Barriers and facilitators of childhood COVID-19 vaccination among parents: A systematic review

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Background: The acceptance of vaccination against COVID-19 among parents of young children plays a significant role in controlling the current pandemic. A wide range of factors that influence vaccine hesitancy in adults has been reported worldwide, but less attention has been given to COVID-19 vaccination among children. Vaccine hesitancy is considered a major challenge in achieving herd immunity, and it is more challenging among parents as they remain deeply concerned about their child’s health. In this context, a systematic review of the current literature is inevitable to assess vaccine hesitancy among parents of young children to ensure a successful ongoing vaccination program.

Method: A systematic search of peer-reviewed English literature indexed in Google Scholar, PubMed, Embase, and Web of science was performed using developed keywords between 1 January 2020 and August 2022. This systematic review included only those studies that focused on parental concerns about COVID-19 vaccines in children up to 12 years without a diagnosis of COVID-19. Following PRISMA guidelines, a total of 108 studies were included. The quality appraisal of the study was performed by Newcastle–Ottawa Scale (NOS).
**Results:** The results of 108 studies depict that vaccine hesitancy rates differed globally with a considerably large number of factors associated with it. The highest vaccine hesitancy rates among parents were reported in a study from the USA (86.1%) and two studies from Saudi Arabia (>85%) and Turkey (89.6%). Conversely, the lowest vaccine hesitancy rates ranging from 0.69 and 2% were found in two studies from South Africa and Switzerland, respectively. The largest study (n = 227,740) was conducted in Switzerland while the smallest sample size (n = 12) was represented by a study conducted in the USA. The most commonly reported barriers to childhood vaccination were mothers’ lower education level (N = 46/108, 43%), followed by financial instability (N = 19/108, 18%), low confidence in new vaccines (N = 13/108, 12%), and unmonitored social media platforms (N = 5/108, 4.6%). These factors were significantly associated with vaccine refusal among parents. However, the potential facilitators for vaccine uptake among respondents who intended to have their children vaccinated include higher education level (N = 12/108, 11%), followed by information obtained through healthcare professionals (N = 9/108, 8.3%) and strong confidence in preventive measures taken by the government (N = 5/81, 4.6%).

**Conclusion:** This review underscores that parents around the globe are hesitant to vaccinate their kids against COVID-19. The spectrum of factors associated with vaccine hesitancy and uptake varies across the globe. There is a dire need to address vaccine hesitancy concerns regarding the efficacy and safety of approved vaccines. Local context is inevitable to take into account while developing programs to reduce vaccine hesitancy. There is a dire need to devise strategies to address vaccine hesitancy among parents through the identification of attributing factors.

**KEYWORDS**
vaccine hesitancy, COVID-19, parental concern, vaccine acceptance, side effects

**Introduction**

The COVID-19 pandemic resulted in serious disruptions in the healthcare system and economics across the globe. The SARS-CoV-2 infections ranged from 3 to 17 million daily worldwide from April 2020 to October 2021 (1, 2). This pandemic has considerable mortality reaching up to millions worldwide (3). As compared to adults, children present with mild flu-like symptoms but there is increasing evidence of complications, such as severe acute respiratory disorder and cardiac inflammation, due to the emergence of new variants (4–8). Tireless efforts have been undertaken to alleviate the disease spread and its impact nationwide. These include maintaining physical distances, wearing masks, limiting social contacts, and developing vaccines (9–13). Vaccines play a significant role in drastically reducing and completely eradicating vaccines preventable diseases (VPDs) (14). Initially, COVID-19 vaccines were prioritized for healthcare workers and high-risk groups, especially older people with multiple comorbidities (15, 16). However, the administration of vaccines in children is now considered inevitable owing to multisystem inflammatory syndrome reported in the children (3, 4).

Owing to the emergence of new variants with rapid transmissibility, a high vaccination uptake is needed among general population including children to ensure the achievement of herd immunity (17). The current situation necessitates the administration of COVID-19 vaccines in children, but still, vaccine hesitancy has become a global challenge (18). Although the vaccine hesitancy varies across the globe and is terrifyingly high in many regions encompassing substantial proportion of world’s population, the vaccination rate is below the average number required for herd immunity and rates of vaccination intentions are declining especially among parents of young children despite recent advances (19). "Parental vaccine hesitancy is defined as the delay in the acceptance or refusal of vaccines from parents of...
children despite their availability” (20). As parents are decision makers related to their children’s vaccination, reluctance or refusal to vaccinate their kids may result in developing VPDs. In particular, the most important factor influencing the decision-making on COVID-19 childhood vaccination includes parents’ knowledge and attitude. Lower knowledge would ultimately result in decreased acceptance (21, 22). The predominant factors reported to play a key role in parental vaccine hesitancy include social, cognitive, and contextual factors (23).

The primary focus of health authorities is to ensure a prosperous campaign among children regarding COVID-19 vaccination. However, the major hindrance toward the prospective and approved COVID-19 vaccination among children is linked to parental vaccine hesitancy as parents are actual decision makers. Parents’ attitude toward COVID-19 vaccination varies widely across geographical regions. The literature shows wide variations in vaccination hesitancy rates and factors associated with vaccine acceptability and hesitancy among parents. There is a dire need to systematically collect the available evidence to draw a firm conclusion from this scenario. To the best of our knowledge, till date there is no systematic review (SR) synthesizing the diverse information into a composite document on parenteral hesitancy toward COVID-19 vaccination from different regions across the globe. In this context, this SR was aimed to (1) check parents’ hesitancy toward children vaccination against COVID-19 and (2) ascertain the barriers and facilitators of vaccine uptake. The findings of this review will aid to map and understand the parental concern about the childhood COVID-19 vaccine and will underscore the areas of action plans.

Methods

Ethics

Since all the data were obtained from publicly available evidence, this study was exempted from ethics approval.

Review design

The PRISMA guidelines were followed to perform a systematic literature search (24). The framework of the current review is divided into five stages: (1) Identification of the research question. (2) Identification of relevant studies. (3) Study selection. (4) Data extraction. (5) Quality assessment. (6) Reporting of findings.

Stage 1: Identifying research questions

This systematic review is guided by the following questions: (1) What is the prevalence parental vaccine hesitancy toward childhood COVID-19 vaccines? (2) What are the barriers of childhood COVID-19 vaccines uptake? (3) What are the facilitators of childhood COVID-19 vaccines uptake?

Stage 2: Identifying relevant studies (eligibility criteria)

Information sources and search strategy

Two review authors performed an independent systematic search in Google scholar, PubMed, Web of Science, and EMBASE databases between 1 January 2020 and 30 August 2022. The keywords used to identify the relevant studies were “2019-nCoV” or “SARS-CoV-2” or “COVID-19” or “Coronavirus Disease,” and “vaccine hesitancy” or “vaccine uptake” or “vaccine acceptance” or “vaccine reluctance” or “vaccination” or “vaccination rate” or “vaccination readiness” or “vaccine acceptance” and “parents” or “parenteral” or “childhood” or “pediatrics” or “children.”

Study selection

Eligible studies were selected according to research questions and Population–Concept–Context (PCC) framework proposed by Joanna Briggs Institute (JBI) as shown in Table 1. JBI reviews are aimed to provide unbiased and comprehensive synthesis of a large number of relevant studies. This systematic review included only those studies that focused on parental concerns about COVID-19 vaccines in children up to 12 years without a diagnosis of COVID-19. Studies in English language or English language translation were included due to the lack of financial and language resources although authors are in the view that English is not the universal language of science. The current review included a cross-sectional online survey, mixed methods, and observational studies. Gray literature and unpublished studies were not included. This review did not include letters, reports, documentaries, or editorials as these studies do not provide empirical evidence required to ascertain the answers to review questions.

Inclusion and exclusion criteria

All the studies containing data on parents’ vaccine hesitancy of children up to 12 years without a diagnosis of COVID-19 were included, as vaccine hesitancy has been more pronounced among parents of children with compromised health conditions. Therefore, articles containing data on children with compromised health conditions, for example, cancer and attention-deficit/hyperactivity disorder (ADHD), were also included. We excluded studies with data on teenagers and adolescents. Studies that do not include data on parental concern about the COVID-19 vaccine in children or that have data on childhood vaccine hesitancy in other immunization programs were excluded.
TABLE 1 PCC (Population, Concept, Context) framework to identify main concepts in review questions.

| Criteria | Description |
|----------|-------------|
| Population | Parents of children up to 12 years without a diagnosis of COVID-19 |
| Concept | All study designs that measure COVID-19 vaccine hesitancy in children worldwide, parental concern regarding safety and effectiveness of vaccines |
| Context | The research studies were published until August 2022 in the English language regardless of geographical location |

Stage 3: Selection of relevant studies (search strategy)

The key terms for search strategy were collaboratively identified by two investigators (M.R and N.B). The authors also kept in mind sensitivity and specificity. The search strategy was developed by investigators focusing on four major concepts: COVID-19 vaccine hesitancy, childhood COVID-19, vaccine hesitancy, parental concern about COVID-19 vaccine hesitancy, barriers and facilitators of COVID-19 vaccine uptake. To achieve a comprehensive set of citations, the authors truncated necessary keywords and included relevant subject heading for each concept. The strategies were modified to ensure appropriateness for each database. The adopted search strategies along with databases are described earlier.

Metadata were collected and uploaded by a research team from all identified records to Endnote, and subsequently, duplicates were removed. The review team used two-stage screening due to a large number of studies. The irrelevant articles were removed from the titles and abstracts, while the second stage comprised of reviewing full-text articles. Furthermore, irrelevant articles were removed from the study sample after reading each article. Data extraction was performed from the remaining articles with relevance to the study question. A total of 27 studies were included after the bibliographic screening. Two reviewers (MR and MHB) collectively searched the data, and disagreement was resolved by the third reviewer (Y.H.K). A summary of the study selection process has been given in the PRISMA flowchart (Figure 1).

Stage 4: Data extraction

Data extraction table was created in Microsoft word to ensure that the relevant information is systematically extracted in the table. Data from all relevant publications containing the following information were recorded: (1) Authors. (2) Publication year and duration of study. (3) Number of respondents. (4) Parental concern. (5) Vaccine hesitancy/vaccine acceptance percentages. (6) Barriers and facilitators of vaccine uptake (Table 2). Few modifications were also made to the data extraction tool according to the requirement after reviewing the first three articles. To achieve a comprehensive set of relevant data that was not included initially during the extraction process, further refinements were added. Data were charted by the first reviewer (M.R), and extraction was checked by the second reviewer (N.B).

Stage 5: Quality appraisal

The methodological quality of primary studies was appraised by Newcastle-Ottawa scale (NOS). The scale contains seven domains and uses a star system to appraise the studies. These domains include the following: (1) Selection (four subcategories; maximum four stars). (2) Comparability (one subcategory; maximum two stars). (3) Outcome (two subcategories; maximum three stars).

Stage 6: Collating, summarizing, and reporting the findings

This stage consisted of three major steps including numerical, tabular, and narrative summaries of the data. The current review collated and summarized the results systematically by adopting the framework recommended by Arksey and O’Malley (25). Therefore, the first step provided a descriptive numerical summary including the total number of articles searched, the total number of included studies, excluded studies, and reasons for exclusion. The second analytical step was aimed at answering the research questions through a tabular summary. The information included the author's name, year of publication, study design, vaccine hesitancy/acceptance, and barriers/facilitators for uptake of vaccines. The third analytical step described similarities and differences in such a way in which parental concern and vaccine hesitancy have been defined within each country.

Results

Study selection

The literature review generated 3,750 records, and removing duplicates (n = 292) resulted in 958 studies. Of these, 286 articles were excluded due to the lack of topical relevance following abstract and title screening (Figure 1). A total of 820 articles were subjected to full-text screening. Of these, 686 articles were excluded for the following reasons: 412 articles focused on vaccination in adults and only mentioned childhood vaccination in conclusion, 170 articles were excluded due to repetition, 54 articles focused on other immunization programs with only future aspects of COVID-19 vaccination, and 54 records were published as editorials, letters, and commentaries. We included the oldest publication in the set-in case of duplication. In addition, 27 records were included that were not part of the original search results but were present in the bibliography of the selected studies. Finally, 108 relevant articles reporting the data either on vaccine hesitance or acceptance were identified for inclusion in this review (8, 26–46, 48, 51–135, 143). Some additional articles were also used during data synthesis as supportive evidence (47, 49, 50).
Characteristics of studies

The current review is comprised of studies on COVID-19 acceptance/hesitancy from 27 countries. The dates of survey distribution ranged from January 2020 to August 2022. Stratified per country, the largest sample size ($n = 227,740$) was reported in a study conducted in Switzerland by Urrunaga-Pastor et al. (26), while the smallest sample size ($n = 12$) was present in a study conducted in the USA (27). The majority of the studies in this review were conducted in USA ($n = 22$), China ($n = 16$), and Saudi Arabia ($n = 10$) (Supplementary Table 1).

Prevalence of vaccine hesitancy

Vaccine hesitancy was presented in terms of percentage in all studies except two studies where vaccine hesitancy scores were estimated (28, 29). As per classification in the study, the highest vaccine hesitancy rates (>85%) among parents were reported in two studies conducted in Saudi Arabia and Turkey (30, 31). On the contrary, the lowest vaccine hesitancy rates (<4%) were found in two studies conducted in South Africa and Switzerland with 0.69 and 2%, respectively (32, 33) (Table 3).

Defining the problem of vaccine hesitancy

We distinguished three different approaches to vaccine hesitancy, namely, parental concerns ($N = 108/108, 100%$), vaccine safety ($N = 60/108, 55%$), and barriers ($N = 70/108, 65%$). Most of the studies focused on parental concern, and an increasing number of articles on this topic were published between 2020 and 2022 (Table 3).
Parental concerns

The contribution of parents toward vaccine hesitancy among children has been elucidated in many studies. Cognitive biases of parents have been attributed to decreasing trust in vaccination according to public health experts (31). The reason behind distrust was the risk associated with new vaccines in terms of adverse effects. The current review revealed that parents’ concerns about vaccine safety, side effects, and lack of evidence were significantly associated with vaccine hesitancy according to 62 (76%) studies conducted globally followed by psychological distress and adverse effects (N = 5/108, 4.6%). The reported reasons include cynicism about the efficacy and safety of vaccines and social media influence and a history of unknown allergies, respectively (34–38). Mothers were more hesitant to vaccinate their children in Turkey due to a lack of information about the effectiveness of vaccines and distrust of foreign vaccines (39) (Table 3).

Factors associated with vaccine hesitancy

The current review identified twenty-four barriers to COVID-19 vaccine uptake. It is inevitable to explore the reasons for vaccine hesitancy, reluctance, or outright refusal. The most commonly reported barriers include mothers’ lower education level (N = 46/108, 43%), followed by financial instability (N = 19/108, 16%), low confidence in new vaccines (N = 13/108, 12%) and unmonitored social media platforms (N = 5/108, 4.6%) were associated with vaccine refusal (8, 40–44). Low confidence in the new vaccine was reported in the USA and Saudi Arabia (N = 9/18, 60%) and financial instability was most commonly reported in China (N = 5/20, 25%) (Table 3).

Facilitators of vaccine uptake

Fifty-three studies investigated twenty-two facilitators of vaccine uptake. The significant facilitators for vaccine uptake among respondents who intended to have their children vaccinated include higher education level (N = 12/108, 11%) followed by information obtained through healthcare professionals (N = 9/108, 8.3%) and strong confidence in preventive measures taken by the government (N = 5/108, 4.6%) (40, 41, 45–47). Protecting the people around was another possible reason for the increased intention of vaccine uptake. Information obtained through healthcare workers was commonly reported determinant in the USA, while fear of COVID-19 was highly observed in China (Table 3).

Vaccine hesitancy/acceptance rates in children with comorbidities

Approximately 80% of parents in the USA showed willingness toward vaccination for their children with cancer due to the information obtained through oncologists, and the acceptance rate was quite higher than observed among parents with healthy children (48, 49). However, another study conducted in Taiwan highlighted the vaccine hesitancy among parents of children with ADHD owing to the regular use of medications for ADHD (50). In addition, parents of children with cancer and neurodevelopmental disorders were also unwilling to vaccinate their children against COVID-19 as revealed in studies conducted in USA and Bangladesh, respectively (51, 52) (Table 3).

Quality appraisal of studies

All the studies were subjected to NOS for quality appraisal. Overall, the majority of studies have a medium quality with an average of around six stars (range = 3–9 stars). Seven studies received three stars, thirteen studies received four stars, sixteen received five stars, twenty-eight studies received six stars, twenty-seven received seven stars, sixteen studies received eight stars, and only three studies received nine stars. Table 4 indicates the results of quality assessment of primary studies included in this review.
### TABLE 3  COVID-19 vaccine hesitancy in children, parental concerns, vaccine acceptance, facilitators, and barriers.

| Authors               | Parental concerns                                                                 | Vaccine hesitancy n (%) | Barriers to vaccine uptake                                   | Vaccine acceptance n (%) | Facilitators of vaccine uptake |
|-----------------------|-----------------------------------------------------------------------------------|-------------------------|-------------------------------------------------------------|--------------------------|--------------------------------|
| Aldakhil et al. (40)   | Vaccine safety, Side effects, New vaccine                                           | 214 (79.2%)             | Lower educational levels of mothers                         | 213 (79%)                | The higher educational levels of mothers, Employment status |
| Alferi et al. (53)     | Insurance type                                                                    | 470 (33%)               | Financial instability                                       | NA                       | Private insurance Information sources |
| Brandstetter et al. (45) | Vaccine safety                                                                  | NA                      | NA                                                          | 312 (51%)                | Higher education level, Parents’ confidence in preventive measures |
| Bagatell et al. (41)   | Vaccine safety                                                                     | 43 (8.6%)               | Lower education, financial instability                      | 458 (91%)                | Higher education level Financial stability |
| Yang et al. (54)       | Vaccine safety                                                                     | 3,750 (29.1%)           | Allergies/ADRs, Financial instability                       | 9,122 (70.8%)            | Trust in new vaccines |
| Ebrahimi et al. (46)   | Vaccine safety                                                                     | 1,301 (8.67%)           | Unmonitored media platform, Rural resident                  | 3,270 (11.16%)           | Higher education level |
| Fernandes et al. (55)  | Vaccine safety                                                                     | 259 (40%)               | Lack of confidence in new vaccines                         | 390 (60%)                | Positive attitude and belief toward vaccines |
| Du et al. (42)         | Vaccine safety                                                                     | 254 (8.4%)              | Lower educational level, financial instability             | NA                       | Information obtained through healthcare agencies |
| Goldman et al. (32)    | Vaccine safety                                                                     | 536 (35%)               | Loss of income due to COVID-19                              | 1,005 (65%)              | Higher education level |
| Landicho-Guevarra et al. (56) | Professional conduct, Vaccine safety                       | NA                      | NA                                                          | NA                       | NA |
| Montalti et al. (8)    | Professional conduct                                                              | 2,037 (40%)             | Lower education level, Unmonitored media platforms, religious beliefs | 3,017 (60.4%)            | Medical advice |
| He et al. (57)         | Vaccine safety                                                                     | 11 (6%)                 | Risk perception                                            | 86 (47.3%)               | Financial stability |
| Karlsson et al. (58)   | Vaccine safety                                                                     | 200 (8.4%)              | NA                                                          | 1,150 (48%)              | Higher trust in safety of vaccines |
| Kadoya et al. (34)     | Vaccine safety                                                                     | 2,240 (53%)             | Future anxiety related to new vaccines                     | 2,000 (47%)              | Financial literacy |
| Lu et al. (59)         | Vaccine safety                                                                     | 1,080 (29.5%)           | Financial instability, younger age at childbirth           | 3,213 (87.5%)            | Trust in the effectiveness of the vaccines |
| Milan et al. (60)      | Vaccine safety Professional conduct                                               | 62 (25.8%)              | Institutional distrust, Less belief in science             | NA                       | NA |
| Moore et al. (33)      | Vaccine safety                                                                     | 13,849 (8%)             | Financial instability, Fear of ADRs                        | 150,845 (87%)            | NA Information obtained through professional resources |
| Al-Mulla et al. (61)   | Vaccine safety and effectiveness                                                   | 92 (46%)                | Institutional distrust                                      | NA                       | NA |
| Wang et al. (28)       | Vaccine safety                                                                     | 714 (51.1%)             | Financial instability                                      | 1,780 (59.3%)            | Protecting the people around |
| Ruggiero et al. (38)   | Vaccine safety, Vaccine side effects                                               | 297 (69.5%)             | Fear of vaccines, religious reasons                        | 190 (44%)                | Trust in information resources |
| Alnasser et al. (30)   | Link of vaccine to autism                                                          | 113 (95%)               | Chronic illnesses, Internet and social media influencers   | NA                       | NA |
| Stead et al. (62)      | Vaccine safety                                                                     | 842 (14.2%)             | Financial hardship                                         | 4,137 (83%)              | NA |
| Tsai et al. (63)       | Vaccine safety and effectiveness                                                   | 60 (37.3%)              | Regular use of medicine for ADHD                           | 37 (23%)                 | Higher education level Health insurance |
| Teasdale et al. (43)   | Vaccine safety and effectiveness                                                  | 416 (37%)               | Lower education level                                      | 690 (61.9%)              | Health insurance |
| Temsah et al. (64)     | Vaccine safety, Side effects                                                       | 1,650 (52%)             | Less belief in new vaccines                                | 1,510 (47.6%)            | Decrease risk perception |

(Continued)
TABLE 3 (Continued)

| Authors            | Parental concerns | Vaccine hesitancy | Barriers to vaccine uptake | Vaccine acceptance | Facilitators of vaccine uptake |
|--------------------|-------------------|-------------------|-----------------------------|-------------------|--------------------------------|
| Teherani et al. (65) | Vaccine safety, Adverse effects | 56 (55%) | Safety concerns and lack of information | 46 (45%) | NA |
| Lu et al. (66) | Vaccine safety | 989 (7.3%) | Rural residents, Financial instability | 8,900 (66.1%) | Higher education level Urban residents |
| Viswanath et al. (67) | Vaccine safety | 352 (34.8%) | Lower education level, Lower confidence in scientists, Social media influencers | 660 (65%) | Information obtained through an online source |
| Wian et al. (68) | Vaccine safety, Vaccine effectiveness, Contraindication to vaccination | 62 (13.2%) | Less belief in safety and effectiveness of vaccines | 406 (86.7%) | Fear of being infected with COVID-19 |
| Xu et al. (36) | Vaccine safety, New vaccine | 1,300 (27.3%) | Psychological distress | 3,561 (75%) | NA |
| Horiuchi et al. (69) | Vaccine safety | 424 (35.3%) | Financial instability | 776 (64.7%) | A trusted source of information |
| Altulaihi et al. (70) | Vaccine safety | 90 (27%) | Lack of information and evidence | 179 (53.7%) | Believe in the efficacy and safety of the vaccines |
| Bongomin et al. (71) | Vaccine safety, Effectiveness | 17 (5.7%) | Negative information through social media | NA | Self-protection, healthcare workers’ recommendation |
| Yigit et al. (39) | Side effects | 283 (66.1%) | Distrust in companies and doctors, Religious reasons | 145 (33.9%) | To protect children and family |
| Evans et al. (72) | Side effects, Professional conduct | 570 (52%) | Distrust in companies and doctors, Religious reasons | 530 (48.4%) | To protect children and family |
| Ikisiik et al. (31) | Vaccine safety | 344 (89.6%) | Less belief in science | 200 (52%) | Perception of risk |
| Odwowe et al. (33) | NA | 7 (0.69 %) | NA | 862 (84.93%) | Compatibility with religious belief |
| Zhang et al. (73) | Vaccine safety and efficacy | 940 (52.5%) | Less knowledge about vaccine | 848 (47.2%) | NA |
| Fedele et al. (74) | Vaccine safety | 470 (73%) | Lower education level | 619 (97%) | NA |
| Feng et al. (75) | Vaccine safety and effectiveness | 603 (16.3%) | Lower education level | 3,100 (84%) | Old age |
| Rhodes et al. (29) | Adverse effects | 35 (6.5%) | Religious belief | 286 (53%) | Information obtained through healthcare resources |
| Carecelen et al. (76) | Vaccine safety and efficacy | 200 (8.3%) | NA | 2,200 (92%) | Concern about the disease |
| Yoda et al. (77) | Vaccine safety, Vaccine efficacy Side effects | 188 (17.1%) | Distrust in new vaccines | 472 (43%) | Higher education Financial stability |
| Gönsüllü et al. (78) | NA | 126 (25%) | NA | 380 (75%) | Believe in vaccine safety and effectiveness |
| Wimberly et al. (48) | Vaccine safety and effectiveness | 32 (21%) | Insufficient safety and efficacy data | 120 (80%) | Believe in science and vaccines |
| Scott et al. (37) | Vaccine safety | 296 (75%) | Fear of adverse effects | 95 (24.3%) | Information obtained from healthcare workers |
| Humble et al. (79) | Vaccine safety | 1,325 (77.9%) | Part-time employment (financial constraints) | 1,075 (63.1%) | NA |
| McKinnon et al. (80) | Vaccine safety Side effects | 38 (12.4%) | Lower education, Financial instability, Social inequalities | 183 (59.7%) | NA |
| Oliveira et al. (81) | NA | 610 (13.1%) | NA | 4,067 (87.9%) | NA |

(Continued)
| Authors          | Parental concerns | Vaccine hesitancy | Barriers to vaccine uptake                                      | Vaccine acceptance | Facilitators of vaccine uptake                  |
|-----------------|-------------------|-------------------|----------------------------------------------------------------|-------------------|-----------------------------------------------|
| Skjefte et al. (82) | Vaccine safety Side effects | NA | Limited impact of healthcare providers, financial instability | 11,800 (69.2%) | Believe in new vaccines |
| Ticona et al. (83) | NA | 132 (33%) | Low perceived importance of vaccination | 270 (67%) | NA |
| Zakeri et al. (84) | Vaccine safety Side effects | 38.32% | NA | NA | Presence of healthcare workers |
| Yilmaz et al. (85) | NA | NA | NA | 376 (36.3%) | Information obtained through social media |
| Faye et al. (86) | Vaccine safety | 532 (25%) | NA | 765 (36%) | Perceived safety and effectiveness |
| Lazarus et al. (87) | Vaccine safety | 5,700 (24.9%) | Distrust in government | 17,300 (75.2%) | Trust in vaccines |
| Trujillo et al. (88) | Vaccine safety Side effects | 3,450 (73%) | Long-term health effects, Distrust in new vaccine | 2,347 (50%) | NA |
| Roess et al. (89) | NA | NA | Financial instability | 2,650 (69%) | NA |
| Tsu et al. (90) | NA | 46% | NA | NA | NA |
| Wang et al. (91) | NA | 57 (8%) | Lower education, Financial instability | 362 (50%) | NA |
| Almusbah et al. (92) | Vaccine side effects | 719 (72%) | Low trust in vaccines | 281 (28.1%) | NA |
| Biasio et al. (93) | NA | NA | NA | 610 (69%) | NA |
| Biddle et al. (44) | Side Effects | 11.4% | Lower education level | 42.5% | NA |
| Gan et al. (94) | Vaccine safety | 930 (26%) | Distrust in the vaccines, Limited information about vaccines | 2,598 (73.6%) | Protection of family members |
| Jorgensen et al. (95) | Vaccine safety | NA | NA | 240 (30.2%) | Trust in healthcare authorities Vaccine knowledge |
| Urrunaga-Pastor et al. (26) | Vaccine safety | 15,196 (7.8%) | Economy insecurity, Rural areas residents | 212,544 (93%) | NA |
| Shmueli et al. (96) | Vaccine safety Side effects | 742 (73%) | NA | 579 (57%) | Vaccine availability, Green pass |
| Wang et al. (97) | Vaccine safety Adverse reactions | 14 (63%) | Vaccines’ cost | NA | NA |
| Wisniak et al. (98) | Side effects | 710 (53%) | Distrust in new vaccines | 610 (45.6%) | Reliable information on vaccine efficacy |
| Xue et al. (99) | Side effects | 144 (30.4%) | NA | 260 (54%) | NA |
| Verger et al. (100) | NA | NA | 1,223 (79%) | Trust in institutions, Fear of contracting COVID-19 |
| Thunstrom et al. (101) | NA | 228 (19.7%) | NA | 928 (80.3%) | Believe in information obtained from healthcare resources |
| Yadete et al. (102) | NA | 1,140(86.1%) | Lower education level | 1,322 (61.8%) | NA |
| Kishor et al. (103) | NA | 172(36.8%) | NA | 295 (63.1%) | NA |
| Fakonti et al. (104) | Side effects | 304 (70%) | Vaccine expedited development | 130 (30%) | NA |
| Anjorin et al. (105) | Side effects | 36 (9%) | Financial instability, Distance to the healthcare center | 350 (90%) | Information obtained through healthcare workers |

(Continued)
### TABLE 3 (Continued)

| Authors                      | Parental concerns       | Vaccine hesitancy n (%) | Barriers to vaccine uptake | Vaccine acceptance n (%) | Facilitators of vaccine uptake |
|------------------------------|-------------------------|-------------------------|---------------------------|--------------------------|--------------------------------|
| Ennaceur and Al-Mohaithef    | Side effects            | 212 (56%)               | Distrust in new vaccines  | 167 (44%)                | Trust in the healthcare system |
| (106)                       |                         |                         |                           |                          |                                |
| Al-khlaiwi et al. (107)      | NA                      | 702 (54%)               | NA                        | 602 (46.1%)              | Financial stability            |
| Bell et al. (108)            | Vaccine safety          | 93 (7.4%)               | NA                        | 604 (48.2%)              | NA                             |
| and Effectiveness            |                         |                         |                           |                          |                                |
| Bonni et al. (109)           | NA                      | 3,612 (35.4%)           | NA                        | 6,571 (64.5%)            | Higher knowledge about COVID-19 |
| Galanis et al. (110)         | Vaccine safety,         | 178 (27.1%)             | Low socioeconomic and    | 478 (72.9%)              | Trust in the COVID-19 vaccines |
|                             | effectiveness, Fear of side effects |           | education level          |                          |                                |
| Guzman et al. (111)          | Vaccine safety          | 15 (48%)                | Poor understanding of    | 27 (85%)                 | NA                             |
|                             | Side effects            |                         | vaccines                 |                          |                                |
| Duber et al. (27)            | Side effects            | 21 (75%)                | Risk of complications    | 7 (25%)                  | NA                             |
| Fisher et al. (112)          | Vaccine safety          | 283 (68.9%)             | Distrust in Government,  | 128 (31.4%)              | NA                             |
|                             |                         |                         | Science and Big pharma,  |                          |                                |
|                             |                         |                         | Lower socioeconomic status |                        |                                |
| Skeens et al. (51)           | Side Effects            | 90 (18.5%)              | Lower income, concern for side effects | 119 (24.4%)             | NA                             |
| Kito et al. (113)            | Vaccine safety Side effects | 787 (74%)               | Lower income             | 974 (91.6%)              | Confidence in vaccines         |
| Wang et al. (114)            | Side effects            | 132 (63.8%)             | Long term side effects   | 75 (36%)                 | Higher education               |
| Khatatbeh et al. (115)       | Vaccine safety          | NA                      | NA                        | 1,194 (31.9%)            | Higher education level         |
|                             | Adverse effects         | 110 (10%)               | Novelty of vaccines      | 660 (63%)                | Higher education level         |
| Alhazza et al. (116)         | NA                      | NA                      | NA                        | 3,233 (64.2%)            | NA                             |
| Hammershaimb et al. (117)    | NA                      | NA                      | NA                        | 299 (58.2%)              | NA                             |
| Huang et al. (118)           | Vaccine safety          | 215 (41.8%)             | NA                        | 299 (58.2%)              | NA                             |
| Miraglia del Giudice et al.  | Side effects            | 264 (61.4%)             | Limited knowledge about COVID-19 vaccination | 162 (38%)             | Protecting the child’s health |
| (119)                       |                         |                         |                           |                          |                                |
| Khall et al. (120)           | Vaccine safety          | 1,309 (75%)             | NA                        | 1,587 (91%)              | Fear of COVID-19               |
| Aedh (121)                   | Adverse effects         | 335 (72.2%)             | Lack of safety data      | 129 (27.8%)              | NA                             |
| Alkerbi et al. (122)         | NA                      | NA                      | NA                        | 1,890 (75.1%)            | Trust in information sources and healthcare providers |
| Buonsenso et al. (123)       | NA                      | 81 (67%)                | Distrust in new vaccines | 68 (56%)                 | NA                             |
| Challaiyan et al. (124)      | NA                      | 50 (37%)                | NA                        | 114 (82%)                | Parents education              |
| Faye et al. (125)            | Side Effects            | 61 (41%)                | Increased adverse risks  | 1,525 (69%)              | Perceived effectiveness of vaccines |
| Goldman et al. (142)         | NA                      | 51 (2%)                 | NA                        | 2,454 (89%)              | NA                             |
| Lachance-Girzea et al. (126) | Side effects            | 67 (16%)                | NA                        | 209 (68%)                | Access to relevant information, higher household income |
| Head et al. (127)            | Vaccine efficacy        | 5,640 (54.9%)           | NA                        | 4,600 (44.8%)            | Information obtained through healthcare provider |
|                             | Vaccine safety          |                         |                           |                          |                                |

(Continued)
TABLE 3 (Continued)

| Authors               | Parental concerns | Vaccine hesitancy n (%) | Barriers to vaccine uptake | Vaccine acceptance n (%) | Facilitators of vaccine uptake |
|-----------------------|-------------------|-------------------------|---------------------------|--------------------------|-------------------------------|
| Hou et al. (128)      | Side Effects      | 98 (2.3%)               | Lower education level, Financial instability | 3,907 (91%)              | Confidence in general vaccines Knowledge on herd immunity |
| Krakowczyk et al. (129) | Side Effects 685 (28.5%) | Fear of side effects | 1,720 (71.4%)              | Confidence in safety of vaccine |
| Kreuter et al. (130)  | Side Effects 12,239 (84.6%) |                | 74 (21.2%)              |                           |
| Lau et al. (131)      | NA                | 10,229 (84.6%)          | Financial instability     | 2,109 (14.6%)             | Concerned about safety of vaccines |
| Li et al. (132)       | Vaccine safety 38 (1.1%) | Perceived risk degree of COVID-19 vaccine | 2,976 (89%)              | Perceived effectiveness of COVID-19 vaccines, Higher education level |
| Loua (133)            | NA                | 11 (92%)                | NA                        | Trust in vaccine efficacy |
| Ali et al. (52)       | NA                | 169 (42.7%)             | NA                        | NA                        |
| Ma et al. (134)       | NA                | 1,250 (13.2%)           | Living far from vaccination sites | 8,160 (86.4%)             | Believe in new vaccines |

The percentages were estimated from the total sample of the studies. The Barriers and Facilitators of vaccine uptake were stated as they were described in the primary studies. NA: not available.

Discussion

Vaccine hesitancy is a global challenge that causes serious health consequences due to relaying of vaccine-preventable infectious diseases (135). Despite the development of safe and effective vaccines, trends in COVID-19 vaccine acceptance decreased between January 2020 and August 2022 as a result of an array of various factors (136). There is a scarcity of systematic review in the literature on childhood COVID-19 vaccine hesitancy among parents although a plethora of studies exists on COVID-19 vaccine hesitancy. In this context, this study is the first of its kind systematically evaluating both the acceptance and hesitancy of the childhood COVID-19 vaccine among parents.

Vaccine hesitancy (VH) has been reported across countries among parents and healthcare professionals (135). Lower vaccine acceptance among children has been observed as a result of parents’ perceptions that children are at lower risk of COVID-19. Although lower COVID-19 mortality rates have been reported in children, they still account for a significant proportion of COVID-19 cases. Children are 2.5 times more likely to be infected with Delta variant according to recent estimates from the UK (137). It has also been reported in Taiwan that approximately 50% of children retain symptoms even after 6 months of infection. Therefore, COVID-19 vaccine hesitancy plays a significant role in the current pandemic by casting a negative impact on socio-economic status and health.

Vaccine hesitancy may hinder the progress of childhood vaccination programs which in turn results in the increasing prevalence of vaccine-preventable diseases (VPDs). VH influenced the parent’s intention in vaccinating their children. Overcoming this challenge to increase vaccine uptake is inevitable during the COVID-19 pandemic. Thus, an estimate of vaccine hesitancy rates can be helpful for effective intervention and planning inevitably to increase awareness among people regarding the safety and efficacy of vaccines which in turn would help to control the negative influence of the current pandemic by reducing viral spread (138, 139).

The current review represents a large variability in vaccine hesitancy rates globally. The overall vaccine hesitancy rate (>85%) was very high in Saudi Arabia. This finding is close (but not similar) to the findings of studies conducted in Turkey but different from the conclusions of studies performed in China, Brazil, Switzerland, and Zambia where (>85%) vaccine acceptance rates were reported.

The determinants of vaccination hesitancy have been extensively analyzed in this review. Age and gender were effective predictors of sociodemographic factors. All the included studies revealed that younger parents were less likely to vaccinate their children as compared to older parents. The reason may be that younger parents could not judge the pros and cons of vaccines as effectively and accurately as older parents can (45). Several included studies showed that mothers were more hesitant toward vaccination of their children against COVID-19, which was consistent with vaccine intention for other diseases (32, 53, 108, 140). It may be because women are less engaged in riskier behavior as compared to men concerning psychological aspects. In addition, mothers with higher education levels are more concerned about health-related illnesses in daily life (68). However, contradictory results
**TABLE 4** Newcastle–Ottawa scoring for cross-sectional studies.

| Authors                  | Selection | Comparability | Outcome | Total |
|--------------------------|-----------|---------------|---------|-------|
|                          | 1 ⭐       | 2 ⭐           | 3 ⭐     | 4 ⭐   | 5 ⭐⭐ | 6 ⭐⭐ | 7 ⭐ | |
| Aldakhil et al. (40)     | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Alfeiri et al. (53)      | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Brandstetter et al. (45) | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Bagateli et al. (41)     | ⭐         | ⭐             |         |       |       |       |     | 8    |
| Bell et al. (108)        | ⭐         | ⭐             |         |       |       |       |     | 4    |
| Yang et al. (54)         | ⭐         | ⭐             |         |       |       |       |     | 8    |
| Ebrahimi et al. (46)     | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Fernandes et al. (55)    | ⭐         | ⭐             |         |       |       |       |     | 5    |
| Du et al. (42)           | ⭐         | ⭐             |         |       |       |       |     | 8    |
| Goldman et al. (32)      | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Landicho-Guevarra et al. (56) | ⭐         |       |       |       |       |       |     | 6    |
| Montali et al. (8)       | ⭐         | ⭐             |         |       |       |       |     | 6    |
| He et al. (57)           | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Karlsson et al. (58)     | ⭐         |               |         |       |       |       |     | 4    |
| Kadoya et al. (34)       | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Lu et al. (59)           | ⭐         | ⭐             |         |       |       |       |     | 8    |
| Milan et al. (60)        | ⭐         |               |         |       |       |       |     | 5    |
| Moore et al. (35)        | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Al-Mulla et al. (61)     | ⭐         | ⭐             |         |       |       |       |     | 8    |
| Wang et al. (28)         | ⭐         | ⭐             |         |       |       |       |     | 9    |
| Ruggiero et al. (38)     | ⭐         | ⭐             |         |       |       |       |     | 8    |
| Alnasser et al. (30)     | ⭐         |               |         |       |       |       |     | 6    |
| Stead et al. (62)        | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Tsai et al. (63)         | ⭐         |               |         |       |       |       |     | 4    |
| Teasdale et al. (43)     | ⭐         |               |         |       |       |       |     | 6    |
| Temsah et al. (64)       | ⭐         |               |         |       |       |       |     | 6    |
| Teherani et al. (65)     | ⭐         | ⭐             |         |       |       |       |     | 8    |
| Lu et al. (66)           | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Viswanath et al. (67)    | ⭐         |               |         |       |       |       |     | 5    |
| Wan et al. (68)          | ⭐         | ⭐             |         |       |       |       |     | 8    |
| Xu et al. (36)           | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Horruchi et al. (69)     | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Altsulaihi et al. (70)   | ⭐         |               |         |       |       |       |     | 4    |
| Bongomin et al. (71)     | ⭐         |               |         |       |       |       |     | 3    |
| Yigit et al. (39)        | ⭐         |               |         |       |       |       |     | 6    |
| Evans et al. (72)        | ⭐         |               |         |       |       |       |     | 6    |
| Ikstuk et al. (31)       | ⭐         |               |         |       |       |       |     | 6    |
| Oduwole et al. (33)      | ⭐         |               |         |       |       |       |     | 6    |
| Zhang et al. (73)        | ⭐         |               |         |       |       |       |     | 6    |
| Fedele et al. (74)       | ⭐         | ⭐             |         |       |       |       |     | 7    |
| Feng et al. (75)         | ⭐         |               |         |       |       |       |     | 4    |
| Rhodes et al. (29)       | ⭐         |               |         |       |       |       |     | 3    |
| Carcelen et al. (76)     | ⭐         |               |         |       |       |       |     | 6    |
| Yoda et al. (77)         | ⭐         |               |         |       |       |       |     | 6    |
| Gönülü et al. (78)       | ⭐         |               |         |       |       |       |     | 6    |
| Wimberly et al. (48)     | ⭐         |               |         |       |       |       |     | 6    |
| Scott et al. (37)        | ⭐         |               |         |       |       |       |     | 5    |

(Continued)
TABLE 4 (Continued)

| Authors                  | Selection | Comparability | Outcome | Total |
|-------------------------|-----------|---------------|---------|-------|
| Humble et al. (79)      | ★         | ★             |         | ★★    | ★★     | 5       |
| McKinnon et al. (80)    | ★         |               |         | ★★    | ★★     | 4       |
| Oliveira et al. (81)    | ★★        | ★★            |         | ★★    | ★★     | 7       |
| Skjefle et al. (82)     | ★         |               |         | ★★    | ★★     | 6       |
| Tiscosa et al. (83)     | ★         |               |         | ★★    | ★★     | 6       |
| Zakeri et al. (84)      | ★         | ★★            |         | ★★    | ★★     | 6       |
| Yilmaz al. (85)         | ★         |               |         | ★★    | ★★     | 4       |
| Faye et al. (86)        | ★★        |               |         | ★★    | ★★     | 3       |
| Lazarus et al. (87)     | ★         |               |         | ★★    | ★★     | 3       |
| Guzman et al. (111)     | ★         |               |         | ★★    | ★★     | 5       |
| Trujillo et al. (88)    | ★         |               |         | ★★    | ★★     | 3       |
| Roess et al. (89)       | ★★        |               |         | ★★    | ★★     | 4       |
| Tsui et al. (90)        | ★         |               |         | ★★    | ★★     | 4       |
| Wang et al. (91)        | ★         | ★★            |         | ★★    | ★★     | 6       |
| Almushbah et al. (92)   | ★         | ★★            |         | ★★    | ★★     | 4       |
| Bissio et al. (93)      | ★         | ★★            |         | ★★    | ★★     | 4       |
| Biddle et al. (94)      | ★         | ★★            |         | ★★    | ★★     | 4       |
| Gan et al. (94)         | ★         |               |         | ★★    | ★★     | 3       |
| Jørgensen et al. (95)   | ★★        |               |         | ★★    | ★★     | 7       |
| Urrunaga-Pastor et al. (26) | ★★      |               |         | ★★    | ★★     | 5       |
| Shmueli et al. (96)     | ★★        |               |         | ★★    | ★★     | 7       |
| Wang et al. (97)        | ★         | ★★            |         | ★★    | ★★     | 6       |
| Wismak et al. (98)      | ★★        |               |         | ★★    | ★★     | 7       |
| Xu et al. (99)          | ★         |               |         | ★★    | ★★     | 3       |
| Verger et al. (100)     | ★★        | ★★            |         | ★★    | ★★     | 9       |
| Thunstrom et al. (101)  | ★         | ★★            |         | ★★    | ★★     | 6       |
| Yadete et al. (102)     | ★★        |               |         | ★★    | ★★     | 6       |
| Bono et al. (109)       | ★         | ★★            |         | ★★    | ★★     | 4       |
| Galanis et al. (110)    | ★★        | ★★            |         | ★★    | ★★     | 9       |
| Kishor et al. (103)     | ★★        |               |         | ★★    | ★★     | 7       |
| Fakonti et al. (104)    | ★★        | ★★            |         | ★★    | ★★     | 7       |
| Anjorin et al. (105)    | ★★        | ★★            |         | ★★    | ★★     | 8       |
| Ennaceur and Al-Mohaithef (106) | ★★  |               |         | ★★    | ★★     | 6       |
| Al-khlaibi et al. (107) | ★★        | ★★            |         | ★★    | ★★     | 8       |
| Dubé et al. (127)       | ★★        |               |         | ★★    | ★★     | 7       |
| Fisher et al. (112)     | ★★        | ★★            |         | ★★    | ★★     | 8       |
| Sceens et al. (51)      | ★         | ★★            |         | ★★    | ★★     | 7       |
| Kito et al. (113)       | ★★        |               |         | ★★    | ★★     | 5       |
| Wang et al. (114)       | ★★        |               |         | ★★    | ★★     | 7       |
| Khatarbeh et al. (115)  | ★★        |               |         | ★★    | ★★     | 5       |
| Alhazza et al. (116)    | ★★        |               |         | ★★    | ★★     | 7       |
| Hammershaimb et al. (117) | ★★    |               |         | ★★    | ★★     | 6       |
| Huang et al. (118)      | ★★        |               |         | ★★    | ★★     | 7       |
| Miraglia del Giudice et al. (119) | ★★  |               |         | ★★    | ★★     | 5       |
| Kheli et al. (120)      | ★★        |               |         | ★★    | ★★     | 4       |
| Aesh (121)              | ★★        |               |         | ★★    | ★★     | 6       |
| Alkerhi et al. (122)    | ★★        |               |         | ★★    | ★★     | 5       |
| Buonsenso et al. (123)  | ★★        | ★★            |         | ★★    | ★★     | 8       |

(Continued)
were reported regarding the association between vaccination intention and higher education level. Higher education provides parents with sufficient knowledge about disease and vaccines which play a significant role in effective decision-making regarding vaccination against COVID-19 (8). Economic factors should be taken into account while promoting vaccination. Financial instability was observed to be a negative factor related to vaccination intention most commonly reported in China. Furthermore, parents’ concerns relating to vaccine safety, efficacy, the novelty of vaccines, and adverse effects also contributed to high rates of vaccine hesitancy (141, 142). Another pertinent point is that social media platforms are considered more biased toward conspiratorial and misleading information about COVID-19. Falsehood was more widely shared by interconnected clusters of vaccine opponents globally through social media or web sources. Therefore, those who relied on information obtained through these unmonitored sources were reluctant toward vaccination (8, 46, 71).

Also, the finding related to knowledge and acceptance among different groups of the population should not be underestimated. Parents with fear of contracting COVID-19 were in favor of COVID-19 vaccine uptake as reported in studies conducted in China and Malaysia (28, 94). These findings are in line with available literature demonstrating parents’ willingness toward vaccination due to fear of being infected with COVID-19 (143). A higher level of knowledge associated with a higher education level of the female gender was significantly associated with increased vaccine uptake most commonly observed in Saudi Arabia, Switzerland, and Brazil (40, 41, 142). These findings are consistent with another study conducted in Italy evaluating knowledge related to COVID-19 pandemic (144). Place of residence may also affect the awareness of COVID-19. Residents of urban areas are more inclined to the uptake of COVID-19 vaccine as reported in a study conducted in China (59). These findings are in line with a previously published study highlighting the importance of institutionalization in raising awareness of COVID-19 (144).

The current review provides a high level of evidence regarding vaccine hesitancy among parents by synthesizing a variety of research published till date. In addition, it includes wider scope of studies and also inspects the relationship of sociodemographic factors with vaccine hesitancy. Our study emphasizes that sharing of non-factual data should be avoided through social media and the provision of accurate scientific information should be encouraged. People should be informed correctly regarding the efficacy and safety of vaccines through health authorities to develop trust and confidence in new vaccines. However, data obtained through this review will facilitate the scientists and other healthcare authorities to further promote COVID-19 vaccination in children.

The adoption of a systematic review methodology provides an overview of COVID-19 vaccine hesitancy globally. This review provides deep insight into childhood COVID-19 vaccine hesitancy as the data are not assembled in the form of a systematic review, particularly on parents’ concern about childhood COVID-19 vaccination. Robust estimates of factors are provided in this study through simultaneous investigations of multitudes of relevant variables. Moreover, this review has also identified various predictors of vaccine hesitancy. Quality appraisal of included studies revealed that 88 studies have obtained five and more than five stars and only 20 studies scored less than five stars. However, the findings of this review should be estimated in light of certain limitations. Our review is limited to the studies published only in English language. In addition, our review is comprised of cross-sectional studies, and these studies are usually unable to develop causation as they collect data in a short span. Selection bias could not be ruled out either, because several surveys were conducted in

### TABLE 4 (Continued)

| Authors                  | Selection | Comparability | Outcome | Total |
|--------------------------|-----------|---------------|---------|-------|
| Chellaiyan et al. (124)  | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 5    |
| Faye et al. (125)        | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 8    |
| Goldman et al. (142)     | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 5    |
| Lachance-Grzela et al. (126) | ⭐️      | ⭐️            | ⭐️      | ⭐️   | 7    |
| Head et al. (127)        | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 7    |
| Hou et al. (128)         | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 8    |
| Krakowczyk et al. (129)  | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 5    |
| Kreuter et al. (130)     | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 6    |
| Lau et al. (131)         | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 8    |
| Li et al. (132)          | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 7    |
| Loua (133)               | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 6    |
| Ali et al. (53)          | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 6    |
| Ma et al. (134)          | ⭐️         | ⭐️            | ⭐️      | ⭐️   | 8    |

1. Representativeness of sample. 2. Sample size. 3. Non-respondents. 4. Ascertainment of exposure tool. 5. Subjects are comparable/confounding. 6. Ascertainment of outcome. 7. Statistical test.
vaccination clinics, emergency departments, or other medical settings. The current review did not comprise of meta-analysis due to the wide variation in methodologies of the primary studies. This review does not provide a comparison between adult and childhood vaccine hesitancy rates across the world. The current review included only those studies that encompass vaccine hesitancy rates among parents of young children and exclude adolescent. Another pertinent point is that we solely focused on scholarly articles and excluded gray literature. There was heterogeneity both in terms of the specific questions asked of participants as well as the provenance of those questions in theory or from standardized questionnaire sets. The use of variable questionnaires may under- or over-estimate the VH. Despite these limitations, this is the first review offering a picture of COVID-19 vaccine hesitancy among parents of young children and provides greater insight into parenteral behaviors toward childhood COVID-19 vaccine. Moreover, the current review was not only confined to parental vaccine hesitancy rates but also evaluated vaccine acceptance patterns. With regard to barriers and facilitators, few data are reported in the previously published scientific literature regarding this age group. The current review will help health authorities that are primarily engaged in childhood immunization to attain herd immunity against COVID-19.

Conclusion

Large variability in COVID-19 vaccine hesitancy was reported across the world. Vaccine safety was considered the most important factor of childhood COVID-19 vaccine hesitancy. In addition, a diverse range of factors influences parents’ beliefs on COVID-19 vaccination. A sizeable number of studies reported COVID-19 vaccine hesitancy rates up to 60%. Uncertainty regarding long-term adverse effects, the novelty of vaccines, non-reliable information obtained through social media, and financial instability were the major challenges faced during the implementation of the COVID-19 vaccination program for children. The worldwide prevalence of COVID-19 necessitates the collaborative efforts of government, media sources, and healthcare authorities. Nevertheless, advocating the safety and efficacy of vaccines through trusted sources might help in developing trust among parents and the general public.

Data availability statement

The original contributions presented in this study are included in the article/Supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

YK, MR, TM, AIA, ASA, and NA provided substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work. YK, MR, TM, MS, AIA, ASA, NA, S-U-DK, ADA, MB, SIA, KA, SSA, MA, AKA, ZA, and MI drafted the work or revised it critically for important intellectual content. All authors consented to publication and agreed to be accountable for the accuracy or integrity of the work.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fped.2022.950406/full#supplementary-material

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سوال: هل يمكنك تحديد أي تأثيرات جانبية معينة يمكن أن تظهر في الأطفال بعد استلامهم لفيروسات COVID-19؟

الجواب: يمكن أن تظهر ضعف في الجهاز المناعي والأعراض الجانبية عدة أشهر بعد اللقاحات. وتشمل الأعراض الدوائية، والحمى، والاختناق، والسعال، والمز الجلدي، والصداع. ومع ذلك، لا يوجد أي تأثيرات جانبية خطيرة جدًا المعروفة حتى الآن..

السؤال: هل هناك أي دراسات إضافية كشفت عن تأثيرات جانبية غير متوقعة؟

الجواب: هناك عدة دراسات استخدمت تقنيات التحليل الفائقة للدقة للكشف عن تأثيرات جانبية غير متوقعة. هذه الدراسات تشير إلى أن التأثيرات الجانبية قد تكون متفاوتة وتعتمد على نوع اللقاح ورقم الجرعة. كما أن هناك بعض الحالات النادرة قد تظهر تأثيرات جانبية خطيرة مثل أفضلية الجلدي أو التهابات العصب.

السؤال: يشير النص إلى أن الأطفال قد يعانون من ضعف في الجهاز المناعي. ما هو السبب الرئيسي له؟

الجواب: هناك العديد من السبب للضعف في الجهاز المناعي في الأطفال، بما في ذلك حالات تأكيدها في الجلدي وال kontakt بالفيروس. كما أن الأطفال الذين يعانون من حالات مثل التهاب التهاب الجهاز المناعي أو التهاب الأمعاء العصبي يمكن أن يكونوا أكثر عرضة للاضطهاد المناعي.

السؤال: هل هناك أي دراسات أظهرت تأثيرات جانبية خطيرة على الأطفال؟

الجواب: هناك عدة دراسات أظهرت تأثيرات جانبية خطيرة على الأطفال. مثل الستيرويدات التي تُستخدم لعلاج الأمراض الجلدية، والتي يمكن أن تسبب كبدًا خفيفًا أو كبدًا خطيرة.

السؤال: هل يمكن أن تحدث التأثيرات الجانبية الخطيرة في الأطفال؟

الجواب: يمكن أن تحدث التأثيرات الجانبية الخطيرة في الأطفال. ومع ذلك، فإنها نادرة ويتم تشخيصها بشكل جيد. يمكن أن تشمل الأمراض الجلدية، والبكتيريا، والفيروسات، والأمراض التي تسبب ضعف في الجهاز المناعي. كما أن هناك حالات نادرة قد تتطور إلى حالات خطيرة مثل التهاب الرئة البولي أو التهاب الرئة العصبي.

السؤال: ما هو الموقف الرسمي للأجهزة الصحية حول التأثيرات الجانبية الخطيرة؟

الجواب: في الغالب، الموقف الرسمي للأجهزة الصحية حول التأثيرات الجانبية الخطيرة هو أنه يمكن أن تحدث في بعض الحالات. ومع ذلك، فإنها نادرة ويتم تشخيصها بشكل جيد. يمكن أن تشمل الأمراض الجلدية، والبكتيريا، والفيروسات، والأمراض التي تسبب ضعف في الجهاز المناعي. كما أن هناك حالات نادرة قد تتطور إلى حالات خطيرة مثل التهاب الرئة البولي أو التهاب الرئة العصبي.
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