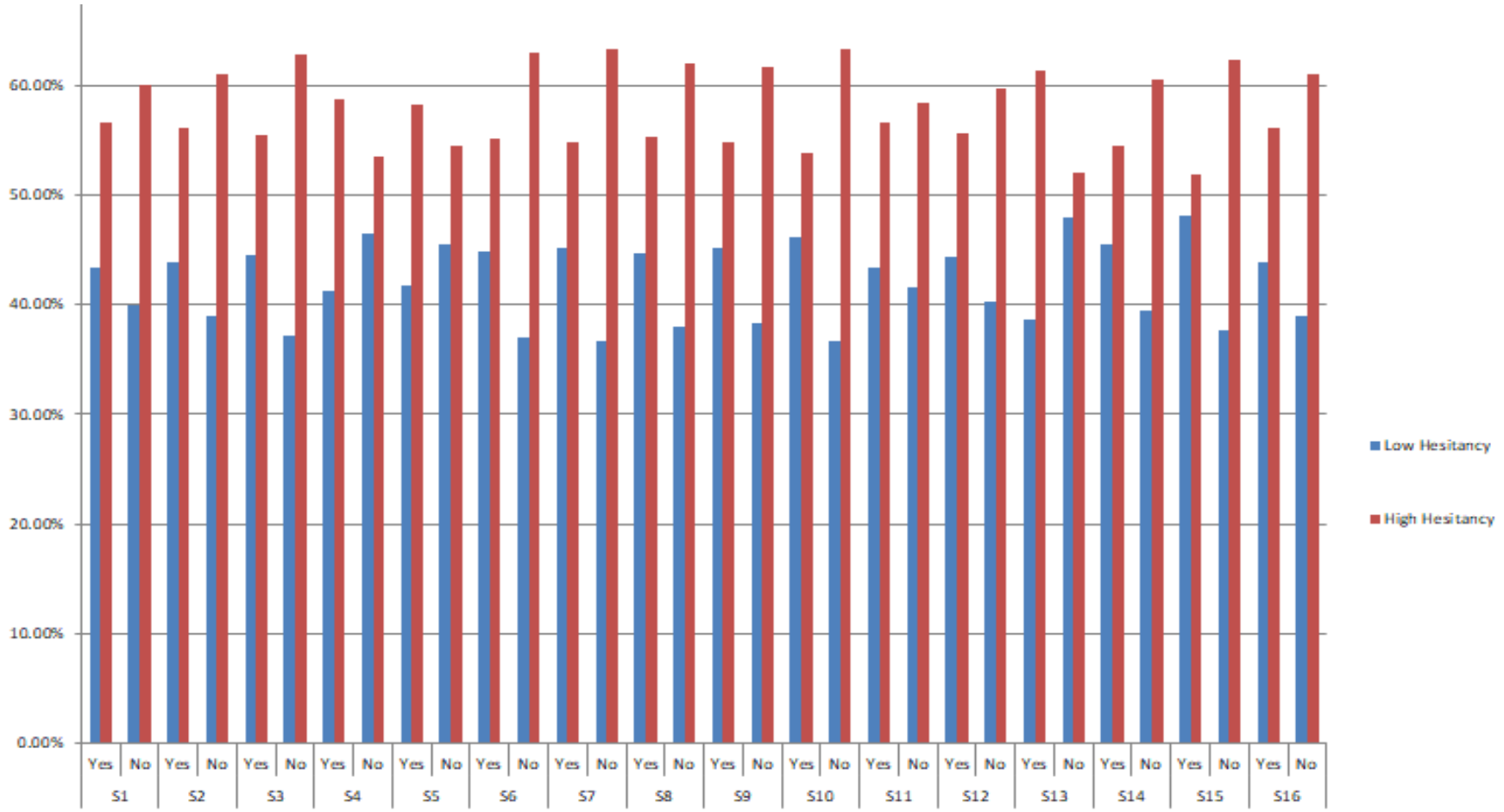


Figure2: Cross tabulation between Sources Vs. COVID 19 Vaccine Uptake hesitance level

Forms of Misinformation and their influence on COVID-19 Vaccine Uptake Hesitancy among Frontline Workers

In order to compute the influence of misinformation on COVID-19 vaccine uptake hesitancy among frontline workers in the study areas, inferential statistical analysis was run using binary logistic regression. Before logistics regression was done, computation of outcome variable COVID-19 vaccine uptake hesitancy was done through creating total score of items about COVID-19 vaccine uptake hesitancy. Then, the total scores were expressed in percentage as $(^{total\ score}/_{total\ of\ item\ maximum\ scores})$*100. The computed percentage scores were categorized using blooms cut point (see also Kaliyaperumal, 2004; Akalu et al., 2020), as Low COVID-19 Vaccine uptake hesitancy (0= Low COVID-19 Vaccine uptake hesitancy) if less than 60% score and High COVID-19 Vaccine uptake hesitancy (1= High COVID-19 Vaccine uptake hesitancy) if equal to 60% and above score. Table 5 details.

Table 5: COVID-19 vaccine uptake hesitancy score of items

Items code	n	Hesitance level in % (n/40*100)
1	8	20
2	16	40
3	24	60
4	32	80
5	40	100

Misinformation variables were generated through dimension reduction factor analysis with principle component method. Rotated component matrix (1-6 components) were considered, and summation of items obtained in each component were used to generate misinformation variable scores Q1, Q2, Q3, Q4, Q5 and Q6. Later on multivariate logistic regression was run to assess the influence of the resultant misinformation variables on COVID-19 vaccine uptake hesitancy among frontline workers.

A multivariate logistic regression model, was fitted to determine the effect of misinformation on COVID-19 Vaccine uptake hesitancy among frontline workers in the study area. In the process of fitting model, all probabilities were two-tailed and p-values <0.05, regarded as significant. Results show that only Q1 and Q2 were significant ($p<0.05$) determinant factors for COVID-19 Vaccine uptake hesitancy among frontline workers in the study areas. Whereas the odds chance of COVID-19 Vaccine uptake hesitancy increased by 16.8% with unit change in Q1 ($\beta=0.155$, S.E=0.04, $p<0.001$, at 95% CI 1.08, 1.262). Also, for unit change in Q2, increased the odds likelihood of Vaccine uptake hesitance by 38.3% ($\beta=0.324$, S.E=0.081, $p<0.001$ at 1.18, 1.621). Q3, Q4, Q5 and Q6 were not statistically significant factors ($p>0.05$) for vaccine uptake hesitancy. In which, the odds chance for unit changes in Q3 and Q4 all increased by 7.9% ($\beta=0.076$, S.E=0.076, $p=0.32$, at 95% CI 0.929, 1.252) and ($\beta=0.076$, S.E=0.067, $p=0.257$, at 95% CI 1.079, 0.946) respectively.

But odds chances decreased for unit changes in Q5 and Q6 though were statistically not significant (Table 6).

Table 5: Factor analysis of misinformation variables

Items	1	2	3	4	5	6
Manipulated content on COVID19 vaccine as hesitancy cause	.878					
Misleading content with misrepresented or skewed facts /information about COVID 19 as cause	.798					
Fabricated content about COVID19 vaccination designed to deceive and do harm as cause	.791					
Imposter content on COVID19 genuine sources shared through media as a cause	.764					
Satire or parody about COVID19 posted online and other media as a cause	.762					
Visual source captions with false connection to the said content on COVID 19 vaccines as cause	.746					
When COVID19 genuine content is shared with false contextual information as cause	.744					
Perception that pharmaceutical companies will not provide safe and effective COVID 19 vaccine		.779				
Perception that the government is pushed on certain vaccine by COVID 19 vaccine manufacturers		.759				
Perception that certain lifestyle does not force one to take COVID19 vaccine		.508				
The government trusts that decisions made on COVID 19 vaccine are in the best interest of the people			.731			
Being not properly informed on vaccines before decision to vaccinate			.730			
Feeling that you have no enough information about COVID19 vaccine			.713			
Religion philosophy/ culture recommending against COVID19 vaccine				.688		
One's faith opining that vaccination is not a good thing				.678		
Some memories of the past make my community refuse to accept other kind of vaccine				.609		
Remembering some events in the past discourage one from getting COVID 19 vaccine				.516		
Disbelief that COVID-19 vaccine is important to protect those that cannot get vaccinated					.771	
Poorly convinced on COVID 19 vaccine quality purchased by the government					.658	
Disbelieving that COVID-19 vaccine is safe for oneself/relatives and community					.608	
Community leaders poorly informed on the need to urgently introduce a COVID-19 vaccine						.750
Health professional not providing most of information on questions relating to COVID-19 vaccination						.651
Information on side effects after COVID19 vaccination not openly discussed by the authorities						.636

Table 6: Multivariate Logistic model for COVID 19 misinformation on COVID-19 Vaccine Uptake Hesitancy among Frontline Workers in Dodoma and Dar-es-salaam regions

Variables	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Q1	0.155	0.04	15.221	1	<0.001	1.168	1.08	1.262
Q2	0.324	0.081	15.999	1	<0.001	1.383	1.18	1.621
Q3	0.076	0.076	0.988	1	0.32	1.079	0.929	1.252
Q4	0.076	0.067	1.283	1	0.257	1.079	0.946	1.23
Q5	-0.074	0.074	1.008	1	0.315	0.928	0.803	1.073
Q6	-0.094	0.135	0.487	1	0.485	0.91	0.699	1.186
Constant	-4.665	1.317	12.539	1		0.009		

P<0.05, means significant

Discussion

This study has studied the influence of misinformation on COVID-19 vaccine uptake hesitancy among frontline workers in Tanzania. Specifically, it has assessed the sources of COVID 19 information respondents relied for their COVID 19 pandemic information; forms of misinformation and their influence on COVID 19 vaccine uptake hesitancy among frontline workers. The findings indicate that although both formal and informal sources were used to inform on COVID 19 related issues, the extent of misinformation relating COVID 19 was not a function of formality of the information sources. The dependable formal sources include local television, Local radio, official ministry of health websites, authorized health workers' spokesperson on COVID 19, top government officials, newspapers, government websites, oversea television, hospital websites, and oversea television. The informal sources included use of family and friends, religious leaders, YouTube, state health department, Facebook and numerous other social media. The findings revealed that both formal and informal sources were in one way or another responsible for misinform decision on COVID 19 related matters including vaccination. Yet, the findings revealed further that the extent of COVID 19 uptake hesitancy was not a function of formality of the sources of information used. It was found that the sources of information (formal and informal) had neither significant influence on- nor relationship with COVID-19 vaccine uptake hesitancy among frontline workers. Impliedly is to say, it was not the source that mattered for one to be hesitancy or not, but the extent to which the information channeled by that source was manipulated or false. This is indicated by Q1 (Manipulated imposters, satire or with fabricated contents) and Q2 (false content). The odds chance of COVID-19 Vaccine uptake hesitancy increased by 16.8% with unit change in Q1 (β=0.155, S.E=0.04, p<0.001, at 95% CI 1.08, 1.262), while for unit change in Q2, increased the odds likelihood of Vaccine uptake hesitance by 38.3% (β=0.324, S.E=0.081, p<0.001 at 1.18, 1.621).

Basing on the findings it is logical that Tanzanians have been hesitancy in regards to COVID-19 vaccine uptake. It is already noted that acceptability rates have a real life impact on management and control of the COVID-19 pandemic (Malik, 2021). Yet, unless doubts caused by misinformation emanating from both formal and informal sources, then COVID 19 vaccine uptake will not be realized. According to Al-Mohaithef & Padhi (2020) vaccine acceptability is determined by three factors: confidence, convenience, and complacency. While COVID 19 can conveniently and easily accessed such that it is physical available, affordable (MacDonald, 2015), unless there is guarantee on safety, efficacy and pharmaceutical quality of the vaccine for use without any perceived risk, then hesitancy occurs (French et al., 2020). As it was seen earlier, in countries where true information relating COVID 19 was concealed from the public for whatever reasons including attempt to manage crisis, to keep the economy alive or for some political reasons (Barua, 2020) COVID 19 vaccination rate remained low, even after some reassurance later on. According to Barua (2020) people tend to remain doubtful and they can hardly later on trust anyone including health care providers, legislators, community leaders, and governments for any acceptance of the vaccines (Coustasse et al., 2021; Omer et al., 2015; MacDonald, 2015). The findings from this study have indicated that more than 51% of respondents reported high hesitancy to COVID 19 vaccine uptake regardless on the sources they relied on,. While more than 26% reported to have low hesitancy. This implies that more than 85% of respondents were to some extent hesitant towards COVID 19 vaccine uptake.

According to Theory of Informative Fictions (TIF) individuals both seek information relevant to their own decisions and communicate information they believe will help others make effective decisions (Margolin, 2020). Yet, the information to be shared can be self-interested, including to influence political decisions that impact the individual, or altruistic, such as advising a friend (Kümpel, Karnowski, & Keyling, 2015; Yuan, Fulk, & Monge, 2007). Where information censored depending on who own the source or the power to manipulate. Consequently, the shared information may end up misinforming the receiving side and the public at large, creating hesitancy toward certain action. This argument is line with Kreps et al. (2021) study on public attitudes toward COVID-19 vaccination who indicated that those who believe COVID-19 misinformation might have a higher perception of risk of COVID-19. It is also in line with Singogo (2021) who indicated that, people with agreeableness feature may be assumed to be believing in information regarding COVID-19 and believing in recommended safety measures enough to comply with easier than those who don't.

Conclusion and study implications

It is therefore important that in order to increase COVID 19 vaccine uptake, and thus curbing the pandemic then quality information is shared that is accurate, objective, compete, timely but also authoritative/verifiable. This is because, misinformation is a stimulus that generate favorable or unfavorable responses regarding COVID-19. This study has the following implications to knowledge, policy makers, practitioners and theoretically:

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