

ORIGINAL ARTICLE

Knowledge and attitudes toward COVID-19 vaccination among a convenience sample of adults in Riyadh, Saudi Arabia: a cross-sectional study

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ABSTRACT

Background: Vaccine hesitancy remains a critical public health challenge that impedes herd immunity and disease mitigation. This study aims to evaluate the knowledge, perceived severity, and attitudes toward COVID-19 vaccines among a convenience sample of adults in Riyadh, Saudi Arabia, and to identify demographic determinants influencing vaccine acceptance.

Methods: A cross-sectional observational study was conducted utilizing convenience sampling across two commercial centers in Riyadh. A validated, self-administered questionnaire was distributed to 379 adult participants aged 18-60 years. Descriptive statistics and chi-square tests were used for statistical evaluations.

Results: Among 379 participants, 88.9% had received a COVID-19 vaccine, and 60.7% reported prior COVID-19 infection. Participants demonstrated significantly higher confidence in locally manufactured vaccines (67.6%) compared to imported options (49.1%). Key barriers to immunization included concerns regarding adverse effects (69.2%) and the belief that natural infection grants sufficient immunity (71.5%). Higher educational attainment and professional occupational status were significantly associated with increased perceived disease severity and vaccine confidence.

Conclusions: Despite high overall vaccination coverage, persistent hesitancy driven by safety apprehensions and reliance on natural immunity remains prevalent among this sample. The findings highlight a strategic opportunity for national biotechnology initiatives, though the convenience sampling method limits broader population generalizability. Targeted messaging is required for optimizing future immunization protocols.

Keywords: COVID-19, Vaccine hesitancy, Public health, Riyadh, Cross-sectional study, Health Belief Model.

Introduction

The emergence of the severe acute respiratory syndrome coronavirus 2 and the resulting COVID-19 disease caused significant disruptions to global health systems and societal structures. The virus transmits primarily via respiratory droplets during close contact and manifests in a broad clinical spectrum ranging from asymptomatic carriage to severe respiratory failure [1,2]. In response to this biological threat, the rapid development and deployment of safe and effective vaccines emerged as the primary public health strategy to curtail viral transmission. However, the efficacy of any immunization program inherently relies on societal uptake. "Vaccine hesitancy" has surfaced as a formidable barrier, officially defined by the World Health Organization's Strategic

Advisory Group of Experts as the delay in acceptance or refusal of vaccines despite the availability of vaccination services [3]. This behavioral phenomenon presents a complex challenge influenced by institutional trust, complacency, and convenience.

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The epidemiological burden of the COVID-19 pandemic was substantial. Globally, the virus infected hundreds of millions of people, resulting in significant global mortality. In Saudi Arabia, the national burden exceeded 824,000 confirmed cases and ~9,500 deaths, prompting health authorities to implement stringent interventions followed by mass vaccination campaigns [4]. The socioeconomic cost of lockdowns, the strain on healthcare infrastructure, and the long-term complications of the disease underscore the epidemiological importance of achieving and maintaining herd immunity. Although natural infection contributes to community immunity, the unpredictable severity of the disease renders widespread vaccination a sustainable strategy for pandemic mitigation [1]. Consequently, acquiring a nuanced understanding of the drivers behind vaccine resistance within specific demographic strata remains vital for public health security.

Current global evidence indicates that vaccine hesitancy is significantly driven by the novelty of the platforms, the accelerated speed of their development, and widespread misinformation. Large-scale surveys have demonstrated variable acceptance rates, with refusal approaching 30% in specific subpopulations [5]. Key factors identified in the international literature include apprehensions regarding unforeseen long-term adverse effects, skepticism toward novel mRNA technology, distrust of pharmaceutical corporations, and the assumption that infection-acquired natural immunity equates to vaccine-induced immunity [6]. Furthermore, social media platforms have acted as catalysts for an “infodemic,” amplifying anecdotal reports of adverse events and introducing doubt regarding the regulatory oversight of vaccine approval processes [7].

In the context of the Saudi Arabian population, available evidence suggests significant early reluctance that evolved dynamically alongside national public health mandates. Early online surveys indicated that only 48% of young Saudi adults were willing to accept the vaccine voluntarily, while a similar proportion stated they would only receive it if mandated for employment or travel [8]. Factors such as reliance on social media for medical information, lower educational attainment, and younger age were correlated with higher hesitancy scores [9]. While the Saudi government achieved high vaccination coverage through regulatory policies, the underlying psychological attitudes and beliefs toward vaccines require continued documentation in real-world settings. A critical knowledge gap also exists regarding public preference for domestically manufactured vaccines versus imported alternatives - an essential variable as the Kingdom pursues the localization of its biotechnology industry under the Vision 2030 framework [10].

The rationale for this study stems from the need to move beyond standard internet-based surveys, which frequently encounter self-selection biases, and capture face-to-face data from the community [8]. By employing a mall-intercept data collection methodology, this research investigates a diverse cross-section of the adult population in Riyadh. The primary objective is to evaluate the knowledge, perceived severity, and attitudes regarding COVID-19 vaccines. Secondary objectives include identifying specific demographic and

occupational determinants influencing these attitudes, assessing definitive barriers to immunization (such as the preference for natural immunity), and quantifying comparative public confidence in locally manufactured versus imported vaccines.

Methods

Study design and setting

This research utilized an observational, cross-sectional, and analytic study design. This epidemiological approach permits the collection of data regarding health beliefs and behaviors at a single point in time, facilitating the identification of correlations between demographic variables and vaccine hesitancy. The study was conducted in Riyadh, the capital of Saudi Arabia. Data collection was strategically executed between October and November 2023 at two active commercial hubs: Sahara Mall and Riyadh Park. Official approvals were secured from mall administrations prior to data collection.

Participants and sample size calculation

The study targeted adult citizens and residents aged 18-60 years present at the designated commercial centers. The required sample size was calculated using the Raosoft sample size calculator [11]. This software utilizes the statistical framework of Cochran’s formula for large populations:

$$n = \frac{(Z^2 \times p \times (1 - p))}{e^2}$$

Where n represents the required sample size, Z is the standard score for the desired confidence level (1.96 for a 95% confidence level), p is the expected response distribution (set at 0.5 to maximize sample size variance), and e is the acceptable margin of error. Assuming a 5% margin of error ($e = 0.05$) and a 95% confidence level, the calculation recommended a minimum sample size of 379 participants to achieve statistically significant results.

Data collection and instrument

A non-probability convenience sampling technique was implemented via a mall-intercept methodology. Field researchers approached potential participants in public areas, providing a brief verbal overview of the study’s purpose. Individuals providing explicit on-the-spot consent were enrolled. The study utilized a previously developed and validated self-administered questionnaire adapted from earlier national public health assessments, structurally aligned to assess constructs of the Health Belief Model [12]. The instrument comprised sections evaluating sociodemographic data, health status and COVID-19 history, manufacturing preferences (local vs. imported), and perceived susceptibility, severity, benefits, and barriers. Responses were recorded on a standard Likert scale.

Statistical analysis

Descriptive statistics were generated to summarize the data, with categorical variables presented as absolute frequencies (f), percentages (%), and 95% confidence intervals (CIs). To evaluate the bivariate relationships

between sociodemographic determinants and vaccine attitudes, inferential statistics were applied using Pearson's chi-square test [13]. Statistical significance was established at an α level of $p < 0.05$. Statistical analyses were performed using SPSS (version 28.0; IBM Corp., Armonk, NY) [14].

Results

Sociodemographic characteristics

A total of 379 valid responses were collected. The demographic profile indicated a predominantly young adult population, with the 21-30 years age bracket representing the largest cohort (36.1%). Gender representation was relatively balanced, comprising 203 males (53.6%) and 176 females (46.4%). The majority of respondents were single (61.7%) and possessed a high level of formal education, with 73.6% holding a university degree or higher. Occupationally, the sample included students (24.3%), government officers (21.6%), and healthcare workers (11.9%) (Table 1).

COVID-19 experiences and general health

A majority (60.7%) confirmed a prior COVID-19 infection. Vaccine uptake was prevalent; 88.9% of participants reported having received the vaccine, while 11.1% were unvaccinated at the time of the survey. Regarding baseline health, 9.0% reported suffering from chronic comorbidities (Table 2).

Vaccine confidence and manufacturing preferences

Participants exhibited significantly higher confidence in domestically developed biotechnology compared to

foreign imports. Specifically, 67.5% expressed confidence in locally manufactured vaccines, compared to 49.1% for foreign alternatives. When indicating an overall preference, 54.9% preferred locally manufactured vaccines, 12.4% favored imported options, and 32.7% indicated no preference, focusing solely on availability (Table 3).

Perceived barriers and hesitancy drivers

Primary drivers of hesitancy centered on safety and post-immunization apprehensions (Table 4). A substantial proportion (69.1%) expressed concern that vaccine side effects would interfere with daily activities. The accelerated timeframe of vaccine development generated skepticism among 60.4% of respondents. Furthermore, 71.5% agreed that prior natural infection provides sufficient immunity.

Bivariate associations and determinant analysis

Bivariate analyses using chi-square testing demonstrated statistically significant correlations between demo-

Table 2. COVID-19 experiences and general health of the study population.

Variable	Category	f	%	95% CI
Experience with COVID-19	Yes	230	60.7	55.8-65.6
	No	149	39.3	34.4-44.2
COVID-19 vaccination history	Yes	337	88.9	85.8-92.1
	No	42	11.1	7.9-14.2
Chronic diseases comorbidity*	Yes	34	9.0	6.1-11.8
	No	345	91.0	88.2-93.9
Overall health status	Very good	252	66.5	61.7-71.2
	Good	105	27.7	23.2-32.2
	Fair	22	5.8	3.5-8.2

*The "yes" category for chronic diseases is notably small (9.0%), reflecting a generally healthy, young adult convenience sample cohort.

Table 1. Baseline characteristics of the study population.

Characteristics	Category	f	%	95% CI
Age	18-20 years	108	28.5	24.0-33.0
	21-30 years	137	36.1	31.3-41.0
	31-40 years	81	21.4	17.2-25.5
	41-50 years	37	9.8	6.8-12.8
	51-60 years	16	4.2	2.2-6.2
Gender	Male	203	53.6	48.5-58.6
	Female	176	46.4	41.4-51.5
Marital status	Married	145	38.3	33.4-43.2
	Single	234	61.7	56.8-66.6
Highest education	High school or below	100	26.4	21.9-30.8
	University or above	279	73.6	69.2-78.1
Occupation	Healthcare Workers	45	11.9	8.6-15.2
	Government Officers	82	21.6	17.5-25.8
	Students	92	24.3	20.0-28.6
	Professional/self-employed	62	16.4	12.6-20.1
	Others/unemployed/Retired*	98	25.8	21.4-30.2

*The category "others/unemployed/retired" was merged due to the small individual sample sizes within these specific groups to ensure robust descriptive reporting.

Table 3. Vaccine manufacturing confidence profiles and origin preferences.

Preference Variable	Response Category	f	%	95% CI
Confidence in local vaccine	Completely confident/confident	256	67.5	62.8-72.3
	Not confident/completely not	123	32.5	27.7-37.2
Confidence in foreign vaccine	Completely confident/confident	186	49.1	44.0-54.1
	Not confident/Completely not	193	50.9	45.9-56.0
Overall manufacturing preference	Prefer locally manufactured vaccine	208	54.9	49.9-59.9
	Prefer imported vaccine	47	12.4	9.1-15.7
	No preference (availability focused)	124	32.7	28.0-37.4

Table 4. Perceived barriers toward COVID-19 immunization uptake.

Perceived barrier item	Response category	f	%	95% CI
Worry that side effects interfere with activities	Strongly agree/agree	262	69.1	64.5-73.8
	Disagree/strongly disagree	117	30.9	26.2-35.5
Uncertainty due to short development timeframe	Strongly agree/agree	229	60.4	55.5-65.3
	Disagree/strongly disagree	150	39.6	34.7-44.5
Belief that natural infection gives sufficient immunity	Strongly agree/agree	271	71.5	67.0-76.0
	Disagree/strongly disagree	108	28.5	24.0-33.0

Table 5. Statistical associations (bivariate chi-square evaluations).

Determinant factor	Evaluated outcome	Chi-square	df	p value
Educational level	Perceived disease severity	4.12	1	0.040
Educational level	Vaccine efficacy on complications	4.05	1	0.044
Occupational profile	Confidence in local vaccines	51.92	4	0.019
Occupational profile	Confidence in imported vaccines	94.22	4	< 0.001

graphic variables and vaccine perceptions. Higher educational attainment was significantly associated with an increased acknowledgment of disease severity ($p = 0.040$) and belief in vaccine efficacy against complications ($p = 0.044$). Occupational profile influenced confidence levels in both local ($p = 0.019$) and imported ($p < 0.001$) vaccines. These inferential findings, along with their respective test statistics, are detailed in Table 5.

Discussion

This cross-sectional study successfully investigated the knowledge, attitudes, and determinants of COVID-19 vaccine hesitancy among a convenience sample of adults in Riyadh, Saudi Arabia. A summary of the key findings indicates that while the cohort exhibited an exceptionally high vaccination uptake rate of 88.9%, underlying psychological reservations regarding the medical necessity of the vaccines remain highly prevalent. Specifically, primary hesitancy drivers included pervasive safety apprehensions regarding accelerated development timelines (60.4%) and the disruptive potential of side effects (69.1%). Furthermore, demographic determinants such as higher educational attainment and specialized occupational status (e.g., healthcare workers) were identified as significant protective factors against vaccine skepticism, underscoring that institutional mandates achieved widespread coverage but did not completely

eradicate the cognitive barriers driving medical hesitancy [12,15].

A critical and detailed interpretation of our findings reveals that the most prominent barrier to ongoing immunization efforts is the belief in natural immunity. A substantial majority (71.5%) of the study population agreed that acquiring a natural COVID-19 infection provides sufficient immunological protection, rendering further vaccination unnecessary. This observation contrasts sharply with early pandemic studies conducted in Saudi Arabia prior to the enforcement of mass mandates, which indicated that only a small minority relied on natural immunity as a primary justification for vaccine refusal [8]. The marked increase observed in this cohort is likely directly associated with subsequent infection waves; as 60.7% of the cohort reported prior infection, the lived experience of surviving the virus appears to have entrenched a false sense of biological security [16]. Relying exclusively on natural immunity presents a persistent public health risk due to the unpredictable severity of primary infections and the documented waning of natural antibodies over time. Public health messaging must be aggressively recalibrated to target this specific fallacy, emphasizing the superior and more durable protection provided by hybrid immunity [16].

In contrast to these barriers, a highly actionable clinical and public health implication emerges from the distinct preference for domestically manufactured vaccines. Our data emphasize that 67.5% of respondents expressed solid confidence in locally developed vaccines, compared to only 49.1% who felt confident in foreign imports. This pronounced disparity provides unique insights seldom quantified in standard international hesitancy literature. The preference for local manufacturing observed in this sample can be contextually linked to national pride and the sociopolitical momentum of the Saudi Vision 2030 initiatives, particularly the National Biotechnology Strategy [10]. The localization of advanced biomedical manufacturing through trusted national scientific institutions clearly fosters robust public confidence. Policymakers should leverage this finding; future immunization campaigns for novel pathogens or routine boosters are likely to achieve significantly superior voluntary uptake rates if the biologics are conspicuously branded and manufactured locally.

Despite yielding valuable insights, this study possesses several limitations that warrant acknowledgment. First, the reliance on convenience sampling at two shopping centers resulted in a cohort predominantly composed of young, university-educated, and generally healthy adults, which inherently restricts the generalizability of the findings to the broader, more diverse population of Riyadh. Second, the cross-sectional design precludes the establishment of temporal or causal inferences between demographic factors and vaccine attitudes. Third, the statistical methodology relied on bivariate chi-square evaluations; the lack of a multivariable logistic regression model prevents the identification of independent predictors of vaccine hesitancy while adjusting for potential confounding variables. Finally, the data are self-reported and therefore subject to both recall bias (particularly regarding the precise history

of prior COVID-19 infections) and social desirability bias, wherein participants may have overreported their vaccination status to align with perceived societal expectations.

Future research directions should seek to address these limitations by employing randomized, population-representative sampling strategies across diverse geographical and socioeconomic strata within Saudi Arabia. Additionally, subsequent studies should incorporate multivariable regression models to accurately isolate independent determinants of vaccine resistance. From a clinical perspective, understanding that generic, one-size-fits-all public health campaigns are inadequate is paramount. Communication strategies should be meticulously segmented, utilizing culturally tailored, health-literate messaging directed by trusted community figures to dismantle misconceptions regarding rapid development timelines and natural immunity, ultimately strengthening resilience against future public health crises.

Conclusions

In conclusion, while high vaccination uptake was documented among the sampled cohort in Riyadh, targeted hesitancy drivers - particularly safety apprehensions and skepticism regarding rapid development timelines - remain prevalent. The widespread belief that natural infection grants sufficient immunity serves as a persistent barrier to ongoing immunization efforts. Furthermore, the demonstrated trust in locally manufactured vaccines presents a significant public health opportunity. Fostering confidence in domestic medical innovations and deploying tailored educational initiatives targeted at specific misconceptions are critical components for optimizing future public health immunization programs. Due to the convenience sampling methodology utilized, these findings are primarily reflective of young, educated adults and underscore the need for broader, population-representative studies in the future.

List of Abbreviations

AI	Artificial intelligence
CI	Confidence interval
COVID-19	Coronavirus Disease 2019
df	Degrees of freedom
f	Frequency
HBM	Health Belief Model
IRB	Institutional Review Board
KAIMRC	King Abdullah International Medical Research Center
KSAU-HS	King Saud bin Abdulaziz University for Health Sciences
mRNA	Messenger Ribonucleic Acid
SAGE	Strategic Advisory Group of Experts
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organization

Conflict of interests

The authors declare that there is no conflict of interest regarding the research, authorship, or publication of this academic article.

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Ethical approval

Ethical approval for this study was formally granted by the Institutional Review Board (IRB) of the King Abdullah International Medical Research Center (KAIMRC), Ministry of National Guard - Health Affairs, Riyadh, Saudi Arabia (Reference Number: IRB/2425/23).

Consent for publication

Written informed consent was obtained from all individual adult participants prior to their enrollment in the study, ensuring strict adherence to the Declaration of Helsinki.

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Supplementary content (if any) is available online.

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