Original Article

Assessment of COVID-19 Vaccine Knowledge, Attitude and Practice among the General Population in Duhok Province, Kurdistan Region of Iraq: A Retrospective Cross-Sectional Study

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ABSTRACT

Given the global significance of vaccinations, particularly in the context of the pandemic caused by the novel coronavirus SARS-CoV-2, this study explores hitherto unexplored territory by examining the knowledge, attitudes, and practices surrounding the vaccines developed to combat the virus. However, following the availability of the vaccines for the novel coronavirus (2019-nCoV), there is a paucity of information regarding public awareness, attitudes, and behaviours towards the vaccines in the Kurdistan region of Iraq. The research was conducted specifically in the Kurdistan Region of Duhok province, Iraq, and its aim is to provide valuable insights for informed decision-making, tailored public health interventions, and effective vaccination promotion in the region. A retrospective cross-sectional study conducted between 1 October and 1 December 2022 included 759 participants aged between 18 and 75 years. The face-to-face interviews were conducted using a structured questionnaire that covered a range of topics, including sociodemographic characteristics, knowledge, attitudes, and practices related to the vaccines used for the treatment of the SARS-CoV-2 virus. The participants, with an average age of 32.95 years (standard deviation±12), were 52.3% male. Approximately 55% of the participants had a history of infection with the SARS-CoV-2 virus, and 25.3% were employed, with 18.3% having chronic diseases. It is noteworthy that 99.60% of participants were aware of the existence of the vaccine against the SARS-CoV-2 virus, and 68% of them considered it safe. Furthermore, 74.04% of respondents indicated that they strongly agreed with the importance of the vaccine. A substantial proportion (62.58%) held the view that the vaccine was effective in protecting against infection. It is noteworthy that 86.2% of individuals were aware of potential side effects, while 96.31% were informed about the multi-dose requirement for vaccination. The findings of this study indicate that there is a high level of awareness of the COVD-19 vaccine, with 99.60% of respondents reporting that they were aware of it. This highlights the importance of cautioning against the potential risks associated with the dissemination of unprofessional opinions on social media. Regional variations highlight the necessity for the implementation of bespoke communication strategies. It is of the utmost importance to identify the factors that contribute to hesitancy, particularly among healthcare personnel, in order to effectively promote vaccination. It is noteworthy that social media, despite its pervasive use, carries inherent risks due to the presence of unprofessional opinions.

Keywords: SARS-COVID19 Virus, KAP, Duhok Province, Iraq.

1. Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the etiological agent responsible for the global pandemic known as coronavirus disease 2019 (COVID-19). The initial emergence of the virus occurred in late 2019 in Wuhan, Hubei province, China. It subsequently proliferated on a global scale, affecting 220 countries. (1). The pandemic had a detrimental impact on the healthcare system, leading to the disruption of services provided to patients, particularly in developing countries such as Iraq (2, 3). The predominant clinical manifestations of the infection are fever and a dry cough. Furthermore, patients may present with additional symptoms such as dyspnoea, fatigue and myalgia (4). The infection can be highly transmissible prior to the onset of clinical symptoms and for several days after patients begin to experience illness. The global effects of the pandemic have been profoundly distressing, necessitating the implementation of measures to control its spread. The majority of countries worldwide adopted a primary approach with the objective of minimising disease transmission. This approach frequently entailed the introduction of non-pharmaceutical interventions, including the mandatory use of masks, the promotion of hand hygiene, the practice of social distancing, the imposition of restrictions on travel, the closure of educational institutions, and the implementation of partial or full lockdowns (6-8). Vaccines represent one of the most reliable and cost-effective public health measures ever implemented, playing a pivotal role in preserving millions of lives annually (9). Following the successful decoding of the SARS-CoV-2 genome sequence in early 2020 and the subsequent declaration of the pandemic by the World Health Organization (WHO) in March of the same year (10), pharmaceutical companies and scientists have been working assiduously to develop vaccines. In order to effectively control the transmission of the virus, it is essential to have a comprehensive understanding of the disease and its modes of spread (8). On 21 February 2023, a considerable number of cases of the novel coronavirus were reported globally, resulting in a significant loss of life. The most effective method of protection against the virus is vaccination. As of 18 February 2023, the World Health Organization has administered a significant number of vaccine doses to the population. A knowledge, attitudes, and practices (KAP) survey regarding the vaccines for the novel coronavirus disease (2019-nCoV) is an essential tool for gauging public awareness, sentiments, and behaviours surrounding the vaccination. Such a survey offers invaluable insights into the community's comprehension of the vaccine, their attitudes towards vaccination, and the practices they adopt in accordance with vaccination recommendations. By evaluating these factors, public health authorities and policymakers can modify communication strategies, address misconceptions, and design targeted interventions to enhance vaccine acceptance and uptake. Furthermore, the KAP survey enables the identification of specific knowledge gaps or concerns that may impede vaccination efforts, thereby facilitating the development of more effective and tailored public health campaigns to promote widespread vaccine coverage and contribute to overall pandemic control. The objective of this KAP study was to furnish policymakers with valuable information regarding the KAP regarding the vaccines of the novel coronavirus (2019-nCoV) among the Iraqi population. The objective of the study was to provide insights that could inform the development of targeted interventions, awareness campaigns and policy enrichments related to the outbreak of the novel coronavirus (2019-nCoV) based on the results.

2. Materials and Methods

2.1. Study Design

This study was conducted as a retrospective cross-sectional study in the Kurdistan Region of Duhok province, Iraq, between 1 October 2022 and 1 December 2022. A convenience sampling approach was employed, whereby individuals from a range of Kurdistan regions in Iraq, including Zakho, Duhok, and Semel, and neighbouring areas, were invited to participate in the study. Prior to the commencement of the study, participants were provided with a detailed explanation of the study's objectives and were asked to give their informed consent. A total of 759 individuals were selected at random from the general population and interviewed in person by the authors. The participants ranged in age from 18 to 75 years, with a mean age of 32.95 (±12 SD).

2.2. Study Tool

The study tool was initially developed based on the findings of a previous study (11). The questionnaire was comprised of three sections. The initial section comprised general enquiries pertaining to the participants' personal lives, incorporating sociodemographic details and health-related aspects. This section addressed a range of topics, including age, gender, marital status, educational level, occupation, employment status, smoking habits, history of chronic illness, experience of infection with the SARS-CoV-2 virus, sources of information about the virus, perceptions of the safety of vaccines developed to combat the virus, and reasons for unwillingness to receive a vaccine developed to combat the virus. The second part of the study comprised eight yes-or-no questions designed to assess participants' comprehension of the SARS-CoV-2 vaccine. The objective of these questions was to ascertain whether the participants had been made aware of the existence of vaccines for the novel coronavirus disease (2019-nCoV), whether they considered the vaccines to be safe, and whether they believed that the vaccines could protect against the disease. The third section comprised six statements pertaining to attitudes towards the use of vaccines against the novel coronavirus (2019-nCoV), with respondents invited to indicate their level of agreement or disagreement with each statement, or to select the option of 'neutral'. The following is an illustrative sample of the statements included in the

survey: The respondents were asked to indicate their level of agreement with the following statements:
1. It is important to get a vaccine to protect people from COIVD-19.
2. Side effects will prevent me from taking a vaccine for the prevention of COIVD-19.

2.3. Inclusion/Exclusion Criteria

The study population comprised all residents of the Kurdistan Region of Iraq aged 18 and above, without any exclusion based on ethnicity, background, religion, occupation, or socioeconomic status. In contrast, the exclusion criteria comprised individuals below the age of 18 years or those with incomplete or missing data, all of whom were excluded from the study.

2.4. Statistical Analysis

The findings of this study were subjected to analysis using the Microsoft Excel software. The results were presented in a clear and concise manner, either as the mean±standard deviation or as simple percentages and frequencies, depending on the most appropriate representation.

3. Results

3.1. Demographic Characteristics of Study Participants

The research study included 759 participants from diverse geographical locations within the Kurdistan region. The mean age of the respondents was 32.95 years (SD±12), with a slight majority of males (52.3%). Furthermore, over half of the participants (56.91%) were married. Approximately 30% of the participants had achieved a primary education level or below, while 37% held intermediate or secondary qualifications, and approximately 33% had obtained higher education degrees. Furthermore, 32% of the participants had a background in health-related education (Table 1). In terms of employment status, 25.3% of the participants were employed, and only 18.3% reported having a chronic disease. A significant majority (over 70%) of the participants were non-smokers. Approximately 55% of the participants indicated a previous history of infection with the novel coronavirus SARS-CoV-2, while approximately 45% had never been infected. It is noteworthy that nearly 68% of respondents expressed confidence in the safety of the vaccine, indicating a high level of trust in the vaccine's efficacy (Table 1). As illustrated in Figure 1, the data indicate that approximately 34% of the participants considered social media to be a reliable source of information regarding the Coronavirus Disease 2019 (Covid-19) vaccines. Approximately 26%, 21.8%, 15.6%, and 12.48% of the participants indicated that they trusted television, healthcare providers, government sources, and friends, respectively, for information. In contrast, only 3.43% of the participants indicated that they placed their trust in information from scientific papers (Figure 1).

Table 1. Demographic characteristics of study participants (n = 759)

Variable		Frequency (%)
Age (Year)	Mean ± SD	32.95±12.08
	18-25 years	275 (36.23)
	26-35 years	221 (29.11)
	>35 years	263 (34.65)
Gender	Male	397 (52.30)
	Female	362 (47.69)
Marital status	Single	327(43.08)
	Married	432 (56.91)
Level of education	Primary or less	224(29.51)
	Secondary or High	284(37.41)
	Higher education	251(33.06)
Occupation (Profession)	Healthcare worker	243(32.01)
	Non-Healthcare worker	516(67.98)
Employment	Unemployed	567(74.70)
	Employed	192(25.29)
Smoking status	Yes	223(29.38)
	No	536(70.61)
History of chronic diseases	Yes	620(81.68)
	No	139(18.31)
Infected with COVID19 virus	Yes	417(54.94)
	No	342(45.05)
Is the COVID-19 vaccine safe	Yes	522(68.77)
	No	237(31.23)

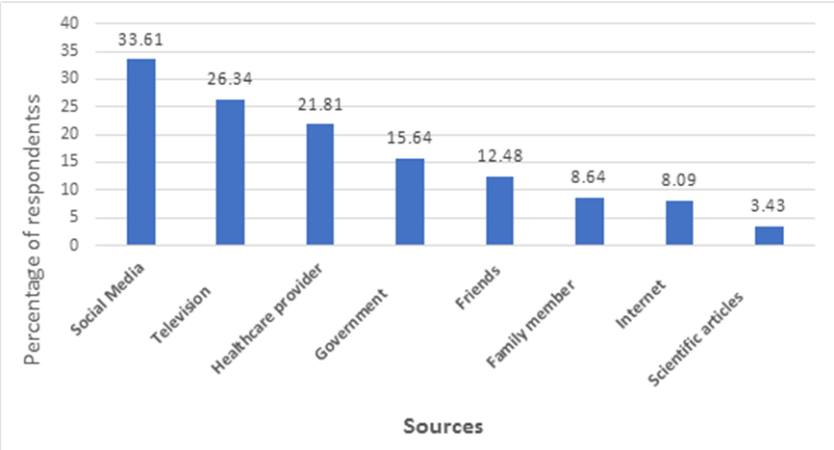

Figure 1: Sources information about COVID-19 vaccination

3.2. Knowledge of COVID-19 Vaccines

The overwhelming majority of participants (99.60%) demonstrated awareness of the existence of the vaccine against the novel coronavirus, SARS-CoV-2. Furthermore, 70.22% of these individuals expressed confidence in the safety of the vaccine, despite acknowledging the potential for adverse effects. A notable proportion (62.58%) of respondents perceived vaccines to be effective in preventing infection with the SARS-CoV-2 virus. However, 73.25% of participants acknowledged the possibility of contracting the virus even after vaccination. Approximately 66.93% of respondents indicated support for the administration of the SARS-CoV-2 vaccine to individuals with a history of the disease, whereas 65.48% expressed reservations about vaccinating those exhibiting symptoms at the time. Furthermore, 86.17% demonstrated familiarity with the potential side effects of vaccines, and 96.31% exhibited an understanding of the necessity of receiving multiple doses. A comprehensive overview of knowledge related to the COIVD-19 vaccine is presented in Table 2.

3.3. Attitudes toward COVID-19 Vaccine

A total of 74.04% of participants indicated a strong preference for receiving a vaccine for protection against SARS-CoV-2 infection (Table 3). Moreover, 59.55% of participants expressed concerns that potential side effects might deter them from getting vaccinated against COIVD-19, and nearly two-thirds (66.53%) indicated their reluctance to accept a COIVD-19 vaccine upon its licensing. Nevertheless, over half (55.59%) of the participants expressed confidence in the ability of pharmaceutical companies to develop safe and effective vaccines for the treatment of the novel coronavirus. Furthermore, the majority (88.93%) concurred that the government would distribute the vaccine to all citizens free of charge. Approximately a quarter of the participants expressed dissenting views, with 5.14% specifically disagreeing with the assertion that the government would ensure free access to the vaccine for all citizens (Table 3).

3.4. Practice towards COVID19 Vaccines

Figure 2 illustrates the factors that contribute to individuals' reluctance to receive the vaccine for the novel coronavirus disease (2019-nCoV), also known as the Coronavirus Disease 2019 (Covid-19) vaccine. Approximately 37% of respondents indicated that time constraints constituted a hindrance to vaccination. Furthermore, approximately 29% of participants expressed concerns regarding vaccine safety, while approximately 18.6% doubted the vaccine's effectiveness. Lastly, approximately 14.5% of participants indicated that they were apprehensive about injections.

4. Discussion

The respiratory illness designated as "Coronavirus Disease 2019" (abbreviated as "COVID-19") was initially documented to the World Health Organization (WHO) on 31 December 2019. The initial cases were recorded in Iraq in March 2020 (12). The vaccines developed to combat the SARS-CoV-2 virus are safe and effective, offering the optimal protection against infection (13, 14). In the context of the ongoing pandemic, individuals have been inclined to seek information and guidance on health-related matters from a diverse array of sources, including television, radio, print media, social media platforms, personal contacts, healthcare professionals, scientists, and governmental sources (15, 16). In this study, social media was considered a reliable source of information on the subject of the COIVD-19 vaccines by nearly 34% of the participants. Approximately 26% of participants indicated that they trusted television, 21.8% trusted healthcare providers, 15.6% trusted the government, and 12.48% trusted friends. In contrast, only 3.43% of participants indicated that they placed their trust in information from scientific papers. A study conducted in six sub-Saharan countries revealed that 58% of participants utilized social media as a source of information (17). In a study conducted in China, social

Table 2. Knowledge Regarding the COVID-19 Vaccine

Part 2: Knowledge Regarding the COVID-19 Vaccine	Yes (%)	No (%)
Have you heard about the COVID-19 vaccine	756 (99.60)	3 (0.395)
The COVID-19 vaccine is safe with some side effects	533(70.22)	226(29.78)
The COVID-19 vaccine protects from getting COVID-19	475(62.58)	284(37.41)
It is not possible to get COVID-19 even after taking the COVID-19 vaccine	203(26.75)	556(73.25)
It is possible to give the COVID-19 vaccine to a person with a history of COVID-19	508(66.93)	251(33.07)
It is not possible to give the COVID-19 vaccine to a person suffering from COVID-19	497(65.48)	262(34.52)
Fever, slight swelling, and redness at the injection site are the side effects of the COVID-19 vaccine	654(86.17)	105(13.83)
The COVID-19 vaccine is given in 2 doses or more	731(96.31)	28(3.689)

Table 3: Attitudes toward covid-19 vaccine

Part 3: Attitudes toward COVID-19 vaccines	Agree No. (%)	Neutral No. (%)	Disagree No. (%)
It is important to get a vaccine to protect the people from COVID-19	562 (74.04)	67 (8.83)	130 (17.13)
Side effects will prevent me from taking a vaccine for the prevention of COVID-19	452 (59.55)	98 (12.91)	209 (27.54)
Pharmaceutical companies are going to develop safe and effective COVID-19 vaccines	422 (55.59)	172 (22.66)	165 (21.74)
COVID-19 vaccines made in Europe or America are safer than those made in other world countries	468 (61.66)	143 (18.84)	148 (19.49)
Most people will refuse to take the COVID-19 vaccine	505 (66.53)	106 (13.97)	148 (19.49)
The government will make the vaccine available for all citizens for free	675 (88.93)	45 (5.93)	39 (5.14)

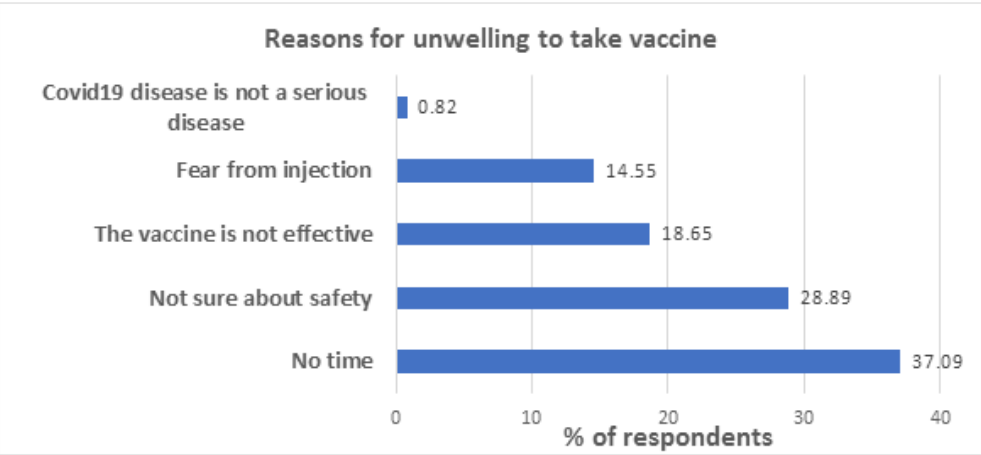

Figure 2. Reasons for unwillingness to take the COVID-19 vaccine

media was identified as the primary source of information, with a percentage of 76.4%, followed by the government at 66.4%, and friends at 54.5% (18). These findings are at odds with the results of a study conducted in Jordan, where healthcare providers were the most utilised source for knowledge about the COIVD-19 vaccination, at 45.4%, followed by pharmaceutical companies at 30.5%, the government at 27.1%, and other sources at lower rates (11). Furthermore, the results of this study diverge from those of a study conducted in Bangladesh, where television (53%), social media (45%), and the internet (38.7%) were identified as the primary sources of knowledge about the COIVD-19 vaccine (19). In a study conducted in Ethiopia, television was identified as a notable source of information (20). In contrast, a study conducted in Palestine revealed that social media and the internet were the most commonly used sources of information (21). It is crucial to acknowledge that the utilisation of social media for the acquisition of information may be deemed as a potentially hazardous practice due to the pervasiveness of unprofessional opinions and a dearth of comprehensive scrutiny. The platform frequently features a diverse array of perspectives, not all of which are anchored in expertise or dependable observation. Consequently, a reliance on social media as the sole source of information may result in individuals being exposed to inaccuracies, misinformation, and potentially unreliable advice regarding a range of topics, including those related to health and safety. The results of our study demonstrate that 99.6% of subjects have been exposed to information about the vaccines for the novel coronavirus disease (COVID-19). Similar results were observed in studies conducted in Oman, which demonstrated that knowledge plays a pivotal role in influencing preventive measures by affecting the perceived effectiveness of those measures, which in turn directly influences attitudes. (22) In our study, 70.22% of participants expressed confidence in the vaccine's safety, acknowledging the possibility of side effects. This finding contrasts with that of a study conducted in Oman, in which only 17% of participants expressed confidence in the safety and efficacy of the vaccine (22). In a separate study conducted in Saudi Arabia, 96.5% of participants expressed the view that the vaccine was safe, which is in alignment with the findings of our study (23). The observed limited trust in the effectiveness and safety of vaccines may be attributed to the circulation of misinformation and rumours surrounding the vaccine. The advent of the pandemic in December 2019 initially created an environment of uncertainty. The proliferation of misinformation coincided with the dissemination of factual information about the disease, resulting in the shaping of perceptions on a global scale. A survey of healthcare personnel at Catania University Hospital (Italy) revealed a notable increase in support for mandatory vaccination among immunocompromised patients, newborns, and those with COPD. Additionally, there was a strong advocacy for the administration of necessary vaccines, including those for measles, varicella, and influenza, during the ongoing pandemic. Moreover, 65% of the personnel indicated their intention to recommend SARS-CoV-2 vaccination to high-risk patients (24). In our study, despite 73.25% of participants expressing doubt regarding the vaccine's capacity to prevent infection, our findings indicated that 74.04% of our sample population considered vaccination a vital measure for protecting against severe illness. Nevertheless, 61.53% of participants concurred that the majority of individuals would decline vaccination, a figure that is consistent with the findings of another cross-sectional study conducted in Iraq, in which 61.40% of respondents expressed reluctance to receive a vaccine for the novel coronavirus (25). Furthermore, over half (55.59%) of the sample population expressed confidence in pharmaceutical companies to develop safe and effective vaccines for the treatment of SARS-CoV-2, which aligns with the findings of another global cross-sectional study that reported 57.60% of the population having confidence in pharmaceutical companies for this purpose (26). The provenance of the vaccine appears to influence perceptions of safety, with approximately 61.66% of participants in our study indicating that vaccines manufactured in Europe or America were perceived as safer than those produced in other countries worldwide. Conversely, another study indicated that approximately one-third (31.70%) of the population perceived the vaccines produced in Europe or America to be safer than those produced in other regions (26). The present study observed an unwillingness to take the vaccines for the novel coronavirus disease 2019 (COVID-19) in approximately 64.2% of the participants. In contrast, a study conducted in China reported a lower rate of only 24% (18). In a separate study conducted in Oman, it was determined that 43% of the participants were reluctant to receive the vaccine (22). The primary reason for declining the vaccine, as identified in our study, was a lack of time, representing 37% of responses, followed by uncertainty about safety, at 28.8%. Other reasons included scepticism about the vaccine's effectiveness, fear of injections, and the perception that the disease is not a serious one. This differs from the findings of a study conducted in Oman, in which only 0.3% of participants reported a lack of time, while 22.6% expressed uncertainty about the vaccine's safety, a figure comparable to our own (22). In conclusion, the findings of this study indicate that there is a high level of awareness (99.60%) of the existence of the vaccine for the novel coronavirus disease, also known as the 2019-nCoV or simply the "Covid-19" virus. It is noteworthy that social media, despite its pervasive use, carries inherent risks due to the presence of unprofessional opinions. The existence of discrepancies in vaccine acceptance across different regions underscores the necessity for the implementation of communication strategies that are tailored to the specific characteristics of each region. It is of the utmost importance to gain insight into the underlying reasons for hesitancy, particularly

among healthcare professionals, in order to effectively promote vaccination and address public concerns.

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Authors' Contribution
Study concept and design: I.N. Acquisition of data; R.E, H.A and R.I; Analysis and interpretation of data: R.E, H.A and R.I; Drafting of the manuscript: I. N and N.H; Critical revision of the manuscript: I. N and N. H. Statistical analysis: I. N

Ethics
The survey was approved by the Ethics and Scientific Committee at the College of Medicine, University of Zakho (Reference number: E50/2022).

Conflict of Interest
The authors confirm that there are no conflicts of interest.

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Data Availability
The data that support the findings of this study are available on request from the corresponding author.

References

1. Wu F, Zhao S, Yu B, Chen Y-M, Wang W, Song Z-G, et al. A new coronavirus associated with human respiratory disease in China. Nature. 2020;579(7798):265-9.
2. Hussein NR, Musa DH, Ibrahim N, Naqid IA, Saleem ZSM, Jacksi K. Impact of Covid-19 pandemic on surgical practice in Kurdistan, Iraq: An online cross-sectional survey. International Journal of Surgery Open. 2020;27:47-51.
3. Hussein NR, Saleem ZSM, Ibrahim N, Musa DH, Naqid IA. The impact of COVID-19 pandemic on the care of patients with kidney diseases in Duhok City, Kurdistan Region of Iraq. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2020;14(6):1551-3.
4. Hussein NR, Naqid IA, Saleem ZSM. A Retrospective Descriptive Study Characterizing Coronavirus Disease Epidemiology among People in the Kurdistan Region, Iraq. Mediterr J Hematol Infect Dis. 2020;12(1):e2020061-e.
5. Phua J, Weng L, Ling L, Egi M, Lim CM, Divatia JV, et al. Intensive care management of coronavirus disease 2019 (COVID-19): challenges and recommendations. The Lancet Respiratory medicine. 2020;8(5):506-17.
6. Hussein NR, Naqid I. Strict social distancing measures helped early control of SARS-CoV-2 spread in Duhok city, Iraq. Journal of infection in developing countries. 2022;16(8):1370-1.
7. Nicola M, Alsafi Z, Sohrabi C, Kerwan A, Al-Jabir A, Iosifidis C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. International Journal of Surgery. 2020;78:185-93.
8. Hussein NR, Naqid IA, Saleem ZSM, Dildar HM, Ibrahim N. The Impact of Breaching Lockdown on the Spread of COVID-19 in Kurdistan Region, Iraq. Avicenna Journal of Clinical Microbiology and Infection. 2020;7(1):34-5.
9. Hajj Hussein I, Chams N, Chams S, El Sayegh S, Badran R, Raad M, et al. Vaccines Through Centuries: Major Cornerstones of Global Health. Frontiers in public health. 2015;3:269.
10. Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. Acta Biomedica Atenei Parmensis. 2020;91(1):157-60.
11. El-Elimat T, AbuAlSamen MM, Almomani BA, Al-Sawalha NA, Alali FQ. Acceptance and attitudes toward COVID-19 vaccines: A cross-sectional study from Jordan. PloS one. 2021;16(4):e0250555.
12. Hussein NR, Naqid IA, Saleem ZSM. A retrospective descriptive study characterizing coronavirus disease epidemiology among people in the Kurdistan Region, Iraq. Mediterr J Hematol Infect Dis. 2020;12(1).
13. Hussein N, Abdulkareem W, Rasheed N, Ameen M. The Efficacy and Safety of Heterologous Immunization with Pfizer-BioNTech (Pfizer) to Individuals Who Have Completed A Primary Vaccination Schedule with Sinopharm (BBIBP-CorV). J Pure Appl Microbiol. 2023;17(3):1783-90.
14. Hussein NR, Rasheed BN, Naqid IA, Dirbaz AM, Saleem ZSM, Ibrahim N, et al. A study of SARS-CoV-2 delta variant breakthrough infections and side effects of the Oxford-AstraZeneca vaccine. Public Health in Practice. 2022;4:100303.
15. Ali SH, Foreman J, Tozan Y, Capasso A, Jones AM, DiClemente RJ. Trends and Predictors of COVID-19 Information Sources and Their Relationship With Knowledge and Beliefs Related to the Pandemic: Nationwide Cross-Sectional Study. JMIR Public Health Surveill. 2020;6(4):e21071.
16. Praveen SV, Boby R, Shaji R, Chandran D, Hussein NR, Ahmed SK, et al. Twitter-Based Sentiment Analysis and Topic Modeling of Social Media Posts using Natural Language Processing, to Understand People's Perspectives Regarding COVID-19 Omicron Subvariants XBB.1.5 and BF.7. Journal of Pure and Applied Microbiology. 2023;17(1):515-23.
17. Iyamu I, Apantaku G, Yesufu Z, Oladele EA, Eboreime E, Afirima B, et al. Is social media, as a main source of information on COVID-19, associated with perceived effectiveness of face mask use? Findings from six sub-Saharan African countries. Glob Health Promot. 2022;29(3):86-96.
18. Hong J, Xu XW, Yang J, Zheng J, Dai SM, Zhou J, et al. Knowledge about, attitude and acceptance towards, and predictors of intention to receive the COVID-19 vaccine

among cancer patients in Eastern China: A cross-sectional survey. J Integr Med. 2022;20(1):34-44.
19. Islam MS, Siddique AB, Akter R, Tasnim R, Sujan MSH, Ward PR, et al. Knowledge, attitudes and perceptions towards COVID-19 vaccinations: a cross-sectional community survey in Bangladesh. BMC Public Health. 2021;21(1):1851.
20. Abebe H, Shitu S, Mose A. Understanding of COVID-19 Vaccine Knowledge, Attitude, Acceptance, and Determinates of COVID-19 Vaccine Acceptance Among Adult Population in Ethiopia. Infect Drug Resist. 2021;14:2015-25.
21. Al-kafarna M, Matar SG, Almadhoon HW, Almaghary BK, Zaazouee MS, Elrashedy AA, et al. Public knowledge, attitude, and acceptance toward COVID-19 vaccines in Palestine: a cross-sectional study. BMC Public Health. 2022;22(1):529.
22. Al-Marshoudi S, Al-Balushi H, Al-Wahaibi A, Al-Khalili S, Al-Maani A, Al-Farsi N, et al. Knowledge, Attitudes, and Practices (KAP) toward the COVID-19 Vaccine in Oman: A Pre-Campaign Cross-Sectional Study. Vaccines (Basel). 2021;9(6).
23. Zahid HM, Alsayb MA. Assessing the Knowledge and Attitude toward COVID-19 Vaccination in Saudi Arabia. Int J Environ Res Public Health. 2021;18(15).
24. Ledda C, Costantino C, Cuccia M, Maltezou HC, Rapisarda V. Attitudes of Healthcare Personnel towards Vaccinations before and during the COVID-19 Pandemic. Int J Environ Res Public Health. 2021;18(5).
25. Alatrany SSJ, Falaiyah AM, Zuhairawi RHM, Ogden R, H ALSA, Alatrany ASS, et al. A cross-sectional analysis of the predictors of COVID-19 vaccine uptake and vaccine hesitancy in Iraq. PloS one. 2023;18(3):e0282523.
26. Mannan DKA, Farhana KM. Knowledge, attitude and acceptance of a COVID-19 vaccine: A global cross-sectional study. International Research Journal of Business and Social Science. 2020;6(4).