

RESEARCH ARTICLE


Potential factors influencing COVID-19 vaccine acceptance and hesitancy: A systematic review


Debendra Nath Roy¹[✉], Mohitosh Biswas²[‡], Ekramul Islam²[‡], Md. Shah Azam^{3,4}^{*}

1 Department of Pharmacy, Jashore University of Science and Technology, Jashore, Bangladesh,

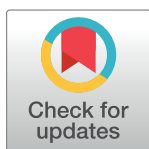
2 Department of Pharmacy, University of Rajshahi, Rajshahi, Bangladesh, **3** Department of Marketing, University of Rajshahi, Rajshahi, Bangladesh, **4** Vice Chancellor, Rabindra University, Sirajganj, Bangladesh

 These authors contributed equally to this work.

 Current address: Institute of Education and Research, University of Rajshahi, Rajshahi, Bangladesh

 These authors also contributed equally to this work.

* mdshah.azam@yahoo.com.au



Abstract

Background and aims

Although vaccines are considered the most effective and fundamental therapeutic tools for consistently preventing the COVID-19 disease, worldwide vaccine hesitancy has become a widespread public health issue for successful immunization. The aim of this review was to identify an up-to-date and concise assessment of potential factors influencing COVID-19 vaccine acceptance and refusal intention, and to outline the key message in order to organize these factors according to country count.

Methods

A systematic search of the peer-reviewed literature articles indexed in reputable databases, mainly Pub Med (MEDLINE), Elsevier, Science Direct, and Scopus, was performed between 21st June 2021 and 10th July 2021. After obtaining the results via careful screening using a PRISMA flow diagram, 47 peer-reviewed articles met the inclusion criteria and formed the basic structure of the review.

Results

In total, 11 potential factors were identified, of which the greatest number of articles ($n = 28$) reported “safety” (34.46%; 95% CI 25.05–43.87) as the overarching consideration, while “side effects” (38.73%; 95% CI 28.14–49.32) was reported by 22 articles, which was the next common factor. Other potential factors such as “effectiveness” were identified in 19 articles (29.98%; 95% CI 17.09–41.67), followed by “trust” ($n = 15$ studies; 27.91%; 95% CI 17.1–38.73), “information sufficiency” ($n = 12$; 34.46%; 95% CI 35.87–63.07), “efficacy” ($n = 8$; 28.73%; 95% CI 9.72–47.74), “conspiracy beliefs” ($n = 8$; 14.30%; 95% CI 7.97–20.63), “social influence” ($n = 6$; 42.11%; 95% CI 14.01–70.21), “political roles” ($n = 4$; 16.75%; 95% CI 5.34–28.16), “vaccine mandated” ($n = 4$; 51.20%; 95% CI 20.25–82.15),

OPEN ACCESS

Citation: Roy DN, Biswas M, Islam E, Azam M.S (2022) Potential factors influencing COVID-19 vaccine acceptance and hesitancy: A systematic review. PLoS ONE 17(3): e0265496. <https://doi.org/10.1371/journal.pone.0265496>

Editor: Camelia Delcea, Bucharest University of Economic Studies, ROMANIA

Received: August 23, 2021

Accepted: March 2, 2022

Published: March 23, 2022

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: <https://doi.org/10.1371/journal.pone.0265496>

Copyright: © 2022 Roy et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: All relevant data are within the paper and its [Supporting Information](#) files.

Funding: No external fund was available

Competing interests: There is no competing interests to declare.

and “fear and anxiety” ($n = 3$; 8.73%; 95% CI 0.59–18.05). The findings for country-specific influential vaccination factors revealed that, “safety” was recognized mostly ($n = 14$) in Asian continents (32.45%; 95% CI 19.60–45.31), followed by the United States ($n = 6$; 33.33%; 95% CI 12.68–53.98). “Side effects” was identified from studies in Asia and Europe ($n = 6$; 35.78%; 95% CI 16.79–54.77 and 16.93%; 95% CI 4.70–28.08, respectively), followed by Africa ($n = 4$; 74.60%, 95% CI 58.08–91.11); however, public response to “effectiveness” was found in the greatest ($n = 7$) number of studies in Asian countries (44.84%; 95% CI 25–64.68), followed by the United States ($n = 6$; 16.68%, 95% CI 8.47–24.89). In Europe, “trust” ($n = 5$) appeared as a critical predictor (24.94%; 95% CI 2.32–47.56). “Information sufficiency” was identified mostly ($n = 4$) in articles from the United States (51.53%; 95% CI = 14.12–88.74), followed by Asia ($n = 3$; 40%; 95% CI 27.01–52.99). More concerns was observed relating to “efficacy” and “conspiracy beliefs” in Asian countries ($n = 3$; 27.03%; 95% CI 10.35–43.71 and 18.55%; 95% CI 8.67–28.43, respectively). The impact of “social influence” on making a rapid vaccination decision was high in Europe ($n = 3$; 23.85%, 95% CI -18.48–66.18), followed by the United States ($n = 2$; 74.85%). Finally, “political roles” and “vaccine-mandated” were important concerns in the United States.

Conclusions

The prevailing factors responsible for COVID-19 vaccine acceptance and hesitancy varied globally; however, the global COVID-19 vaccine acceptance relies on several common factors related to psychological and, societal aspect, and the vaccine itself. People would connect with informative and effective messaging that clarifies the safety, side effects, and effectiveness of prospective COVID-19 vaccines, which would foster vaccine confidence and encourage people to be vaccinated willingly.

Introduction

The corona virus disease 2019 (COVID-19) has been an unprecedented disease burden around the world that has drastically impacted diverse areas of human societies, from public health systems to, education, economic growth, and personal well-being. As of the end of the first week of August 2021, more than 200 million confirmed cases and more than 4.2 million deaths caused by the disease have been reported worldwide [1]. Public health authorities are searching for preventive strategies to limit the spread of corona viruses because an effective treatment for the COVID-19 disease is not yet to be available, [2–4]. Since the pandemic poses a significant disease burden to health systems and a threat to the global health, along with preventive community measures, massive immunization is considered the most powerful and cost-effective health intervention, as well as the most promising strategy to combat this contagious virus and to save human lives. According to the Centers for Disease Control and Prevention (CDC), to date, vaccines are the most powerful therapeutic tools available to curb the spread of infectious viruses such as COVID-19 [5]; however, promoting effective vaccine candidates and achieving public acceptance are urgent matter and public health priorities that must be satisfied to successfully manage COVID-19.

After the new corona virus emerged in 2019, using past experiences many scientists around the world focused their endless efforts into quickly developing an effective vaccine.

Impressively, since last year an unprecedented number of 74 vaccine candidates have been developed, which have successfully passed through clinical trials and are included in COVID-19 vaccine platform. The World Health Organization (WHO) and Food and Drug Administration (FDA) have approved 3 candidates to date, and granted conditional approval for 7 more candidates in phase three trials [6, 7]. As such, alongside an implementable and equitable vaccine distribution policy, ensuring the vaccine acceptance of a new vaccine by the general public is equally important, because it has been reported that, the real uptake rate of a pandemic vaccine could be much lower than the expected values [8, 9]. For example, in the H1N1 influenza pandemic, the acceptance rates of a newly launched vaccine were seen to range from 17 to 67%, even in many developed countries [8–10].

Although vaccination has been one of the most important interventions in the field of public health throughout the 21st century, worldwide COVID-19 vaccine hesitancy is a prevalent issue and is viewed as one of the top ten global public health challenges [11]. Vaccine hesitancy refers to the reluctance or unwillingness to get vaccinated or unwillingness to administer vaccines to one's children against an infectious disease, even if the vaccine is proven to be safe and effective and the service is assessable to uptake the vaccine [12]. Vaccine hesitancy is expressed in “3C” sequences, which point to confidence, complacency, and convenience. The World Health Organization Strategic Advisory Group of Experts (WHO-SAGE) defines vaccine hesitancy as a “delay in acceptance or refusal of vaccines, despite the availability of vaccination services” [13]. Actually, low initial vaccine uptake intention to a particular vaccine or vaccination program is a psychological and dynamic phenomenon observed through global perspectives [14]. The extent to which and how clearly an individual understand the relevance of the pandemic vaccine significantly depends on trust, which in turn is related to personal beliefs, motivation, perceived risk exposure, knowledge, and awareness of the vaccination [14]. A highly effective vaccine was found to have strong acceptance [15], while vaccine with low effectiveness could negatively impact on uptake intention and reduce the willingness to receive the new vaccine [16]. Resource less and marginalized peoples and disadvantaged minority group have previously been less likely to be vaccinated for influenza [17]. During a crude vaccine optimization process, inadequate vaccine safety data diminished the vaccine confidence index and produced distrust in health services, public health experts and state agencies. Moreover, widespread fake news on vaccines and the vaccination process, misinformation, and propaganda were identified as several key determinants of global vaccine refusal [18]. Taken together, an effective intervention is needed to improve public acceptance and trust of COVID-19 vaccines, to ease concerns over the safety, side effects, and benefits of vaccines; and target inoculation campaigns in disadvantaged and marginalized groups who have already been seriously affected by COVID-19 [19]. In this regard, frequent communication between health workers and remote population groups is also important to address the hesitancy-associated predictors and to motivate vaccine-hesitant individuals towards vaccine acceptance [20].

The current evidence confirming that, best-practice community interventions, such as the use of face masks, good hand hygiene, and maintaining social distancing, are effective ways of preventing the rapid spread of COVID-19 in low-and middle-income countries (LMICs) [21]; however, optimization of crude immunization through an effective vaccine is the ultimate therapeutic tool in useful public health interventions against the COVID-19 disease [5]. Public willingness to accept a newly promoted vaccines varies with space, social class, time, ethnicity and contextual human behavior as reported in previous studies [14, 22, 23]; therefore, in order to implement a vaccine-based community health intervention nationwide, the primary aim is to understand the common factors that lead to COVID-19 vaccine hesitancy and refusal

intention globally, because a lag in the vaccination process in LMICs could facilitate the spread of new variants of COVID-19 to rest of the world.

To date, however, most of the systematic reviews and meta-analysis is performed on COVID-19 vaccination have focused on the assessment of vaccine acceptance or rejection rates [19, 24, 25] and few studies have tried to summarize the factors that most influence COVID-19 vaccine acceptance intention and refusal among the different countries. As a result, there is a paucity of systematic reviews describing the most common factors influencing COVID-19 vaccine uptake or refusal intention, with the factors varying by country count globally; hence, this systemic review aimed to identify and highlight the most common factors of COVID-19 vaccine uptake and refusal intention and to, summarize the key drivers that influence the complex motives behind COVID-19 vaccine hesitancy among individuals in different continents.

Materials and methods

In this review the relevant factors and themes associated with the COVID-19 vaccine acceptance or hesitancy concerns were examined. We searched scholarly peer-reviewed databases to identify and design a framework of the probable factors influencing hesitancy to uptake a new vaccine aimed at COVID-19 infection. The screening procedure involved a flow diagram in accordance with the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) 2020 [26] statement for new systematic reviews of databases and for the literature selection process. The inclusion criteria were the following: 1) peer-reviewed published articles from electronic databases including Pub Med (MEDLINE), Elsevier, Embase, Science Direct, Scopus and other reputed resources; 2) survey studies involving all types of sample populations; (3) the scope and principal aim of the study was to identify the potential factors influencing COVID-19 vaccine acceptance and hesitancy; (4) publication studies in the English language. The exclusion criteria were the following: (1) unpublished manuscripts; (2) the article did not publish the required data related to vaccine acceptance and refusal factors; (3) the publication language was not in English. To understand the complex interplay of a wide variety of intervening factors for COVID-19 vaccine acceptance and hesitancy, this study was aimed to identify potential factors influencing COVID-19 vaccine acceptance and hesitancy across the world. The search items we used in this study were adopted from recently published articles on COVID-19 vaccine acceptance and hesitancy, and systematic review focused on the assessment of COVID-19 vaccine acceptance and rejection rate. The literature search for peer-reviewed articles was conducted on 21st June 2021 to 10th July by using the keywords: “COVID-19 vaccine hesitancy” OR “COVID-19 vaccine hesitancy and associated factors” OR “COVID-19 vaccine confidence” OR “COVID-19 vaccine AND acceptance intention” using a descriptive style. In addition, the references for the studies that met the inclusion criteria were searched to include additional articles in the review. The initial searches of peer reviewed records from electronic databases produced 98 articles, 5 of which articles were identified from reference lists from included articles. All authors independently assessed the documents during the inclusion process. In the initial phase and before screening, 6 duplicate articles and 1 review article were recognized and removed from the process while 96 articles were screened. During the eligibility assessment, 11 articles were removed after the abstract screening step. After full text assessment, 38 articles were excluded by the independent reviewer due to lacking key searched data set that meet the study objectives; hence 47 articles were selected for the review and final analysis to explore the potential factors associated with COVID-19 vaccine uptake intention and hesitancy. The types of papers included in the study were mostly cross-sectional survey research papers. The search strategy used for potential factor identification

involved identifying multiple key factors from individual articles, collecting the respondent's number of each variable, and calculating the respondent's mean (%) against the total mean value. From the sample, standard deviation (SD) and standard error (SE) were calculated to show the 95% confidence interval (CI).

Results

“Fig 1” shows the PRISMA statement flow diagram for the literature search and selection process. After removal of duplicates, the independent reviewer abstract screening process resulted in 93.20% of initial agreement on which abstracts were satisfactory for the purpose of the study. After the application of inclusion criteria during the abstract screening and full-text assessment of the eligibility stages, finally 48.96% studies meeting initial agreement criteria were included in the final analysis.

In this review, the sample populations we analyzed were from different countries in Asia (Bangladesh, India, China, Jordan, Saudi Arabia, Qatar, Israel, Kuwait, Turkey), Europe (Portugal, Slovenia, Poland, Germany, France, United Kingdom), the United States, and Africa (Uganda, Zambia, Middle East, Egypt, involving multi-ethnic (report of 19 and 22 countries) backgrounds and LMICs (9 countries and Asia, Africa, and South America). The characteristics of the study participants included general populations, industrial service workers, self-employed workers, university employees, service personnel, farmers, managers and administrators, associate professionals, clerical support workers, service and sales workers, craft and related workers, plant and machine operators and assemblers, elementary occupations, private

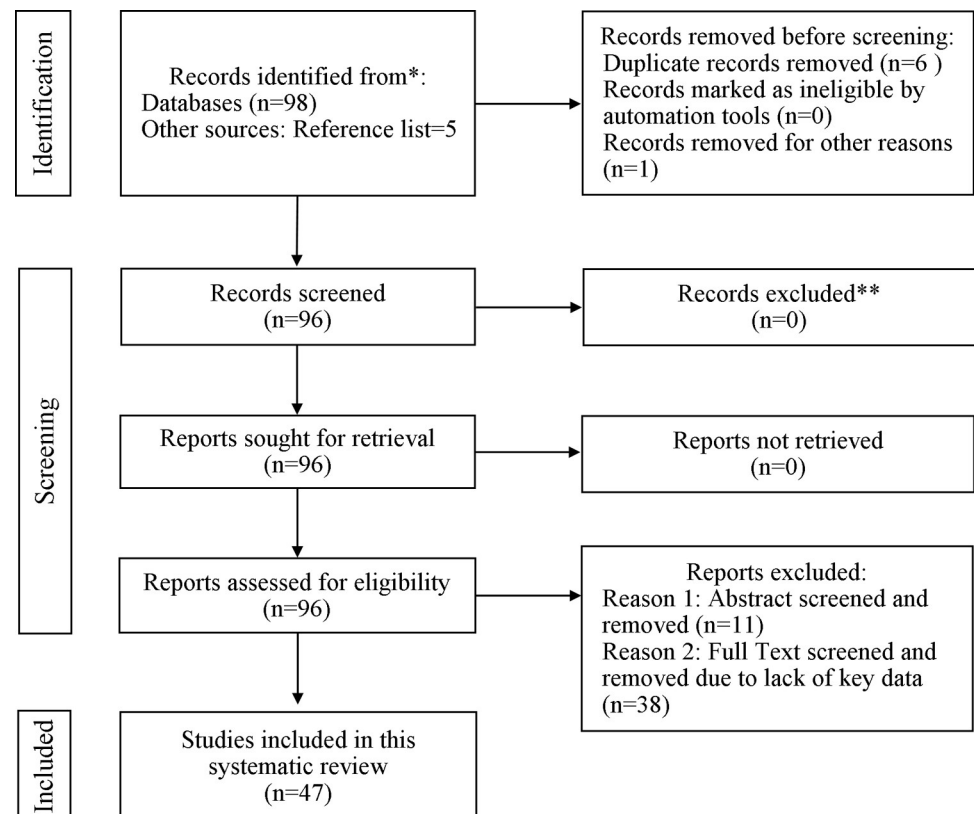


Fig 1. PRISMA-based flow diagram of study selection process for new systematic reviews.

<https://doi.org/10.1371/journal.pone.0265496.g001>

workers, government workers, monthly paid job holders, agricultural employees, business people, day-laborers, house wives, unemployed people, health professionals, students in various backgrounds, adolescents, young adults, older adults, and various ethnicities.

The most frequently identified key factors in COVID-19 vaccine acceptance and refusal are illustrated in “Table 1”. Since we identified multiple factors from each individual article in

Table 1. Potential factors associated with COVID-19 vaccine acceptance and hesitancy.

Factors	Authors [Count]	Mean total populations (\bar{X})	Mean respondents (\bar{x}), (95% CI)	Mean respondents ($\bar{x}\%$) (95% CI)
Safety	Soares et al., 2021 [27]; Jain et al., 2021 [28]; Lin et al., 2020 [29]; Wang K et al., 2021[30]; Suresh et al., 2021 [31]; Abedin et al., 2021 [32]; Bai et al., 2021 [33]; El-Elimat et al., 2021 [34]; Cai et al., 2021 [35]; Almaghaslah et al., 2021 [36]; Silva et al., 2021 [37]; Manning et al., 2021 [38]; Sharun et al., 2020 [39]; Palm et al., 2021 [40]; Pogue et al., 2020 [41]; Wang J et al., 2020 [42]; Al-Mulla et al., 2021 [43]; Kanyike et al., 2021 [44]; Petravić et al., 2021 [45]; Grochowska et al., 2021 [46]; Rosental&Shmueli, 2021 [47]; Jiang et al., 2021 [48]; Mudenda et al., 2021 [49]; Lazarus et al., 2021 [50]; Faezi et al., 2021 [51]; Nikolovski et al., 2021 [52]; Burhamah et al., 2021 [53]; Holzmann-Littig et al., 2021 [54]	2088.64	513.29 (275.87–750.72)	34.46 (25.05–43.87)
Efficacy	Jain et al., 2021 [28]; Lin et al., 2020 [29]; Almaghaslah et al., 2021 [36]; Kanyike et al., 2021 [44]; Nikolovski et al., 2021 [52]; Tavolacci et al., 2021 [55]; Kose et al., 2021 [56]; Freeman et al., 2021 [57]	2851.75	556.38 (-2.55–1115.31)	28.73 (9.72–47.74)
Information sufficiency	Soares et al., 2021 [27]; Lin et al., 2020 [29]; Suresh et al., 2021 [31]; Almaghaslah et al., 2021 [36]; Silva et al., 2021 [37]; Kanyike et al., 2021 [44]; Nikolovski et al., 2021 [52]; Sherman et al., 2021 [58]; Saied et al., 2021 [59]; Riad et al., 2021 [60]; Kaplan et al., 2021 [61]; Lucia et al., 2020 [62]	2246.33	1333.67 (397.18–2270.16)	49.47 (35.87–63.07)
Trust	Soares et al., 2021 [27]; Jain et al., 2021 [28]; El-Elimat et al., 2021 [34]; Kanyike et al., 2021 [44]; Petravić et al., 2021 [45]; Riad et al., 2021 [60]; Lazarus et al., 2021 [50]; Kose et al., 2021 [56]; Freeman et al., 2021 [57]; Holzmann-Littig et al., 2021 [54]; Lucia et al., 2020 [62]; Mascarenhas et al., 2021 [63]; Kelekar et al., 2021 [64]; Grüner&Krüger, 2020 [65]; Padhi& Al-Mohaithef, 2021 [66]	2678.80	635 (103.37–1166.63)	27.91 (17.1– 38.73)
Side effect	Suresh et al., 2021 [27]; Bai et al., 2021 [33]; El-Elimat et al., 2021 [34]; Manning et al., 2021 [38]; Kanyike et al., 2021 [44]; Petravić et al., 2021 [45]; Rosental&Shmueli, 2021 [47]; Jiang et al., 2021 [48];Mudenda et al., 2021 [49]; Faezi et al., 2021 [51]; Nikolovski et al., 2021 [52]; Holzmann-Littig et al., 2021 [54]; Tavolacci et al., 2021 [55]; Kose et al., 2021 [56];Freeman et al., 2021 [57]; Sherman et al., 2021 [58]; Saied et al., 2021 [59];Riad et al., 2021 [60]; Lucia et al., 2020 [62];Bono et al., 2021 [67]; Szymyd et al., 2021 [68]; Arce et al., 2021 [69]	3303.55	1209.36 (516.85–1901.87)	38.73 (28.14–49.32)
Effectiveness	Wang K et al., 2021 [30]; Abedin et al., 2021 [32]; El-Elimat et al., 2021 [34]; Almaghaslah et al., 2021 [36]; Silva et al., 2021 [37]; Sharun et al., 2020 [39]; Palm et al., 2021 [40]; Pogue et al., 2020 [41]; Wang J et al., 2020 [42]; Al-Mulla et al., 2021 [43];Grochowska et al., 2021 [46]; Mudenda et al., 2021 [49]; Lazarus et al., 2021 [50]; Nikolovski et al., 2021 [52]; Holzmann-Littig et al., 2021 [54]; Saied et al., 2021 [59]; Lucia et al., 2020 [62]; Bono et al., 2021 [67]; Reiter et al., 2021 [70]	2817.32	508.74 (243.31–774.18)	29.38 (17.09–41.67)
Conspiracy beliefs	Pogue et al., 2020 [41]; Lazarus et al., 2021 [50]; Burhamah et al., 2021 [53]; Szymyd et al., 2021 [68]; Islam et al., 2021 [71]; Sallam et al., 2021a [72]; Sallam et al., 2021b [73]	2843.13	426.38 (-18.43–871.19)	14.30 (7.97–20.63)
Social influence	Lin et al., 2020 [29]; Cai et al., 2021 [35]; Holzmann-Littig et al., 2021 [54]; Tavolacci et al., 2021 [55]; Freeman et al., 2021 [57]; Mascarenhas et al., 2021 [63]	2924.83	1172.50 (-73.52–2418.52)	42.11 (14.01–70.21)
Political roles	Palm et al., 2021 [40]; Holzmann-Littig et al., 2021 [54]; Riad et al., 2021 [60]; Reiter et al., 2021 [70]	3567	521.25 (102.55–939.95)	16.75 (5.34–28.16)
Vaccine-mandate	Almaghaslah et al., 2021 [36]; Silva et al., 2021[37]; Lucia et al., 2020 [62]; Mascarenhas et al., 2021 [63]	378.50	194 (37.94–350.06)	51.20 (20.25–82.15)
Fear & anxiety	Rosental&Shmueli, 2021 [47]; Nikolovski et al., 2021 [52]; Holzmann-Littig et al., 2021 [54];	4176.67	180 (60.17–299.82)	8.73 (-0.59–18.05)

<https://doi.org/10.1371/journal.pone.0265496.t001>

response to COVID-19 vaccine acceptance intention and hesitancy, in total 11 potential factors were identified from 47 articles [27–73], among which the most articles (n = 28) reported “safety”(respondent’s mean (\bar{x}) = 513.19; 95% CI 275.87–750.72, respondent’s mean ($\bar{x}\%$) = 34.46; 95% CI 25.05–43.87; total sample populations mean (\bar{X}) = 2088.64) as the overarching concern, while “side effects” (\bar{x} = 1209.36, 95% CI 516.85–1901.87; $\bar{x}\%$ = 38.73, 95% CI 28.14–49.32, and \bar{X} = 3303.55) was identified in 22 studies as influencing COVID-19 vaccination intention. Of the other key factors, “effectiveness” was identified in 19 articles (\bar{x} = 508.74, 95% CI 243.31–774.18; $\bar{x}\%$ = 29.98, 95% CI 17.09–41.67 and \bar{X} = 2817.32); followed by “trust” (n = 15; \bar{x} = 635, 95% CI 103.37–1166.63; $\bar{x}\%$ = 27.91, 95% CI 17.1–38.73 and \bar{X} = 2678.80); “information sufficiency” (n = 12; \bar{x} = 1333.67, 95% CI 397.18–2270.16; $\bar{x}\%$ = 34.46, 95% CI 35.87– 63.07 and \bar{X} = 2246.33), while 8 articles reported both “efficacy” (\bar{x} = 556.38, 95% CI -2.55–1115.31; $\bar{x}\%$ = 28.73, 95% CI 9.72–47.74 and \bar{X} = 2851.75) and “conspiracy beliefs”(\bar{x} = 426.38, 95% CI -18.43–871.19; $\bar{x}\%$ = 14.30, 95% CI 7.97–20.63 and \bar{X} = 2843.13). “social influence” (n = 6) was another key factor (\bar{x} = 1172.5, 95% CI -73.52–2418.52; $\bar{x}\%$ = 42.11, 95% CI 14.01–70.21 and \bar{X} = 2924.83). The terms “political roles” and “vaccine-mandated” were reported by 4 studies (\bar{x} = 521.25, 95% CI 102.55–939.95; $\bar{x}\%$ (%) = 16.75, 95% CI 5.34–28.16 and \bar{X} = 3567; \bar{x} = 194, 95% CI 37.94–350.06; $\bar{x}\%$ = 51.20, 95% CI 20.25–82.15, \bar{X} = 378.50 respectively) respectively. Finally “fear and anxiety” was also identified as a potential factor (n = 3; \bar{x} = 180, 95% CI 60.17–299.82; $\bar{x}\%$ = 8.73, 95% CI 0.59–18.05 and \bar{X} = 4176.67) as shown in Table 1.

“Table 2” summarizes and describes the mode of distribution frequency of these key factors around the world. Following Table 1, the results revealed that “safety” was recognized mostly (n = 14) in Asian countries (\bar{x} = 496.93, 95% CI 179.39–814.47; $\bar{x}\%$ = 32.45, 95% CI 19.60–45.31 and \bar{X} = 1521.14), then in the United States (n = 6; \bar{x} = 570, 95% CI-

Table 2. Distribution of potential factors across different continents.

Ethnicity	Factors	Author [Count]	Mean total populations (\bar{X})	Mean respondents (\bar{x}), (95% CI)	Mean respondents (\bar{x} %) (95% CI)
Asia	Safety	Jain et al., 2021 [28]; Wang K et al., 2021 [30]; Suresh et al., 2021 [31]; Abedin et al., 2021 [32]; Bai et al., 2021 [33]; El-Elimat et al., 2021 [34]; Cai et al., 2021 [35]; Almaghaslah et al., 2021 [36]; Sharun et al., 2020 [39]; Wang J et al., 2020 [42]; Al-Mulla et al., 2021 [43]; Rosental & Shmueli, 2021 [47]; Jiang et al., 2021 [48]; Burhamah et al., 2021 [53]	1521.14	496.93 (179.39–814.47)	32.45 (19.60–45.31)
	Efficacy	Jain et al., 2021 [28]; Almaghaslah et al., 2021 [36]; Kose et al., 2021 [56]	1022.67	269 (115.70–422.30)	27.03 (10.35–43.71)
	Information sufficiency	Suresh et al., 2021 [31]; Almaghaslah et al., 2021 [36]; Kaplan et al., 2021 [61]	931.33	419.33 (7.93–830.73)	40 (27.01–52.99)
	Trust	Jain et al., 2021 [28]; El-Elimat et al., 2021 [34]; Kose et al., 2021 [56]; Padhi & Al-Mohaithef, 2021 [66]	1574.50	275.25 (51.22–499.28)	16.78 (6.20–27.35)
	Side effect	Suresh et al., 2021 [27]; Bai et al., 2021 [33]; El-Elimat et al., 2021 [34]; Rosental & Shmueli, 2021 [47]; Jiang et al., 2021 [48]; Kose et al., 2021 [56]	1598.83	660.33 (-9.57–1330.23)	35.78 (16.79–54.77)
	Effectiveness	Wang et al., 2021 [30]; Abedin et al., 2021 [32]; El-Elimat et al., 2021 [34]; Almaghaslah et al., 2021 [36]; Sharun et al., 2020 [39]; Wang J et al., 2020 [42]; Al-Mulla et al., 2021 [43]	1638.71	563.57 (180.27–946.87)	44.84 (25–64.68)
	Conspiracy beliefs	Burhamah et al., 2021 [53]; Sallam et al., 2021a [72]; Sallam et al., 2021b [73]	1598.75	273.50 (54.91–492.10)	18.55 (8.67–28.43)
	Social influence	Cai et al., 2021 [35]	1057	332–	31.4–
	Vaccine-mandate	Almaghaslah et al., 2021 [36]	862	402 –	46.7–
	Fear & anxiety	Rosental & Shmueli, 2021 [47]	628	112 –	17.8–

(Continued)

Table 2. (Continued)

Ethnicity	Factors	Author [Count]	Mean total populations (\bar{X})	Mean respondents (\bar{x}), (95% CI)	Mean respondents (\bar{x} %) (95% CI)
Europe	Safety	Soares et al., 2021 [27]; Petravić et al., 2021 [45]; Grochowska et al., 2021 [46]; Holzmann-Littig et al., 2021 [54]	1826.50	423 (-132.07–978.07)	28.10 (0.96–55.24)
	Efficacy	Tavolacci et al., 2021 [55]; Freeman et al., 2021 [57]	4101.5	265 –	5.45 –
	Information sufficiency	Soares et al., 2021 [27]; Sherman et al., 2021 [58]	1721.5	901.5 –	50.5 –
	Trust	Soares et al., 2021 [27]; Petravić et al., 2021 [45]; Grüner&Krüger, 2020 [65]; Freeman et al., 2021 [57]; Holzmann-Littig et al., 2021 [54]	2477.80	361.60 (-83.64–806.84)	24.94 (2.32–47.56)
	Side effect	Tavolacci et al., 2021 [55]; Petravić et al., 2021 [45]; Szmyd et al., 2021 [68]; Sherman et al., 2021 [58]; Freeman et al., 2021 [57]; Holzmann-Littig et al., 2021 [54]	2799.67	300.50 (154.02–446.98)	16.39 (4.70–28.08)
	Effectiveness	Grochowska et al., 2021 [46]; Holzmann-Littig et al., 2021 [54]	2369.5	281.5–	10.8 –
	Conspiracy beliefs	Szmyd et al., 2021 [68]	1971	310–	15.7 –
	Social influence	Holzmann-Littig et al., 2021 [54]; Tavolacci et al., 2021 [55]; Freeman et al., 2021 [57]	4234.33	1207.33 (-965.03–3379.69)	23.85 (-18.48–66.18)
	Political roles	Holzmann-Littig et al., 2021 [54]	4500	206 –	4.5–
	Fear and anxiety	Holzmann-Littig et al., 2021 [54]	4500	302 –	6.7–
The United States	Safety	Lin et al., 2020 [29]; Silva et al., 2021 [37]; Manning et al., 2021 [38]; Palm et al., 2021 [40]; Pogue et al., 2020 [41]; Nikolovski et al., 2021 [52]	2274.67	570 (-214.95–1,354.95)	33.33 (12.68–53.98)
	Efficacy	Lin et al., 2020 [29]; Nikolovski et al., 2021 [52]	5471.5	1369 –	37.55 –
	Information sufficiency	Lin et al., 2020 [29]; Silva et al., 2021 [37]; Nikolovski et al., 2021 [52]; Lucia et al., 2020 [62]	2836.75	2231.50 (-420.29–4883.29)	51.43 (14.12–88.74)
	Trust	Lucia et al., 2020 [62]; Mascarenhas et al., 2021 [63]; Kelekar et al., 2021 [64]	276.67	94.67 (16.58–172.76)	34.53 (3.74–65.32)
	Side effect	Manning et al., 2021 [38]; Lucia et al., 2020 [62]; Nikolovski et al., 2021 [52]	2866	1025 (-686.87–2736.87)	36.23 (20.29–52.17)
	Effectiveness	Silva et al., 2021 [37]; Palm et al., 2021 [40]; Pogue et al., 2020 [41]; Nikolovski et al., 2021 [52]; Lucia et al., 2020 [62]; Reiter et al., 2021 [70]	1875.17	173.17 (-7.92–354.26)	16.68 (8.47–24.89)
	Conspiracy beliefs	Pogue et al., 2020 [41]	316	3 –	1–
	Social influence	Lin et al., 2020 [29]; Mascarenhas et al., 2021 [63]	1894.5	1540.5 –	74.85–
	Political roles	Palm et al., 2021 [40]; Reiter et al., 2021 [70]	1564.5	405.5 –	23.25–
	Vaccine-mandate	Silva et al., 2021 [37]; Lucia et al., 2020 [62]; Mascarenhas et al., 2021 [63]	217.33	124.67 (62–187.34)	52.70 (27.43–77.97)
Fear and anxiety	Nikolovski et al., 2021 [52]	7402	126–	1.7–	
Africa	Safety	Kanyike et al., 2021 [44]; Mudenda et al., 2021 [49]; Faezi et al., 2021 [51]	935.33	581 (32.01–1129.99)	64.73 (58.36–71.10)
	Efficacy	Kanyike et al., 2021 [44]	600	376–	62.7 –
	Information sufficiency	Kanyike et al., 2021 [44]; Saied et al., 2021 [59]	1366.5	963–	67.7–
	Trust	Kanyike et al., 2021 [44]	600	376–	62.7–
	Side effect	Kanyike et al., 2021 [44]; Mudenda et al., 2021 [49]; Faezi et al., 2021 [51]; Saied et al., 2021 [59]	1234.75	957.75 (140.55–1774.94)	74.60 (58.08–91.11)
	Effectiveness	Saied et al., 2021 [59]; Mudenda et al., 2021 [49]	1229.5	1010.5–	51.7 –

(Continued)

Table 2. (Continued)

Ethnicity	Factors	Author [Count]	Mean total populations (\bar{X})	Mean respondents (\bar{x}), (95% CI)	Mean respondents (\bar{x} %) (95% CI)
Multi-ethnic areas	Safety	Lazarus et al., 2021 [50]	13426	560—	4.1—
	Information sufficiency	Riad et al., 2021 [60]	6639	2091—	31.5—
	Trust	Riad et al., 2021 [60]; Lazarus et al., 2021 [50]	10032.5	2978—	30.3—
	Side effect	Riad et al., 2021 [60]	6639	3369—	50.7—
	Effectiveness	Lazarus et al., 2021 [50]	13426	560—	4.1—
	Conspiracy beliefs	Lazarus et al., 2021 [50] Islam et al., 2021 [71]	7031.5	1002—	11.75—
	Political roles	Riad et al., 2021 [60]	6639	1068—	16—
LMICs	Side effect	Bono et al., 2021 [67]; Arce et al., 2021 [70]	13055.5	5283—	40.6—
	Effectiveness	Bono et al., 2021 [67]	10183	1538—	15.1—

<https://doi.org/10.1371/journal.pone.0265496.t002>

214.95–1,354.95; $\bar{x}\%$ = 33.33, 95% CI 12.68–53.98, \bar{X} = 2274.67), followed by Europe (n = 4; \bar{x} = 423, 95% CI -132.07–978.07; $\bar{x}\%$ = 28.10, 95% CI 0.96–55.24 and \bar{X} = 1826.50), Africa (n = 3; \bar{x} = 581, 95% CI 32.01–1129.99; $\bar{x}\%$ = 64.73, 95% CI 58.36–71.10, and \bar{X} = 935.33), and multi-ethnic areas (n = 1; \bar{x} = 560; $\bar{x}\%$ = 4.1 and \bar{X} = 13426). “Side effects” was identified and distributed as a potential factor equally (n = 6) in Asia (\bar{x} = 660.33, 95% CI -9.57–1330.23; $\bar{x}\%$ = 35.78, 95% CI 16.79–54.77, \bar{X} = 1598.83) and Europe (\bar{x} = 300.50, 95% CI 154.02–446.98; $\bar{x}\%$ = 16.93, 95% CI 4.70–28.08, \bar{X} = 2799.67), followed by Africa (n = 4; \bar{x} = 957.75, 95% CI 140.55–1774.94; $\bar{x}\%$ = 74.60, 95% CI 58.08–91.11 and \bar{X} = 1234.75); the United States (n = 3; \bar{x} = 1025, 95% CI -686.87–2736.87; $\bar{x}\%$ (%) = 36.23, 95% CI 20.29–52.17, \bar{X} = 2866), LMICs (n = 2; \bar{x} = 5283, $\bar{x}\%$ = 40.6 and \bar{X} = 13055.5) and multi-ethnic regions (n = 1; \bar{x} = 3369, $\bar{x}\%$ = 50.7 and \bar{X} = 6639). The greatest responses to “effectiveness” were found (n = 7) in the studies in Asian countries (\bar{x} = 563.57, 95% CI 180.27–946.87; $\bar{x}\%$ (%) = 44.84, 95% CI 25–64.68 and \bar{X} = 1638.71), followed by the United States (n = 6; \bar{x} = 173.17, 95% CI -7.92–354.26; $\bar{x}\%$ = 16.68, 95% CI 8.47–24.89 and \bar{X} = 1875.17), Africa (n = 2; \bar{x} = 1010.5, $\bar{x}\%$ = 51.7 and \bar{X} = 1229.5) and, LMICs and multi-ethnic areas (n = 1; \bar{x} = 560, $\bar{x}\%$ = 4.1, \bar{X} = 13426; \bar{x} = 1538, $\bar{x}\%$ = 15.1, \bar{X} = 10183, respectively). In Europe “trust” (n = 5) was distinguished as a critical predictor (\bar{x} = 361.60, 95% CI -83.64–806.84; $\bar{x}\%$ = 24.94, 95% CI 2.32–47.56 and \bar{X} = 2477.80), whereas in Asian countries trust was recognized in only 4 studies (\bar{x} = 275.25, 95% CI 51.22–499.28; $\bar{x}\%$ = 16.78, 95% CI 6.20–27.35 and \bar{X} = 1574.50) followed by the United States (n = 3; \bar{x} = 94.67, 95% CI 16.58–172.76, $\bar{x}\%$ = 34.53, 95% CI = 3.74–65.32 and \bar{X} = 276.67), multi-ethnic areas (n = 2; \bar{x} = 2978, $\bar{x}\%$ = 30.3, \bar{X} = 10032.5), and Africa (n = 1; \bar{x} = 376, $\bar{x}\%$ = 62.5, \bar{X} = 600). “Information sufficiency” was an important determinant in reducing COVID-19 vaccine hesitancy, which was identified mostly (n = 4) in articles from the United States (\bar{x} = 2231.5, 95% CI -420.29–4883.29; $\bar{x}\%$ = 51.53, 95% CI 14.12–88.74, \bar{X} = 2836.75) followed by Asia (n = 3; \bar{x} = 419.33, 95% CI 7.93–830.73; $\bar{x}\%$ = 40, 95% CI 27.01–52.99 and \bar{X} = 931.33), and articles (n = 2) from Europe and Africa (\bar{x} = 901.5, $\bar{x}\%$ = 50.5, \bar{X} = 1721.5; (\bar{x} = 963, $\bar{x}\%$ = 67.7, \bar{X} = 1366.5, respectively). The public concern regarding the “efficacy” of the COVID-19 vaccine was predominant (n = 3) in the studies conducted in Asian countries (\bar{x} = 269, 95% CI 115.7–422.30; $\bar{x}\%$ = 27.03, 95% CI 10.35–43.71 and \bar{X} = 1022.67), followed by an equal (n = 2) distribution in the United States and Europe (\bar{x} = 1367, $\bar{x}\%$ = 37.55, \bar{X} = 5471.5; (\bar{x} = 265, $\bar{x}\%$ = 5.45, \bar{X} = 4101.5, respectively). Among the total articles we analyzed, “conspiracy beliefs” was explored as one of the key

predictors, especially in Asian countries ($n = 3$; $\bar{x} = 273.5$, 95% CI 54.91–492.10; $\bar{x}\%$ (%) = 18.55, 95% CI 8.67–28.43 and $\bar{X} = 1598.75$), followed by multi-ethnic areas ($n = 2$; $\bar{x} = 1002$, $\bar{x}\% = 11.75$ and $\bar{X} = 7031.5$). The opinions provided by friends, family, and social networks (social influence) were mostly valued by individual's when making a rapid vaccination decision in Europe ($n = 3$; $\bar{x} = 1207.33$, 95% CI -665.03–3379.69; $\bar{x}\% = 23.85$, 95% CI -18.48–66.18 and $\bar{X} = 4234.33$), followed by the United States ($n = 2$; $\bar{x} = 1540.5$, $\bar{x}\% = 74.85$ and $\bar{X} = 1894.5$). It was observed that, information from political leaders directly affected vaccination decisions, particularly in the United States; hence, “political roles” was mostly identified in the United States ($n = 2$; $\bar{x} = 405.5$, $\bar{x}\% = 23.25$ and $\bar{X} = 1564.5$). In the same manner, “vaccine-mandated” was a vital issue that was mostly reported in studies ($n = 3$) from the United States ($\bar{x} = 124.67$, 95% CI 62–187.34; $\bar{x}\% = 52.7$, 95% CI 27.43–77.97 and $\bar{X} = 217.33$). The influence of negative emotions such as “fear and anxiety” on the COVID-19 vaccine acceptance intention was found in single articles from Asia, the United States, and Europe as shown below in [Table 2](#).

Discussion

Public acceptance of a new vaccine is not an old concept; rather, it is a dynamic phenomenon that is regulated sharply by psychological behavior, societal issues, and vaccine-derived factors related to a particular vaccine candidate. Since human psychological behaviors change over space, time, and environment, achieving equitable vaccination rates across all population groups indeed is a challenging issue in light of such multifaceted psychological behavior [74]. The human psychological behaviors related to immunization are almost the same in terms of responses to uptake intention for national vaccination programs and protection from a particular pandemic disease [75]. In this complex behavioral patterns, vaccine hesitancy and low initial vaccine uptake for a particular vaccine or even a vaccination program are serious threats to global health, with several common socio-psychological factors having been reported during the outbreaks of measles and pertussis [76] and for influenza vaccination [77]. Importantly, the introduction and distribution of a new vaccine is an economically costly and time-consuming process, while acceptability of a vaccine is the leading indicator that controls the overall success of vaccination programs [78, 79]. As such, estimating and exploring the common factors of COVID-19 vaccine hesitancy is an effective step in designing an action plan for improving the overall acceptance rate.

In our review, the safety, side effects, and effectiveness were identified as the most common predictors of COVID-19 vaccine acceptance around the world. Perceived vaccine safety and effectiveness were seen as the most common factors associated with vaccine hesitancy in previous vaccination programs, as reported in several scientific studies. A comprehensive review of 2791 studies conducted between 1990 and 2019 revealed that, although vaccine hesitancy largely depends on the disease severity, culture and local context, concerns about vaccine safety are the actual cause of vaccine refusal [80]. Another review of 1187 articles primarily on HPV and flu vaccines concluded that, both side effects and safety concerns were the leading causes of vaccine refusal by the general public and health care workers [81]. In the same manner, Karafillakis and Larson (2017)-, performed a review of 2895 English, French, and Spanish studies from 2004 to 2014 and found that, the greatest vaccine concerns were safety and efficacy issues, among other factors [82]. Along with safety concerns, the perceived efficacy of new vaccines was found to be a critical predictor of vaccine acceptance decisions in a study on H1N1 vaccine promotion to the older adults [79, 83]. All together, these results are consistent with the identified factors associated with COVID-19 vaccine acceptance and hesitancy. Vaccine uptake could also be a decreasing function of current or past incidences of side effects that have appeared with vaccination [84]. Chapman and Coups (1999) reported that, side effects and

effectiveness were the most important factors in influenza vaccine uptake decisions by healthy adults [85].

The extent to which the public trust the vaccine to be safe and effective after administration was the strongest forecaster of COVID-19 vaccine uptake intention. In the same way, a recent past study showed that, vaccine confidence levels regarding the safety and effectiveness were influenced by the level of trust in the vaccine, because trust plays a key role in regulating vaccine hesitancy [86]. Larson et al., (2018) performed a systematic review and reported that trust had the greatest impact on vaccine acceptance in low-and middle-income countries (LMICs) [87]. Similarly, misconceptions and mistrust regarding vaccine efficacy were recognized as the most common reasons to refuse the seasonal influenza vaccine for the health care workers in Ireland [88]. Even in national vaccination programs, trust and information sufficiency are the critical predictors needed for parents to make informed decision regarding their children's HPV vaccination [89]. Individual acceptance of vaccination depends not only on knowledge about the risks and benefits of vaccines, but also religious, cultural, emotional, and social factors which are considered the more complex determinants [90, 91]. Restoring public trust in vaccines and the vaccination process was accepted as a key solution to the above aspects [92]; therefore, the critical role of public trust in COVID-19 vaccination has been prioritized as an important factor in our analysis.

We speculated that, conspiracy beliefs and information sufficiency are other important factors in implementing successful vaccination programs in different countries, and along with a lack of trust regarding vaccine benefits, government policies, health systems, vaccine developers and service providers. Additionally, we speculated that hidden and inadequate health information would accelerate anti-vaccine conspiracy beliefs and rumors [93–95]. Accordingly, information sufficiency and conspiracy beliefs were identified as predictors of COVID-19 vaccine acceptance and hesitancy. To ensure vaccine trust, the communication strategies and vaccine delivery techniques to be applied during vaccination should be transparent, honest, accurate, truthful, multimodal, and frequent, involving partnerships with community and health workers in an inclusive manner. Typical communication methods used for health professionals and health policy makers will not be very effective in reaching marginalized groups in improving confidence levels, as the COVID-19 itself is not a typical scenario. In such atypical settings, remote contact strategies are preferred, with information presented a non-professional manner, following a general style that is easily understandable by the general public and communicating the major issues to be addressed. As a result, a more unique, multidisciplinary, organized approach from reputed public health experts, academicians, scientist, health professionals, and local political leaders is needed. A rapid solution for reducing vaccine hesitancy would be to focus on communicating effectively using evidence-based information, counter-acting messages that can misinform the general public. Rzymiski et al., (2021) emphasized evidence-based communication strategies are essential when dealing with community members in order to control the COVID-19 vaccine-related misinformation and to ensure large public benefits [96]. On the other hand, Arede et al., (2019) focused on long-term communicative approaches to overcome vaccine hesitancy, involving the promotion of vaccine literature through different communication channels. This strategy can work as a fundamental tool for appropriate communication by enabling critical thinking and access to vaccine related health education and information [97].

The positive social influences on the vaccines intention have examined in past articles on HPV [98]. Friends who had already been vaccinated had significant influence on individual's decision to receive the influenza vaccine [99] and flu vaccine [100, 101]. Perceived vaccine effectiveness and social influence were identified as the core determinants of influenza vaccine uptake intention among healthy adults in the United States [102]. Similarly, social influence

has been recognized as an important predictor of COVID-19 vaccination uptake intention in Europe and the United States.

In our analysis, “political roles” was a factor identified in scientific studies from the United States. The general populations of the United States has become sharply divided regarding all aspects of science surrounding COVID-19, ranging from its origin to the government actions and policies seeking to mitigate the pandemic’s impacts [103, 104]. In this regard, a content analysis of electronic and print media coverage surrounding the COVID-19 issue showed that politicians were featured as often as or some times more often than public health experts and scientists regarding the COVID-19 issues in the United States [105]. In addition to the above mentioned key factors, some other important factors such as previous vaccine exposure, cultural history, perceived risk of infection, personal consequence, and regional ethnicity were also considered by the general population when deciding to decline or accept a new H1N1 vaccine, as reported in past studies [106–108].

Mass vaccination programs against COVID-19 have been started worldwide; therefore, identifying the factors associated with vaccine acceptance intention and hesitancy is an important consideration that needs to be addressed. While the vaccination process has started, many people in specific regions have remained confused about whether they should take the vaccine or not. A recent review conducted on 13 countries reported that 60% (95% CI 49%–69%) of the sample population had the intention to be immunized by the COVID-19 vaccine [19]; therefore, if the overwhelming majority of the hesitant population is kept outside of the vaccination process, attempts to offer free vaccinations would not be successful in restricting the COVID-19 contamination rates. Given the potential influential factors associated with COVID-19 vaccination consequences, vaccine policy makers should develop guidelines for COVID-19 vaccination on the basis of priority group identification. To reduce pandemic-induced morbidity and mortality rates, COVID-19 vaccine administration should be mandated for elderly and co-morbid individuals, because these groups are more vulnerable to the corona virus than others and there is a strong association of age and co-morbidities with the mortality rate as shown found in a recent systematic review and meta-analysis [109].

Limitations

The current study had some limitations; the foremost of which was article sample size. The total number of articles we examined was not highly satisfactory in comparison with other scholarly articles published during the current COVID-19 vaccination era. We wanted to emphasize certain on some selective predictors that potentially impact on COVID-19 vaccine receptivity and refusal intention; however, other relevant and important factors may also lead to vaccine refusal, thereby reducing acceptance intention, including socio-demographic characteristics, employment status, perceived risk exposure, cultural differences, personal and professional consequences, doctor recommendations, and inoculation history [110–112]. Ethnicity is also a predictor, along with socio-demographic differences, of accepting COVID-19 vaccines [113]. Religious beliefs and rumors in South Asian countries [114] were not included in this analysis. Finally, most of the research studies included in this review employed a cross-sectional survey type, providing snapshots of the vaccine hesitancy status in each country. These studies applied different sampling strategies, which might lack some of the potential factors that are closely associated with the actual vaccine acceptance rates and hesitancy levels reported in different countries.

Implications

The practical implications of this systematic review in terms of vaccination policy and future research include the following aspect: (a) This review acts as scientific evidence for initiating

further predictive studies of COVID-19 vaccine acceptance and for examining the association between hesitancy and explanatory variables. This study could be helpful in determining the influential factors in countries in which small scale vaccine-delivery has started or has to start. At a press briefing, the director general of the WHO was worried about mismanagement in vaccine distribution and social inequalities globally, because poor countries are still far away from the adequate access to the required COVID-19 vaccine needed for mass immunization of their population. The WHO director general thereby urged drug makers to supply maximum amounts of COVID-19 vaccines to poor countries on a priority basis [115]. As a result, there is an opportunity for researchers in these countries to identify the potential factors in advance and implement effective policies on vaccine delivery to accomplish crude vaccine coverage. (b) The upcoming studies will pave the way in identifying the key influential factors of vaccine hesitancy in particular regions, thereby supporting efforts to estimate the effect size of such factors towards the acceptance intention of the general public. (c) This study could motivate health students and health care workers to describe their experiences of the influence of potentially related factors and could encourage them to engage in adequate vaccine health campaigns. Such efforts help in reinforcing the building of sustainable trust levels and accelerating the COVID-19 vaccination progression in marginalized areas. (d) This study shows the way to determine country-specific reasons for vaccine hesitancy in order to develop mitigation strategies that would ensure high and equitable vaccination coverage across LMICs. (e) This study will largely benefit health policy makers and vaccine promoters in different countries to design evidence-based promotional strategies that will enhance public engagement in the COVID-19 vaccine roll-out.

Conclusions

The reluctance towards and refusal of COVID-19 vaccines is currently a global concern. Large variability in COVID-19 vaccine acceptance rates has been clearly reported all around the world [19, 24]. In this study, we explored and described 11 potential common factors, among which safety, efficacy, side effects, effectiveness, and conspiracy beliefs were identified most frequently from the studies in Asian countries. In Europe, side effects, trust, and social influence were the predominant influences on decision to receive a COVID-19 vaccine, while information sufficiency, political roles, and vaccine-mandates in the United States. Although the prevailing vaccine resistance factors may vary widely depending on the geographic location, it is clear from the results reported in this review that global COVID-19 vaccine acceptance is dependent on several common psychological, societal, and vaccine related factors. Investigating the key influential factors of COVID-19 vaccine hesitancy is a fundamental task that must be undertaken to ensure an effective COVID-19 immunization plan worldwide.

A major challenge to the successful implementation of COVID-19 vaccination programs is the unpredictable nature of the pandemic. The adequate manufacture of vaccines and proper distribution, vaccine safety confirmation, uncertainty regarding long-term efficacy, and the acquisition of optimal immunity are other challenges that must be overcome. Public trust in health systems and in the vaccine information provided by government agencies regarding vaccine safety, efficacy, and side effects as well as the communicative roles of the media and public health experts will also be essential in improving vaccine confidence among rural and disadvantaged groups in low-income countries. Useful communication channels and public trust in vaccinations will remove anti-vaccine beliefs, fear, anxiety, and rumors, thereby enabling rapid vaccine uptake. Regular, follow-up and timely communication during the pandemic could be important drivers of vaccine confidence and in maintaining peak trust among population groups. Effective messages clarifying the safety, effectiveness, and side effects of

COVID-19 vaccines will increase public trust and promote vaccine confidence among less-educated and doubtful individuals in rural places. In summary, the policy makers should focus on the effects of psychological, societal, and vaccine-related factors, which may be associated with the uptake intention and lead to vaccine hesitancy in a particular territory. To ensure the prompt achievement of herd immunity, the scientific community and health authorities should pay attention to and validate potential common and individual factors, and the potency with which they may influence COVID-19 vaccine acceptance and hesitancy in a given geographical location.

Supporting information

S1 Checklist. PRISMA 2020 checklist.

(DOCX)

S1 Dataset.

(DOCX)

Acknowledgments

All authors greatly acknowledge the graduate students of Jashore University of Science and Technology, who were sincerely assisted in literature search process.

Author Contributions

Conceptualization: Debendra Nath Roy, Md. Shah Azam.

Data curation: Debendra Nath Roy, Mohitosh Biswas, Ekramul Islam, Md. Shah Azam.

Formal analysis: Debendra Nath Roy, Mohitosh Biswas, Ekramul Islam, Md. Shah Azam.

Investigation: Debendra Nath Roy, Mohitosh Biswas, Ekramul Islam, Md. Shah Azam.

Methodology: Debendra Nath Roy, Mohitosh Biswas.

Project administration: Ekramul Islam, Md. Shah Azam.

Resources: Debendra Nath Roy.

Software: Debendra Nath Roy.

Supervision: Ekramul Islam, Md. Shah Azam.

Validation: Mohitosh Biswas, Ekramul Islam, Md. Shah Azam.

Visualization: Debendra Nath Roy, Mohitosh Biswas, Ekramul Islam.

Writing – original draft: Debendra Nath Roy.

Writing – review & editing: Mohitosh Biswas, Md. Shah Azam.

References

1. World Health Organization (WHO). Weekly operational update on COVID-19—9 August 2021. <https://www.who.int/publications/m/item/weekly-operational-update-on-covid-19—9-august-2021>
2. Huang C.; Wang Y.; Li X.; Ren L.; Zhao J.; Hu Y.; et al. Clinical features of patients infected with 2019 novel corona virus in Wuhan, China. *Lancet* 2020, 395, 497–506. [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5) PMID: 31986264
3. Bloom BR, Nowak GJ, Orenstein W. “When will we have a vaccine?”—Understanding questions and answers about Covid-19 vaccination. *New England Journal of Medicine*. 2020 Dec 3; 383(23):2202–4. <https://doi.org/10.1056/NEJMp2025331> PMID: 32897660

4. Schoch-Spana M, Brunson EK, Long R, Ruth A, Ravi SJ, Trotochaud M, et al. The public's role in COVID-19 vaccination: Human-centered recommendations to enhance pandemic vaccine awareness, access, and acceptance in the United States. *Vaccine*. 2020 Oct 29.
5. Centers for Disease Control and Prevention (CDC). Ten great public health achievements—United States, 2001–2010. *MMWR. Morbidity and mortality weekly report*. 2011 May 20; 60(19):619–23. PMID: [21597455](https://pubmed.ncbi.nlm.nih.gov/21597455/)
6. Li Y, Tenchov R, Smoot J, Liu C, Watkins S, Zhou Q. A comprehensive review of the global efforts on COVID-19 vaccine development. *ACS Central Science*. 2021 Mar 29; 7(4):512–33. <https://doi.org/10.1021/acscentsci.1c00120> PMID: [34056083](https://pubmed.ncbi.nlm.nih.gov/34056083/)
7. Koff WC, Schenkelberg T, Williams T, Baric RS, McDermott A, Cameron CM, et al. Development and deployment of COVID-19 vaccines for those most vulnerable. *Science translational medicine*. 2021 Feb 3; 13(579). <https://doi.org/10.1126/scitranslmed.abd1525> PMID: [33536277](https://pubmed.ncbi.nlm.nih.gov/33536277/)
8. Schwarzingler M.; Flicoteaux R.; Cortarenoda S.; Obadia Y.; Moatti J.-P. Low Acceptability of A/H1N1 Pandemic Vaccination in French Adult Population: Did Public Health Policy Fuel Public Dissonance? *PLoS ONE* 2010, 5, e10199. <https://doi.org/10.1371/journal.pone.0010199> PMID: [20421908](https://pubmed.ncbi.nlm.nih.gov/20421908/)
9. Raude J.; Caille-Brillet A.-L.; Setbon M. The 2009 pandemic H1N1 influenza vaccination in France: Who accepted to receive the vaccine and why? *PLoS Curr*. 2010, 2, rrn1188. <https://doi.org/10.1371/currents.RRN1188> PMID: [20972476](https://pubmed.ncbi.nlm.nih.gov/20972476/)
10. Seale H.; Heywood A.E.; McLaws M.; Ward K.F.; Lowbridge C.P.; Van D.; et al. Why do I need it? I am not at risk! Public perceptions towards the pandemic (H1N1) 2009 vaccine. *BMC Infect. Dis*. 2010, 10, 99. <https://doi.org/10.1186/1471-2334-10-99> PMID: [20403201](https://pubmed.ncbi.nlm.nih.gov/20403201/)
11. Omar DI, Hani BM. Attitudes and intentions towards COVID-19 vaccines and associated factors among Egyptian adults. *Journal of Infection and Public Health*. 2021 Jul 3 <https://doi.org/10.1016/j.jiph.2021.06.019> PMID: [34247946](https://pubmed.ncbi.nlm.nih.gov/34247946/)
12. Coustasse A.; Kimble C.; Maxik K. COVID-19 and Vaccine Hesitancy. *J. Ambul. Care Manag*. 2021, 44, 71–75. <https://doi.org/10.1097/JAC.0000000000000360> PMID: [33165121](https://pubmed.ncbi.nlm.nih.gov/33165121/)
13. MacDonald NE, Eskola J, Liang X, Chaudhuri M, Dube E, Gellin B, et al. Vaccine hesitancy: definition, scope and determinants. *Vaccine*. 2015; 33(34):4161–4. <https://doi.org/10.1016/j.vaccine.2015.04.036> PMID: [25896383](https://pubmed.ncbi.nlm.nih.gov/25896383/)
14. Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007–2012. *Vaccine*. 2014 Apr 17; 32(19):2150–9. <https://doi.org/10.1016/j.vaccine.2014.01.081> PMID: [24598724](https://pubmed.ncbi.nlm.nih.gov/24598724/)
15. Sun X, Wagner AL, Ji J, Huang Z, Zikmund-Fisher BJ, Boulton ML, et al. A conjoint analysis of stated vaccine preferences in Shanghai, China. *Vaccine*. (2020) 38:1520–5. <https://doi.org/10.1016/j.vaccine.2019.11.062> PMID: [31822426](https://pubmed.ncbi.nlm.nih.gov/31822426/)
16. Wagner AL, Boulton ML, Sun X, Mukherjee B, Huang Z, Harmsen IA, et al. Perceptions of measles, pneumonia, and meningitis vaccines among caregivers in Shanghai, China, and the health belief model: a cross-sectional study. *BMC Pediatr*. (2017) 17:143. <https://doi.org/10.1186/s12887-017-0900-2> PMID: [28606106](https://pubmed.ncbi.nlm.nih.gov/28606106/)
17. Myers LB, Goodwin R. Determinants of adults' intention to vaccinate against pandemic swine flu. *BMC Public Health* 2011; 11(1): 15. <https://doi.org/10.1186/1471-2458-11-15> PMID: [21211000](https://pubmed.ncbi.nlm.nih.gov/21211000/)
18. Hou Z, Tong Y, Du F, Lu L, Zhao S, Yu K, et al. Assessing COVID-19 Vaccine Hesitancy, Confidence, and Public Engagement: A Global Social Listening Study. *Journal of Medical Internet Research*. 2021 Jun 11; 23(6):e27632. <https://doi.org/10.2196/27632> PMID: [34061757](https://pubmed.ncbi.nlm.nih.gov/34061757/)
19. Robinson E, Jones A, Daly M. International estimates of intended uptake and refusal of COVID-19 vaccines: A rapid systematic review and meta-analysis of large nationally representative samples. *MedRxiv*. 2020 Jan 1.
20. Leask J, Kinnersley P, Jackson C, Cheater F, Bedford H, Rowles G. Communicating with parents about vaccination: a framework for health professionals. *BMC Pediatrics*. 2012; 12:154. <https://doi.org/10.1186/1471-2431-12-154> PMID: [22998654](https://pubmed.ncbi.nlm.nih.gov/22998654/)
21. Abdullahi L, Onyango JJ, Mukiira C, Wamicwe J, Githiomi R, Kariuki D, et al. Community interventions in Low—And Middle-Income Countries to inform COVID-19 control implementation decisions in Kenya: A rapid systematic review. *PLoS one*. 2020 Dec 8; 15(12):e0242403. <https://doi.org/10.1371/journal.pone.0242403> PMID: [33290402](https://pubmed.ncbi.nlm.nih.gov/33290402/)
22. Xiao X, Wong RM. Vaccine hesitancy and perceived behavioral control: a meta-analysis. *Vaccine*. 2020; 38(33):5131–5138. <https://doi.org/10.1016/j.vaccine.2020.04.076> PMID: [32409135](https://pubmed.ncbi.nlm.nih.gov/32409135/)

23. Cooper S, Schmidt B, Sambala EZ, et al. Factors that influence parents' and informal caregivers' acceptance of routine childhood vaccination: a qualitative evidence synthesis. *Cochrane Database Syst Rev*. 2019; (2).
24. Sallam M. COVID-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. *Vaccines*. 2021 Feb; 9(2):160. <https://doi.org/10.3390/vaccines9020160> PMID: 33669441
25. Abdulmoneim SA, Aboelsaad IA, Hafez DM, Almaghraby A, Alnagar A, Shaaban R, et al. Systematic Review and Meta-analysis on COVID-19 Vaccine Hesitancy. *medRxiv*. 2021 Jan 1.
26. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021; 372:n71. <https://doi.org/10.1136/bmj.n71> PMID: 33782057
27. Soares P, Rocha JV, Moniz M, Gama A, Laires PA, Pedro AR, et al. Factors associated with COVID-19 vaccine hesitancy. *Vaccines*. 2021 Mar; 9(3):300. <https://doi.org/10.3390/vaccines9030300> PMID: 33810131
28. Jain J, Saurabh S, Goel AD, Gupta MK, Bhardwaj P, Raghav PR. COVID-19 vaccine hesitancy among undergraduate medical students: results from a nationwide survey in India. *medRxiv*. 2021 Jan 1.
29. Lin Y, Hu Z, Zhao Q, Alias H, Danaee M, Wong LP. Understanding COVID-19 vaccine demand and hesitancy: A nationwide online survey in China. *PLoS neglected tropical diseases*. 2020 Dec 17; 14(12):e0008961. <https://doi.org/10.1371/journal.pntd.0008961> PMID: 33332359
30. Wang K, Wong EL, Ho KF, Cheung AW, Yau PS, Dong D, et al. Change of willingness to accept COVID-19 vaccine and reasons of vaccine hesitancy of working people at different waves of local epidemic in Hong Kong, China: Repeated cross-sectional surveys. *Vaccines*. 2021 Jan; 9(1):62. <https://doi.org/10.3390/vaccines9010062> PMID: 33477725
31. Suresh A, Konwarh R, Singh AP, Tiwari AK. Public awareness and acceptance of COVID-19 vaccine: An online cross-sectional survey, conducted in the first phase of vaccination drive in India.
32. Abedin M., Islam M. A., Rahman F. N., Reza H. M., Hossain M. Z., Hossain M. A., et al. (2021). Willingness to vaccinate against COVID-19 among Bangladeshi adults: Understanding the strategies to optimize vaccination coverage. *PLoS One*, 16(4), e0250495 <https://doi.org/10.1371/journal.pone.0250495> PMID: 33905442
33. Bai W, Cai H, Liu S, Liu H, Qi H, Chen X, et al. Attitudes toward COVID-19 vaccines in Chinese college students. *International journal of biological sciences*. 2021; 17(6):1469. <https://doi.org/10.7150/ijbs.58835> PMID: 33907510
34. El-Elimat T, AbuAlSamen MM, Almomani BA, Al-Sawalha NA, Alali FQ. Acceptance and attitudes toward COVID-19 vaccines: a cross-sectional study from Jordan. *Plos one*. 2021 Apr 23; 16(4): e0250555. <https://doi.org/10.1371/journal.pone.0250555> PMID: 33891660
35. Cai H, Bai W, Liu S, Liu H, Chen X, Qi H, et al. Attitudes Toward COVID-19 Vaccines in Chinese Adolescents. *Frontiers in Medicine*. 2021 Jul 7; 8:994. <https://doi.org/10.3389/fmed.2021.691079> PMID: 34307416
36. Almaghaslah D, Alsayari A, Kandasamy G, Vasudevan R. COVID-19 Vaccine Hesitancy among Young Adults in Saudi Arabia: A Cross-Sectional Web-Based Study. *Vaccines*. 2021 Apr; 9(4):330. <https://doi.org/10.3390/vaccines9040330> PMID: 33915890
37. Silva J, Bratberg J, Lemay V. COVID-19 and influenza vaccine hesitancy among college students. *Journal of the American Pharmacists Association*. 2021 May 21. <https://doi.org/10.1016/j.japh.2021.05.009> PMID: 34092517
38. Manning ML, Gerolamo AM, Marino MA, Hanson-Zalot ME, Pogorzelska-Maziarz M. COVID-19 vaccination readiness among nurse faculty and student nurses. *Nursing Outlook*. 2021 Feb 5. <https://doi.org/10.1016/j.outlook.2021.01.019> PMID: 33610324
39. Sharun K, Rahman CF, Haritha CV, Jose B, Tiwari R, Dhama K. Covid-19 vaccine acceptance: Beliefs and barriers associated with vaccination among the general population in india. *Journal of Experimental Biology and Agricultural Sciences*. 2020 Jan 1; 8
40. Palm R, Bolsen T, Kingsland JT. The Effect of Frames on COVID-19 Vaccine Resistance. *Frontiers in Political Science*. 2021 May 13; 3: 41.
41. Pogue K, Jensen JL, Stancil CK, Ferguson DG, Hughes SJ, Mello EJ, et al. Influences on attitudes regarding potential COVID-19 vaccination in the United States. *Vaccines*. 2020 Dec; 8(4):582. <https://doi.org/10.3390/vaccines8040582> PMID: 33022917
42. Wang J, Jing R, Lai X, Zhang H, Lyu Y, Knoll MD, et al. Acceptance of COVID-19 Vaccination during the COVID-19 Pandemic in China. *Vaccines*. 2020 Sep; 8(3):482. <https://doi.org/10.3390/vaccines8030482> PMID: 32867224

43. Al-Mulla R, Abu-Madi M, Talafha QM, Tayyem RF, Abdallah AM. COVID-19 Vaccine Hesitancy in a Representative Education Sector Population in Qatar. *Vaccines*. 2021 Jun; 9(6):665. <https://doi.org/10.3390/vaccines9060665> PMID: 34207012
44. Kanyike AM, Olum R, Kajjimu J, Ojilong D, Akech GM, Nassozi DR, et al. Acceptance of the coronavirus disease-2019 vaccine among medical students in Uganda. *Tropical Medicine and Health*. 2021 Dec; 49(1):1–1 <https://doi.org/10.1186/s41182-020-00291-y> PMID: 33397511
45. Petravić L, Arh R, Gabrovec T, Jazbec L, Rupčić N, Starešinič N, et al. Factors affecting attitudes towards COVID-19 vaccination: An online survey in Slovenia. *Vaccines*. 2021 Mar; 9(3):247. <https://doi.org/10.3390/vaccines9030247> PMID: 33808958
46. Grochowska M, Ratajczak A, Zdunek G, Adamiec A, Waszkiewicz P, Feleszko W. A Comparison of the Level of Acceptance and Hesitancy towards the Influenza Vaccine and the Forthcoming COVID-19 Vaccine in the Medical Community. *Vaccines*. 2021 May; 9(5):475. <https://doi.org/10.3390/vaccines9050475> PMID: 34066790
47. Rosental H, Shmueli L. Integrating health behavior theories to predict COVID-19 vaccine acceptance: differences between medical students and nursing students in Israel. *medRxiv*. 2021 Jan 1.
48. Jiang N, Wei B, Lin H, Wang Y, Chai S, Liu W. Nursing students' attitudes, knowledge, and willingness to receive the COVID-19 vaccine: A cross-sectional study. *medRxiv*. 2021 Jan 1.
49. Mudenda S, Mukosha M, Meyer JC, Fadare J, Godman B, Kampamba M, et al. Awareness and Acceptance of COVID-19 Vaccines among Pharmacy Students in Zambia: The Implications for Addressing Vaccine Hesitancy.
50. Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, et al. A global survey of potential acceptance of a COVID-19 vaccine. *Nature medicine*. 2021 Feb; 27(2):225–8. <https://doi.org/10.1038/s41591-020-1124-9> PMID: 33082575
51. Faezi NA, Gholizadeh P, Sanogo M, Oumarou A, Mohamed MN, Cissoko Y, et al. Peoples' attitude toward COVID-19 vaccine, acceptance, and social trust among African and Middle East countries. *Health Promotion Perspectives*. 2021; 11(2):171. <https://doi.org/10.34172/hpp.2021.21> PMID: 34195040
52. Nikolovski J, Koldijk M, Weverling GJ, Spertus J, Turakhia M, Saxon L, et al. Factors indicating intention to vaccinate with a COVID-19 vaccine among older US Adults. *PloS one*. 2021 May 24; 16(5): e0251963. <https://doi.org/10.1371/journal.pone.0251963> PMID: 34029345
53. Burhamah W, AlKhayyat A, Oroszlányová M, AlKenane A, Jafar H, Behbehani M, et al. The SARS-CoV-2 Vaccine Hesitancy Among the General Population: A Large Cross-Sectional Study From Kuwait. *Cureus*. 2021 Jul; 13(7). <https://doi.org/10.7759/cureus.16261> PMID: 34268064
54. Holzmann-Littig C, Braunisch MC, Kranke P, Popp M, Seeber C, Fichtner F, et al. COVID-19 vaccination acceptance among healthcare workers in Germany. *medRxiv*. 2021 Jan 1. <https://doi.org/10.3390/vaccines9070777> PMID: 34358193
55. Tavalacci MP, Dechelotte P, Ladner J. COVID-19 Vaccine Acceptance, Hesitancy, and Resistancy among University Students in France. *Vaccines*. 2021 Jun; 9(6):654. <https://doi.org/10.3390/vaccines9060654> PMID: 34203847
56. Kose S, Mandiracioglu A, Sahin S, Kaynar T, Karbus O, Ozbel Y. Vaccine hesitancy of the COVID-19 by health care personnel. *International Journal of Clinical Practice*. 2021 May; 75 (5):e13917.
57. Freeman D, Loe BS, Chadwick A, Vaccari C, Waite F, Rosebrock L, et al. COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (Oceans) II. *Psychological medicine*. 2020 Dec 11:1–5.
58. Sherman SM, Smith LE, Sim J, Amlôt R, Cutts M, Dasch H, et al. COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-sectional survey. *Human vaccines & immunotherapeutic*. 2021 Jun 3; 17(6):1612–21.
59. Saied SM, Saied EM, Kabbash IA, Abdo SA. Vaccine hesitancy: Beliefs and barriers associated with COVID-19 vaccination among Egyptian medical students. *Journal of medical virology*. 2021 Jul; 93 (7):4280–91. <https://doi.org/10.1002/jmv.26910> PMID: 33644891
60. Riad A, Abdulqader H, Morgado M, Domnori S, Koščik M, Mendes JJ, et al. Global Prevalence and Drivers of Dental Students' COVID-19 Vaccine Hesitancy. *Vaccines*. 2021 Jun; 9(6):566. <https://doi.org/10.3390/vaccines9060566> PMID: 34072500
61. Kaplan AK, Sahin MK, Parildar H, AdadanGuvenc I. The willingness to accept the COVID-19 vaccine and affecting factors among healthcare professionals: A cross-sectional study in Turkey. *International Journal of Clinical Practice*. 2021 Apr 16:e14226. <https://doi.org/10.1111/ijcp.14226> PMID: 33864328
62. Lucia VC, Kelekar A, Afonso NM. COVID-19 vaccine hesitancy among medical students. *Journal of Public Health (Oxford, England)*. 2020 Dec 26.

63. Mascarenhas AK, Lucia VC, Kelekar A, Afonso NM. Dental students' attitudes and hesitancy toward COVID-19 vaccine. *Journal of Dental Education*. 2021 Apr 29. <https://doi.org/10.1002/jdd.12632> PMID: 33913152
64. Kelekar AK, Lucia VC, Afonso NM, Mascarenhas AK. COVID-19 vaccine acceptance and hesitancy among dental and medical students. *The Journal of the American Dental Association*. 2021 Mar 26. <https://doi.org/10.1016/j.adaj.2021.03.006> PMID: 34030867
65. Grüner S, Krüger F. The intention to be vaccinated against COVID-19: stated preferences before vaccines were available. *Applied Economics Letters*. 2020 Dec 1:1–5.
66. Padhi BK, Al-Mohaithef M. Determinants of COVID-19 vaccine acceptance in Saudi Arabia: a web-based national survey. *medRxiv*. 2020 Jan 1. <https://doi.org/10.2147/JMDH.S276771> PMID: 33262600
67. Bono SA, Faria de Moura Villela E, Siau CS, Chen WS, Pengpid S, Hasan MT, et al. Factors affecting COVID-19 vaccine acceptance: An international survey among Low-and Middle-Income Countries. *Vaccines*. 2021 May; 9(5):515. <https://doi.org/10.3390/vaccines9050515> PMID: 34067682
68. Szmyd B, Bartoszek A, Karuga FF, Staniecka K, Błaszczuk M, Radek M. Medical students and SARS-CoV-2 vaccination: Attitude and behaviors. *Vaccines*. 2021 Feb; 9(2):128. <https://doi.org/10.3390/vaccines9020128> PMID: 33562872
69. Arce JS, Warren SS, Meriggi NF, Scacco A, McMurry N, Voors M, et al. COVID-19 vaccine acceptance and hesitancy in low and middle income countries, and implications for messaging. *medRxiv*. 2021 Jan 1.
70. Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: How many people would get vaccinated?. *Vaccine*. 2020 Sep 29; 38(42):6500–7. <https://doi.org/10.1016/j.vaccine.2020.08.043> PMID: 32863069
71. Islam MS, Kamal AH, Kabir A, Southern DL, Khan SH, Hasan SM, et al. COVID-19 vaccine rumors and conspiracy theories: The need for cognitive inoculation against misinformation to improve vaccine adherence. *PloS one*. 2021 May 12; 16(5):e0251605 <https://doi.org/10.1371/journal.pone.0251605> PMID: 33979412
72. Sallam M, Dababseh D, Eid H, Al-Mahzoum K, Al-Haidar A, Taim D, et al. High rates of COVID-19 vaccine hesitancy and its association with conspiracy beliefs: A study in Jordan and Kuwait among other Arab countries. *Vaccines*. 2021 Jan; 9(1): <https://doi.org/10.3390/vaccines9010042> PMID: 33445581
73. Sallam M, Dababseh D, Eid H, Hasan H, Taim D, Al-Mahzoum K, et al. Low covid-19 vaccine acceptance is correlated with conspiracy beliefs among university students in Jordan. *International journal of environmental research and public health*. 2021 Jan; 18(5):2407. <https://doi.org/10.3390/ijerph18052407> PMID: 33804558
74. Habersaat KB, Jackson C. Understanding vaccine acceptance and demand—and ways to increase them. *BundesgesundheitsblattGesundheitsforschungGesundheitsschutz*. 2020; 63(1):32–39. <https://doi.org/10.1007/s00103-019-03063-0> PMID: 31802154
75. Determann D, Korfage IJ, Lambooj MS, Bliemer M, Richardus JH, Steyerberg EW, et al. Acceptance of vaccinations in pandemic outbreaks: a discrete choice experiment. *PLoS One*. 2014; 9(7): e102505. <https://doi.org/10.1371/journal.pone.0102505> PMID: 25057914
76. Phadke V.K.; Bednarczyk R.A.; Salmon D.A.; Omer S.B. Association between Vaccine Refusal and Vaccine-Preventable Diseases in the United States: A Review of Measles and Pertussis. *JAMA* 2016, 315, 1149–1158 <https://doi.org/10.1001/jama.2016.1353> PMID: 26978210
77. Schmid P, Rauber D, Betsch C, Lidolt G, Denker ML. Barriers of influenza vaccination intention and behavior—a systematic review of influenza vaccine hesitancy, 2005–2016. *PloS one*. 2017 Jan 26; 12(1):e0170550. <https://doi.org/10.1371/journal.pone.0170550> PMID: 28125629
78. Mahoney RT, Krattiger A, Clemens JD, Curtiss R III. The introduction of new vaccines into developing countries: IV: global access strategies. *Vaccine*. 2007 May 16; 25(20):4003–11. <https://doi.org/10.1016/j.vaccine.2007.02.047> PMID: 17363119
79. Nan X, Xie B, Madden K. Acceptability of the H1N1 vaccine among older adults: the interplay of message framing and perceived vaccine safety and efficacy. *Health Communication*. 2012 Aug 1; 27(6):559–68. <https://doi.org/10.1080/10410236.2011.617243> PMID: 22092270
80. Sweileh WM. Bibliometric analysis of global scientific literature on vaccine hesitancy in peer-reviewed journals (1990–2019). *BMC public health*. 2020 Dec; 20(1):1–5. <https://doi.org/10.1186/s12889-019-7969-5> PMID: 31898494
81. Yaqub O., Castle-Clarke S., Sevdalis N., and Chataway J. (2014). Attitudes to Vaccination: a Critical Review. *Soc. Sci. Med.* 112, 1–11. <https://doi.org/10.1016/j.socscimed.2014.04.018> PMID: 24788111

82. Karafillakis E., and Larson H. J. (2017). The Benefit of the Doubt or Doubts over Benefits? A Systematic Literature Review of Perceived Risks of Vaccines in European Populations. *Vaccine* 35 (37), 4840–4850. <https://doi.org/10.1016/j.vaccine.2017.07.061> PMID: 28760616
83. Nan X, Madden K, Richards A, Holt C, Wang MQ, Tracy K. Message framing, perceived susceptibility, and intentions to vaccinate children against HPV among African American parents. *Health communication*. 2016 Jul 2; 31(7):798–805. <https://doi.org/10.1080/10410236.2015.1005280> PMID: 26646190
84. d'Onofrio A, Manfredi P. Vaccine demand driven by vaccine side effects: dynamic implications for SIR diseases. *Journal of Theoretical Biology*. 2010 May 21; 264(2):237–52 <https://doi.org/10.1016/j.jtbi.2010.02.007> PMID: 20149801
85. Chapman G. B., and Coups E. J. (1999). Predictors of Influenza Vaccine Acceptance Among Healthy Adults. *Prev. Med.* 29 (4), 249–262. <https://doi.org/10.1006/pmed.1999.0535> PMID: 10547050
86. Quinn SC, Jamison AM, An J, Hancock GR, Freimuth VS. Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: results of a national survey of White and African American adults. *Vaccine*. 2019; 37(9):1168–1173. <https://doi.org/10.1016/j.vaccine.2019.01.033> PMID: 30709722
87. Larson HJ, Clarke RM, Jarrett C, et al. Measuring trust in vaccination: a systematic review. *Hum Vaccin Immunother*. 2018; 14 (7):1599–1609. <https://doi.org/10.1080/21645515.2018.1459252> PMID: 29617183
88. Halpin C, Reid B. Attitudes and beliefs of healthcare workers about influenza vaccination. *Nurs Older People*. 2019; 31(2):32–39. <https://doi.org/10.7748/nop.2019.e1154> PMID: 31468782
89. Mortensen GL, Adam M, Idtaleb L. Parental attitudes towards male human papillomavirus vaccination: a pan-European cross-sectional survey. *BMC public health*. 2015 Dec; 15(1):1–0
90. Philip R, Shapiro M, Paterson P, Glismann S, Van Damme P. Is It Time for Vaccination to “Go Viral”? *Pediatr Infect Dis J*. 2016; 35:1343–49 <https://doi.org/10.1097/INF.0000000000001321> PMID: 27626913
91. Dube E, Gagnon D, Nickels E, Jeram S, Schuster M. Mapping vaccine hesitancy—country-specific characteristics of a global phenomenon. *Vaccine*. 2014; 32:6649–54. <https://doi.org/10.1016/j.vaccine.2014.09.039> PMID: 25280436
92. Badur S, Ota M, Öztürk S, Adegbola R, Dutta A. Vaccine confidence: The keys to restoring trust. *Human vaccines & immunotherapeutics*. 2020 May 3; 16(5):1007–17. <https://doi.org/10.1080/21645515.2020.1740559> PMID: 32298198
93. Eastwood K.; Durrheim D.N.; Jones A.; Butler M. Acceptance of pandemic (H1N1) 2009 influenza vaccination by the Australian public. *Med. J. Aust.* 2010, 192, 33–36. <https://doi.org/10.5694/j.1326-5377.2010.tb03399.x> PMID: 20047546
94. Maurer J.; Uscher-Pines L.; Harris K.M. Perceived seriousness of seasonal and A (H1N1) influenza attitudes toward vaccination, and vaccine uptake among US adults: Does the source of information matter? *Prev. Med.* 2010, 51, 185–187. <https://doi.org/10.1016/j.ypmed.2010.05.008> PMID: 20510270
95. Blaskiewicz R. The Big Pharma conspiracy theory. *Med. Writ*. 2013, 22, 259–261.
96. Rzymiski P, Borkowski L, Drag M, Flisiak R, Jemielity J, Krajewski J, et al. The strategies to support the COVID-19 vaccination with evidence-based communication and tackling misinformation. *Vaccines*. 2021 Feb; 9(2):109. <https://doi.org/10.3390/vaccines9020109> PMID: 33535716
97. Arede M, Bravo-Araya M, Bouchard É, Singh Gill G, Plajer V, Shehraj A, et al. Combating vaccine hesitancy: teaching the next generation to navigate through the post truth era. *Frontiers in public health*. 2019 Jan 14; 6:381. <https://doi.org/10.3389/fpubh.2018.00381> PMID: 30693276
98. Xiao X, Borah P. Do norms matter? Examining norm-based messages in HPV vaccination promotion. *Health communication*. 2020 May 27:1–9. <https://doi.org/10.1080/10410236.2020.1770506> PMID: 32452218
99. Allen JD, Mohllajee AP, Shelton RC, Othus MK, Fontenot HB, Hanna R. Stage of adoption of the human papillomavirus vaccine among college women. *Preventive medicine*. 2009 May 1; 48 (5):420–5. <https://doi.org/10.1016/j.ypmed.2008.12.005> PMID: 19133288
100. Bruine de Bruin W, Parker AM, Galesic M, Vardavas R. Reports of social circles' and own vaccination behavior: A national longitudinal survey. *Health Psychology*. 2019 Nov; 38 (11):975. <https://doi.org/10.1037/hea0000771> PMID: 31259597
101. Parker AM, Vardavas R, Marcum CS, Gidengil CA. Conscious consideration of herd immunity in influenza vaccination decisions. *American journal of preventive medicine*. 2013 Jul 1; 45 (1):118–21. <https://doi.org/10.1016/j.amepre.2013.02.016> PMID: 23790997
102. Abbas KM, Kang GJ, Chen D, Werre SR, Marathe A. Demographics, perceptions, and socioeconomic factors affecting influenza vaccination among adults in the United States. *PeerJ*. 2018; 6: e5171. <https://doi.org/10.7717/peerj.5171> PMID: 30013841

103. Bolsen T, Palm R, Kingsland JT. <? covid19?> Framing the Origins of COVID-19. *Science communication*. 2020 Oct; 42(5):562–85.
104. Hart PS, Chinn S, Soroka S. <? covid19?> politicization and polarization in COVID-19 news coverage. *Science Communication*. 2020 Oct; 42(5):679–97.
105. Rutjens BT, van der Linden S, van der Lee R. Science skepticism in times of COVID-19. *Group Processes & Intergroup Relations*. 2021 Feb; 24(2):276–83.
106. Gidengil CA, Parker AM, Zikmund-Fisher BJ. Trends in risk perceptions and vaccination intentions: a longitudinal study of the first year of the H1N1 pandemic. *Am J Public Health*. 2012; 102 (4):672–679. <https://doi.org/10.2105/AJPH.2011.300407> PMID: 22397349
107. Setbon M, Raude J. Factors in vaccination intention against the pandemic influenza A/H1N1. *Eur J Public Health*. 2010; 20 (5):490–494. <https://doi.org/10.1093/eurpub/ckq054> PMID: 20444821
108. Wilson K, Nguyen HH, Brehaut H. Acceptance of a pandemic influenza vaccine: a systematic review of surveys of the general public. *Infect Drug Resist*. 2011; 4: 197. <https://doi.org/10.2147/IDR.S23174> PMID: 22114512
109. Biswas M, Rahaman S, Biswas TK, Haque Z, Ibrahim B. Association of sex, age, and comorbidities with mortality in COVID-19 patients: a systematic review and meta-analysis. *Intervirology*. 2020 Dec 9:1–2.
110. Azizi FS, Kew Y, Moy FM. Vaccine hesitancy among parents in a multi-ethnic country, Malaysia. *Vaccine*. 2017 May 19; 35(22):2955–61. <https://doi.org/10.1016/j.vaccine.2017.04.010> PMID: 28434687
111. Troiano G, Nardi A. Vaccine hesitancy in the era of COVID-19. *Public Health*. 2021 Mar 4. <https://doi.org/10.1016/j.puhe.2021.02.025> PMID: 33965796
112. Lin C, Tu P, Beitsch LM. Confidence and Receptivity for COVID-19 Vaccines: A Rapid Systematic Review. *Vaccines* 2021, 9, 16.
113. Thorneloe R, Wilcockson H, Lamb M, Jordan CH, Arden M. Willingness to receive a COVID-19 vaccine among adults at high-risk of COVID-19: A UK-wide survey.
114. Kanozia R, Arya R. “Fake news”, religion, and COVID-19 vaccine hesitancy in India, Pakistan, and Bangladesh. *Media Asia*. 2021 Apr 27:1–9.
115. WHO: Rich countries should donate vaccines, not use boosters. *The Times of India*. Updated: Jul14,2021, http://timesofindia.indiatimes.com/articleshow/84391734.cms?fbclid=IwAR1CibLre5mr5C2IUciTdpLGPGB1TE1apoHcgkzP5WRCSC3aBZ3gLTCM&utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.