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Global disparities in COVID-19 vaccine booster dose (VBD) acceptance and hesitancy: An updated narrative review

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ABSTRACT

The global deployment of COVID-19 vaccine booster dose (VBD) has been recognized as a promising therapeutic alliance to provide repeated immunity against the arrival of new variants. Despite scientific evidence supports the effectiveness of periodic doses, COVID-19 vaccine booster reluctance continues to thrive. This narrative review aimed to examine global COVID-19 vaccine booster dose (VBD) acceptance and summarize an up-to-date assessment of potential antecedents associated with VBD acceptance. A comprehensive search was performed in several reputable databases such as Medline (via PubMed), Scopus, Google scholar, and Web of Science from June 10th, 2023, to August 1st, 2023. All relevant descriptive and observational studies on COVID-19 VBD acceptance and hesitancy were included in this review. A total of fifty-eight (58) studies were included, with Asia representing the highest count with thirty-one (53%) studies, Europe with eleven (19 %), the United States with nine (16 %), and other regions (Africa and multi-ethnic) with seven (12 %). Worldwide, the pooled COVID-19 VBD acceptance rate was 77.09 % (95 % CI: 76.28–78.18), VBD willingness (n) = 164189, and the total sample (N) = 212,990. The highest and the lowest VBD acceptance rate was reported in Europe and American regions, respectively, 85.38 % (95 % CI: 85.02–85.73, (n) = 32,047, (N = 37,533) vs. 66.92 % (95 % CI: 66.56–67.4), (n) = 29335, (N) = 43,832. However, Asia and multi-ethnic areas reported moderately high VBD acceptance rate 79.13 % (95 % CI: 78.77–79.23, (n) = 93,994, (N) = 11,8779) and 72.16 % (95 % CI: 71.13–72.93, (n) = 9276, (N) = 12,853), respectively. The most common and key antecedents of COVID-19 VBD acceptance and hesitancy across the countries were “equal safety”, “efficacy”, “effectiveness”, “post-vaccination side effects”, “community protection” “family protection”, “risk-benefit ratio”, “booster necessity”, “trust”, and “variants control”. Disparities in the uptake of COVID-19 VBD were observed globally, with the highest rates found in Europe, and the lowest rates in American regions. Multiple potential antecedents including safety, efficacy, and post-vaccination side effects were associated with VBD acceptance and hesitancy.

Abbreviations: COVID-19, Coronavirus disease-2019; VBDs, Vaccine booster doses; SARS-CoV-2, Severe acute respiratory syndrome coronavirus-2; 2019-nCoV, 2019-novel coronavirus; CDC, Centers for disease control and prevention; H1N1, The influenza type- A virus; WHO, World Health Organization; CI, Confidence Interval; UAE, United Arab Emirates; UK, The United Kingdom; USA, The United States of America; EMR, East Mediterranean Regionz; LMICs, Low-and-middle income countries; iCARE, International COVID-19 Awareness and Response Evaluation; MENA, Middle East and North Africa; D-A-CH region, Germany, Austria, Switzerland.

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1. Introduction

The global transmission of novel Coronavirus is not completely over yet and the socio-economic impact of the COVID-19 pandemic cannot be overstated. The emergence of new SARS-CoV-2 variants, which were either more transmissible or were able to cause severe morbidity and mortality, further raised the concern for a more cost-effective therapeutic solution.

For a few decades, vaccines have remained one of the most potent and cost-effective public health interventions to control and, in some instances, eradicate a highly infectious disease. Therefore, vaccination has therefore been considered the most effective and crucial strategy to fight Coronavirus 2019 ever since vaccines became available and approved in 2020 [1–3]. As COVID-19 waves continue to emerge with new variants with compromised host immunity, booster doses are considered an essential part of therapeutic alliance [4,5].

Nevertheless, for the booster vaccination program to become successful, a considerable proportion of the community must to be vaccinated. Recent research disclosed that 70 % of the population must be fully immunized to create herd immunity; however, this percentage may be higher based on the vaccine type and the transmissibility of circulating variations [2,6,7]. Thus, the public acceptance of COVID-19 vaccine booster shots has become the primary key to control of the long-term COVID-19 pandemic. In order to ensure maximum vaccine booster dose coverage, it is essential to make vaccines accessible and affordable and raise public awareness so that VBDs are accepted as widely as possible [8].

Vaccine hesitancy is a rate-limiting step in forwarding successful vaccination practices at the regional and global level [9]. Vaccine hesitancy, defined as refusing to get vaccinated despite the availability of vaccination services, was named one of the top ten global health threats in 2019 by the WHO [10]. There have been several studies showing significant increases in vaccine hesitancy over the past few decades, making this the major concern in the fight against COVID-19 [11–13]. This growing hesitancy may be due to altered perception of disease risk, safety, efficacy, uncertainty about the available vaccines, and fear of side effects, misinformation, and fake news [14–16]. There is a strong link between vaccine hesitancy and public perception of health risk. For vaccine apprehension to be reduced, public health must first understand the socioeconomic, demographic, and socio-psychological factors that contribute to it. Several key elements such as demographics, geographical diversity, adverse events, COVID-19 positive experiences, disease severity, disease knowledge and health status, contextual issues, anti-vaccination sentiment could potentially lead to booster disagreements [17].

Despite booster vaccine doses playing a key role in preventing emerging variants, hesitancy to receive a booster dose has been recognized as a barrier to mass vaccination. Studies have shown that people from developed [18–20] and developing countries [21–23] have different attitudes toward booster acceptance. It is alarming that people of low-income countries are more hesitant to receive COVID-19 booster doses [24,25]. Moreover, a significant disparity was observed in the acceptance of COVID-19 booster doses in different societies of a country [26]. The VBD acceptance variability in individual countries seeks the rationale of an updated narrative review highlighting COVID-19 VBD acceptance rates and the potential antecedents of VBD decisions across the continents around the world. Therefore, this narrative review aimed to examine COVID-19 vaccine booster dose acceptance across the continents and summarize an up-to-date assessment of potential antecedents associated with VBD acceptance and hesitancy.

2. Materials and methods

2.1. Data source and search strategy

The review examined the relevant factors and themes associated with COVID-19 vaccine booster acceptance or hesitancy concerns. On June 10th, 2023, Medline (via PubMed), Scopus, Google Scholar, and Web of Science were searched by authors to find relevant articles. This review evaluated 58 recent studies that addressed COVID-19 VBD hesitancy and acceptance. This study sought to identify and understand the complex interplay of multicultural factors that influence the acceptance and hesitancy of COVID-19 VBD across the globe. The key search items were adopted from a theoretical analysis of recent literatures published on COVID-19 vaccination consequences, as well as systematic reviews focused on assessing COVID-19 VBD acceptance and rejection rates globally. We also conducted interviews with vaccine experts to better understand the driving forces behind acceptance and rejection of booster shots. The search strategy was as follows: (((((((“Booster Vaccination Hesitancy”) OR (“Booster Vaccination Refusal”)) OR (“Booster Vaccine Hesitancies”)) OR (“Booster Acceptance of vaccination”)) OR (“Booster Vaccination Delay”)) OR (Booster Vaccine Hesitancy)) AND (((((((“SARS2 Vaccine”) OR (“COVID-19 booster Vaccines”)) OR (“SARS-CoV-2 Vaccine booster”)) OR (“2019-nCoV Vaccine booster”)) OR (“2019 Novel Coronavirus Vaccine booster”)) OR (“SARS Coronavirus 2 Vaccines booster”)) OR (“COVID-19 Vaccine booster”))) AND ((((((((“SARS-CoV-2″) OR (”COVID-19″)) OR (“2019-nCoV Disease”)) OR (“COVID19″)) OR (”SARS Coronavirus 2 Infection“)) OR (”Coronavirus“)) OR (”Severe Acute Respiratory Syndrome Coronavirus 2 Infection“)) OR (”COVID-19 Pandemic“))).

2.2. Eligibility criteria

Descriptive and observational studies (cross-sectional, retrospective cohort study, and longitudinal) on COVID-19 VBD vaccine hesitancy and acceptance were included in this review. There was no time constraint for studying or publishing articles, nor was there any restriction on the population of the study. Non-English studies, studies without full-text access, and those not relevant to vaccine booster acceptance and hesitancy were excluded. Review design, meta-analysis, commentary, communication, letter to the editor, unpublished data, books, and conference papers were also excluded from the search protocol.

2.3. Study selection

Based on the eligibility criteria, all retrieved records were screened for inclusion by reviewing the title/abstract and the full text. Records that met the inclusion criteria were manually screened by two independent reviewers. First and second authors separately screened title/abstracts and full-texts, ensuring every single article were reviewed by two independent reviewers. Disagreements were resolved by consensus.

2.4. Data extraction

Data relevant to the review were extracted by two reviewers, rechecked, and confirmed by another. Finally, the results were presented in a report. The following data were extracted for each study: title, first author’s name, date of study (year and month), study design, number of respondents/participants, age groups, gender, race/ethnicity, religion, marital status, country, metropolitan classification (rural, urban), income, insurance status, education, occupation/employment status, work setting (high-risk or non-high-risk), presence of any disease/chronic situation/history of co-morbidities (physical/psychiatric), ongoing treatments, smoking status/alcohol consumption, mistrust in the government/healthcare system, received training on COVID-19 prevention, contact with confirmed/suspected COVID-19 patients, history of COVID-19 diagnosis, lost someone from COVID-19, health believes on COVID-19 (perceived susceptibility, severity, benefits, barriers, cues to action, etc.), being informed about COVID-19 vaccines, booster vaccination-related intentions, booster vaccine hesitancy, people/participants’ attitudes and beliefs toward COVID-19 booster vaccine, fear of booster vaccination’s adverse effects and acceptance of

other vaccines. The reviewers synthesized the multi-dimensional and socio-psychological antecedents of VBD acceptance and hesitancy. Two authors prepared an Excel data collection sheet and the sheet was critically evaluated, reviewed, and approved by third and fourth reviewer to chart the data from included articles. The filled data sheet comprised the key information including author(s) information- name, study type, study title, year of publication, sample size, population characteristics, study design, and the analytical approach used in the respective studies. The extracted data were organized and tabulated and used in an analysis of the results. The reviewers then discussed their findings and agreed on a consensus. Descriptive statistics described percentage and weighted frequencies of the study samples. Percentage (%) and corresponding 95 % confidence interval (CI) were computed for booster vaccine acceptance intention.

3. Results

The independent reviewer abstract screening process resulted in 92.9 % agreement on which abstracts were suitable for the study after removing duplicates. Following abstract screening and full-text assessment, 59.2 % of studies meeting initial agreement criteria made it into the final analysis. In total, fifty eight studies [18–25,27–76] were included in this narrative review representing the highest thirty one (53 %) studies counted from Asian countries [20–24,27–52], followed by eleven studies (19 %) from European countries [18,19,53–61], nine studies (16 %) from American countries [62–70], one study from Africa [25], and six (12 %) from multi-ethnicity [71–76]. The characteristics of the global sample population included teachers, staffs and students of university, adult population, nurses, medical professionals, Allied health professionals, younger generation, general population, healthcare workers, older citizens, administrative staffs, Chinese residents' vaccinated adults and Hispanic community. Worldwide, the pooled level of COVID-19 VBD rate was 77.09 % (95 % CI: 76.28–78.18) where total respondents were (N) = 212990 and booster dose willingness was (n) = 164189.

3.1. COVID-19 VBD consequences in Asian countries

A total of thirty-one studies were synthesized from the Asian continents displays in Table 1.The study was conducted in representative Asian countries were Bangladesh (1), Jordan (1), Japan (4), Pakistan (2), Malaysia (2), China (9), Singapore (1), India (2), United Arab Emirates (UAE) (1), Nepal (1), Hong Kong (1), Indonesia (1), Saudi Arabia (4), and a combined study of India and Saudi Arabia (1). Most of the studies were cross-sectional and the characteristics of sample population we analyzed from Asian countries included university community, adults, nurses, medical professionals, allied health professionals, younger generation, general population, healthcare workers, older citizens, administrative staffs, and Chinese residents. The pooled level of COVID-19 vaccine booster acceptance rate in Asian continents was 79.13 % (95 % CI: 78.77–79.23), total population (N) = 118779 and booster willingness (n) = 93,994. In Asia, the highest VBD acceptance rate was found in Japan (97.9 %) [27] and the lowest rate was noted in Saudi Arabia (22.6 %) [44]. This review deduced several potential antecedents (socio-demographic, socio-economic, socio-cultural, behavioral, and psychological) of COVID-19 VBD decisions among Asian peoples including equal safety, efficacy, effectiveness, risk–benefit ratio, variant control, post-vaccination side effects, community protection, trust, communication, academic attainment, booster necessity, perceived benefits, primer dose duration, perceived severity, self-efficacy, booster choice, government strategy, social influence, information sufficiency, health beliefs, patient contact, post vaccination infection, perceived susceptibility, previous vaccination, cues to actions, gender, area of residency, limitation on movements, work place, education, knowledge, nationality, occupation, unemployment, low income, lack of knowledge, media uses, infection history, free of cost, certain illness.

3.2. COVID-19 VBD consequences in European countries

Table 2 represents the results of eleven studies conducted in European continents. More specifically, the study was performed in Germany (1), Poland (2), Czechia (1), Italy (1), the United Kingdom (UK) (2), Greece (1), Belgium (1), Denmark (1), and Meuse-Rhine Euro-region (1). Most of the studies were cross-sectional types. The profiles of the sample population in these studies were university students and employees, healthcare professionals and students, healthcare workers, vaccinated adults, and the adult population. The pooled level of COVID-19 vaccine booster acceptance rate in European countries was 85.38 % (95 % CI: 85.02–85.73) where total populations were (N) = 37,533 and booster acceptor/ willingness was (n) = 32,047. In Europe, the highest VBD acceptance rate was evident in UK (92.3 %) [19] and the lowest rate was reported in Greece (37.7 %) [57]. Several multi-dimensional factors were associated with the European peoples' response to COVID-19 vaccine booster doses including the safety profile, efficacy, effectiveness, risk–benefit ratio, variants control, post-vaccination side effects, family health protection, community health protection, and patients' health protection, protection of individual health, and favorable risk–benefit ratio, health literacy, primer dose response, complacency, trust, age, vaccine types.

3.3. COVID-19 VBD consequences in American continents

Table 3 highlights the summary of nine studies carried out in American countries. This study included seven studies from the USA and one study from Canada and Peru. The sample characteristics of these studies involved healthcare workers, university community, general population, adults aged 18 years and older and Hispanic community. The pooled COVID-19 vaccine booster acceptance rate in American countries was 66.93 % (95 % CI: 66.56–67.4), total study population was (N) = 43,832 and total booster acceptor was (n) = 29,335. Remarkably, the USA had both the highest and lowest VBD acceptance rates (92.12 % and 45 %, respectively) [62,63]. The antecedents of VBD decisions among the American people include safety issues, effectiveness, efficacy, effectiveness, post-vaccination side effects, trust, booster benefits, booster necessity, unvaccinated individual, low level of education, age, income status, unmarried, gender, education, employment, area of residence, COVID-19 history, hesitant to other vaccines, and chronic diseases.

3.4. COVID-19 VBD consequences in African and multi-ethnic areas

Table 4 presents the findings from seven investigations, including one conducted in the African region (Algeria) and six studies from multi-ethnicity (Colombia, El Salvador, and Spain (1), Malay, China, India, and Sudan (1), Egypt, Iraq, Palestine, Saudi Arabia, and Sudan (1), and Bahrain and Egypt (1), East Mediterranean Region (EMR) of 14 countries (1), D-A-CH region (1), and multi-country investigation (1). The population types surveyed in these multi-country level studies included general population, adult population, and health worker. The pooled COVID-19 vaccine booster acceptance rate in these studies was 72.16 % (95 % CI: 71.13–72.93) where total study population was (N) = 12853 and the total booster acceptor was (n) = 9276. However, the highest VBD acceptance rate (87.5 %) was found in the multi-country [72] while the lowest VDB willingness (57.6 %) was documented in the African country (Algeria) [25]. The most common predictors of COVID-19 VBD willingness were safety concern, efficacy, effectiveness, patient contact, post vaccination infection, booster mandated occupational status and primer vaccination status, necessity over primer dose, recommendation, and travelling to another country.

Table 1
Analysis of COVID-19 VBD acceptance in Asian countries.

Author(s) and year	Study type	Country	Sample type	Total Sample (N)	Booster acceptor (n)	Acceptance rate	Key antecedents
Wang R et al., (2022) [20]	Cross-sectional survey	China	General population	3,119	2916	93.5 %	Employment, Low income, Lack of knowledge, Cues to actions, Media uses
Roy et al., (2023) [21]	Cross-sectional comparative study	Bangladesh	University teachers and students	1250 (505 vs. 745)	928 (427 vs. 501)	84.6 % vs. 67.2 %	Equal safety, Risk–benefit ratio, Variants control, Post-vaccination side effects Community protection, Trust, Communication, and Academic attainment
Sharma et al., (2023) [22]	Cross –sectional study	India	Adult people	3804	2217	58.28 %	Educational level, Income status
Seboka et al., (2022) [23]	Cross –sectional study	Pakistan	General people	787	612	77.76 %	Safety, Effectiveness, Free of cost
Al-Qerem et al., (2022) [24]	Cross-sectional survey	Jordan	University community	915	408	44.6 %	Risk-benefit ratio
Yoshida et al., (2022) [27]	Retrospective cohort study	Japan	Adult people	2439	2388	97.9 %	Perceived side effects, Efficacy, booster necessity
Arshad et al., (2022) [28]	Nation-wide survey	Pakistan	Nurses	1164	606	52.1 %	Safety, Efficacy, Rsk/benefits ratio, and Community protection
Khan et al., (2022) [29]	Online enabled survey	Japan	Younger generation	2912	1932	66.35 %	Socioeconomic and behavioral factors
Wong et al., (2022) [30]	Web-based survey	Malaysia	Allied health professionals	1010	820	81.25 %	Fear of short term and long term side effects,
Abullais et al., (2022) [31]	Cross-sectional survey	Saudi Arabia	Younger generation	609	316	51.9 %	Gender, Area of residency, Education, Nationality, and Occupation
Lai et al., (2022) [32]	Cross-sectional survey	China	General people	1145	971	84.85 %	Safety profile, Age, Educational level, Employment status
Qin C et al., (2022) [33]	Cross-sectional survey	China	Older citizen	3321	2750	82.8 %	Certain illness, Safety, Booster necessity, Restriction on movements, Perceived benefits
Koh et al., (2022) [34]	Observational study	Singapore	Healthcare worker and administrative staffs	891	658	73.8 %	Workplace, Sex, duration of first dose
Achrekar et al., (2022) [35]	Cross-sectional study	India	Healthcare Workers	687	384	55.9 %	Income status, Area of residence, Infection history
Tokiya et al., (2022) [36]	Cross-sectional study	Japan	General people	6172	4832	78.3 %	Perceived side effects
Wu J et al., (2021) [37]	Cross-sectional study	China	Chinese residents	29,925	27,441	91.6 %	Demographic, Risk–benefit ratio, Trust, Access to information, Conspiracy beliefs
Miao Y et al., (2022) [38]	Cross-sectional study	China	General people	26,755	25,104	93.83 %	Psychological experiences
Jairoun et al., (2022) [39]	Cross-sectional study	UAE *(United Arab Emirates)*	Adult people	614	522	85.0 %	Knowledge, Infection history, Primer vaccination status
Mori et al., (2022) [40]	Text Mining-Based survey	Japan	Medical staff	260	250	96.1 %	Perceived side effects
Zhou M et al., (2022) [41]	Cross-sectional study	China	Chinese parents	1602	1399	87.3 %	Response efficacy, Response cost,
Alobaidi et al., (2022) [42]	Cross-sectional study	Saudi Arabia	Healthcare worker	2059	1464	71.1 %	Nationality, Marital status, Gender, Education, Income level, Co-morbidity, Risk–benefit ratio
Alshahrani NZ et al., (2023) [43]	Cross –sectional study	Saudi Arabia	Adult people	2101	1824	86.8 %	Age, Education, Marital status, Influenza vaccination
Alshahrani NZ et al., (2022) [44]	Cross –sectional study	Saudi Arabia	General people	2332	527	22.6 %	Socio-demographic profiles
Paudel et al., (2023) [45]	Cross –sectional study	Nepal	Health care professionals	300	236	78.66 %	Gender, Educational level,
Wang Z et al., (2022) [46]	Cross –sectional study	Hong Kong	Older people	395	124	31.39 %	Booster choice, Government strategy, Social influence
Wirawan et al., (2022) [47]	Cross –sectional study	Indonesia	General people	2674	1506	56.32 %	Health beliefs, Trust, Media influence
Sun et al., (2022) [48]	Cross –sectional study	China	General people	1062	960	90.39 %	Efficacy, Side effects
Qin C et al. (2022) [49]	Cross-sectional survey	China	Chinese resident	3119	2923	93.7 %	Perceived susceptibility, Previous vaccination, Cues to actions
Chang et al., (2022) [50]	Cross-sectional study	Malaysia	General people	6294	5514	87.6 %	Booster efficacy, Ethnicity
Wu F et al., (2022) [51]	Cross-sectional study	China	60 Years and older	8229	6320	76.8 %	Perceived side effects, Primer dose duration
Velapelly et al., (2022) [52]	Cross –sectional study	India & Saudi Arabia	Healthcare workers	833 (503 vs.303)	656 (423 vs. 233)	84.0 % vs. 77.0 %	Efficacy, Long-term side effects, Information sufficiency

note: COVID-19 (Coronavirus disease-2019), VBDs (Vaccine booster doses), SARS-CoV-2 (Severe acute respiratory syndrome coronavirus-2), 2019-nCoV (2019-novel coronavirus), UAE (United Arab Emirates).

Table 2
Analysis of COVID-19 VBD acceptance in Europe.

Author(s) and year	Study type	Country	Sample type	Total sample (N)	Booster acceptor (n)	Acceptance rate	Key antecedents
Folcarelli et al., (2022) [18]	Cross-sectional survey	Italy	Healthcare Workers	1018	872	85.7 %	Perceived side effects, Booster necessity
Paul et al., (2022) [19]	Observational study	UK	Adult people	22,139	20,434	92.3 %	Variants control
Attia et al., (2022) [53]	Cross-sectional study	Germany	University Students and Employees	930	817	87.8 %	Protection of patient, family, and community health
Dziedzic et al., (2022) [54]	Cross-sectional study	Poland	Healthcare professionals and students	443	330	74.5 %	Individual and community health protection, Equal safety, and Risk–benefit ratio
Rzymski et al., (2021) [55]	Cross-sectional survey	Poland	Adult population	2427	1723	71.0 %	Side effects, Necessity over primer doses, Safety
Klugar et al., (2021) [56]	Cross-Sectional study	Czechia	Healthcare Workers	3454	2463	71.3 %	Effectiveness, Family protection, Patient protection, andC ommunity health protection
Galanis et al., (2022) [57]	Cross-sectional study	Greece	Vaccinated adults	795	300	37.7 %	Perceived side effects, Safety, Effectiveness, Necessity over primer dose
Paridans et al., (2022) [58]	Longitudinal study	Belgium	Students and staff of the university	1030	940	91.3 %	Health literacy, Primer dose response
Williams L et al., (2022) [59]	Cross-sectional study	UK	General people	423	243	57.4 %	Side effects, Inaccessibility of vaccine services, Social influences, Health protection
Sonderskov et al., (2022) [60]	Longitudinal study	Denmark	Adult population	1555	1418	91.2 %	Age, Vaccine types
van Bilsen et al., (2023) [61]	Cross-sectional study	Meuse-Rhine Euro-region (Netherlands, Belgium, and Germany)	General people	3319	2507	75.5 %	Gender, Communication, Effectiveness, Community measures

note: COVID-19 (Coronavirus disease-2019), VBDs (Vaccine booster doses), SARS-CoV-2 (Severe acute respiratory syndrome coronavirus-2), 2019-nCoV (2019-novel coronavirus), UK (the United Kingdom).

Table 3
Analysis of COVID-19 VBD acceptance in American regions.

Author(s) and year	Study type	Country	Sample type	Total Sample (N)	Booster acceptor (n)	Acceptance rate	Key antecedents
Pal S et al., (2021) [62]	Cross-sectional study	the USA	Healthcare workers	1358	1251	92.12 %	Mistrust, Booster necessity, Effectiveness
Lennon et al., (2022) [63]	Cross-sectional study	the USA	Adult people	12,887	5,799	45.0 %	Gender, Ethnicity, Area of residence
Yadete et al., (2021) [64]	Cross-Sectional study	the USA	Adult people	2138	1326	62.0 %	Trust
Batra et al., (2022) [65]	Multi-Theory-Model	the USA	University community	501	292	58.3 %	Unvaccinated status, Lower education, Marital status
Quispe et al., (2022) [66]	Cross-sectional study	Peru	General population	20,814	16,339	78.5 %	Gender, Education, Employment, Area of residence, COVID-19 history
Kheil et al., (2022) [67]	Cross-sectional study	Arab Americans	Adult aged 18 years or older	1746	1275	73.0 %	Safety, Effectiveness, Hesitant to other vaccines
Neely R et al., (2022) [68]	Web-based survey	the USA	Adult people	600	418	69.7 %	Adverse effects, Necessity over primer dose, Educational level, Race, Trust
Leger et al., (2023) [69]	iCARE study	Canada	General people	3001	2011	67.0 %	Efficacy, Safety, Age, Chronic disease
Berrios et al., (2023) [70]	Cross-sectional study	the USA	Hispanic community	787	624	78.0 %	Safety, Efficacy, Income, Booster benefits

note: COVID-19 (Coronavirus disease-2019), VBDs (Vaccine booster doses), SARS-CoV-2 (Severe acute respiratory syndrome coronavirus-2), 2019-nCoV (2019-novel coronavirus), USA (United States of America), iCARE (International COVID-19 Awareness and Response Evaluation).

4. Discussion

Population-based booster vaccination is considered one of the core global response strategies for the containment of new Coronavirus variant across regions; however, the emergence of new variants appeared as a threat to global public health. While a safe and effective booster vaccine is critical to controlling the COVID-19 pandemic, ensuring widespread acceptance is just as crucial to achieving sufficient herd immunity. Booster dose uptake willingness thus plays a significant role in achieving long-lasting herd immunity against COVID-19 to end the pandemic. The basic reproductive number for an infectious disease is used to calculate the level of population immunity required to limit pathogen spread [77]. According to the most recent COVID-19 estimates, a population of 60 %–75 % immune individuals would be necessary to prevent the virus from spreading forward and further infecting the community [78,79]. A booster vaccination, in this consequence, provides long-term host immunity against severe medical conditions and hospitalization in a community. This updated review was

Table 4
Analysis of COVID-19 VBD acceptance in Africa and multi-ethnic areas.

Author(s)	Study type	Country	Sample type	Sample number (N)	Booster acceptor (n)	Acceptance rate	Key antecedents
Lounis et al. (2022) [25]	Cross-Sectional study	Algeria	General population	787	406	51.6 %	Necessity over primer dose, Recommendation, Travelling
Iguacel et al. (2022) [71]	Cross-sectional study	Colombia, El Salvador, and Spain	Adult population	3026	2403	79.4 %	Booster mandated, Occupation, Primer vaccination status
Weitzer J et al., (2022) [72]	Cross –sectional study	D-A-CH region	General people	3067	2480	82.4 %	Employment, Religious engagement, Mitigation measures, Age, Having voted in the election
Abouzid et al., (2022) [73]	Online survey	MENA region (Egypt, Iraq, Palestine, Saudi Arabia, and Sudan)	General population	3041	1831	60.2 %	Safety, Side effects, Booster necessity
Salah et al., (2022) [74]	Cross –sectional study	Bahrain and Egypt	Healthcare workers	389	210	53.98 %	Effectiveness, Patient contact, Post-vaccination infection
Ghazy et al., (2022) [75]	Cross –sectional study	East Mediterranean Region (EMR), 14 countries	General people	2327	1785	76.7 %	Age, Information sufficiency, Perceived severity, Side effects, Perceived benefits,
Al-Mugheed et al., (2022) [76]	Cross –sectional study	Multi-country	Nursing students	216	161	75.5 %	Safety, Side effects, Effectiveness

note: COVID-19 (Coronavirus disease-2019), VBDs (Vaccine booster doses), SARS-CoV-2 (Severe acute respiratory syndrome coronavirus-2), 2019-nCoV (2019-novel coronavirus), EMR (East Mediterranean Region), MENA (Middle East and North Africa), D-A-CH region Germany, Austria, Switzerland).

conducted to assess the global VBD acceptance rate and to synthesize the influential antecedents of COVID-19 booster acceptance and hesitancy globally. This review also co-related the themes of prior studies and made consistent finding across studies to foster ongoing research as well as to overcome booster vaccination barriers. Since no single intervention can evaluate vaccine reluctance, thus, it was rational for this concise review to summarize the most common predictors of booster vaccination to address the hesitancy. Further analysis of COVID-19 VBD acceptance can help plan actions and intervention measures to raise public awareness and reassure people about the safety and benefits of vaccines, which can help control virus spread and mitigate the negative effects of this unprecedented pandemic.

A growing number of research studies investigated numerous multi-dimensional factors associated with booster acceptance and hesitancy including demographic variables (age, gender, ethnicity), socioeconomic factors (education, occupation, and income), geographical diversity (rural, semi-urban, urban), socio-psychological factors (rumor, conspiracy beliefs), vaccine related factors (safety, efficacy, side effects), socio-cultural issues (social influences), COVID-19 history, and previous vaccination experiences [17,80]. However, male gender, age older than 45, trust in vaccine optimization, and severe disease condition were the most potential predictors of a booster decision [17]. Even with eventual willingness, vaccine reluctance, on the other hand, could be a major stumbling block to successfully controlling the present COVID-19 outbreak. Since herd immunity wanes over time, all booster shots should be taken as physician's recommended and administering one booster or periodic vaccine would lead people to further COVID-19 contamination. Worldwide, the most common determinants of COVID-19 VBD acceptance and hesitancy were equal safety concerns, efficacy, and vaccine effectiveness. Recent studies have reported that numerous factors were associated with the public acceptance of periodic COVID-19 vaccine doses on Asian continents [81–85], European continents [86,87], African continents [88,89], the USA [90], LMICs [91] and multi-ethnic areas [92]. In the same line, a side effect was one of the key predictors of primer COVID-19 vaccine uptake intention in Asian countries [93,94], European nation [95], African region [88], the USA [90], and LMICs [91].

It becomes essential to explore the antecedents of global acceptance and hesitancy of COVID-19 VBDs in order to promote acceptability of booster doses while working to reduce those factors likely to reduce or increase acceptance or hesitancy. We observed multiple socio-demographic factors in our review, including age, sex, marital status, educational status, and place of residence. Most of the articles reported that age was not critically associated with booster hesitancy. However, according to our results, being male, married people, having a higher income level, and an educated individual had a lower level of vaccine booster hesitancy compared to their counterparts. Moreover, rural people showed a higher rate of vaccine booster reluctance than people living in urban and semi-urban areas. The findings showed reasons for hesitation are frequently associated with distrust in medical authorities and necessity over periodic doses. Other factors related to the perception of risk–benefit were also important in vaccine booster acceptance, such as community protection, family protection and repeated protection. Hence, future vaccination campaigns should emphasize the importance of individual and include activities aimed at increasing health behavior and knowledge. These actions should be performed at all healthcare system levels to increase vaccine awareness and trust. The rapid development of an effective and safe COVID-19 vaccine was unprecedented [96] while vaccine apprehension could be a stumbling block in worldwide attempts to contain the pandemic induced harmful health and socioeconomic consequences [97]. Vaccine booster dose reluctance could be a major barrier to successfully controlling the present COVID-19 outbreak. Vaccine safety profile, effectiveness, perceived side effects, cost, and duration of protection provided by vaccines all appear to be important factors in reducing vaccine hesitancy [96,98]. Evaluation of public attitudes and acceptance rates for COVID-19 vaccine boosters can aid in launching much needed communication initiatives to boost public trust in health authorities. Using the findings of multiple studies on COVID-19 vaccine boosters conducted across the world, the current review analyzed the disparities in COVID-19 VBDs acceptance and hesitancy globally.

This review addressed the following limitations and the foremost limitation was the limited sample size. Based on our analysis of the total number of articles published during the current booster vaccination period for COVID-19, we were not highly satisfied. The majority of the studies included in this review were cross-sectional surveys that offered snapshots of vaccine hesitancy across countries. Hence, some of the potential factors that were highly associated with the booster vaccination acceptance rate across countries were missing from these studies due to their differences in sampling strategies. Therefore,

interpretations made from the findings should be cautious.

4.1. Practical implications

Understanding the global disparities in vaccine booster decisions can support planning actions and intervention measures to raise public awareness and reassure people about the equal safety and perceived benefits of vaccines, which can mitigate the negative effects of the current pandemic. Vaccine policymakers should therefore develop communication programs to convey the message of vaccine effectiveness, safety, and health-protecting ability to increase acceptance rates among various population sub-groups. However, public policy should limit information on health risks or deaths caused by unexpected vaccine effects, which may occasionally occur, in order to reduce public anxiety fear of vaccine boosters. The safety profile is temporary and the permanent effects of COVID-19 vaccines have not been fully established, despite recent developments. The constant technological advancement suggests that the future healthcare systems will be integrated with technology. In order to reduce vaccine booster hesitancy, vaccine information must be publicly available and a communication strategy based on vulnerable population should be implemented in developing countries [99]. It is thus essential that healthcare personnel and influential social persons communicate about booster efficacy, safety, and perceived side effects. Health care providers and community leaders are encouraged to form multidisciplinary alliances, communicate scientifically about booster immunizations, share vaccination data periodically, prevent fake evidence spread on virtual media, and provide more opportunities for vaccination discussions and counseling. All potential candidates included in the COVID-19 vaccine platform appeared to be effective and safe to some extent. However, inconsistencies in information about vaccines have been confirmed to decrease acceptance for certain vaccines, such as those from China. Hence, policymakers should counter misinformation and disseminate corrective information about booster vaccines in the media environment to reduce noise, thus helping to increase booster vaccine uptake, particularly for vaccines from countries with a low acceptance rate.

5. Conclusions

COVID-19 VBDs are critical components of an effective prevention alliance to limit break-through infections and control new variant's arrival. This updated review extends our understanding of the global response to COVID-19 VBDs acceptance and potential antecedents associated with VBDs acceptance. Globally, there were differences in the COVID-19 VBD uptake, with substantial regional variation. This study reported a low pooled COVID-19 VBD acceptance in American countries and a high pooled VBD intention in Europe and Asian continents while highlighting multiple factors associated with COVID-19 VBD acceptance and hesitancy across the continents. Potential factors including equal safety, efficacy, and post vaccination side effects were more stable and significant predictors of VBD acceptance and hesitancy globally. This study suggested effective communication and health education about the booster side effects and their management to increase public confidence in COVID-19 booster vaccination drive.

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CRediT authorship contribution statement

Debendra Nath Roy: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Writing – original draft, Writing – review & editing. **Nowrin Ferdiousi:** Data curation, Formal analysis, Methodology, Resources, Software, Validation, Visualization, Writing – original draft. **Md. Mohabbot Hossen:** Data curation, Formal analysis, Investigation, Methodology, Resources, Software. **Ekramul Islam:** Conceptualization, Formal analysis, Investigation, Project administration, Supervision, Validation, Visualization, Writing – review & editing. **Md. Shah Azam:** Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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