Prevalence, nature, and determinants of COVID-19-related conspiracy theories among healthcare workers: a scoping review

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ABSTRACT

Background: Healthcare workers (HCWs) are pivotal in managing the global COVID-19 pandemic, particularly in regions with vulnerable health systems. COVID-19 vaccination hesitancy due to conspiracy theories (CTs), however, has been observed among HCWs. Not only poses this a threat to global health efforts fighting the COVID-19 pandemic, it may also fuel public fear and erode trust towards the healthcare system. Understanding the extent of and the factors involved in COVID-19-related CTs therefore is needed.

Methods: A systematic literature search of Medline, EMBASE, Web of Science, Scopus, and CINAHL electronic databases (from inception to October 2023) was conducted for studies examining the impact of COVID-19-related CTs on vaccination willingness among HCWs and health students and/or factors driving HCWs into believing CTs.

Results: Prevalence rates of Covid-19 related CTs among HCWs varied widely across studies, ranging from 0.89% to75.6%. Higher prevalence rates of CTs were found in the Arab world, Ethiopia and Nigeria, compared to other African and Western countries. Limited and heterogeneous data prevented conclusive findings on the relationship between CTs and sociodemographic factors, ethnicity and psychological traits among HCWs. However, a consistent observation emerged regarding the level of education, indicating HCWs with higher educational attainment tend to endorse CTs less frequently.

Conclusion: Although COVID-19 related CTs may be highly prevalent among HCWs, gaps in understanding the drivers of CTs among HCWs remain. Given HCWs' critical role in public health, especially during pandemics, further research is therefore essential to mitigate the impact of COVID-19-related CTs on vaccine willingness among HCWs.

Keywords: Healthcare workers; vaccine hesitancy; conspiracy theory; COVID-19

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BACKGROUND

Vaccine hesitancy has been defined by the World Health Organization (WHO) Strategic Advisory Group of Experts on Vaccine Hesitancy as the "*delay in acceptance or refusal of vaccination despite the availability of vaccine services*"[1]. Vaccine hesitancy is complex and context-specific, with variability across time, place and type of vaccines [1,2]. Vaccine-hesitant individuals are a heterogeneous group along this spectrum of variability. Their state of ambivalence towards vaccination should not always be seen as irrational, as it can reflect legitimate doubts and concerns about vaccines [3].

In 2019, the WHO identified vaccine hesitancy as one of the 10 threats to global health [4]. Although there have always been people hesitant towards receiving vaccinations, this threat has only increased since the COVID-19 pandemic [1,2]. The rapidity of the COVID-19 vaccine development and concerns regarding the vaccine's safety certainly have contributed to the lack of vaccine confidence [5,6].

Several factors have been found to be associated with vaccine hesitancy towards the COVID-19 vaccine, such as sociodemographic factors (e.g. age, gender, education), health-related factors (e.g. vaccination history/medical conditions), and vaccine-related factors (e.g. concerns about the safety or quality of the vaccine) [7]. However, another important factor associated with vaccine hesitancy is vaccination beliefs and attitudes, such as conspiracy theories (CTs).

CTs can be defined as secret plans hatched by powerful groups or individuals with the intention to harm a given individual or group of people, often to the benefit of the powerful group [8–10]. They are attempts to understand complex social and political events and circumstances [11–13].

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Despite their scientific and medical training, healthcare workers (HCWs) and healthcare students have been identified as a sub-group displaying considerable hesitancy towards accepting a COVID-19 vaccine [5,14,15]. Although the prevalence of COVID-19 vaccination hesitancy in HCWs varied widely, a large-scale review published in 2021 found that among HCWs (n=76,471) more than a fifth of HCWs worldwide reported COVID-19 vaccination hesitancy [15]. The vaccine hesitancy rate among healthcare students has been found to be almost equal to the hesitancy rate in practicing HCWs [14]. Limited information exists about the nature and extent of the impact of CTs on COVID-19 vaccination hesitancy in HCWs and healthcare students worldwide. The purpose of this study therefore was to conduct a comprehensive worldwide assessment of published evidence on the impact of CTs on COVID-19 vaccine hesitancy among HCWs and healthcare students. More specifically, we wanted to (a) estimate the prevalence of conspiracy beliefs on COVID-19 vaccines among HCWs and healthcare students worldwide, and (b) identify the nature and determinants of CTs on COVID-19 vaccine hesitancy among this population. Getting insight in the factors contributing to these beliefs among this population is pivotal as vaccine hesitancy among HCWs and healthcare students may have consequences for the acceptance of vaccines in the general population. CTs held by these people may foster (more) distrust towards health authorities and their recommendations, which could impede efforts to end pandemics [13].

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METHODS

Search strategy

A comprehensive and systematic literature search of Medline, EMBASE, Web of Science Core Collection, Scopus, and CINAHL electronic databases (from inception to October 2023) was conducted for English, Dutch and German studies examining the impact of COVID-19-related CTs on vaccination willingness among HCWs and healthcare students, and/or the nature of CTs and factors driving HCWs into believing these theories. Full search strategies are available as Supplementary Material. Duplicates were removed by J.D., using EndNote X9. After removing duplicates, titles and abstracts were screened by H.L, using Rayyan QCRI. H.L. and J.D. did the full-text screening. Articles that were deemed potentially relevant according to the selection criteria were included. Any disagreements were solved by consensus or by decision of a third reviewer (M.D.H.). References of the identified studies and pertinent reviews were carefully cross-checked for additional relevant studies.

Eligibility criteria

Studies were eligible for inclusion if they:

(1) were peer-reviewed articles exploring the relationship between vaccine hesitancy and conspiracy belief(s). We used the description of the WHO Strategic Advisory Group of Experts on Vaccine Hesitancy to define vaccine hesitancy: the "*delay in acceptance or refusal of vaccination despite the availability of vaccine services*" [1]. The first vaccines therefore had to be available in the country or region at the time the study was conducted;

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(2) labelled CTs as beliefs featuring a secret plot by a group of powerful elites that involve the harm of a given individual or group of people, often to the benefit of the powerful group [8,10];

(3) included a population of HCWs and/or healthcare students. For defining HCWs, we used the International Standard Classification of Occupations (ISCO), also used by WHO [16]. This classification includes health professionals (e.g. generalist medical doctors, nursing professionals, midwifery professionals, dentists, pharmacists, physiotherapists, dieticians and nutritionists), health associate professionals (e.g. technicians for medical imaging, laboratory work and dental prosthetics, pharmaceutical and dental assistants, community health workers, ambulance workers), personal care workers in health services (e.g. healthcare assistants, home-based personal care workers), health management and support personnel (e.g. health service managers, biomedical engineers, medical secretaries) and other health service providers;

(4) presented prevalence rates of COVID-19-related CTs and/or explored the nature and determinants of CTs on COVID-19 vaccine hesitancy among HCWs and/or healthcare students;

(5) provided quantitative data (e.g. prospective and retrospective cohort studies, case-control studies, cross-sectional studies).

Studies that were not peer-reviewed or published (preprints, dissertations, conference papers, books/book sections, commentary/opinion pieces), studies exclusively presenting qualitative data, case reports and non-original research were excluded. Studies including other professions not covered by the WHO definition of HCWs (e.g. studies with first-responders that also include enforcement officers and firefighters, next to HCWs) without providing

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separate data for this subpopulation, as well as studies written in other languages than English, Dutch or German were excluded. When conspiracy beliefs were not embedded into a belief system involving a secret plot, the study was also excluded.

Data extraction

Data were extracted and mapped descriptively by H.L., using a data extraction form. This form included the following information: author(s), year of publication, country/region where the study has been conducted, study design, specific population of HCWs and/or healthcare students, sample size, mean age, gender, ethnicity, vaccine hesitancy rate(s) due to CTs, and/or information on the determinants or nature of CTs. We refrained from employing meta-analytical methods due to the significant heterogeneity of the included studies regarding methodology, measures and outcomes.

RESULTS

Search strategy

The original search in the Medline, EMBASE, Web of Science, Scopus, and CINAHL databases yielded a total of 12,538 reports (Medline: 2,671; Embase: 3,983; Web of Science: 2,749; Scopus: 2,633; CINAHL: 502). Of these, 7,539 duplicate reports were removed **(see Fig. 1).** Overall, 272 references of published reports were selected as potentially eligible, together with additionally 2 published reports identified through references, of which 39 original reports met the inclusion criteria **(Fig. 1)** [9,17–54].

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Study and patient characteristics

The 39 eligible reports included 37 studies with a total of 55,556 participants. Roberts (2022) [39] and Dubov (2022) [40] extracted their data from Dubov (2021) [41] for secondary analysis. These reports therefore were counted as one study. All studies were performed between 2021 and 2023. Most studies were conducted in the Arab world (n=10). The other studies were conducted in African (n=9) and Asian countries (n=3) not belonging to the Arab world, European countries (n=6), Turkey (n=4) and North America (n=3). Two studies were conducted worldwide (n=2). Of the 37 eligible studies, 33 had a cross-sectional design, 1 was a prospective cohort study and 3 were mixed-method studies. Mean age was 32.8 years (SD=6, range: 18-78); 58.0% of the participants were female. All patient and study characteristics of the included studies are presented in **Table 1**.

Prevalence of COVID-19-related CTs among HCWs

Prevalence rates of COVID-19-related CTs among HCWs varied widely, ranging from 0.89 % [17] to 75.6 % [21] (average rate across 22 studies = 21.7%, median = 14.4).

When comparing prevalence rates by geographical location, higher rates of COVID-19-related CTs among HCWs were found in most countries of the Arab world. Studies conducted in Jordan consistently found 30% to 45.5% of their HCWs believing in CTs [23,27,34]. Studies performed in Sudan, Saudi Arabia, Kuwait and Libya also found almost one third to half of their HCWs believing in CTs [24,35,49,51]. A large-scale multinational study (n=5,708), measuring vaccine hesitancy among Arabic-speaking HCWs in 21 Arab countries (87.5%) and 54 other countries (e.g. European countries, Turkey and North America) (12.5%), however, observed a lower prevalence rate of CTs among HCWs (12.3%) [47]. Lower CT prevalence rates (2.6%-5%) were also found among HCWs in three other

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studies from the Arab World [22,42,50]. Among African countries not belonging to the Arab world, highest prevalence rates of CTs among HCWs were found in two studies from Ethiopia (30.1% and 75.6%) [21,30] and one from Nigeria (52.8%) [54]. In the remaining African countries less than 10 % of HCWs were found to believe in COVID-19-related CTs [18,29,45]. US studies showed heterogeneous results. While Dubov et al. found conspiracy prevalence rates up to 38 % among HCWs [41], no conspiracy thinking was found in the study by Hoffman et al. [31]. Prevalence rates of COVID-19-related CTs among European HCWs were less than 10% [32,37,43,44,46] except for one study conducted in Croatia and Bosnia where prevalence rates of CTs among medical students reached up to 46.4% [26].

While some of the included studies examined various CTs related to the pandemic, others did not differ between different CTs. Therefore, it was difficult to determine whether certain CTs were more prevalent among HCWs than other. Despite this, it seems that the prevalence of "irrational CTs" (i.e. CTs that are not based on a deep-rooted mistrust of government, medicine and/or science caused by countless examples of abuse of minority ethnic groups during history) among HCWs, such as the belief that one wants to embed microchips through vaccinations, remained low (between 0.89%-5%) [17,22,28,32,43,44,53] - with the exception of one study conducted in Nigeria where 26.7% of HCWs believed in the microchip CT [19]. On the contrary, "rational CTs", such as the belief that COVID-19-vaccination is used as a biological weapon for gaining political control, were found to be more prevalent among HCWs (6.6%-44.24%) [25,33,36,38,45,49], with the exception of two studies finding less than 4% of HCWs believing in these CTs [18,28]. Specific prevalence of various types of CTs along with detailed descriptions are found in **Table 1**.

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Determinants associated with CTs among HCWs

The majority of studies among HCWs did not investigate sociodemographic, psychological, religious or political determinants of CTs. Moreover, heterogeneous results were found.

Sociodemographic determinants

Only three studies investigated the relationship between gender and CTs [19,36,37]. Of these, Petersen et al. found that women tended more towards CTs than men ($p<0.001$) [37]. Although Oyeyemi et al. found men to be statistically more likely to believe in "DNA alteration theory" than women, results between genders were not significant for the "microchip injection theory"[19]. Jamil et al. found no correlation between these variables [36].

Two studies investigating the relationship between age and CTs, did not find an age-related effect [9,37].

Regarding race and ethnicity, the study of Odejinmi et al. found no significant association between ethnicity and conspiracy thinking [32]. Woolf et al. however, found Black and Asian HCWs having higher scores on the COVID-19 conspiracy beliefs scale to be more vaccine hesitant than White people ($p<0.001$) [46]. Moreover, in the US study of Dubov et al., CTs were more widespread among Hispanic HCWs than among Asian-American and African-American HCWs. These groups, however, were not compared with White HCWs [40].

Several studies found an association between educational level or profession and conspiracy endorsement. For example, in the study of Habib et al., 97.9% of medical students believing in CTs were undergraduates [35]. Another study demonstrated that medical students in general believed less in CTs than other healthcare students [34]. In a German study, CTs

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were found to be significantly more prevalent among nursing, medical technical and administrative staff, in comparison to physicians and scientific staff [37]. In a study from Nigeria, nurses were significantly more likely to believe in CTs than physicians [19]. Kaya et al. demonstrated that HCWs with higher educational levels (masters and doctorate degree) believed significantly less in CTs, in comparison to HCWs with a bachelor degree and lower educational level [9].

Political orientation, government trust, information sources, and religious beliefs

A US study found that the group of HCWs who had the highest rate of CTs were leaned Republicans and the group with lowest CTs rates were Democrats [41]. One study in Nigeria showed that the odds of believing in the microchip-theory increased significantly with a decreasing level of trust in the government's information regarding the COVID-19 pandemic and vaccines (odds ratio [OR] 4.6, 95% CI 2.6-8.0), when compared to those with a high level of trust. Findings were similar for those who believed in the DNA alteration theory (OR 5.2, 95% CI 3.1-8.8) [19].

Regarding information sources, HCWs who were more dependent on social media, TV programs and popular newspapers had a higher score on the Vaccine Conspiracy Belief Scale, compared to those who relied on information provided by scientists, doctors (or HCWs in general), or scientific journals [51]. In line with these findings, Oyeyemi et al. found HCWs using health authorities as the main source of information to be less likely to believe in CTs about microchips (OR 0.4, 95% CI 0.2-0.7) and the DNA alteration theory (OR 0.5, 95% CI 0.3-0.9) [19].

No study was found examining the relationship between religion and CTs among HCWs.

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Psychological aspects

One large international study (n=12,792) suggested that HCWs with current depressive symptoms had higher overall tendency in believing in CTs [25].

DISCUSSION

Our systematic review has shown that HCWs are not immune to CTs. Although prevalence rates of COVID-19-related CTs varied considerably (ranging from 0.89% to 75.6%), they generally appeared to be higher among HCWs in most countries of the Arab world, Ethiopia, and Nigeria, in comparison to those in other African and most Western countries. Limited and heterogeneous data prevented conclusive findings on determinants associated with CTs among HCWs. The only consistent observation was that HCWs with higher educational attainment tend to endorse CTs less frequently.

The wide variance in prevalence rates of COVID-19-related CTs among HCWs is in line with the results that have been found in the general population (prevalence rates ranging from 0.4% to 82.7%) [55,56]. Despite this wide range, our results suggest that geographical variations exist, with higher prevalence rates in most countries of the Arab world and some countries on the African continent. One potential explanation for this phenomenon is the instability in most of these regions, stemming from political, economic, and/or religious conflicts, as well as natural disasters [19,36,57–59]. This results in ineffective governance and initiatives, fostering mistrust and leading to a conspiracy mentality. Another potential explanation is that some of these regions have had a certain history of alleged unethical practices by pharmaceutical companies, raising suspicions about profit or ethnocide motives [19,60,61]. In European countries, prevalence of COVID-19-related CTs among HCWs remained under 10% [32,37,43,44,46], which is in line with the results that have been

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reported by the ECDC (European Centre for Disease Prevention and Control) [62]. Western countries usually are politically more stable. However, the recent shift towards more radical right-wing political orientations could become a fueling factor for endorsing more CTs [63].

Our results indicated that, during the pandemic, HCWs generally held more "rational" CTs (between 6.6% and 44.1%), such as the belief that (the) government(s) had malevolent plans to control or eliminate specific groups through vaccination, mostly fueled by a historical context filled with numerous examples of abuse against minority ethnic or religious groups [25,33,36,38,45,49]. In contrast, "irrational CTs", such as belief that the government wanted to embed microchips through vaccinations in large portions of the global population to control people, were less common (between 0.89% and 5%) [17,22,28,32,43,44,53]. Historical CTs surrounding vaccination against other diseases, such as rumors that the polio vaccine contained sterilizing chemicals, may also have contributed to a culture of suspicion within some of these countries [54]. As it has been shown that people who believe in one CT are more likely to believe another, these pre-existing CTs may be a potential danger for the emergence of new CTs, creating a reinforcing cycle of mistrust and conspiracy ideation [64].

As mentioned above, limited and heterogeneous data prevented conclusive findings on determinants associated with CTs among HCWs. While we only identified one study finding women having statistical significant higher rates of CTs than men [37], data from the general population clearly demonstrated young females having more CT beliefs [55,56]. Although our data on race and ethnicity are difficult to interpret, in general, it is known that CTs flourish particularly among cohesive minority groups that are suppressed by a dominant majority coalition [55,65]. Regarding the level of education, three studies were found showing that HCWs with higher educational levels (master's and doctorate degrees) believed significantly

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less in CTs, in comparison to HCWs with bachelor's degrees and lower educational levels (nurses, medical-technical and administrative staff) [9,19,37]. These results are in line with studies that have been conducted in the general population [55].

Depending on the information sources HCWs use, CT rates seem to differ. One study showed that HCWs who relied on information provided by scientists, doctors or scientific journals, are less prone to believing CTs than HCWs who relied on other sources, such as social media [51]. This also has been shown within the general population [55]. Moreover, this could potentially lead to HCWs using (social) media platforms themselves to disseminate misinformation and CTs, posing a significant danger for the general population [66].

Only one study included in our review examined the relationship between psychological factors and CTs among HCWs, finding that HCWs with current depressive symptoms have higher CT rates [25]. Studies among the general population, however, have also shown that personality traits such as low tolerance for uncertainty and ambiguity, impulsivity, low perceived risk, lower analytical thinking and negative emotions are significantly associated with belief in CTs [55,67,68]. An interesting potential psychological contributing factor to CTs among HCWs may be "collective conspiracy thinking". This theory suggests that when a group is under threat or perceived prolonged levels of stress and uncertainty (HCWs faced immense stress and uncertainty during the pandemic [25]), some can experience a lack of inclusion within the vaccine accepting group of HCWs, thereby heightening their susceptibility to CTs and prompting them to seek out others with similar beliefs [69–71].

Vaccination hesitancy among HCWs not only poses a threat to global health efforts fighting the COVID-19 pandemic, it may also fuel public fear and erode trust towards the healthcare system [39,72]. Therefore, the following recommendations can be implemented to reduce the likelihood of CTs among HCWs.

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Delivering counterarguments to people before they encounter CTs (i.e. prebunking), has been shown to increase vaccine willingness, compared to people already exposed to CTs [11,73,74]. Moreover, exposing the manipulative persuasion tactics used to spread CTs (such as the use of emotional language, misleading rhetoric or fake experts that sow doubt about the scientific consensus) may also reduce the likelihood of adapting CTs [11,74]. Another effective preventive approach is to encourage people to be more critical consumers of CTs before they are first exposed to these by stimulating metacognitive reflection or critical thinking [11,74,75].

Once they are established, health-related CTs may be extremely resistant to correction [76]. Confrontation by simply presenting fact-based anti-conspiracy arguments may even strengthen CTs [77,78]. An open-minded approach**,** empathy, active listening by inviting the person towards a deeper examination of the building bricks of their CTs, and reducing concerns by restoring personal control are more productive [76,77]. One such technique (the Empathetic Refutational Interview) has been shown to reduce support for anti-vaccination arguments and to increase vaccine acceptance [79,80]. Complementary approaches may be highlighting and creating social norms, and increasing connections to others. Many people and HCWs with CTs incorrectly believe that their hesitancy to be vaccinated is rather common and overestimate how much others believe anti-vaccine CTs. One therefore should highlight that CTs are not as commonplace they may think, for example by using normative feedback[1], preferably in context of a relevant social group [73,76,81]. Healthcare leaders should act as a role model by being a trusted source of information and creating new social norms by getting publicly vaccinated and explicitly expressing the benefits of vaccination. This way, they can convey through their actions that getting vaccinated is safe and beneficial

[1] intervention designed to correct misperceptions regarding the prevalence of problematic behavior by showing individuals engaging in such behaviors that their own behavior is atypical with respect to actual norms

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and connect it to a shared collective identity and enhance feelings of control and self-efficacy of their employees [73].

There are, however, reasons to suspect that strategies that have been discussed above will be insufficient to convince HCWs who are still unvaccinated. The Empathetic Refutational Interview technique, for example, has only showed small effects [79,80]. Several authors therefore endorse the use of vaccine mandates to lessen the deleterious effects of CTs [73,82]. Although mandatory vaccination interferes with the right to private life, the exceptions under Article 8 of the European Convention on Human Rights (in particular the protection of public health and the protection of the rights and freedom of others) might justify these interferences [83]. Moreover, fear of social sanctions can be a powerful motivator. Although this approach has been proven effective, defenders of this approach admit this measure may also have significant drawbacks. Additionally, even vaccinated individuals sometimes dislike mandates [82]. Despite this, Lewandowsky et al. state that even if mandates prove ineffective in reducing CTs, they will at least save lives [82].

Regardless of the above mentioned recommendations it is important to know that HCWs holding CTs probably are not a homogeneous group. Research has shown that next to "COVID-19 conspiracy believers", there also exist "COVID-19 conspiracy ambivalent believers". These groups differ in terms of psychological characteristics [84]. Moreover, ambivalent conspiracy believers may come from various social and political backgrounds [85]. The need to tailor interventions for HCWs believing in COVID-19 CTs therefore remains necessary.

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Strengths and limitations

A key strength of this analysis is the extensive search strategies including several databases (see Supplementary Material). One major limitation of this study is the exclusion of qualitative data, which give the opportunity to understand more deeply why HCWs believe in CTs. Moreover, heterogeneity across studies in terms of tools, methods, and survey designs made it hard to perform a thorough quantitative analysis of the data. Although we didn't critically appraise the included studies, we also noticed that several of these studies were poorly performed. Furthermore, we surmise that the actual number of HCWs with conspiracy beliefs may be higher than our results indicate. There may be unidentified "unspoken vaccine hesitancy" cases, a phenomenon where HCWs do not express publicly their hesitancy and potentially conspiratorial concerns about vaccines due to institutional and societal pressure and out of fear of being mocked or stigmatized [86]. Finally, the majority of the included studies had a cross-sectional design, which does not us allow us to infer causal relationships.

CONCLUSION

Although COVID-19 related CTs may be highly prevalent among HCWs, gaps in understanding the drivers of CTs among HCWs remain. Given HCWs' critical role in public health, especially during pandemics, further research is therefore essential to mitigate the impact of CTs on vaccine willingness among HCWs.

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682 **Table 1: characteristics of quantitative studies, including conspiracy findings and/or correlation between different determinants and CTs**
683 **among HCWs and healthcare students**

Reference	Country	Study Design	Healthcare Workers	N	Mean age in years (±SD)	Female (%)	Race/ Ethnicity (%)	Prevalence of CTs and/or correlation between different determinants and CTs among HCWs and students
Azimi et al. (2023) [17]	Afghanistan	Cross-sectional	Medical students in clinical years (4th, 5th, 6th, and 7th year) of five universities	459	21.00 (±NR)	70.30%	NR	"There is a chip in the vaccine": n=4 (0.89%)
Joseph et al. (2023) [18]	Sierra Leone	Cross-sectional	Clinical and non-clinical staff in six facilities (hospital, health center…)	609	NR	45.35%	NR	"Vaccine designed to harm me, e.g. conspiracy": n= 23 (3.8%) Clinical staff: 3% Non-clinical staff: 4%
Oyeyemi et al. (2023) [19]	Nigeria	Cross-sectional	Medical doctors, nurses, pharmacists, laboratory scientists, community health extension officers or workers, health assistants and others	557	NR	71.70%	NR	"I think COVID-19 vaccine is a means to implant digital microchips to track and control people": n=147 (26.7%) [aOR] men vs. women (95% CI): 1.4 (0.8-2.5) [OR] low level of trust in government (95%CI): 4.6 (2.6-8.0) [aOR] nurses vs. physicians (95% CI): 3.9 (1.3-12.0) [aOR] pharmacists vs. physicians (95% CI): 3.0 (0.4-22.0) [aOR] laboratory scientists vs. physicians (95% CI): 5.1 (1.0-25.9) [aOR] CHEO vs. physicians (95% CI): 4.0 (1.2-13.8) [aOR] health authority as main source (vs media) (95% CI): 0.4 (0.2-0.7) "I think COVID-19 vaccine will alter my DNA or genetic information" : n=167 (30.5%) [aOR] men vs. women (CI 95%) : 1.8 (1.1-3.2) [OR] low level of trust in government (95%CI): 5.2 (3.1-8.8) [aOR] nurses vs. physicians (95% CI): 2.2 (0.9-5.4) [aOR] pharmacists vs. physicians (95% CI): 3.1 (0.6-16.2) aOR] laboratory scientists vs. physicians (95% CI): 1.9 (0.4-7.9) [aOR] CHEO vs. physicians (95% CI): 1.7 (0.6-4.5) [aOR] health authority as main source and belief in CTs (vs media) (95% CI): 0.5 (0.3-0.9)
Akova et al. (2023) [20]	Turkey	Cross-sectional	Physicians, nurses/midwives and others	1111	34.3 (±9.2)	59.6%	NR	"The virus is man-made and part of a conspiracy plan": n=516 (46.4%)

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Bereda et al. (2023) [21]	Ethiopia	Cross-sectional	HCWs working in a registered healthcare setting (physician, midwive, nurse, health officer, laboratory technician and others)	422	NR	45.5%	NR	"Belief in CTs": n=319 (75.6 %) [aOR] Belief in CTs and vaccine hesitant vs. non-hesitant (95%CI): 2.43 (1.948–5.170)*
Almojaibel et al. (2023) [22]	Saudi Arabia	Cross-sectional	Physician, nurse, dentist, pharmacist, other health care specialists, technician in allied medical sciences	505	NR	NR	NR	"It has a chip to control me", "It will change my DNA": n=25 (5%)
Kaya (2023) [9]	Turkey	Cross-sectional	HCWs at the hospital (midwife, nurse, technician, medical laboratory technique, research assistant)	128	30.97 (±8.07)	NR	NR	Belief in CTs not correlated with age (NS) Belief in CTs negatively associated with positive attitude towards vaccination** Research assistants, participants who had higher education attainments and those with a longer duration of working life: less likely to believe in CTs** HCWs with bachelor's degrees and below: more likely to believe in CTs than HCWs with master's and doctorate degrees*
Rezq et al. (2023) [23]	Jordan	Cross-sectional	Nurses at three private hospitals	189	30.2 (±3.7)	75.7%	NR	"COVID-19 is man-made": n=86 (45.5%)
Satti et al. (2023) [24]	Sudan	Cross-sectional	Community pharmacists	382	30.4 (±5.6)	65.4%	NR	"COVID-19 is a man-made virus and part of a conspiracy plan": n=111 (29.1%) HCW with CT beliefs were still more likely to accept vaccination: 62.2%** [OR] Vaccine hesitancy and belief in CTs (95%CI): 0.44 (0.23-0.85)*
Fountoulakis et al. (2023) [25]	Worldwide (40 countries)	Cross-sectional	Doctors, nurses, administrative staff in hospitals, other healthcare profession and hospital staff	12,792	NR	62.40%	NR	"Belief in CTs": approx. 33% "COVID-19 is the result of 5G antenna technology": 20.81% "Believing in the deliberate inflation of death rates by government": 44.24% HCWs with current depressive symptoms: higher tendency in believing in CTs*
Vranic et al. (2023) [26]	Bosnia and Croatia	Cross-sectional	Medical students of UNSA university (Bosnia), UNIRI	557	NR	NR	NR	"The pharmaceutical industries are creating infections with the goal of increasing earnings":

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			university (Croatia) and UNIRI-E university (where 85.3% German students of medicine in English)					UNSA: n=27 (16.0%) UNIRI: n=143 (42.9%) UNIRI-E: n=26 (46.4%)
AlKhawaldeh et al. (2022) [27]	Jordan	Cross-sectional	HCWs in public, private and university hospitals: (70.1%) nurses, doctors, pharmacists, respiratory therapists, lab technicians and nutritionist/dietitians	904	35.04 (±9.07)	53.80%	NR	"COVID-19 vaccination is a conspiracy": n=228 (25.2%)
Azizoğlu et al. (2022) [28]	Turkey	Cross-sectional	HCWs at a private hospital (nurses, technical, medical records and allied health personnel, physicians)	309	28.48 (±9.09)	NR	NR	"I believe that they will inject microchips to people with the coronavirus vaccine": n=7 (2.2%) "I believe that the coronavirus vaccine will be the end of humanity": n=11 (3.6%) "I think the coronavirus vaccine is a complete fabrication": n=23 (7.4%)
Konje et al. (2022) [29]	Tanzania	Cross-sectional	Nurse, clinical officer, medical officer and specialist in different health facilities (dispensary, health center, district hospital, regional hospital and tertiary hospital)	811	35 (±9.04)	48%	NR	"Belief in CTs": n=42 (5.2%) Correlation belief in CTs (3.5%) and vaccine willingness (1.7%) vs. vaccine hesitancy (3.5%) (NS)
Demeke et al. (2022) [30]	Ethiopia	Cross-sectional	Medical doctors, nurses, pharmacy, midwifery, laboratory, anesthesia, physiotherapy, optometry and others	319	NR	25.1%	NR	"Being a plot or conspiracy": n=96 (30.1%)
Hoffman et al. (2022) [31]	USA	Mixed-Method	HCWs, health science student on Twitter	106	NR	NR	NR	"Belief in CTs": n=0 (0%)
Odejinmi et al. (2022) [32]	United Kingdom	Mixed-method	Midwives employed in two teaching hospitals	378	NR	99%	White:66.93% Black:21.16% Asian: 3.44%	"The government is able to track you": n= 13 (3%) [aOR] Belief in CTs Black vs. White (95%CI): 0.97 (0.24-3.84) (NS)

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							Mixed Race: 5.03% Other: 2.38%	
Asres et al. (2022) [33]	Ethiopia	Cross-sectional	Students of medicine, medical laboratory, pharmacy, health officer, nursing, anesthesia, environmental health, midwifery	387	21.97 (±1.67)	44.9%	NR	"It is a biological weapon": n= 68 (16.8 %) "It is a political game": n= 118 (30.5%) "Vaccination is a money-making venture": n=9 (12.7%)
Al-Qudah et al. (2022) [34]	Jordan	Cross-sectional	Healthcare specialties and healthcare students (applied health sciences, dentistry, medicine and surgery, nursing, pharmacy, other healthcare specialties)	1409	NR	NR	NR	"COVID -19 is a political manipulation": approx. 20% "The virus is bioengineered": approx. 30% "Vaccines are manufactured to increase pharmaceuticals": approx. 20% "COVID-19 pandemic aims to place a microchip in": approx. 5% Medical students and graduates: less CTs compared to other HCWs *(exception vs nurses NS)
Habib et al. (2022) [35]	Saudi Arabia	Cross-sectional	Medical students	1445	NR	11.3%	Saudi: 98.8% Non-Saudi: 1.2%	"The COVID-19 vaccine involves a conspiracy": n = 234 (48.6%) 97.9% of students believing in CTs were preclinical students
Jamil et al. (2022) [36]	Pakistan	Cross-sectional	Undergraduate medical students from different medical universities	401	NR	73.8%	NR	"World superpowers use it as a cover to launch a vaccination program to facilitate a global surveillance regime and establish one world order": n=153 (38.1%) "COVID-19 virus is a bioweapon released deliberately by the Chinese government to control the world's population" n=106 (26.4%) "Pandemic is a hoax perpetrated by a global to diverge Muslim belief by shutting down mosques": n=63 (15.7%) Correlation CT and gender (NS) Correlation CT and year of study (NS) Correlation absence of belief in CTs and vaccinated HCWs*

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Petersen et al. (2022) [37]	Germany	Cross-sectional	Nursing, administrative staff, medical-technical staff, physicians, and scientific staff in hospitals	1683	NR	78.7%	NR	CTs negatively associated with vaccination willigness.* Physicians and scientific staff: less CTs beliefs vs. nurses, medical-technical and administrative staff.* Administrative and nursing staff: most CT beliefs.* Women: more CT beliefs vs. men (with small to very small differences)* Correlation age and CTs (NS)
Inah et al. (2022) [38]	Nigeria	Cross-sectional	Medical radiation workers (radiologists, radiographers, radiotherapists, medical physicists, and radiology nurses)	50	38.04 (± 12.25)	32%	NR	"The Western world plans to destroy the world": 8.40% "Plans to systematically alter DNA signaling": 10.69% "It has to do with 5G technology": 5.3%
Dubov et al.(2022, 2021) & Roberts et al. (2022) [a] [39-41]	USA	Cross-sectional	Physicians, nurses, advanced practice providers, pharmacists, other allied health professionals, administrators and nonclinical ancillary staff at academic and private hospitals	2491	NR	74.95%	White: 72.8% Black/ African: 4.94% Asian:17.58% Pacific Island: 1.89% Native: 2.73%	<u>CTs among all HCWs:</u> *"The virus is or could be manmade": n=947 (38%)* [aOR] unvaccinated HCWs with "manmade -belief" vs. non-belief (95% CI): 1.37 (1.12-1.68)* Hispanic: 22.98% African-American: 20.33% Asian American: 13.47% *"The pandemic is a hoax": n=149 (6%)* [aOR] unvaccinated HCWs with "hoax -belief" vs. non-belief (95%CI): 0.82 (0.62-1.10) (NS) "The pandemic is a hoax": Hispanic: 3.68% African-American: 1.63% Asian American: 3.42% "Misinformed HCW group" (n=38): up to 92% believed CTs. They were slightly older, leaned Republican, and came from all levels of education. "Unconcerned HCW group" (n = 86): up to 13% believed CTs. They were younger, racially diverse, most educated, and leaned Democrat. <u>CT among nurses:</u>

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								"COVID-19 is a fabrication or a hoax, a synthetic virus manufactured under nefarious motives such as bioterrorism, economic destabilization, population control": n=212 (24 %) Vaccine acceptance nurses: (Willing to be) Vaccinated who believe in conspiracy: 19.3% Unwilling/not vaccinated who believe in conspiracy: 43% [OR] belief in CTs and vaccine acceptance vs. non-belief (95%CI): 2.05 (1.29-3.25) Vaccine acceptance HCW of color: [aOR] lower acceptance of CTs vs higher acceptance with CT belief (95%CI): 1.39 (1.10-1.76)
Nasr et al. (2021) [42]	Lebanon	Cross-sectional	Dentists	529	40.54 (±14.01)	44.80%	NR	"I believe that COVID-19-vaccination is a conspiracy": (apr. 5%)
Szmyd et al. (2021) [44]	Poland	Cross-sectional	Physicians and administrative healthcare assistants	387	NR	68.50%	NR	"Belief in CTs (overall)": n=30 (7.75%) Physician: 3.17% Healthcare assistant: 16.3% "Microchip injection": n= 5 (1.29%) Physician: 0% Healthcare assistant: 3.7% "Control of births by vaccine manufacturers": n=12 (3.10%)
Ditekemena et al. (2021) [45]	Democratic Republic of Congo	Cross-sectional	HCWs	324	NR	NR	NR	"They want to kill us": n=10 (6.6%) "They want to make us sterile": n= 5 (3.3%) "There are several CTs going around": n=1 (7.1%)
Woolf et al. (2021) [46]	United Kingdom	Prospective cohort study	All HCWs or ancillary workers	11,584	45 (±NR)	75.9%	White: 70.3%; Asian: 19.2%; Black: 4.2%; Other 6.4%	Higher COVID-19 CBS-score with vaccine hesitant HCWs*** [OR]: CBS-score with vaccine hesitant HCWs (95%CI): 1.12 (1.08-1.16)** Black and Asian HCWs with higher COVID-19 CBS-scores: more vaccine hesitant vs. White HCWs**

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Qunaibi et al. (2021) [47]	Worldwide	Cross-sectional	Arab-speaking HCWs	5708	30.6 (±10)	44.4%	NR	"Coronavirus/vaccine is a conspiracy": n=700 (12.3%)
Usman et al. (2021) [48]	Pakistan	Cross-sectional	Undergraduate healthcare tudents	410	NR	46.8 %	NR	"Microchip implantation theory associated with Bill Gates" and "COVID-19 as a part of economic war between developed countries": n=67 (16.4%)
Elhadi et al. (2021) [49]	Libya	Cross-sectional	Physicians, medical students, paramedics	3967	30.6 (±9.8)	58.7%	NR	"The novel corona virus is undoubtedly human-made to implement particular agendas": n=1432 (36.1%) Medical Students: 34.9% Physicians: 34.1% Paramedic and nurses: 41.9%
Szmyd et al. (2021))[43]	Poland	Cross-sectional	Medical students (dentistry, dietetics, emergency medical service, laboratory diagnostic, medicine, nursing, obstetric, pharmacy and physiotherapy student)	687	NR	64.77%	NR	"Belief in CTs (overall)": n=59 (8.59%) "Belief in microchip injection": n=12 (1.75%) "Belief in control of births by vaccine manufacturers": n=5 (0.73%)
Shehata et al. (2021) [50]	Egypt	Cross-sectional	Physicians working at various healthcare levels	1268	NR	59.4%	NR	"I think vaccination is a plot": n=33 (2.6%)
Al-Sanafi et al. (2021) [51]	Kuwait	Cross-sectional	Physicians, dentists, pharmacists, nurses, laboratory technicians, other (physiotherapists; dieticians and nutritionists; optometrists, etc.)	1019	34 (±9.7)	61.4%	Kuwait:75.1% Non-Kuwait: 21.7% Stateless/unknown: 3.2%	"COVID-19 has a human-made origin": n= 300 (29.4%) Belief in "COVID-19 has a human made origin" (67.3%): more hesitancy vs. non-belief/no opinion** Higher VCBS score correlated with COVID-19 vaccine hesitancy** Rejection of vaccination (vs. hesitancy and acceptance) correlated with higher levels of CT** The dependence on social media platforms, TV programs, newspapers, and news releases correlated with higher VCBS (vs. scientists/scientific journals, doctors/other HCWs**
Castañeda-Vasquez et al. (2021) [52]	Mexico	Cross-sectional	Medical guild, nursing, dental, psychology, and laboratory personnel	543	NR	65%	NR	"The vaccine is part of a worldwide conspiracy": n=34 (6%) Higher CT beliefs (40%) among vaccine-hesitant HCWs; vs. belief in CTs among vaccine – acceptant HCWs***

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								[OR] Belief in CTs among vaccine – hesitant HCWs vs. belief in CTs and vaccine acceptance (95%CI): 14.879 (6.384–34.677)***
Kükrer et al. (2021) [53]	Turkey	Cross-sectional	Academic physicians, specialist physicians, family physicians, midwives, nurses, health technicians, health officers, and pharmacists in public and private institution hospitals	442	NR	66.5%	NR	"I think it is the sheath theory of implanting traceable microchips in the bodies of millions of people with the vaccine microchip claimed in the media": n= 14 (3.2%)
Iliyasu et al. (2021) [54]	Nigeria	Mixed-method	Clinical staff (physician, nurse/midwife, pharmacist, laboratory scientist, physiotherapist; CHEO, ward attendant) and non-clinical staff (administrative, management, support service) at a tertiary referral hospital center	284	37.9 (± 10.36)	46.1%	Hausa/Fulani: 82.04% Others:18.06 %	"Concerned about rumors of depopulation (or "population control') and infertility related to COVID-19 vaccines": n=150 (52.8%) HCWs believing in CTs but still willing to accept vaccination: 12.7% [OR] HCWs not believing in CTs (vs believing) and vaccine acceptance (95%CI): 2.55 (1.25–5.20)

CBS: Conspiracy Belief Scale; CHEO: community health extension officers; CT: Conspiracy theory; HCW: Healthcare Worker; (a)OR: (adjusted) Odds Ratio with coincidence interval of 95%; NR: not reported; NS: not significant; * $p < 0.05$, ** $p < 0.001$, *** $p<0.0001$; VCBS: Vaccine Conspiracy Belief Scale

[a]: Dubov (2022) and Roberts (2022) extracted their data from Dubov (2021) for secondary analysis.

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689 **Table 2: Types of COVID-19-related CTs (based on Fotakis & Simou, 2023) [69]**

Types of COVID-19-related CTs	Examples
Destabilization and power gain: *prevention and control measures were deployed as destabilizing actions for achieving financial or political power*	- COVID-19 is a biological weapon from China to establish world order. - Spread of the virus is a deliberate attempt by a group of powerful people to make money or to take control.
Population reduction: *the virus and vaccines were developed to reduce the global or specific population*	- COVID-19 was intentionally created to reduce the world's population or to get rid of certain groups of people. - Vaccine is used to carry out mass sterilization.
Liberty restriction: *the virus and vaccines were developed to reduce liberty*	- Vaccine contains microchips to control people. - Vaccine is used to alter DNA structures. - Coronavirus is just an excuse to suppress civil liberties.
Big pharma plot: *Big Pharma created the virus and/or is knowingly producing ineffective or harmful vaccine*	- Big Pharma created coronavirus to profit from the vaccines. - Vaccine's effectiveness data are fabricated by Big Pharma.
5 G: *5 G networks promote the spread of COVID-19*	- COVID-19 pandemic is induced by 5 G networks. - 5 G cell phone technology is responsible for the spread of the coronavirus.
Non-existence: *COVID-19 does not exist*	- Coronavirus is a hoax or a myth to force vaccinations on people.
Other	- COVID-19 is a message from God. - Bill Gates is behind the coronavirus pandemic.

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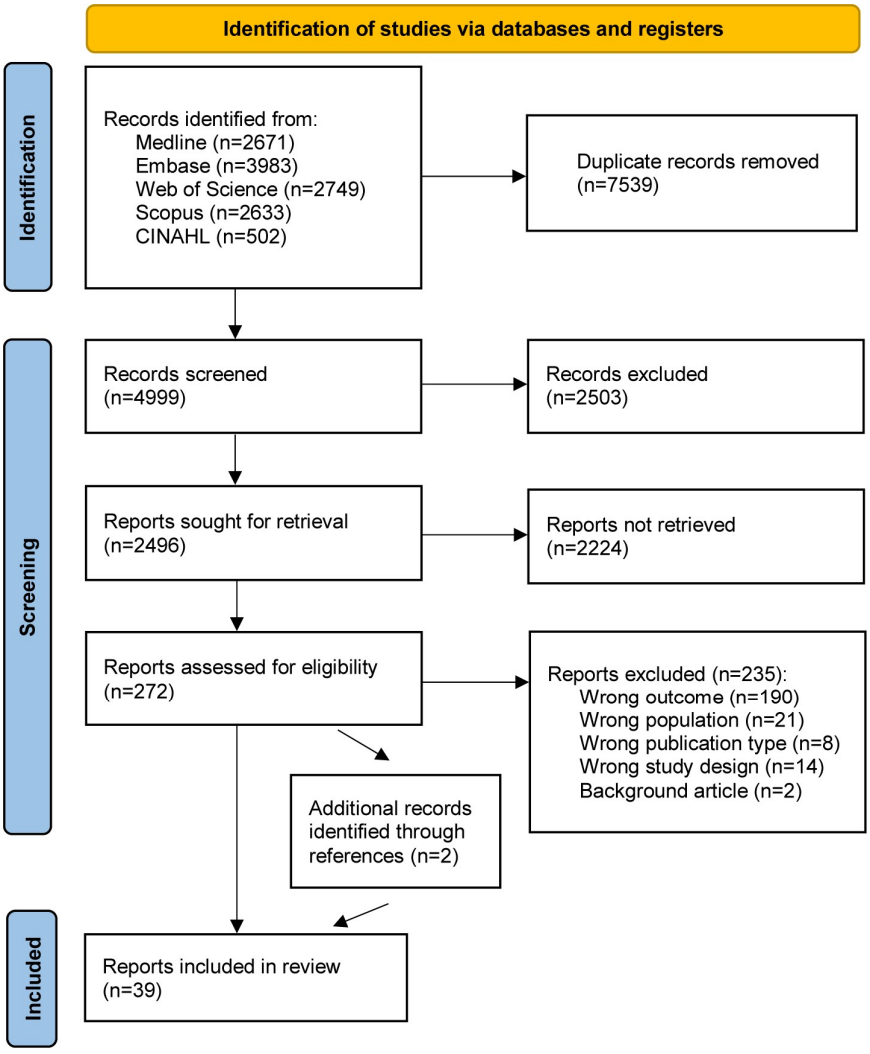
691 Figure 1



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