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REVIEW

Impact of COVID-19 pandemic on influenza vaccination rates among healthcare workers and the general population in Saudi Arabia: A meta-analysis

Salah Alshagrawi and Ahmed Hazazi

College of Health Sciences, Department of Public Health, Saudi Electronic University, Riyadh, Saudi Arabia

ABSTRACT
We aim to identify how the seasonal IVRs have been impacted by the COVID-19 pandemic in Saudi Arabia. We conducted a meta-analysis of cross-sectional studies to statistically examine IVRs before and after the COVID-19 pandemic among the general population and HCWs in Saudi Arabia. The meta-regression analysis showed a significant correlation among the general population was observed between the IVR and the timing of the study, with a mean effect size estimate of 14.3 (95% CI = 5.7–22.9; $p < .001$). Among HCWs, no significant relationship was observed between the IVR and the timing of the study, with a mean effect size estimate of 6.7 (95% CI = −19.3–32.7; $p = .5$). COVID-19 might have contributed to a rise in IVR among HCWs, whereas the general population has seen a decline in IVR.

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Introduction

According to the World Health Organization (WHO), the influenza virus leads to 3 to 5 million episodes of severe illness and contributes to 290,000 to 650,000 fatalities linked to respiratory diseases worldwide.[1] Such high mortality and morbidity rates have a significant influence not only on the health of the general population but on the economy as well.[2] Influenza-related indirect expenses were 88% of the total economic impact of flu in the 18–64 age range, whereas 75% of the direct expenses of influenza-related expenses were associated with being hospitalized. Moreover, the expenses linked to influenza rise as individuals become older and if they have preexisting medical conditions within the age range of 18–64.[3]

The annual influenza vaccine is widely recognized as an effective preventive measure against the disease, particularly among healthcare workers (HCWs) and the general population.[4] A systematic review of randomized controlled trials has provided data showing that inactivated flu vaccines given to people in good health are capable of preventing 59% of laboratory-confirmed incidents of influenza. Additionally, when the vaccine strains roughly correspond to the variants of the flu virus that are spreading, it has been demonstrated that they minimize the occurrence of influenza-like symptoms by 42%.[5] To maintain the health of the whole population and limit the transmission of influenza, the WHO recommended governments enhance the reach of flu vaccination programs and prioritize their implementation. More than 40 countries and territories globally have implemented this recommendation. Nevertheless, there were notable disparities in immunization coverage across different countries.[6]

Due to the concurrent existence of SARS-CoV-2, a strain of coronavirus that causes COVID-19, and influenza virus through the 2020/21 season, it is critical to understand the impact of the COVID-19 pandemic on the influenza vaccination rate (IVR). In comparison to earlier seasons, various studies indicate that IVR has notably risen in the 2020/21 season among HCWs as well as the general population.[7] This implies individuals are demonstrating a more adhering attitude toward being vaccinated for influenza during the pandemic.[8–11] Additional evidence for this increase in compliance has been observed in the WHO report, which documented a rise in vaccination coverage throughout the 2020/21 period.[12] Additionally, the same pattern has been documented in other groups at increased risk, such as older people, individuals suffering from chronic conditions, and HCWs,[13–15] in addition to the general population.[16] However, this trend of increasing IVR after the pandemic has been contradicted by other studies.[17] Thus, this study aims to find out how the IVR has been impacted by the COVID-19 pandemic in Saudi Arabia. In order to achieve this objective, we conducted a meta-analysis of the published literature to statistically examine and compare vaccination rates before and after the COVID-19 pandemic among the general population and HCWs in Saudi Arabia.

Methods

The meta-analysis process was developed in accordance with the Preferred Reporting Items for Meta-Analysis (PRISMA) checklist.[18] The review question has been methodically formulated using the Population, Intervention, Comparison, and Outcome (PICO) framework. The question aimed to determine whether the COVID-19 pandemic has an impact on IVR among Saudi Arabian HCWs and the general population. The review question was: What was the impact of how the IVR has been impacted by the COVID-19 pandemic on IVR among the general population and HCWs in Saudi Arabia? To address this question, we conducted a meta-analysis study that included cross-sectional

CONTACT Salah Alshagrawi sshagrawi@gmail.com College of Health Sciences, Department of Public Health, Saudi Electronic University, Abi Bakr As Siddiq Rd, Ar Rabi, Riyadh 13316, Saudi Arabia.

peer-reviewed articles that reported seasonal IVR among HCWs or the general population in Saudi Arabia.

Study population: the study population consisted of the general population who are adults aged 18. We also included studies that involve HCWs.

Outcome measures: The primary outcome of concern was the seasonal IVR, which is characterized as the percentage of those who were vaccinated within the total defined population.

Inclusion criteria

(1) Studies had to fulfill the following requirements to be considered for inclusion in this meta-analysis:
(2) Studies describing the IVR among the adult general population or HCWs in Saudi Arabia.
(3) The study population involved the adult general population (18 years old and above) or HCWs in Saudi Arabia.
(4) Studies included detailed data on sample size and vaccination rates.
(5) The study design was cross-sectional.

Exclusion criteria

The criteria outlined below were employed to exclude studies from this meta-analysis:

(1) Studies about influenza vaccine variants outside seasonal influenza vaccinations.
(2) Studies that included pregnant women were excluded.
(3) Studies that failed to provide essential data, including sample size, vaccination rates, and the count of vaccinated persons, or those that did not identify the vaccination year or only provided aggregated vaccination rates over many years.
(4) Duplicate publications, where the same study is published in several different sources.

Literature search strategy

Systematic searches were conducted across many databases, including PubMed, EMBASE, Scopus, CINAHL, and ISI Web of Science. The objective of the search was to identify cross-sectional studies that documented the seasonal IVRs among the general population or HCWs. The search process was performed to locate eligible papers published from the beginning of January 2000 in each database until September 26, 2024. The search method included a selection of subject terms and free-text terms. Search terms like "Influenza Vaccine*," "Flu Vaccine*," "Influenza Virus Vaccine*," "Universal Influenza Vaccine*," "Universal Flu Vaccine*," "Immunization Coverage*" and "Vaccination Coverage*" were utilized. This thorough search strategy was developed to identify pertinent studies and compile an extensive list of literature regarding seasonal IVR in the general population and HCWs.

Literature screening and data extraction

We imported the identified literature into Endnote, a program for managing literature, and we deleted duplicate studies. In performing the eligibility assessment and data extraction, two researchers, consisting of the author and a senior research assistant, conducted an independent screening of the literature and carried out data extraction. In cases of disagreement, the two researchers discuss the difference of opinion to achieve a consensus. If the disagreement persists, a third senior researcher is to be engaged in deliberation and to achieve a consensus. Nonetheless, no disagreements have arisen between the two researchers.

The title and abstract of each publication were first examined to exclude irrelevant research. The whole text of the remaining papers was meticulously scrutinized to assess whether they were qualified for consideration in the meta-analysis. Data extraction included many critical elements, such as the first author's name, publication year, survey location, research population, vaccination period, sample size, number of vaccinated persons, and pertinent data. The meticulous screening and data extraction method guaranteed the obtaining of relevant and credible material from the selected studies for further analysis.

The primary outcome was the IVR in the years preceding and following the COVID-19 pandemic. Secondary outcomes were related to subgroup analyses of the primary outcome by population, the period before vs. after the COVID-19 pandemic. The age, gender, occupation, and location of the study were not included as secondary outcomes since not all studies have reported such measures. The study does not involve human participants thus ethical approval does not apply to the study.

Evaluation of quality in included studies

A comprehensive evaluation of the methodological quality of the cross-sectional studies was facilitated by a systematic examination. This assessment facilitated the identification of possible biases that may have affected the research outcomes and assured the findings' trustworthiness. A checklist based on suggested standards was implemented to evaluate the cross-sectional research's methodological quality. This checklist included the items from the Newcastle-Ottawa Scale (NOS), a cross-sectional research quality assessment instrument.[19] The list comprised 7 essential items designed to assess the potential biases present in the included studies. The following items were included:

(1) Representativeness of the cases (maximum 2 points).
(2) Sample size (maximum 1 point).
(3) Non-Response rate (maximum 1 point).
(4) Ascertainment of the screening/surveillance tool (maximum 2 points).
(5) The potential confounders were investigated by subgroup analysis or multivariable analysis (maximum 1 point).
(6) Assessment of the outcome (maximum 2 points).
(7) Whether the statistical test used to analyze the data is appropriate and was clearly described (maximum 1 point).

Two researchers evaluated the risk of bias for each study independently; any discrepancies were noted and addressed through consensus. The scores have been allocated as follows: Very Good Studies: 9–10 points Good Studies: 7–8 points Satisfactory Studies: 5–6 points Unsatisfactory Studies: 0 to 4 points.

Data analysis

The data extraction and analysis were performed using Excel 2021 and SPSS software. Two researchers evaluated the results of the extracted data; the synthesized data was then reviewed by both reviewers and any discrepancies were discussed to reach an agreement. Egger's test and funnel plot were employed to evaluate publication bias. A significance level of 0.05 or less was deemed statistically significant. A random-effects model was used for the study due to the expected heterogeneity. A sensitivity analysis was performed to evaluate the robustness and reliability of the overall vaccination rate estimate. Furthermore, subgroup analysis was conducted to investigate possible causes of heterogeneity.

Results

Identification of relevant studies

The flowchart, developed following PRISMA guidelines[18] (Figure 1), illustrates the article selection procedure. A thorough search of relevant articles yielded a total of 1789 entries. A total of 306 articles were found in PubMed, 252 in CINAHL, 724 in EMBASE, 405 in Scopus, and 102 in ISI Web of Science, according to the established inclusion criteria. Following the removal of duplicate articles from the two databases, a total of 1091 studies were deemed eligible. Of these, 785 were removed for failing to assess influenza vaccination rates, 249 had alternative research designs, 21 did not disclose vaccination rates, and 5 were not in English. As a result, 31 studies were

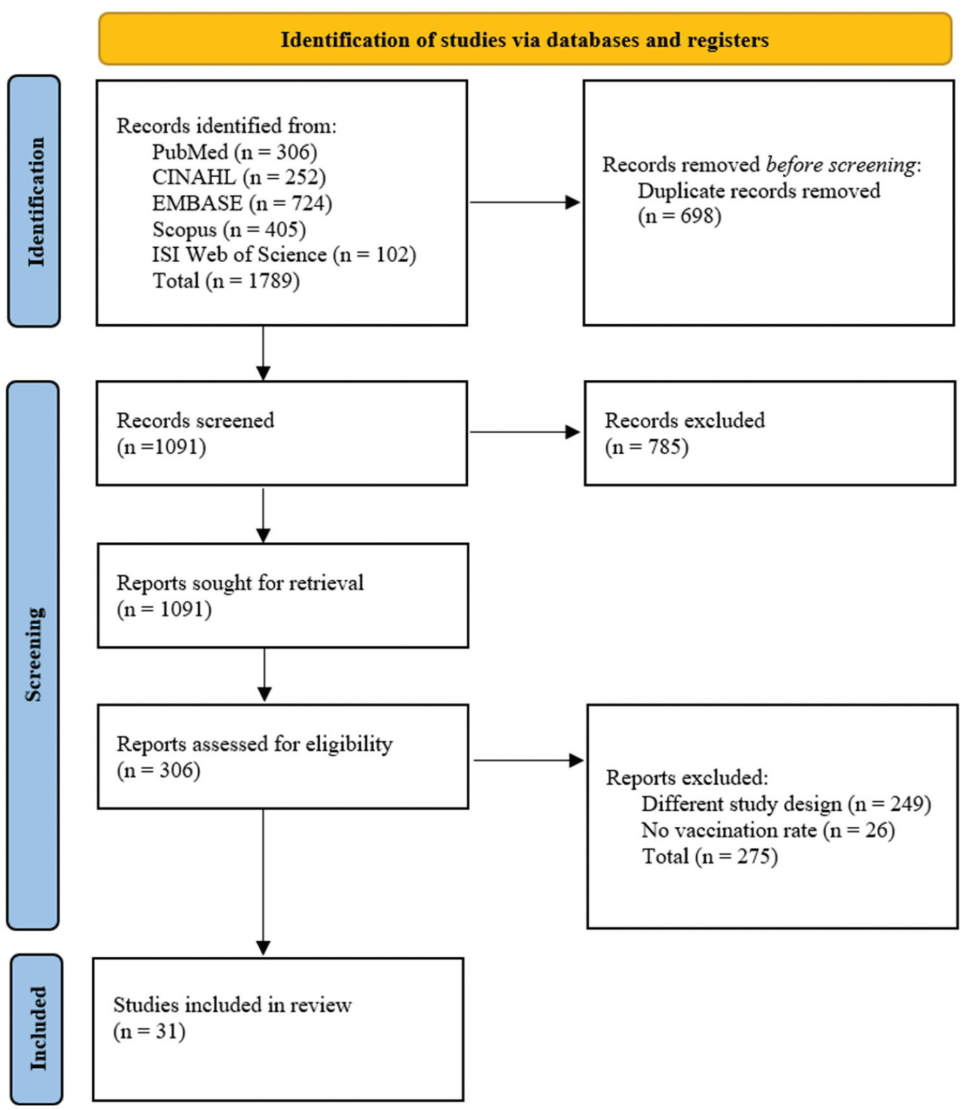

Figure 1. PRISMA flow diagram of the studies selection process.

Table 1. Characteristics of the selected articles ($n = 31$).

ID	Study	Study Population	Study Region	Vaccination time	Age	Female	Sample size	Flu Vaccine Uptake last year	Quality score
1	Aljamili[20]	General Population	Riyadh	Before COVID-19	18–30 years (45.4%) 30–45 years (30.5%) 45–60 years (22%) >60 years (2.2%)	75	778	55	8
2	Alzeer et al.[21]	General Population	Riyadh	After COVID-19	Mean=36.9 years (SD=13.8)	45	317	50	8
3	Haridi et al.[22]	HCWs	Makkah	Before COVID-19	NA	NA	447	54.5	9
4	Alqahtania et al.[23]	General Population	Taif	Before COVID-19	NA	43	1298	44.5	8
5	Abalkhail et al.[24]	General Population	Riyadh	Before COVID-19	Mean= 22.1 years (SD = 1.2)	30	421	57.24	9
6	AlMasoud et al.[25]	General Population	different regions	Before COVID-19	18–21 years (28.7%) 21–30 years (42.3%) 31–40 years (15.5%) 41–50 years (8.5%) >50 years (4.9%)	74	1018	35.6	8
7	Barry et al.[26]	General Population	Riyadh	Before COVID-19	18–36 years (43.4%) >36 years (57.6%)	64	503	44.3	8
8	Mojamamy et al.[27]	HCWs	Jazan	Before COVID-19	18–34 years (41.5%) 35–44 years (20.4%) >45 years (38.1%)	60	368	79	8
9	Alhawsawi et al.[28]	General Population	Riyadh	Before COVID-19	18–20 years (27.8%) 20–22 years (45.5%) >22 years (26.75%)	100	385	56.8	8
10	Al Hassan et al.[29]	General Population	Al Ahsa	Before COVID-19	18–27 years (17.9%) 28–37 years (45.6%) >38 years (36.5%)	53	1377	44.1	9
11	Almotairy et al.[30]	General Population	AlMadinah	Before COVID-19	Mean= 37 years (SD = 12.5)	35	381	58.3	8
12	Al-Tawfi et al.[31]	HCWs	Dammam	Before COVID-19	NA	NA	244	41	7
13	Alsuhaibani[32]	HCWs	Al-Qassim	After COVID-19	18–30 years (37.5%) 30–39 years (40.0%) ≥40 years (22.5%)	54	523	48.6	9
14	Mohamad et al.[33]	General Population	Tabuk	After COVID-19	Mean=34.3 years (SD=9.8)	34	623	45	9
15	Alshammari et al.[34]	HCWs	Riyadh	Before COVID-19	NA	NA	242	39	8
16	Sales et al.[35]	General Population	Different regions	Before COVID-19	18–24 years (57%) 24–33 years (30%) 34–51 years (10%) 52–64 years (3%)	69	790	12.65	8
17	Alhatim et al.[36]	General Population	Riyadh	After COVID-19	Mean=36.2 years (SD=2.1)	37	611	43.7	9
18	Alharbi et al.[37]	HCWs	Qassim	After COVID-19	18–30 years (42.8%) 31–45 years (42.8%) > 45 years (14.4)	58	327	33.3	8
19	Rehmani et al.[38]	HCWs	Al-Ahsa	Before COVID-19	Mean=35.8 years (SD=8.9)	60	512	34.4	8
20	Abushouk et al.[39]	General Population	Jeddah	After COVID-19	NA	32	336	30.7	8
21	Alfalogy et al.[40]	General Population	Makkah	After COVID-19	18–20 years (42.9%) 21–24 years (57.1%)	50	355	25.6	7
22	Mallhi et al., 2022[41]	General Population	Jouf	After COVID-19	Mean=21.40 years (SD = 1.94)	49	790	30	9
23	Alshammari et al.[42]	HCWs	Different regions	Before COVID-19	NA	62	364	67.6	7
24	Javed et al.[43]	General Population	Different regions	After COVID-19	18–25 years (25.1%) 26–35 years (25.7%) 36–45 years (30.5%) > 45 years (18.6%)	41	1650	31.5	9
25	Awadalla et al.[44]	HCWs	Abha	After COVID-19	18–40 years (84.6%) >40 years (15.4%)	58	312	45.5	8
26	Alwazzeh et al.[45]	General Population	Different regions	After COVID-19	Mean=37.7 years (SD=11.6)	46	1734	19.31	9

(Continued)

Table 1. (Continued).

ID	Study	Study Population	Study Region	Vaccination time	Age	Female	Sample size	Flu Vaccine Uptake last year	Quality score
27	Mujallad et al.[46]	General Population	Jeddah	After COVID-19	18–25 years (24.7%) 26–35 years (28.5%) 36–49 years (33%) 50–65 years (12.8%) <65 years (1%)	62	311	37	8
28	Minshawi et al.[47]	General Population	Different regions	After COVID-19	18–28 years (46.5%) 29–39 years (16.7%) 40–50 years (23.2%) >51 years (13.6%)	67	2401	25.7	9
29	Alkathlan et al.[48]	HCWs	Different regions	After COVID-19	18–30 years (33.7%) 31–40 years (49.3%) >40 years (16%)	73	424	59	9
30	Fayed et al.[49]	General Population	Different regions	After COVID-19	18–30 years (52.7%) 30–49 years (38.2%) 50> years (9.1%)	59	1539	19.5	8
31	Alshahrani et al.[50]	General Population	Different regions	After COVID-19	18–24 years (27%) 25–34 years (32.6%) 35–44 years (24.1%) 45–54 years (11.9%) <55 years (4.4%)	40	758	31.8	9

considered suitable, with 20 studies investigating the vaccination rate of the general population and 11 studies analyzing the vaccination rate among HCWs (Table 1).

Quality assessment

The Newcastle-Ottawa Scale (NOS) was effectively utilized for the cross-sectional studies included, with 90.3% being categorized as high quality (Table 1).[19] The assessment of the quality of studies yielded an average score of 8.3 points. Among the included articles, 3 of them were rated as medium quality, while a total of 28 were classified as high quality. Most of the risk of bias was related to the following: lack of representativeness of the cases and small sample size.

Publication bias and sensitivity analysis test

Funnel plots were generated with the 20 vaccination rate data from the general population studies and the 11 hCWs papers (Figures 2 and 3). Both plots indicated that the dispersion was primarily wide-ranging and approximately symmetrical. Egger's test for the general population ($t = 2.2$, $p = .3$) and HCWs studies ($t = 1.3$, $p = .2$) indicated no substantial publication bias, supporting the robustness of the meta-analysis findings.

General pooled analysis

The analyzed 31 studies included 31 data points for influenza vaccination rates, with sample sizes varying from 242 to 2401 people. The reported vaccination rates varied

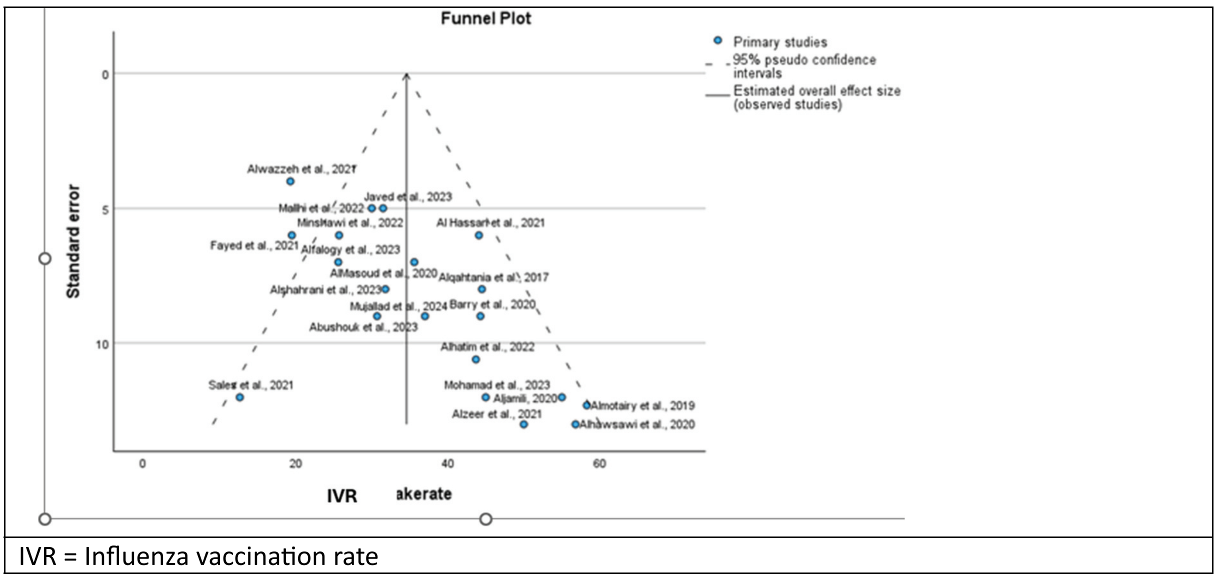

Figure 2. Funnel plot of the general population studies with pseudo 95% confidence limits. IVR = Influenza vaccination rate.

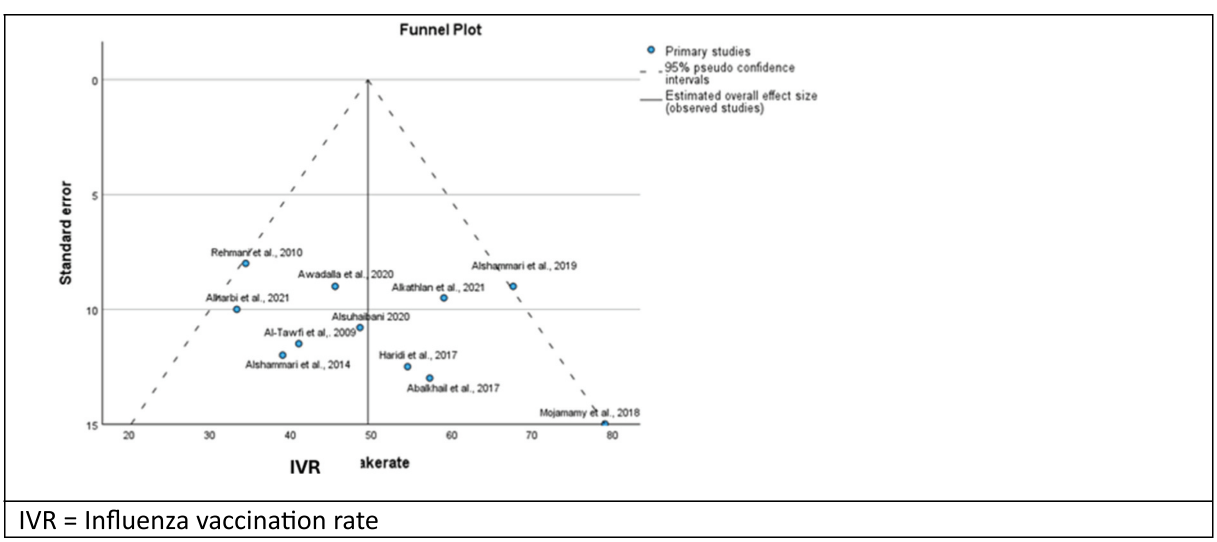

Figure 3. Funnel plot of the HCWs studies with pseudo 95% confidence limits. IVR = Influenza vaccination rate.

between 12.7% and 79%. Table 1 summarizes the essential characteristics of the studies included, detailing their fundamental details and vaccination data. A total of 31 cross-sectional studies were included in the meta-analysis, utilizing a random effects model. The data indicated that the influenza vaccination rates among the general population and HCWs were 37.1% (SD = 13.1) and 50.8% (SD = 14.3), respectively. In order to assess heterogeneity among general population studies, we analyzed Q-statistics, Tau^2, H^2, and I^2 values. The Q-statistics ($Q = 44.2$, $df = 19$, $p < .001$) were determined to be statistically significant. In addition, Tau^2, H^2, and I^2 values were calculated to be 85.9, 2.6, and 61.5, respectively. Consequently, there is a statistically significant heterogeneity among general population studies. Similarly, in the investigations involving HCWs, Q-statistics, Tau^2, H^2, and I^2 values were analyzed. The statistics ($Q = 17.1$, $df = 10$, $p < .05$) were determined to be statistically significant. Moreover, the Tau^2, H^2, and I^2 values were determined to be 80.7, 1.7, and 42.3, respectively, signifying a statistically significant heterogeneity. Given the observed substantial variation among the studies, subgroup analyses were performed to investigate the origins of this heterogeneity, categorizing by the timing of vaccination (pre- versus post-COVID-19 pandemic).

Subgroup analysis

The influenza vaccination rate among the general population was 43.3% ($p < .001$, 95% CI = 33.3–53.3%) before the COVID-19 pandemic, but it decreased to 29.1% ($p < .001$, 95% CI = 24.1–-34.1%) after the pandemic. In studies including HCWs, the influenza vaccination rate before the COVID-19 pandemic was 48.5% ($p < .001$, 95% CI = 39.6–57.6%), however, post-COVID-19, it increased to 59% ($p < .001$, 95% CI = 41.3–57.9%).

Meta-regression was performed on general population studies to analyze the correlation between vaccination rates and the timing of the research (pre- vs. post-COVID-19 pandemic), sample size, and quality score of the study. A significant correlation was observed between the influenza vaccination rate and the timing of the trial (pre- vs. post-COVID-19 pandemic), with a mean effect size estimate of 14.3 (95% CI = 5.7–22.9; $p < .001$). The sample size of the study and its quality score were not significantly associated with the influenza vaccination rate.

Among HCWs studies, a meta-regression analysis was performed to investigate the correlation between vaccination rates and the timing of the study (pre- vs. post-COVID-19 pandemic), the sample size of the study, and the quality score of the study. No significant relationship was observed between the influenza vaccination rate and the timing of the study (pre- vs. post-COVID-19 pandemic), with a mean effect size estimate of 6.7 (95% CI = −19.3–32.7; $p = .5$). The sample size of the study and its quality score did not show a significant association with the rate of influenza vaccination.

Discussion

General findings

This meta-analysis is the first comprehensive study to investigate the potential impact of the COVID-19 pandemic on IVR among HCWs and the general population in Saudi Arabia by including and analyzing peer-reviewed published papers that reported IVR since 2000. In general, we found that the pandemic had significantly influenced and changed the trend of IVR among the two populations. The main findings of the study are: (1) IVR was significantly greater among HCWs compared to the general population (2) In investigating the IVR among the general population, it was discovered that the rate decreased substantially after the COVID-19 pandemic, but it has grown significantly among HCWs. The paper provides significant evidence for understanding the current state of IVR in Saudi Arabia by comparing two vital groups. This arises at a time when there is conflicting evidence concerning global IVR levels.

IVR among the general population

Our findings showed that IVR among the general population (37.1%) was substantially higher in comparison to other countries. A recent meta-analysis that included 522 studies from 68 countries, aimed at quantifying global IVRs, reported an average IVR of 24.9%. (CI 95%: 23.45%-26.50%).[51] However, IVRs among the general population might differ significantly between countries, which can be attributed to the absence of a surveillance mechanism for influenza vaccination coverage in some countries. Additionally, there is a possibility that there is a connection between a low perceived risk of the disease and concern about vaccine safety. Subgroup analysis revealed a significant difference between IVR post and pre-COVID-19 pandemic, indicating a considerable impact on IVR among the general population. The findings indicated a decrease in the mean IVRs from 43.3% to 29.1%, which contradicts what some studies have reported in the literature.[52] In the US, the COVID-19 pandemic has resulted in a rise in vaccine adoption rates, as shown by multiple studies. For instance, according to a report from 11 US jurisdictions provided by the Centers for Disease Control and Prevention (CDC), the average dosage of influenza vaccination delivered between September and December 2020 was 9.0% greater than the average doses given during the same weeks in 2018 and 2019.[53] An additional study indicated that the IVR in Greece rose from 76% to 83% during the COVID-19 pandemic.[54] However, some studies have reported results similar to the ones found in our findings. In a study that utilized data on influenza vaccination policy and coverage submitted by countries and territories in the Americas using the electronic Joint Reporting Form on Immunization (eJRF) for the years 2019 to 2021, a decrease of 21% in IVR among adults was reported.[17] To mitigate vaccination hesitancy, it is essential to address three primary factors: complacency, confidence, and convenience.[55] Individuals who refused vaccination because of complacency viewed influenza as a non-serious illness, considered themselves to be at minimal risk, and regarded the influenza vaccine as less important. A previous meta-analysis identified the perceived low personal risk of disease as a significant factor contributing to vaccine hesitancy.[56] Furthermore, the rise in vaccine misinformation and hesitancy during the COVID-19 pandemic may have led to the decline in IVR and must be investigated further and addressed to reverse the decrease in vaccination rates.[57,58] Other factors that might have led to the difference in IVR and vaccine hesitancy include the presence of COVID-19 variants and the availability of mRNA vaccines. Additionally, strategies tailored to the specific contexts and needs of target groups should be created to enhance vaccine trust and diminish vaccine disinterest.[59] Health campaigns and HCWs must continually underscore vaccinations as a potent means of safeguarding people and the community, while also countering anti-vaccination narratives on social media.[60] Targeted communications addressing the myths around certain vaccinations may prove more successful than broad vaccination promotion initiatives that require strategic methods that emphasize sustainable regular and seasonal vaccination initiatives while enhancing accessibility.[61]

IVR among HCWs

The IVR among HCWs was found to be 50.8%, which exceeds the global average reported. A recent systematic review and meta-analysis involving 26 countries indicated that the mean IVR among HCWs was 46.9%.[4] HCWs have a considerable risk of being exposed to the influenza virus in their regular duties, categorizing them as an extremely susceptible group to influenza infections.[4] The incidence of lab-confirmed flu among non-vaccinated HCWs was 18.7%, as revealed by a meta-analysis. This rate is 3.4 times higher than the rate observed in healthy adults.[62] HCWs may experience increased absenteeism as a result of contracting the flu, which can result in challenges to healthcare services and a higher incidence of hospital-acquired infections. Additionally, the spread of the flu to other people, especially relatives, may be facilitated by continuing to work while infected.[4] HCWs have the potential to spread influenza to susceptible patients, which would put patient safety at risk.[63] Vaccination against influenza should be administered annually to HCWs, as recommended by the WHO.[64] In Saudi Arabia, the Ministry of Health (MOH) has advised that all HCWs receive mandatory influenza vaccinations annually. Additionally, the vaccine is provided at no cost to all HCWs.[48] Such initiative enables higher IVR among HCWs and creates an environment that hinders the spread of infectious diseases among HCWs and their patients. However, several studies have reported reduced IVR rates despite such a rule. This vaccine hesitancy can be attributed to several factors including individual factors such as awareness and attitudes or organizational factors such as educating HCWs or the promotion of such vaccines.

The subgroup analysis revealed a substantial disparity between the IVR post- and pre-COVID-19 pandemic; the mean IVR among HCWs increased from 48.5.3% to 59%. This is consistent with the findings of other studies. A recent systematic review and meta-analysis indicated that the COVID-19 pandemic significantly influenced IVR among HCWs.[7] The rise in IVR following the pandemic can be linked to the heightened distress and challenges encountered by HCWs in hospital environments during such time, including a greater awareness of their increased risk of infection, the complications associated with COVID-19, vaccine accessibility, cost, standards of healthcare services, and the knowledge of HCWs concerning influenza and its vaccinations.[65] An additional meta-analysis that monitored IVR over 14 years indicated that the seasonal IVR among HCWs gradually increased as a result of the H1N1 influenza pandemic in 2009 and the subsequent COVID-19 epidemic, which is likely due to the increased awareness of the contagious nature of these diseases.[4] Numerous studies in the literature indicate that the COVID-19 pandemic served as a catalyst for greater IVR, suggesting that the pandemic may have promoted more favorable health-seeking behaviors. Other factors that played a role in enhancing vaccination rates include the desire for personal protection and the intention to protect others, as well as the perception of personal vulnerability and the seriousness of the illness.[66] Additional factors were also reported, including the prospect of being at risk, concern about the disease, and social pressures to be vaccinated.[67] It is important to note that some studies identified an increase in IVR before and immediately after the pandemic (influenza season of 2020/21), ranging from 17% to 38%.[68–70] However, numerous studies documented a decline in IVR during the influenza season of 2021/22[71,72] and by public health organizations.[73] This evidence indicates that the attitude of HCWs may have deteriorated after the acute phase of the emergency when the vaccine has been widely available and the number of serious cases has declined, potentially as a result of the absence of a robust preventive culture, as they returned to values similar to those attained in the seasons before the COVID-19 pandemic.[8] Due to the lack of required information from the collected studies, we could not analyze the influencing factors that contribute to the higher likelihood of HCWs receiving influenza vaccinations, including age, experience, education level, and professional occupation. Thus, future studies can shed light on how such factors can explain any variability that might exist among HCWs. Additionally, in our meta-analysis all the included studies are cross-sectional studies, and the research design type is relatively single. Cross-sectional studies have certain limitations in exploring causal relationships and the inability to determine the causal sequence between vaccination rate changes and the pandemic. Thus, mention in future research, a combination of multiple research designs (such as cohort studies, and intervention studies) can be used to explore this issue more comprehensively.

This review has many limitations. There was considerable variability in the analyses, attributable to differences in study settings. Nonetheless, we performed subgroup analyses to address this concern. Additionally, the use of random-effects analysis in the statistical evaluation mitigated this bias, making it less consequential. Despite these limitations, our results indicate that COVID-19 has a significant role in influencing the uptake of influenza vaccination. Moreover, our existing data may provide a basis for future research and investments in the well-being of HCWs and the general population. Finally, despite our effort to reduce the bias of the selected studies, the inclusion of only English-language studies may have limitations in terms of the generalization of the results.

Conclusion

Our analysis speculatethat COVID-19 has led to an increase in IVR among HCWs, whereas the general public has seen a decrease in IVR. This may suggest that a major hesitation toward influenza vaccination might persist, attributed partly to a low perceived risk of influenza, worries over effectiveness, and safety apprehensions related to the vaccine. Thus, we recommend the following:

(1) Healthcare officials and policymakers should focus on enhancing favorable attitudes toward vaccination and concentrate on enhancing views while rectifying misconceptions about influenza and immunization.
(2) It is essential to establish systematic strategies that encourage influenza vaccination among HCWs and the rest of the population. Efforts must concentrate on increasing knowledge of vaccine significance, offering affordable and easy vaccination services, and improving awareness of influenza and its prevention.
(3) Our results provide significant insights for enhancing flu vaccine efforts. This may include initiatives such as the enforcement of compulsory vaccination laws for certain high-risk demographic groups.
(4) A multifaceted strategy is necessary to achieve higher compliance. The provision of on-site vaccination clinics, efficient promotion campaigns, health staff education and training, and communication efforts by public health and governmental organizations are all proactive steps that should be part of this strategy.
(5) It is imperative to implement short-term mandated immunization programs for HCWs. Mandatory vaccination programs for HCWs have been effectively instituted during the past decade and should be seen as essential in addressing infectious diseases that result in considerable morbidity and mortality among HCWs and patients. We assert that patients' rights to safe healthcare services should take precedence over HCWs' rights to accept or refuse immunizations. We also suggest medium-to-long -term strategies to address HCW vaccination reluctance, enhance awareness, and foster a culture of prevention. However, these kinds of actions could also have negative consequences, depending on the historical, political, and cultural environment in which they are made.

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Notes on contributor

Dr. Salah Alshagrawi, Associate Professor of Public Health at the Department of Public Health at the Saudi Electronic University. I have been involved in several publications related to pandemic and emergency determinants among healthcare professionals and the public during the COVID-19 pandemic. My main areas of research interest include emergency response systems and public health, public health, and the relationship between improving health systems and public health. I have a strong emphasis on enhancing public health policy and practice to mitigate the health consequences of disasters. This involves taking charge of strategic planning, program development, and health policy formulation.

ORCID

Salah Alshagrawi http://orcid.org/0000-0003-2800-4794
Ahmed Hazazi http://orcid.org/0000-0002-0105-6802

Author contributions

SA designed, interpreted the results, and wrote the manuscript. AH interpreted the results and wrote the manuscript.

Data availability statement

The data that support the findings of this study are available upon request.

Consent for publication

I give my consent for the publication of identifiable details to be published in the Journal.

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