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Evaluating the Efficacy of COVID-19 Vaccines in Reducing Infection and Symptomatic Presentation in Libya

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تقييم فعالية اللقاحات المضادة لكوفيد- 19 في الحد من انتشار العدوي وظهور الاعراض في ليبيا

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Abstract
Vaccination against SARS-CoV-2 remains the primary global strategy to mitigate the pandemic and reduce viral contamination and transmission. Despite full vaccination, breakthrough infections can still occur, as evidenced by international clinical data. This study aimed to evaluate the effectiveness of COVID-19 vaccines in preventing infection and reducing the severity of symptoms among Libyan citizens. A cross-sectional survey was conducted between September 2021 to February 2022, collecting data from 1,183 vaccinated and 275 unvaccinated individuals. The results showed an infection rate of 10.4% among the vaccinated group compared to 25.4% in the unvaccinated control group. Statistically significant differences were observed in both infection rates and symptom severity between the two groups. Furthermore, household contact with infected family members was identified as the most prevalent source of infection among vaccinated participants.

Keywords: SARS-CoV-2, COVID-19, Symptoms severity, Vaccinated and unvaccinated Libyan.

الملخص
يظل التطعيم ضد فيروس كرونا المستجد (*SARS- CoV- 2*) هو الاستراتيجية العالمية الأساسية للتخفيف من أثار الجائحة والحد من التلوث الفيروسي للبيئة وانتشاره وانتقال العدوي، وعلى الرغم من تلقي التطعيم الكامل الا ان العدوي الاختراقية تبقي واردة الحدوث، كما اثبتت البيانات السريرية الدولية ونتائج العديد من الدراسات العلمية. هدفت هذه الدراسة الي تقييم فعالية اللقاحات المضادة لفيروس كورونا المستجد في الوقاية من العدوي وتقليل شدة الاعراض بين المواطنين الليبيين. تم اجراء دراسة مسحية في الفترة ما بين سبتمبر 2021 وفبراير 2022, حيث جُمعت البيانات من 1,183 مواطنا ليبيا ملقحاً و275 مواطنا ليبيا غير ملقحاً كعينة ضابطة للدراسة. أظهرت النتائج ان معدل الإصابة كانت 10.4% بين الملقحين مقارنة بنسبة 25.4% بين غير الملقحين، كما بينت الدراسة وجود فروقات ذات دلالة معنوية في كل من معدلات الإصابة وشدة الاعراض بين الملقحين وغير الملقحين، علاوة على ذلك تم تحديد ان اهم مصادر العدوي بالفيروس بين المشاركين الملقحين كانت مخالطة مصاب من العائلة.

الكلمات المفتاحية: فيروس، كورونا المستجد (SARS- CoV- 2)، كوفيد-19, شدة الاعراض، الملقحين وغير الملقحين الليبيون.

Introduction

In December 2019, the world health organization (WHO) identified cases of pneumonia of unknown etiology in Wuhan, China, later determined to be caused by a novel coronavirus (Cov- 2019) [1], then the International Committee on Taxonomy of Viruses (ICTV) called it the SARS-Cov- 2 Virus, and it is indicated that Covid- 19 is the name of the disease that causes this virus, was declared a public health emergency of international concern shortly thereafter[2, 3]. By February 2021, global reports exceeded 106 million confirmed cases and 2.3 million deaths, with environmental contamination facilitating the rapid spread of the virus [4, 5].

Coronaviruses are positive- sense RNA viruses with large genomes, the genus Betacoronavirus, which includes SARS-CoV-2, is believed to have originated in bats [6]. This viral family ranges from causing the common cold to severe acute respiratory syndrome (SARS) [7]. Clinical manifestations of COVID-19 vary from mild symptoms such as fever, cough, dyspnea, and the loss of smell and taste, to severe pneumonia and multi-organ failure [7]. Certain populations, including those with pre-existing conditions like hypertension, diabetes, COPD, and individuals over the age of 60, face a higher risk of mortality [8].

The first global vaccination program began in the United Kingdom in December 2020 following the emergency use authorization of the BNT162b2 mRNA vaccine [9, 10]. In Libya, the vaccination campaign commenced in April 2021 [11]. This study seeks to verify the impact of these vaccines on the infection rate and their effectiveness in reducing the pathogenicity of the virus within Libyan society.

Material and methods

Study area and Population: This research was designed to include a representative sample of both vaccinated and unvaccinated Libyan citizens (control sample) across various regions of Libya. The study area was geographically divided into three primary regions (Tripoli, Cyrenaica, and Fezzan) to facilitate participant selection based on their place of residence.

Study period and objectives: The study was conducted between September 2021 and February 2022, coinciding with the initial months of the national vaccination campaign against SARS-CoV-2 in Libya. The primary objectives were to evaluate the impact of vaccines on the infection rate, assess their effectiveness in reducing viral pathogenicity, and identify the most common factors contributing to the spread of the virus within Libyan society.

Data collection and Survey design: Data were collected using a structured electronic questionnaire **developed via** Google Forms. The survey was distributed online across multiple social media platforms, including medical, educational, and administrative groups, to ensure broad reach among Libyan internet users. Separate questionnaire was tailored for vaccinated and unvaccinated participants. The inclusion criteria targeted Libyan citizens aged 18 years and older.

Statistical analysis: Data collected through the Google system were initially processed to determine the percentage of each variable. Subsequently, the data were exported to the SPSS (Statistical Package for the Social Sciences) software for further analysis. Descriptive statistics were generated, and the chi-squared test was applied to determine statistical significance between variables, with a p-value threshold of less than 0.05 used to define significance.

Results

Participation and Geographic Distribution: Out of the 3,353,611 individuals vaccinated in Libya by February 2022, (1,183) participated in the survey, representing a response rate of 0.035%. The majority of participants were from the Tripoli region (75.4%), followed by Cyrenaica (22.1%) and Fezzan (2.5%). Although the highest infection rate among the vaccinated was observed in Tripoli (11.0%), statistical analysis showed no significant correlation between geographic region and the likelihood of infection ($p = 0.467$).

Table (1): Distribution of vaccinated participants and infection rates by region.

SN.	Region name	Number of participants	Percentage of participants	Number of infected cases	Infection rate	p-value
1	Tripoli Region	892	% 75.4	98	% 11.0	0.467
2	Cyrenaica Region	260	% 22.1	23	% 8.8	
3	Fezzan Region	31	% 2.5	2	% 6.5	
4	Total	1183	%100	123	10.4	

Vaccine efficacy and symptom severity: A highly significant association was found between vaccination status and infection risk (p = 0.0017). while the majority of vaccinated who contracted the virus experienced only mild symptoms (57.0%), a higher proportion of the unvaccinated group remained asymptomatic (57.1%), which may be attributed to the younger age demographic within that control group.

Table (2): Comparison of infection rates and symptom severity.

Variable	Group	Infected (%)	Non-infected (%)		p-value
Vaccination Status	Unvaccinated	25.4%	74.5%		0.0008
	Vaccinated	10.4%	89.6%		
Symptom Severity		**Asymptomatic**	**Mild**	**Severe**	0.0017
	Unvaccinated	57.1%	25.7%	17.1%	
	Vaccinated	28.4%	57.0%	14.6%	

Demographic and clinical correlates of infection: Statistical analyses revealed no significant relationship between infection rates among the vaccinated and several variables, including the number of doses received (p = 0.251), gender (p = 0.735), age group (p = 0.889), or the presence of chronic comorbidities (p = 0.25). Similarly, neither the type of vaccine administered (p = 0.35) nor the participants profession (p = 0.10) showed a statistically significant correlation with infection status. However, the cause of infection was highly significant (p < 0.0001). Contact with an infected family member was identified as the primary source of transmission, accounting for 57.0% of cases among vaccinated individuals.

Table (3): Factors associated with SARS-CoV-2 infection among vaccinated participants:

SN.	Variables	Cases N= 1183	%	Infected	%	Non-infected	%	P-value
1	**Vaccination doses**							
	Single dose	795	67.2	77	9.6	718	90.3	0.251
	Two doses	388	32.8	46	11.8	342	88.1	
	Male	273	23.1	30	11.1	243	89.0	0.735
	Female	910	76.9	93	10.2	817	89.8	
2	**Average age**							
	18 – 25 years	814	68.8	70	8.6	744	91.4	0.889
	26 – 40 years	217	18.3	30	13.8	187	86.2	
	41 – 65 years	137	11.6	21	15.3	116	84.6	
	Over 65 years	15	1.3	2	13.3	13	86.6	
3	**Participants with chronic illnesses**							
	hypertension	22	1.9	6	27.3	16	72.7	0.25
	Diabetes	25	2.1	2	8.0	23	92.0	
	Hypertensive and diabetes	8	0.7	2	25.0	6	75.0	
	COPD	55	4.6	7	12.7	48	87.3	
	Other allergic diseases	18	1.5	2	11.1	16	88.8	
	Autoimmune diseases	5	0.4	1	20.0	4	80.0	

4	**Causes of infection among the vaccinated**							
	not know the cause of the infection	/	/	35	28.4	/	/	< 0.0001
	contact with an infected family member	/	/	70	57.0	/	/	
	contact with an infected person at work	/	/	10	8.1	/	/	
	in contact with customers at work	/	/	8	6.5	/	/	
5	**Subscribers' Professions**							
	Students	727	61.5	63	8.7	664	91.3	0.10
	Educational field	129	11.0	20	15.5	109	84.4	
	Medical field	108	9.1	17	15.7	91	84.2	
	Housewife	73	6.2	6	8.22	67	91.7	
	Self-employment	61	5.15	8	16.6	53	86.8	
	Administrative offices	85	7.2	9	10.6	76	89.4	
6	**Type of vaccine**							
	Sputnik V	532	45.1	66	12.4	466	87.6	0.35
	Sinopharm & Sinovac	397	33.5	34	8.6	363	91.4	
	AstraZeneca	202	17.1	17	8.4	185	91.6	
	Pfizer–BioNTech	50	4.2	6	12.0	44	88.0	
	BioNTech	2	0.1	0	0	0	0	

Discussion

Survey Response and Participation Challenges: The study utilized an online survey, a method widely adopted during the COVID-19 pandemic due to movement restrictions and lockdowns, such as [12, 13, 14]. However, the response rate was notably low at 0.035%. this highlights a significant challenge in scientific research within Libya: a lack of public awareness regarding the importance of participating in medical and social studies. Increasing engagement through educational and media institutions is essential to improve the quality of future public health data.

Vaccine effectiveness in reducing transmission: The results, collected during the third wave and the Delta variant surge, demonstrate that unvaccinated individuals had a significantly higher infection rate (25.4%) compared to vaccinated participants (10.4%). This confirms the protective role of vaccines in reducing the spread of the virus by lowering viral loads in the respiratory tract, and reduce the density of the virus in the nose and back of the throat, and thus reduce the risk of transmission to another person because they reduce the number of viruses contaminating the air and surfaces These findings align with global literature indicating that vaccination is a key tool in mitigating person-to-person transmission [15, 16, 17, 18, 19].

Impact on Symptom Severity: A critical finding of this study is the statistically significant difference in symptom severity between the two groups ($p = 0.0017$). Mild symptoms were more prevalent among the vaccinated (57.0%), whereas severe symptoms were less frequent compared to the unvaccinated group. While 57.1% of unvaccinated participants reported being asymptomatic, this is likely attributed to their younger age profile (18-25 years). Overall, the data supports World Health Organization (WHO) reports and international studies stating that fully vaccinated individuals are far less likely to face hospitalization, severe, or death.), this finding is consistent with the results of several other studies such as [20, 21, 22, 23].

Risk factors and demographic variables: The study no significant correlation between infection rates and variables such as gender, age, profession, or the number of vaccine doses. Interestingly, all major vaccine types (Sputnik V, Sinopharm, AstraZeneca, and Pfizer) showed comparable levels of protection in this sample ($p = 0.35$). The most significant factor in transmission was contact with an infected family member, accounting for 57% of infections among the vaccinated ($p < 0.0001$). This emphasizes that prolonged and close-range contact within households remains a primary driver of infection, even for vaccinated individuals.

Conclusion

The available evidence from the current study confirms that vaccination against COVID-19 is an effective tool in preventing SARS-CoV-2 infection and reducing disease severity. The results showed that vaccination provides a significant level of protection against COVID-19, contributes to reducing disease severity, and prevents disease progression and the onset of severe symptoms. However, the effect of vaccines against SARS-CoV-2 in preventing or quickly and safely treating long-term COVID-19 syndrome has not yet been definitively determined. Therefore, many scientific studies with larger samples, standardized criteria for results, and more accurate analytical methods are needed, along with improved quality of reports and long-term follow-up of participants.

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Authors contributions

Najat M. Al-Ghatmi: Conceptualization, Methodology, Data Curation, Writing-Original Draft, and Bibliography Management. Houssni Amhamad Aldawadi: Questionnaire Design (Formatting), and Online Survey Distribution. Ali Ammar Abdulla Dow: Data Collection and Participant Follow-up. Kunouz ALMabrouk Quraysiah and Amani Jummah Ziada: Contributed to Data Entry (SPSS) and Literature Review Assistance.

Disclosure of Conflict of Interest

The authors declare that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. No funding or compensation was received from vaccine manufacturers or pharmaceutical companies. Furthermore, the authors affirm the authenticity and integrity of the data; all data were collected, analyzed, and reported with full transparency and honesty, reflecting the actual findings of the study.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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