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Review Paper

Public attitudes and influencing factors toward COVID-19 vaccination for adolescents/children: a scoping review

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ARTICLE INFO

Article history:

Received 18 October 2021

Received in revised form

30 January 2022

Accepted 1 February 2022

Available online 9 February 2022

Keywords:

COVID-19

Vaccine

Adolescents

Children

Attitude

Scoping review

ABSTRACT

Objective: This study aimed to systematically clarify attitudes and influencing factors of the public toward COVID-19 vaccination for children or adolescents.**Study design:** This was a scoping review.**Methods:** This scoping review screened, included, sorted, and analyzed relevant studies on COVID-19 vaccination for children or adolescents before December 31, 2021, in databases, including PubMed, Elsevier, Web of Science, Cochrane Library, and Wiley.**Results:** A total of 34 studies were included. The results showed that the public's acceptance rate toward COVID-19 vaccination for children or adolescents ranged from 4.9% (southeast Nigerian mothers) to 91% (Brazilian parents). Parents' or adolescents' age, gender, education level, and cognition and behavior characteristics for the vaccines were the central factors affecting vaccination. The vaccine's safety, effectiveness, and potential side-effects were the main reasons affecting vaccination.**Conclusions:** Realizing current public attitudes of COVID-19 vaccination for adolescents or children can effectively develop intervention measures and control the pandemic as soon as possible through herd immunity.

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Introduction

The COVID-19¹ is a new strain of coronavirus called as a severe acute respiratory syndrome coronavirus (SARS-CoV-2) or COVID-19. COVID-19 was first discovered and wildly spread in Wuhan, China, in December 2019. So far, the global COVID-19 pandemic has been complex.² COVID-19 adapts to new human hosts and produces mutant individuals with different characteristics from their ancestral strains, such as Alpha (B.1.1.7), Delta (B.1.617.2), etc.³ These mutant individuals continue to cause damage and waves of pandemic around the world. All by August 2021,⁴ persistent COVID-19 pandemic has generated more than 4,500,000 deaths worldwide. Since the first pandemic spread, experts have always stressed the importance of personal protective measures (e.g. home quarantine, wear masks, and disinfecting).⁵ However, in essence, these physical protective measures cannot eliminate the virus and restore

people's everyday life. Similarly, it is also impossible for the public to abide by protective measures for many years.

Herd immunity^{6,7} is an important measure to control the pandemic situation as soon as possible from protecting susceptible individuals through a significant enough immune individual in the group. The COVID-19 vaccines' development and application may be the effective roads to curb the pandemic spread and then realize herd immunity.⁶ As we know, the Pfizer-BioNTech COVID-19 vaccine was emergently approved and put into use in the United States on December 11, 2020. After that, a variety of vaccines with reasonable safety and effectiveness (Oxford-AstraZeneca, Moderna's mRNA-1273, Sinovac's CoronaVac, etc.) displayed a fantastic speed of research and development. All by January 2022,⁸ nearly 134 vaccines remain in clinical development. Existing studies reported that the messenger RNA vaccine (specifically reference Pfizer-BioNTech COVID-19) showed excellent reliability to reach the global vaccine demand against COVID-19.⁹ Even so, we found that adults varied degrees of hesitation about the vaccine, and the acceptance rate ranged from 29.4% to 86% in COVID-19 vaccination studies over the past few months.¹⁰ The majority of people hesitated because of COVID-19 vaccines' safety

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and side-effects, which remains a principal problem for children. Today, lots of evidence about the vaccines' safety and effectiveness among children is provided, and Food and Drug Administration (FDA) urgently approved Pfizer-BioNTech COVID-19 vaccines for application among adolescents on May 10, 2021,¹¹ and among children aged 5–11 years on October 29, 2021.¹² Experts have repeatedly stressed that child protection remains the key to reducing infection rates. Once a vaccine is available, vaccinating young people and children is necessary.¹³ However, there was no high acceptance rate in Pan's¹⁴ report. Most parents were skeptical and unwilling to receive emergency-approved vaccines. With the continuous fermentation of COVID-19 pandemic, the pace of vaccine development has also increased, appearing the new progress in public willingness to vaccinate children.

Until now, COVID-19 vaccination remains essential for achieving herd immunization to reduce the pandemic burden.¹⁵ Vaccination hesitancy has been identified as a significant public health crisis. Whereas, we conducted a rapidly scoping review for the latest studies in recent months to clarify the public (including adults, parents, and adolescents themselves) attitudes and influencing factors toward COVID-19 vaccination for adolescents or children and provide information or advice for public institutions to better implement immunization plans. Considering the vaccines' rapid development and application, we mainly included studies after Pfizer-BioNTech COVID-19 vaccine first emergency approval among adults to present the latest views.

Methods

Protocol and registration

We conducted a scoping review according to PRISMA Extension for Scoping Reviews (PRISMA-ScR)¹⁶ (see [supplementary documents](#)). Furthermore, we preregistered on OSF Registries (osf.io/qw985). The study's questions are as follows:

- 1 What are the public attitudes toward COVID-19 vaccination for adolescents or children after COVID-19 vaccination approval among adults? Is there any difference between before and after approval COVID-19 vaccination for adolescents?
- 2 What are the influencing factors about COVID-19 vaccination for adolescents or children?

Information sources

We searched databases including PubMed, Wiley, Web of Science, Elsevier, and Cochrane Library to obtain relevant literature about the public attitudes toward COVID-19 vaccines for adolescents or children before December 31, 2021. Moreover, we searched the reference list of the included literature to find missed literature. The search strategy of Web of Science is as follows:

TS=((Corona OR "SARS-CoV-2" OR "COVID 19" OR 2019 nCov) AND (vaccine OR vaccination) AND (children OR kid OR teen OR juvenile OR teenagers OR adolescent OR youth) AND (hesitancy OR accept OR demand OR willingness OR antivaccine OR anti-vaccine OR reject OR rejection OR resistance OR refuse OR refusal))

Study selection

We imported retrieved literature into Endnote 9.1 and removed the duplicate; two researchers screened the title and abstract according to the principle of PICO (P: participants; I: intervention; C:

control; O: outcome; S: study design) and cross-checked. After initial screening, we downloaded full texts. Two researchers read full texts for rescreening, and the third researcher decided on conflicts.

Eligibility criteria

Included studies were produced since 2021, only in English. The study population consisted of adults aged >18 years, adolescents, children, and parents (grandparents and other guardians were defined as parents in this study). Articles with incomplete or incorrect content, repeated data studies, commentary studies, and letters to editors without data were excluded to improve the included literature's quality.

Data charting process

We extracted relevant data through Excel (Microsoft Corporation), including the study's first author, study setting, study time, country, recruitment, study population, sample size, children or adolescents' age, COVID-19 vaccination acceptance rate, and subjective reasons or related factors associated with vaccination.

Collate, summarize of results

According to the extracted content, study characteristics and influencing factors toward COVID-19 vaccines were presented in tables to clarify this scoping review's subject. In addition, the figures described influencing factors of high frequency.

Results

Selection of sources of evidence

According to the literature screening flowchart shown in [Fig 1](#), 34 studies were finally included. After removing the dropout and loss of follow-up caused by various reasons, 85,608 subjects (54,703 parents and adults, 30,905 adolescents) were left.

Study characteristics

All included studies described survey methods and outcome indicators in detail. [Table 1](#) shows the primary characteristics. There were 33 cross-sectional surveys and one cross-sectional survey combined with semistructured interviews.²⁴ Most studies were online surveys; only seven studies^{17,18,22,23,32,44,45} completed questionnaires by face-to-face or paper. All study populations were from one country; 15 of these studies^{17,22,23,29,33,35–38,40–44,50} were based on data from Asia, one¹⁸ from Africa, seven^{19,20,27,28,39,46,47} from North America, one³² from South America, seven^{21,26,30,31,34,45,48} from Europe, two^{24,49} from Oceania, and one²⁵ from the Eurasian continent.

In terms of study time, 20 studies^{31–50} were collected after commencing the national childhood COVID-19 vaccination program, and the data of adolescents came from these.^{44–50} The recruitment methods are briefly described as follows: five studies^{17,32,37,44,45} used convenient sampling, two studies^{20,39} included data from representative regions, two studies^{23,29} used purposive sampling, two studies^{27,28} used non-probability quota-based sampling, three studies^{19,35,38} used snowball sampling, four studies^{18,22,31,47} used random sampling, one study³⁶ was cluster

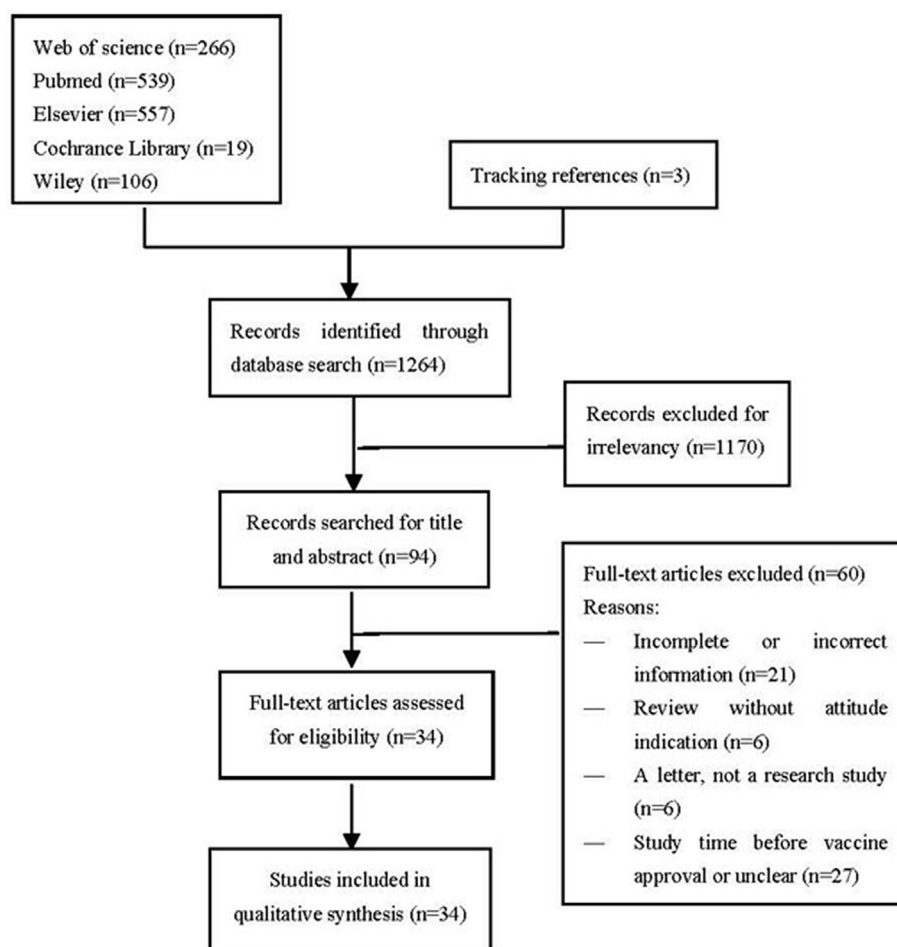


Fig. 1. Literature screening flowchart.

sampling, populations of five studies^{21,34,40,43,50} were from participant pool or other registered research centers/database, seven studies^{24–26,30,33,41,42} were recruited through online platforms (via Facebook, WhatsApp, mail, Wen-Juan-Xin, etc.) or visits, and three studies^{46,48,49} did not mention specific recruitment methods.

Public attitudes toward COVID-19 vaccination for adolescents or children

All studies reported the acceptance rate of vaccination for children in the study population. One study⁴⁴ reported parents' and adolescents' acceptance rates (we separately analyzed the data), and one study³¹ reported three child age levels' acceptance rates (we selected the median of the three for analysis). The acceptance rate ranged from 4.9% (southeast Nigerian mothers) to 91.0% (Brazilian parents), and the median acceptance rate was 53.70% (47.60%, 70.40%). As a reference, the median acceptance rate of 28 studies reported adults' or parents' attitudes was 60.20% (46.78%, 70.03%) and seven studies reported by adolescents was 50.40% (49.60%, 72.10%). At the same time, we analyzed the data before and after the commencement of the national adolescent's COVID-19 vaccination program. The median before the approval was 49.43% (43.55%, 60.78%), and the median after the approval was 64.20% (48.95%, 80.20%). Even if the data have high heterogeneity, it can provide a reference in this study.

Influencing factors toward COVID-19 vaccination for adolescents or children

According to the studies reported, we summarized and charted the influencing factors of acceptance and hesitation for COVID-19 vaccine among the study population, divided into related factors (single factors or multifactor statistical analysis; Table 2) and related reasons (qualitative data; Table 2). Meanwhile, we summarized high-frequency factors and reasons as shown in Figs. 2 and 3.

Sociodemographic or personal characteristics

Twenty-four studies depicted sociodemographic or personal characteristics in vaccination attitudes for adolescents or children (Table 2). Female,^{27,28,33,43,49} low household income,^{28,32,34,39,43,45,49} parents with lower educational level,^{21,28,32,34} and non-native^{27,39,40} were more likely to hesitate, whereas older parents^{17,30,38} and children^{38,47,48,50} were associated with vaccination acceptance. Similarly, parents who worked for health care were associated with vaccination for children,^{25,30,36,38} and freelance³⁴ or part-time jobs²⁰ parents were more hesitant about vaccination; Asian parents²⁸ and adolescents⁴⁷ were more likely to vaccination. In addition, other factors such as the number of children,^{32,36,37} children who attended in-person school or daycare,²⁷ and rural residence³⁶ were related factors affecting children's vaccination. Adolescents with remote, poor schools,

Table 1
Study characteristics.

First author	Study setting	Recruitment	Study time	Country	Study population	Sample size	Age of the child (year)	Acceptance rate
Bader A. Altulaihi ¹⁷	A cross-sectional, paper questionnaire	Convenience sampling	After adult approval	Saudi Arabia	Parents	333	≤18	53.70%
Awoere T. Chinawa ¹⁸	A cross-sectional, face-to-face survey	Simple random sampling in hospital	After adult approval	Southeast Nigeria	Mothers	577	Baby	4.90%
Kristine M. Ruggiero ¹⁹	A cross-sectional, online survey	Snowball sampling	November 2020 to January 2021	The United States	Parents	427	≤18	49.45%
Robin M. Humble ²⁰	A cross-sectional, online survey	Representatively sampling survey	December 10 to 24 2020	Canada	Parents	1702	0–17	63.10%
Marco Montalti ²¹	A cross-sectional, online survey	Personnel of the local public health service	December 2020 to January 2021	Italy	Parents	4993	≤18	60.40%
Xiao Wan ²²	A cross-sectional, paper questionnaire	Two-stage stratified random sampling	December 2020 to February 2021	Korea	Parents	468	3–6	86.75%
Haifa Aldakhil ²³	A cross-sectional, face-to-face survey	Non-probability purposive sampling	January to February 2021	Saudi Arabia	Mothers	270	≤7	43.77%
S. Evans ²⁴	A cross-sectional, online survey, and open interview	Via paid and unpaid social media advertisements	January to February 2021	Australia	Parents	1094	≤18	48.30%
Meltem Yilmaz ²⁵	A cross-sectional, online survey	Via Facebook, WhatsApp, and mail groups	February 2021	Turkey	Parents	1035	≤17	36.30%
Nuno Fernandes ²⁶	A cross-sectional, online survey	Institutional email and online social networks (e.g. Facebook)	January to March 2021	Portugal	Adults and parents	649	–	60.00%
Chloe A. Teasdale ²⁷	A cross-sectional, online survey	Non-probability quota-based sampling	March to April 2021	The United States	Parents	1119	4.7 (2.0, 8.5)	61.90%
Chloe A. Teasdale ²⁸	A cross-sectional, online survey	Non-probability quota-based sampling	March to April 2021	The United States	Parents	2074	≤12	49.40%
Takeshi Yoda ²⁹	A cross-sectional, online survey	Purposive sampling	April 2021	Japan	Parents	1100	0–15	42.90%
Mateusz Babicki ³⁰	A cross-sectional, online survey	Via Facebook.com social network, promoting and disseminated in groups	May 2021	Poland	Parents	4432	≤18	44.10%
Pierre Verger ³¹	A cross-sectional, online survey	Randomly selected	May 2021	France	Adults	2533	≤17	62.70% for adolescents ; 48.30% for school children ; 30.90% for preschoolers
Leonardo Evangelista Bagateli ³²	A cross-sectional, face-to-face survey	Convenient sampling in hospital	May to June 2021	Brazil	Parents	501	≤17	91.00%
Mei-Xian Zhang ³³	A cross-sectional, online survey	Wen-Juan-Xing platform without random	June 2021	China	Parents	1788	13.7 ± 3.2	46.50%
Stefano Zona ³⁴	A cross-sectional, online survey	The Crowd Signal platform	July to August 2021	Italy	Parents	1799	12–17	26.50%
Jian Wu ³⁵	A cross-sectional, online survey	Snowball sampling	August 2021	China	Parents or grandparents	16,133	3–18	82.61%
Yunyun Xu ³⁶	A cross-sectional, online survey	Cluster sampling	July to August 2021	China	Parents	917	–	68.90%
Mohammed Samannodi ³⁷	A cross-sectional, online survey	Convenience sampling	June to July 2021	Saudi Arabia	Parents	581	0–17	63.90%
Mohamad-Hani Temsah ³⁸	A cross-sectional, online survey	Snowball sampling	After adolescent approval	Saudi Arabia	Parents	3167	≤18	47.60%
Britt McKinnon ³⁹	A cross-sectional, online survey	Representatively sampling survey	May to June 2021	Canada	Parents	809	2–17	87.60%
Sarah Musa ⁴⁰	A cross-sectional, online survey	A database of adolescents	May to June 2021	Qatar	Parents	4023	13.4 ± 1.1	82.10%

Yulia Gendler ⁴¹	A cross-sectional, online survey	Via public Facebook pages of parents' groups	June 2021	Israel	Parents	520	12–15	70.40%
Konstadina Griva ⁴²	A cross-sectional, online survey	Via Facebook, WhatsApp and mail, social media posts, self-referral and by recruiting past participants	June to July 2021	Singapore	Parents	233	12–18	84.10%
Sayaka Horiuchi ⁴³	A cross-sectional, online survey	Registered Research Center	May to June 2021	Japan	Parents	1200	3–14	64.70%
Soo-Han Choi ⁴⁴	A cross-sectional, face-to-face survey	Convenient sampling	May to June 2021	Korea	Parents	226	≤18	64.20%
Mina Fazel ⁴⁵	A cross-sectional, paper questionnaire	General sampling in school	May to July 2021	England	Adolescents	117	10–18	49.60%
Don E. Willis ⁴⁶	A cross-sectional, online survey	—	May 2021	The United States	Adolescents	27,910	9–18	50.10%
Adam A. Rogers ⁴⁷	A cross-sectional, online survey	Stratified random sampling	June 2021	The United States	Adolescents	345	12–15	42.00%
Anna Zychlinsky Scharf ⁴⁸	A cross-sectional, online survey	—	May to June 2021	Germany	Adolescents	916	12–17	50.40%
Elke Humer ⁴⁹	A cross-sectional, online survey	—	June to July 2021	Austria	Adolescents	903	14.6 ± 2.3	78.30%
Ateret Gewirtz-Meydan ⁵⁰	A cross-sectional, online survey	Participants' pool	May to June 2021	Israel	Adolescents	564	16.34 ± 1.33	53.00%
						150	12–18	72.10%

smoking, and time in media⁴⁵ or television⁴⁶ were associated with vaccine hesitation.

Cognition and behavior characteristics for the vaccines

Twenty-five studies depicted the cognition and behavior characteristics for the vaccines in vaccination attitudes for adolescents or children (Table 2). Parents' willingness to get themselves vaccinated,^{20,29,30,33,35,38,41,44,47,50} positive or negative attitudes,^{17,23,25,26,35,36,41} history of taking influenza vaccine,^{17,19,20,30,35,41} impact of social vaccination programs,^{30,31,44} and high risk for their children to COVID-19^{18,22,30} were related factors affecting children's vaccination. Next, accessing information about COVID-19 vaccines from community workers³⁵ or the World Health Organization³⁸ were associated with vaccine acceptance and from web/social media²¹ or unofficial media⁴³ were associated with vaccine hesitation. The attention to COVID-19 vaccine-related information^{22,23,30,47} was also a related factor. In addition, compulsory vaccination policy,^{21,30} general favorability to vaccination,³¹ trusting doctors,^{24,35} and COVID-19's tested or infected histories^{40,44} affected willingness to vaccinate children.

Reasons associated with vaccination

Twenty-one articles reported reasons associated with COVID-19 vaccination for children, see Table 2 for details; the main reasons for acceptance or hesitancy are shown in Fig. 3.

We found that most of them were associated with the vaccine characteristics among relevant reasons. Most people accepted the vaccine because of its protective effects^{17,24,25,35} or they believed in the vaccines' safety and effectiveness.^{22,25,34,36} They were afraid that their children would be infected in the future,^{22,36} and they would spread the virus to people around them.²² Nevertheless, 17 articles pointed out that parents and adolescents were reluctant to vaccinate as they were worried about the vaccine's safety, effectiveness, and potential side-effects. Meanwhile, some people believed that children were at a low risk,^{27,28,35,39,40} and COVID-19 vaccine lacked sufficient information and evidence.^{17,24,25,37–39}

Moreover, a small number of people preferred to vaccinate as they followed medical advices^{21,34} or mandatory policies,^{21,37} the vaccines were provided free of charge,³⁵ insufficient supply,¹⁷ and they could contribute to national epidemic prevention and control.^{17,25} Equally, a small number of people were reluctant to vaccinate because of their personal beliefs^{21,27,28} or they had no time to vaccinate their children.¹⁷

Discussion

This scoping review updates 34 recent studies on the public attitudes toward COVID-19 vaccination for adolescents or children. We found that the public's willingness to vaccinate children was not high, and the median acceptance rate was 53.70%. This rate is lower than the 61.40% vaccination rate for parents.¹⁴ Snehota's systematic review⁵¹ mentioned that percentage of people's intention to vaccinate themselves was 75%, which is also much higher than this study's results. Meanwhile, the results showed that the vaccination willingness of different study populations remained different. The median vaccination rate for children among adults and parents was 60.20%, whereas the median acceptance rate among adolescents was 50.40% (in particular, these studies' time was after children's COVID-19 vaccination program). This may be because adolescents do not fully understand COVID-19 vaccine and did not experience adequate vaccination plans' publicity like parents. In addition, the results showed that the acceptance rate after approval for children's COVID-19 vaccination was higher than

Table 2

Attitudes and individual factors of COVID-19 vaccines vaccination among adolescents/children.

First author	Related factors	Related reasons	Acceptance/hesitancy
Bader A. Altulaihi ¹⁷	1. Parents aged between 31 and 40 years; 2. Children age group was 4–12; 3. Had a history of taking the seasonal influenza vaccine; 4. The scores of negative attitude scale. The scores of positive attitude scale	1. Highly effective in protecting their children from COVID-19; 2. Contributed to the control of COVID-19; 3. Adequate supply of COVID-19 vaccination. 1. Lack of information and evidence; 2. Severe side-effects; 3. The protection of COVID-19 vaccines will only last for a short time; 4. Child was afraid of vaccination; 5. Lack of time.	Acceptance Hesitancy
Awoere T. Chinawa ¹⁸	1. Believed they could be infected with the COVID-19; 2. Aware of someone that died from COVID-19.	—	Acceptance
Kristine M. Ruggiero ¹⁹ Robin M. Humble ²⁰	Already or planned to vaccinate their child against influenza this season 1. Parents employed part-time; 2. Parents who spoke English; 3. Children did not receive the influenza vaccine prepandemic; 4. Parents had low intention to vaccinate themselves; 5. Lacked confidence in the safety of COVID-19 vaccines; 6. If vaccines had not yet been tested in children.	Vaccine side-effects and safety —	Hesitancy Acceptance
Marco Montalti ²¹	1. Children aged 6–10 years old; 2. Parents aged ≤29 years, with low educational level; 3. Rely on information found in the Web/social media; 4. Dislike mandatory vaccination policies.	1. Rely on medical advice; 2. Mandatory vaccination policies.	Acceptance
Xiao Wan ²²	— 1. Female parents; 2. High risk for their children to COVID-19; 3. Often pay attention to the COVID-19 vaccine—related information; 4. Believed in the safety of the COVID-19 vaccine; 5. Thought the COVID-19 vaccine could prevent COVID-19.	Followed personal beliefs, Web/social media, or celebrities 1. Worried about their children being infected in the future; 2. Spreading the virus to people around them; 3. Quarantined after being infected; 4. Believed in the safety and effectiveness of vaccines.	Hesitancy Acceptance
Haifa Aldakhil ²³	— 1. Not know where to get vaccination; 2. Not know where to access good/reliable information; 3. Not think vaccine was effective and necessary; 4. Not think the vaccine was safe or concerned about side-effects; 5. Someone else told their child had a bad reaction and was not safe; 6. Heard or read negative media associated with vaccine hesitancy toward childhood immunizations.	1. Vaccine side-effects, safety, and effectiveness; 2. Had contraindication to vaccination. —	Hesitancy Hesitancy
S. Evans ²⁴	— Lower trust in doctors	To parent is to protect, for children have health issues 1. Vaccine risks were higher and benefits are lower; 2. To parent is to protect, for child's ill health would be further compromised; 3. Unclear advice.	Acceptance Hesitancy
Meltem Yilmaz ²⁵	1. Parents are healthcare workers; 2. Parents' willingness to receive the vaccine and positive attitudes (participate in the COVID-19 vaccine trial, participate in the COVID-19 vaccine trial, etc.). —	1. Need for COVID-19 control; 2. The benefits of the COVID-19 vaccine outweighing its potential harm; 3. To protect their own families and others. 1. Lack of sufficient scientific studies; 2. Concerned about safety and side-effects; 3. Potential inefficacy of the vaccine due to mutations.	Acceptance Hesitancy
Nuno Fernandes ²⁶	Positive beliefs and attitudes toward the vaccine —	— Possible adverse side-effects effectiveness of the vaccine	Acceptance Hesitancy
Chloe A. Teasdale ²⁷	Children attend in-person school or daycare 1. Female parents; 2. Non-Hispanic Black parents.	— 1. Safety and effectiveness of COVID-19 vaccination; 2. Children are at low risk; 3. Medical; 4. Religious or philosophical reasons.	Acceptance Hesitancy
Chloe A. Teasdale ²⁸	Asian parents	—	Acceptance Hesitancy

Takeshi Yoda ²⁹	1. Female parents; 2. lower education; 3. Household income \$25,000. Parents' willingness to get themselves vaccinated —	1. Potential safety and effectiveness; 2. Children are at low risk; 3. Religious or medical reasons. — Vaccine side-effects, vaccine safety, and effectiveness —	Acceptance Hesitancy Acceptance
Mateusz Babicki ³⁰	1. Female parents; 2. Older parents; 3. Parents are healthcare workers; 4. Parents vaccinated themselves against COVID-19; 5. Mandatory vaccinations; 6. History of vaccinations in child; 7. COVID-19 vaccination campaign for children; 8. Assessment of COVID-19 severity and the risk among children. 1. COVID-19 vaccination was unsafe for children; 2. The same applies to the number of concerns.	1. Concerned about complications that may arise in the future; 2. The effectiveness of the preparation used. —	Hesitancy Acceptance
Pierre Verger ³¹	1. Trust in institutions, sensitivity to social pressure, and general favorability to vaccination (for adolescents); 2. Low perception of the risks of COVID-19 vaccines, general favorability to vaccination, and sensitivity to social pressure (for school children); 3. General favorability to vaccination, fear of contracting COVID-19, and trust in institutions (for preschoolers).		
Leonardo Evangelista Bagateli ³²	1. Parents' young age; 2. ≥ 2 children in the house; 3. Lower educational level; 4. Low household income.	Serious side-effects and safety of the vaccines	Hesitancy
Mei-Xian Zhang ³³	1. Female parents; 2. Younger child; 3. Lower scores of knowledge about COVID-19 vaccination; 4. Lower awareness of the permission of vaccinating children; 5. Hesitancy to inoculate themselves. —	—	Hesitancy
Stefano Zona ³⁴	—	1. Confidence on safety and efficacy of pediatric vaccines; 2. Confidence in health institutions. —	Acceptance Hesitancy
Jian Wu ³⁵	1. Parents aged ≤ 40 years; 2. Parents with a secondary school or three-year degree; 3. Parents are freelancers; 4. Family income $< €28,000$; 5. An erroneous perception of the risk of COVID-19 as the disease. 1. Married; 2. Total family income last year between 9 and 14 ten thousand; 3. Rejected to Category 1 vaccines; 4. Accessed information about the COVID-19 vaccines from community workers; 5. Low COVID-19 vaccine conspiracy; 6. Guardian's vaccination behavior; 7. The importance of vaccinating teenagers. 1. Worried about the safety of general vaccines; 2. Low trust in doctors; 3. Vaccine developers.	1. Prevention of COVID-19; 2. Vaccines free of charge.	Acceptance
Yunyun Xu ³⁶	In Shandong: 1. Female parents; 2. ≥ 2 children raised. In Zhejiang: 1. Rural residence; 2. ≥ 2 children raised. In Shandong: 1. Yearly household incomes $\geq 120,000$ RMB; 2. Parents were medical workers; 3. General attitudes of Parental Attitudes toward Childhood Vaccines (PACV). In Zhejiang: 1. Behavior; 2. Safety and efficacy; 3. General attitudes of PACV. — ≥ 5 children raised	1. Teenagers' young age; 2. Worried about the safety of vaccines; 3. Believed that the risk of infection was low. 1. If the vaccine was proven to be safe; 2. A low risk of side-effects; 3. For reducing the risk of COVID-19 infection. Vaccine side-effects, unknown effects, and effectiveness	Hesitancy Acceptance Hesitancy
Mohammed Samannodi ³⁷	—	1. Adequate information about vaccines; 2. Compulsory vaccination. 1. Poor awareness about the effectiveness of the vaccine on children;	Acceptance Hesitancy

(continued on next page)

Table 2 (continued)

First author	Related factors	Related reasons	Acceptance/hesitancy
Mohamad-Hani Temsah ³⁸	1. Parents received the COVID-19 vaccine themselves; 2. Kids were aged 12–18 years; 3. Older parents; 4. Had an educational level of high school or less; 5. Native; 6. Relied on the Saudi MOH website information.	2. Vaccine approval process was fast, so the safety of the vaccine was not assessed adequately; 3. Heard that blood clots were a common side-effect of the vaccine. —	Acceptance
Britt McKinnon ³⁹	1. Parental COVID-19 hesitancy; 2. Parents are healthcare workers; 3. Parents were hesitant about the COVID-19 vaccine. 1. Annual household income <\$100,000; 2. Non-nationals; 3. Racialized parents.	1. Inadequate safety information; 2. Worried about side-effects. 1. Lack of information about the vaccine safety and potential side-effects; 2. Believed that their child would not get seriously ill from COVID-19.	Hesitancy Hesitancy
Sarah Musa ⁴⁰	1. Younger children; 2. Non-nationals; 3. Previously COVID-19 infected.	—	Hesitancy
Yulia Gendler ⁴¹	1. COVID-19 vaccination status of the participants; 2. Higher mean levels of vaccine literacy; 3. More positive perception of the vaccine; 4. Lower perceived vaccine hesitancy.	—	Acceptance
Konstadina Griva ⁴²	1. Male parents; 2. Individuals with lower risk perception of COVID-19; 3. Lower perceived benefits of the vaccines; 4. Higher vaccination concerns and perceptions of higher personal necessity for the COVID-19 vaccine.	—	Hesitancy
Sayaka Horiuchi ⁴³	1. Trusted in sources of COVID-19 related information other than government/public organization or public news media; 2. Female gender either of parent or child; 3. Parents aged <34 years; 4. Lower household income; 5. Parents are unemployed; 6. Lower perceived risk of infection; 7. Younger children; 8. Mothers with lower satisfaction to social relationships.	COVID-19 vaccines adverse reaction and safety	Hesitancy
Soo-Han Choi ⁴⁴	1. High confidence of COVID-19 vaccines safety; 2. Parents' willingness to vaccinate themselves; 3. Awareness of the need for children's COVID-19 vaccination. History of tested for COVID-19 in themselves or family members	—	Acceptance
Mina Fazel ^{45*}	1. From deprived socio-economic contexts; 2. Higher rates of home rental vs. homeownership; 3. School locations were more likely to be in areas of greater deprivation; 4. Smoke or vape; 5. Spent longer on social media; 6. Felt that they did not belong in their school community; 7. Lower levels of anxiety and depression.	—	Hesitancy Hesitancy
Don E. Willis ^{46*}	Spent more hours of TV watched during school days	—	Hesitancy
Adam A. Rogers ^{47*}	1. Older adolescents; 2. More education; 3. Higher income; 4. Asian American and Latinx youth; 5. More COVID-19-related anxiety; 6. High vaccine-related concerns; 7. Parent and peer vaccination norms.	—	Acceptance

Anna Zychlinsky Scharff ^{48*}	Concerned about the safety and efficacy of the vaccine	Vaccine's perceived safety	Hesitancy
Elke Humel ^{49*}	1. Older adolescents; 2. Parents or guardians with no college educated; 1. Migration background; 2. Female adolescents.	—	Acceptance
Ateret Gewirtz-Meydan ^{50*}	1. Older adolescents; 2. Had both parents vaccinated; 3. Social media use. Higher distress over the effects of the vaccine	—	Hesitancy
		1. Not know enough about the harms that a vaccine has in the long run; 2. Not trust the drug companies that the vaccine will be safe; 3. Believed the virus is not dangerous; 4. Doubt the safety of the vaccine in the short term.	Acceptance

*Influencing factors for adolescent population; the rests are adults or parents.

before (64.20% vs. 49.43%). This shows the official vaccination programs' influence on the public, and the public attitudes toward vaccination will also change over time. Even if vaccination for adolescents was approved, the results about vaccination intention remained not high. A low COVID-19 vaccination rate cannot satisfy the herd immunity criteria, which may prolong the pandemic. In the later stage, providing multiparty publicity or intervention measures is the key to improving vaccination.

Clarifying factors affecting vaccination intention is the key to improving children's vaccination coverage. Thirty-four studies reported the influencing factors or reasons associated with vaccination intention. These results may play a specific role in developing immunization plans and controlling COVID-19 pandemic.

In sociodemographic characteristics' factors of the high frequency, parents' and adolescents' age, gender, and education level were related factors affecting vaccination and hesitant vaccination. Nehal's research⁵² also mentioned the three. Older adolescents or parents were associated with receiving vaccines. Whereas, we can formulate publicity strategies according to the vaccinated objects' age, such as increasing publicity frequency for younger people and strengthening health education for parents with lower grade children. Next, females were also an important factor in receiving and hesitating vaccination. Due to the critical position of women in decision-making on children's vaccination, we should consider them in the development of the vaccine promotion strategies.⁵³ Moreover, parents with low educational levels were associated with hesitation to vaccinate, and these populations also need to be considered when formulating vaccination plans. We can improve their understanding through the internet, television, other media, and home visits by community service center staffs.⁵⁴

Parents' willingness to get themselves vaccinated was the most common factor affecting acceptance and hesitancy for the vaccine's cognition and behavior characteristics. People with negative attitudes or low confidence in vaccines also caused vaccine hesitation. Healthcare centers should improve the cognition, behavior, and attitudes of vaccinated people and carry out regular public education activities to effectively improve the acceptance rate of vaccines.⁵⁵ In addition, taking the influenza vaccines' histories was relevant in accepting the vaccine. Parents who have previously vaccinated adolescents with influenza had a higher acceptance of the vaccine, providing us with relevant experience. We also could identify and implement multilevel strategies about COVID-19 relying on influenza's experience to maximize COVID-19 vaccination rates.⁵⁶ Second, among the reasons for qualitative data, parents or adolescents accepted vaccines because they relied on medical advice and considered that it could contribute to control of COVID-19. However, there are many ways to get medical advice. Especially in the age of information explosion, it is difficult for people to distinguish obtained information's accuracy and timeliness. Therefore, the official departments and media should strengthen the publicity to ensure that adolescents and parents get correct and adequate information about COVID-19 vaccination.^{54,57} Another result was people's cognition and understanding of childhood vaccination. Some refused vaccination because they deemed children were at low risk, and others accepted for fear of infection among their children. According to current studies, the advantages of COVID-19 vaccine outweighed the disadvantages. Therefore, improving parents' knowledge and cognitive ability is also necessary to enhance vaccination rate.⁵⁸ Next, the pandemic risk rate in the study area was also the basis for parents' choice, which we should consider in promoting vaccines. Different vaccination rates should be planned for different strategies and strive for full coverage. Moreover, some people refused vaccination because of their personal beliefs, whereas relevant departments can seek help from religious or ethnic institutions to reduce the conspiracy

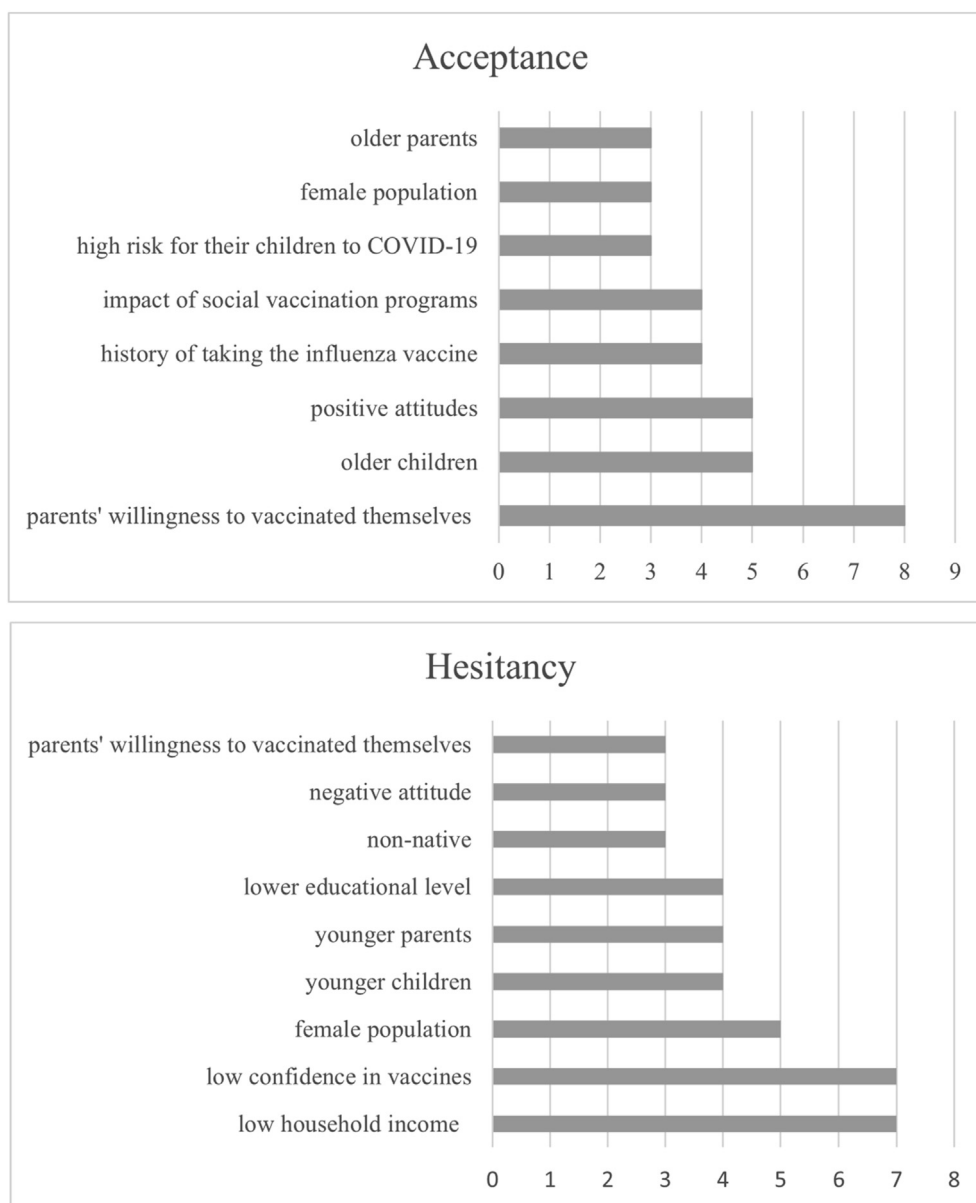


Fig. 2. Factors associated with the vaccine acceptance and hesitation.

theories spread and implement the immunization plans as far as possible on-premise of respecting beliefs.⁵⁹

Vaccine characteristics were essential factors affecting parents' or adolescents' attitudes among the vaccination reasons. One of the characteristics that people were concerned about the most was COVID-19 vaccines' safety and efficacy. There has been sufficient evidence about the vaccines' development and application in the population. Nevertheless, most hesitant people mentioned the lack of evidence. In addition to the inconvenience of personal communication, healthcare departments should increase publicity and follow-up of COVID-19 vaccine knowledge to ensure that parents and adolescents have adequate and correct access to information, including advertisements on "we media" and streaming media.⁵⁴ Similarly, although some people were encouraged to receive COVID-19 vaccine through compulsory and free policies, most people hesitated to get the vaccine because of side-effects. However, most reported adverse events in children were mild and

transient, and <1% of children needed medical care.⁶⁰ Hence, it is imperative to make adolescents and parents trust healthcare centers and increase their vaccines' recognition to improve the vaccination rate.⁶¹

Limitations

Based on this, we summarized and sorted out published studies. Although our results reported the global data, there may be insufficient inclusion and loss of data as languages are all in English. Second, almost all studies included were cross-sectional surveys, which cannot track and update the public opinions and lead to limitations in our inference. Moreover, some studies did not detail specific situations for children of different ages. Still, they contained infants' and young children's data, which may impact results. Future research could focus more on COVID-19 vaccines'

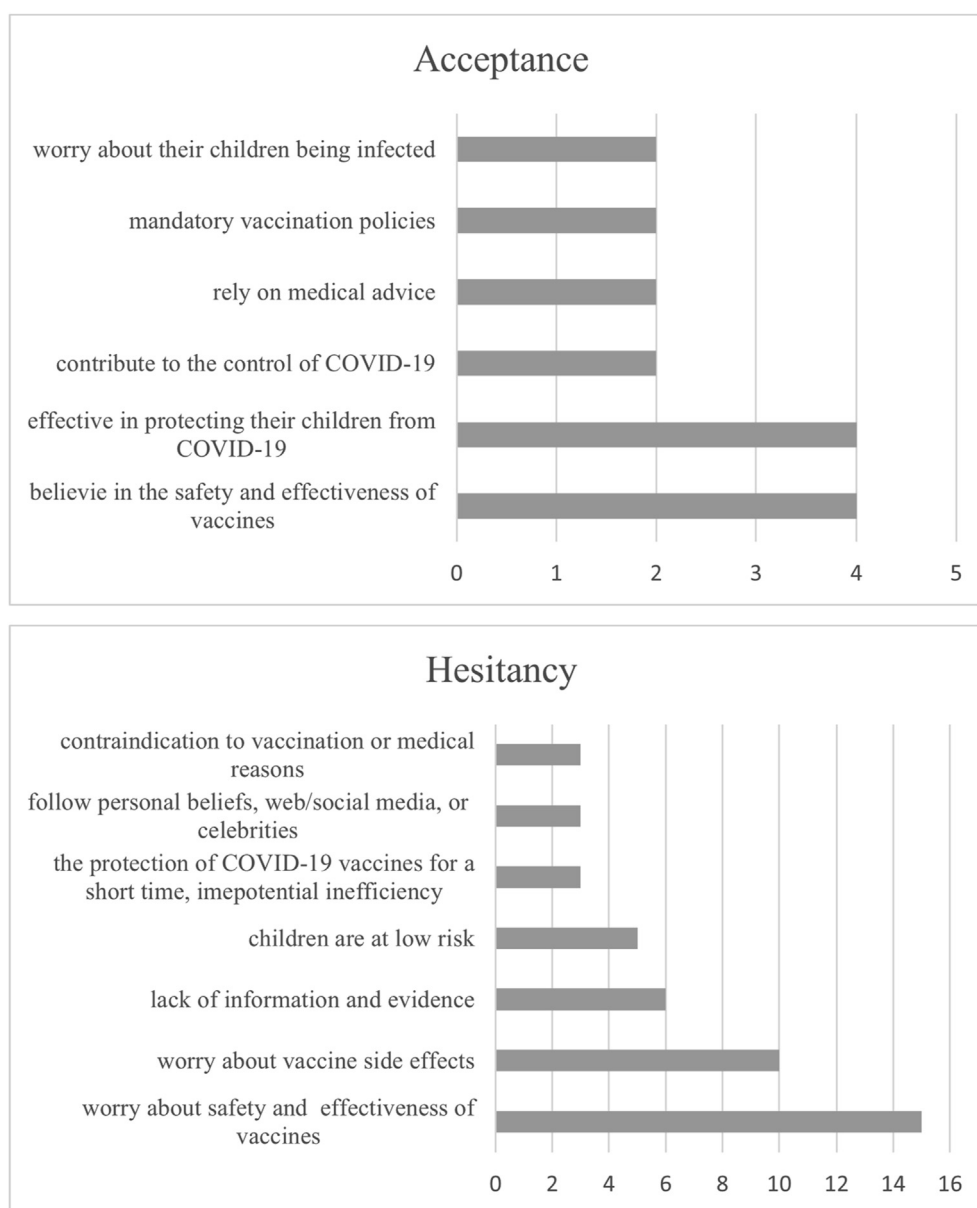


Fig. 3. Reasons associated with the vaccine acceptance and hesitation.

development and application in special crowds to improve produced vaccines' utilization rate.

Conclusions

The above stated the acceptance rate and influencing factors toward COVID-19 vaccination for children or adolescents among adults, parents, and adolescents. The survey data showed that people's willingness to vaccinate children was weak. At the same time, the vaccine's cognition, behavior, and vaccine characteristics were the central influencing factors. Thus, the government should base on scientific data and fully consider individual experiences during the vaccine promotion.⁶² The specific situations shall be analyzed and improved according to local and individual conditions. In the future, we can mobilize multiple sectors (healthcare centers, communities, schools, etc.) to improve vaccination rates by

providing multilevel interventions for children and parents, controlling COVID-19 pandemic's development as soon as possible, and returning to everyday life.

Author statements

Ethical approval

None sought.

Funding

This research received support from the Education Department of Hunan Province (No.19A419).

Competing interests

None declared.

Informed consent statement

Not applicable.

Data availability

The author confirms that all data generated or analyzed during this study are included in this published article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2022.02.002>.

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