Original Article

Comparative Safety of COVID-19 Vaccines Among Healthcare Workers in Iran

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Abstract

Background: COVID-19 vaccination is the most effective strategy to control the pandemic; however, concerns regarding vaccine-related adverse effects remain, particularly among healthcare workers who were prioritized for vaccination. In Iran, several COVID-19 vaccines with different platforms have been administered, and comparative safety data are limited. This study aimed to evaluate and compare the frequency and severity of adverse effects following administration of Sinopharm, Sputnik V, and AstraZeneca COVID-19 vaccines among healthcare workers in Iran.

Materials and Methods: This cross-sectional study was conducted in 2021 among Iranian healthcare workers who received COVID-19 vaccines through official healthcare organizations. Data were collected using a validated, researcher-designed online questionnaire assessing demographic characteristics and vaccine-related adverse effects after the first and second doses. Adverse effects were categorized by type and severity (mild, moderate, severe). Statistical analyses were performed using chi-square and Fisher's exact tests, with a significance level of $p < 0.05$. Comparisons were performed using chi-square and Fisher's exact tests.

Results: A total of 456 participants were included (55% female, 45% male). Sinopharm was associated with the lowest frequency and severity of adverse effects, while AstraZeneca showed the highest frequency across both doses. Injection-site pain, fatigue, fever, headache, myalgia, and chills were the most commonly reported adverse effects. Adverse effects were generally more frequent after the first dose than the second. Women experienced significantly higher frequencies and greater severity of adverse effects compared to men. Serious adverse events were rare and no vaccine-related deaths were reported.

Conclusion: Among the three COVID-19 vaccines evaluated, Sinopharm demonstrated the most favorable safety profile, whereas AstraZeneca was associated with a higher frequency and severity of adverse effects. Most adverse effects were mild to moderate and self-limiting. These findings may help improve public confidence in vaccination programs and guide future vaccine safety monitoring.

Keywords: COVID-19, Vaccines, Adverse effects, Healthcare workers, Sinopharm, AstraZeneca, Sputnik V

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Introduction

The emergence of the coronavirus disease (COVID-19) in January 2019 took the world by surprise and posed an unprecedented challenge to global health systems[1]. Originating in Wuhan, China, the virus demonstrated a high transmission capacity and, within approximately three months, escalated into a pandemic that disrupted both public health and economic stability worldwide[2-5]. Although the genomic structure of COVID-19 shares similarities with severe acute respiratory syndrome (SARS)[6], the novel nature of the virus rendered many early predictions inaccurate. For instance, initial assumptions that warmer weather would suppress viral activity proved unfounded[7, 8]. Similarly, the hypothesis of herd immunity was undermined by the virus's frequent mutations, which sustained transmission despite widespread infection[9, 10].

Vaccination has historically played a pivotal role in the control of infectious diseases[11]. Consequently, within months of the pandemic's onset, vaccination and the establishment of collective immunity were recognized as the most effective strategies to mitigate viral spread and reduce morbidity and mortality. Nevertheless, vaccines are not without adverse effects, and unmanaged side effects may negatively impact recipients' health. Given their heightened risk of exposure, healthcare workers were prioritized for vaccination. However, the initiation of vaccination campaigns was accompanied by growing public concern regarding vaccine safety[12], concerns that were also evident among healthcare professionals themselves[13].

Previous investigations into COVID-19 vaccine safety have largely reported mild to moderate adverse reactions[14]. The frequency and severity of these reactions varied depending on the vaccine type. For example, Kadali et al. identified 21 commonly reported side effects among healthcare workers, including pain, fatigue, myalgia, headache, chills, fever, joint pain, nausea, muscle spasms, sweating, dizziness, flushing, brain fog, loss of appetite, local swelling, reduced sleep quality, itching, tingling, diarrhea, nasal congestion, and palpitations[15]. Similarly, Nabavi and colleagues in Iran observed comparable outcomes, though differences in the nature and prevalence of side effects were noted, likely attributable to methodological limitations in their study[16].

In Iran, vaccine development efforts were initiated alongside the importation and emergency authorization of several vaccines, including Sinopharm and Bharat (inactivated virus platform), Sputnik V (dual Ad5 and Ad26 vector platform), and AstraZeneca (adenovirus vector platform via the COVAX mechanism)[17]. Considering prior experiences with pandemics such as SARS and Middle East respiratory syndrome (MERS), rigorous research into vaccine safety remains essential, particularly in anticipation of potential future pandemics. Accordingly, the present study aims to investigate and compare the frequency of adverse effects experienced by healthcare workers, the first group to be vaccinated in Iran.

Methods

Study Design and Participants: This cross-sectional study was conducted in 2021 (1400 in the Iranian calendar) following ethical approval. The objective was to assess the frequency of adverse effects associated with COVID-19 vaccines administered to healthcare workers in Iran. Sampling was performed with consideration of age group distribution. Eligibility criteria included receipt of the vaccine through the Medical Council or Nursing Organization, regardless of current professional activity in healthcare settings (e.g., physicians pursuing PhD studies). Individuals who declined to complete the questionnaire or submitted incomplete responses were excluded. Due to restrictions on physical access during the COVID-19

crisis, data collection was conducted using an online questionnaire distributed via social media platforms. Additional support for recruitment was obtained from the Nursing Organization. The study adhered to the principles outlined in the Declaration of Helsinki.

Sample Size Calculation: The sample size was calculated based on the estimated prevalence of the most common adverse effect (injection-site pain). Assuming a prevalence (p) of 0.6, a 95% confidence level (z = 1.96), and a precision (d) of 0.05, the minimum required sample size was calculated. To account for potential incomplete responses, a larger sample was targeted. Ultimately, 456 valid responses were included in the final analysis. To enhance accuracy, 490 responses were collected. After exclusion of invalid data, the final sample size comprised 456 participants.

Data Collection Instrument: A researcher-designed questionnaire, validated for reliability and validity, was employed. The instrument consisted of 63 items: 13 demographic questions and 50 items addressing the presence or absence of mild, moderate, or severe adverse effects following the first and second vaccine doses. The demographic section captured socio-demographic information, including age, gender, marital status, educational level, affiliation with healthcare organizations, current occupation, and history of underlying medical conditions.

Questionnaire Content:

- Anticipated adverse effects of the COVID-19 vaccine (e.g., muscle pain at the injection site, swelling, flushing, fatigue, fever, headache, nasal congestion, irregular heartbeat, depression, and other possible reactions).
- Whether fear or expectation of side effects prevented vaccination (Yes/No).
- Sources of information about the COVID-19 vaccine (local electronic media, local print media, international media, social media, peer networks, scientific journals/websites).
- Experienced adverse effects within the first three days post-vaccination (same categories as above).
- Severity of experienced adverse effects (no pain, mild, moderate, severe, very severe).

Age was categorized into 10-year intervals from 20 to over 80 years. Participants with underlying diseases were not excluded but analyzed separately and compared with healthy individuals. Underlying conditions were grouped into cardiovascular diseases, hypertension, cancer, diabetes, immunodeficiency and autoimmune disorders, and neurological/psychiatric conditions. The three vaccine types evaluated included Sinopharm (inactivated virus), Sputnik V (adenoviral vector), and AstraZeneca (adenoviral vector). Adverse effects were assessed separately after the first and second doses. Severity was categorized as mild, moderate, or severe based on self-reported impact on daily activities. Subgroup analyses were performed by sex and dose number.

Variables: Study variables were classified into three categories:

1. Demographic characteristics
2. Frequency of adverse effects (by first and second dose)
3. Severity of adverse effects (by first and second dose)

All variables were quantitative; no qualitative variables were included.

Statistical Analysis: Only valid data were included in the analysis. Descriptive statistics were presented using frequency tables, percentages, means, and standard deviations. For group comparisons, non-parametric tests, including the Chi-square test and Fisher's exact test (applied when sample sizes in contingency tables were small), were used. A p-value < 0.05 was considered statistically significant. Statistical analyses were performed using SPSS software, version 25.

Results

A total of 496 participants completed the questionnaire, of which 40 were excluded due to incomplete or invalid responses. Ultimately, 456 participants were included in the final analysis. The study population comprised 250 women (55%) and 206 men (45%) (Table 1).

Regarding prior COVID-19 infection, 33.6% of participants reported a previous positive test (Table 1). In addition, 383 participants (84%) reported no underlying medical conditions. Reported comorbidities included cardiovascular disease, hypertension, cancer, diabetes, immunodeficiency and autoimmune disorders, and neurological or psychiatric conditions (Table 1). Blood group distribution revealed that O+ (147 participants, 32.2%) and B+ (87 participants,

19.1%) were the most frequent (Table 1).

Table 1. Demographic and Clinical Characteristics of the Study Population.

Variable	Result	N	Percent
Gender	Male	206	45
	Female	250	55
	Total	456	100
History of COVID-19	Yes	153	33.6
	No	303	66.4
Comorbidity	Yes	73	16
	No	383	84
Blood Group	O+	147	32.2
	O-	14	3.1
	A+	130	28.5
	A-	12	2.6
	B+	87	19.1
	B-	11	2.4
	AB+	36	7.9
	AB-	4	0.9
I don't know my blood group		15	3.3

Frequency of Adverse Effects After the First and Second Doses

First Dose: As shown in Table 2, significant differences were observed only in mild systemic symptoms (injection-site pain, fever, chills, headache, myalgia, arthralgia, nausea, and fatigue) ($p = 0.05$). Other adverse events (lip swelling, facial edema, Bell's palsy, lower limb swelling, VITT, anaphylactic shock, thrombosis, skin rash, chest pain, syncope, dizziness) were not statistically significant. Overall, Sinopharm was associated with the lowest frequency of adverse effects, whereas AstraZeneca demonstrated the highest frequency across all categories.

- Injection-site pain was the most common adverse effect: AstraZeneca (138 participants, 93.9%), Sputnik (96 participants, 72.7%), and Sinopharm (80 participants, 59.7%).
- Fatigue was the second most common: AstraZeneca (120 participants, 79.5%), Sputnik (84 participants, 52.5%), Sinopharm (50 participants, 34.5%).
- Fever occurred in 114 participants (75.5%) with AstraZeneca, 68 (42.5%) with Sputnik, and 19 (13.1%) with Sinopharm.
- Headache was reported by 92 participants (60.9%) with AstraZeneca, 57 (35.6%) with Sputnik, and 30 (20.7%) with Sinopharm.
- Myalgia was reported in 94 participants (62.3%) with AstraZeneca, 70 (44%) with Sputnik, and 29 (20%) with Sinopharm.
- Arthralgia was reported in 44 participants (29.1%) with AstraZeneca, 40 (25%) with Sputnik, and 15 (10.3%) with Sinopharm.
- Nausea was the least frequent significant adverse effect: AstraZeneca (23 participants, 15.2%), Sputnik (14 participants, 8.8%), Sinopharm (6 participants, 4.1%).

Second Dose: Similar patterns were observed after the second dose. Injection-site pain and fatigue remained the most common adverse effects: AstraZeneca (32 participants, 21.2%), Sputnik (86 participants, 53.8%),

Table 2. Comparison of Side Effects of Vaccines among Healthcare Worker.

Symptoms	Sinopharm	AstraZeneca	Sputnik V	p-value
First dose				
Fever	19 (13.1%)	114 (75.5%)	68 (42,5%)	0.001
Chills	9 (6.2%)	95 (62.9%)	48 (30%)	0.001
Injection Site Pain	80 (59.7%)	138 (93.9%)	112 (72.7%)	0.001
Headache	30 (20.7%)	92 (60.9%)	57 (35.6%)	0.001
Myalgia	29 (20%)	94 (62.3%)	70 (44%)	0.001
Arthralgia	15 (10.3%)	44 (29.1%)	40 (25%)	0.001
Nausea	6 (4.1%)	23 (15.2%)	14 (8.8%)	0.005
Diarrhea	7 (4.8%)	15 (9.9%)	10 (6.3%)	0.204
Weakness and Fatigue	50 (34.5%)	120 (79.5%)	84 (52.5%)	0.001
Second dose				
Fever	11 (7.6%)	13 (8.6%)	36 (22.6%)	0.001
Chills	4 (2.8%)	6 (4%)	37 (23.1%)	0.001
Injection Site Pain	57 (39.3%)	32 (21.2%)	86 (53.8%)	0.001
Headache	20 (13.8%)	12 (7.9%)	41 (25.6%)	0.001
Myalgia	13 (9%)	12 (7.9%)	51 (31.9%)	0.001
Arthralgia	6 (4.1%)	7 (4.6%)	26 (16.3%)	0.001
Nausea	4 (2.8%)	2 (1.3%)	10 (6.3%)	0.05
Diarrhea	1 (0.7%)	1 (0.7%)	4 (2.5%)	0.26
Weakness and Fatigue	29 (20%)	21 (13.9%)	63 (39.4%)	0.001

Key Proof

Table 3. Comparison of the Severity of Side Effects Based on Vaccines among Healthcare Workers.

Symptoms	Sinopharm			AstraZeneca			Sputnik V			P value
Severity of symptoms	Severe	Moderate	Mild	Severe	Moderate	Mild	Severe	Moderate	Mild	
Fever	2 (10.5%)	4 (21.1%)	13 (68.4%)	38 (33.3%)	60 (52.6%)	16 (14%)	14 (20.6%)	38 (55.9%)	16 (23.5%)	0.001
Chills	1 (11.1%)	4 (44.1%)	4 (44.4%)	36 (38.3%)	47 %)50%)	11 (11.7%)	16 (33.3%)	20(41.7%)	12(25%)	0.056
Injection Site Pain	1 (1.2%)	28 (32.6%)	57 (66.3%)	18 (12.7%)	68 (47.9%)	56 (39.4%)	10 (8.7%)	47 (40.9%)	58 (50.4%)	0.001
Headache	4 (13.3%)	13 (43.3%)	13 (43.3%)	27 (29.3%)	41 (44.6%)	24 (26.1%)	11 (19.3%)	27 (47.4%)	19 (33.3%)	0.245
Myalgia	2 (6.9%)	16 (55.2%)	11 (37.9%)	28 (29.5%)	60 (63.2%)	7 (7.4%)	18 (25.7%)	39 (55.7%)	13 (18.6%)	0.001
Arthralgia	1 (6.7%)	6 (40%)	8 (53.3%)	17 (38.6%)	20 (45.5%)	7 (15.9%)	8 (20%)	25 (62.5%)	7 (17.5%)	0.005
Nausea	3 (50%)	0 (0%)	3 (50%)	4 (17.4%)	10 (43.5%)	9 (39.1%)	1 (7.1%)	5 (35.7%)	8 (57.1%)	0.116
Diarrhea	1 (14.3%)	1 (14.3%)	5 (71.4%)	4 (26.7%)	4 (26.7%)	7 (46.7%)	2 (20%)	4 (40%)	4 (40%)	0.695
Weakness and Fatigue	4 (8%)	22 (44%)	24 (48%)	49 (40.8%)	59 (49.2%)	12 (10%)	27 (32.1%)	43 (51.2%)	14 (16.7%)	0.001
Fever	1 (9.1%)	4 (36.4%)	6 (54.5%)	1 (7.7%)	9 (69.2%)	3 (23.1%)	3(23.1%)	15 (40.5%)	14 (37.8%)	0.274
Chills	0 (0%)	1 (25%)	3 (75%)	1 (16.7%)	4 (66.7%)	1 (16.7%)	1 (16.7%)	10 (27%)	14 (37.8%)	0.156
Injection Site Pain	1 (1.8%)	18 (31.6%)	38 (66.7%)	3 (9.4%)	13 (40.6%)	16 (50%)	16 (50%)	36 (41.9%)	45 (52.3%)	0.26
Headache	3 (15%)	5 (25%)	12 (60%)	1(8.3%)	8(66.7%)	3(25%)	3(25%)	19 (46.3%)	14 (34.1%)	0.142
Myalgia	1(7.7%)	4 (30.8%)	8 (61.5%)	3(25%)	6(50%)	3(25%)	3(25%)	26(51%)	12 (23.5%)	0.112
Arthralgia	1 (16.7%)	2 (33.3%)	3 (50%)	2 (28.6%)	4 (57.1%)	1 (14.3%)	1 (14.3%)	11 (42.3%)	6 (23.1%)	0.595
Nausea	2 (50%)	2 (50%)	0 (0%)	1 (50%)	1 (50%)	0 (0%)	0 (0%)	3 (30%)	5 (50%)	0.345
Diarrhea	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (50%)	0.136
Weakness and Fatigue	1 (3.4%)	17 (58.6%)	11 (37.9%)	5 (23.8%)	9 (42.9%)	7 (33.3%)	7 (33.3%)	27 (42.9%)	18 (28.6%)	0.104

Sinopharm (57 participants, 39.3%). Fatigue was reported by 21 participants (13.9%) with AstraZeneca, 63 (39.4%) with Sputnik, and 29 (20%) with Sinopharm (Table 2). Overall, the frequency of adverse effects decreased after the second dose compared with the first, except for dizziness.

Other adverse events (lip swelling, facial edema, Bell's palsy, lower limb swelling, VITT, anaphylaxis, thrombosis, rash, chest pain, syncope, dizziness) were assessed but did not show statistically significant differences.

Severity of Adverse Effects

First Dose: Table 3 presents the comparison of adverse effect severity. Significant differences were observed for fever, chills, injection-site pain, myalgia, arthralgia, and fatigue.

- In Sputnik recipients, moderate severity was most common for fever (38 participants, 55.9%), chills (20, 41.7%), myalgia (39, 55.7%), arthralgia (25, 62.5%), and fatigue (43, 51.2%). Injection-site pain was more often reported as mild (58 participants, 50.4%).
- AstraZeneca recipients also showed predominantly moderate severity: fever (60 participants, 52.6%), chills (47, 50%), injection-site pain (68, 47.9%), myalgia (60, 63.2%), arthralgia (20, 45.5%), fatigue (59, 49.2%). Severe responses were more frequent with AstraZeneca compared to Sputnik.
- Sinopharm was associated with the lowest severity of adverse effects, indicating a comparatively safer profile.

Second Dose: No statistically significant differences in severity were observed after the second dose due to

Table 4. Comparison of the frequency of adverse effects following the first dose of COVID-19 vaccines (Sputnik V, AstraZeneca, and Sinopharm) by gender among healthcare workers.

Symptoms	Sinopharm	AstraZeneca	Sputnik V	p-value
Women / First dose				
Fever	7(9.1%)	52(73.2%)	44(44%)	0.000
Chills	4(5.1%)	49(63.6%)	32(31.4%)	0.000
Injection Site Pain	53(69.7%)	72(96%)	77(76.2%)	0.000
Headache	20(25.6%)	56(72.7%)	40(39.2%)	0.000
Myalgia	19(24.4%)	49(63.6%)	49(48.0%)	0.000
Arthralgia	9(11.5%)	22(28.6%)	29(28.4%)	0.013
Nausea	5(6.4%)	16(20.8%)	13(12.7%)	0.30
Diarrhea	4(5.1%)	7(9.1%)	7(6.9%)	0.625
Weakness and Fatigue	29(37.2%)	68(88.3%)	59(57.8%)	0.000
Men / First dose				
Fever	5(8.9%)	55(75.3%)	22(37.2%)	0.000
Chills	5(7.5%)	46(62.6%)	16(47.6%)	0.000
Injection Site Pain	27(46.6%)	66(91.7%)	35(66%)	0.000
Headache	10(14.9%)	36(48.6%)	17(29.3%)	0.000
Myalgia	10(14.9%)	45(60.8%)	21(36.8%)	0.000
Arthralgia	6(9%)	22(29.7%)	11(19%)	0.008
Nausea	1(1.5%)	7(9.5%)	1(1.7%)	0.005
Diarrhea	3(4.5%)	8(10.8%)	3(5.2%)	0.274
Weakness and Fatigue	21(41.3%)	52(70.3%)	25(43.3%)	0.000

smaller sample sizes ($p < 0.05$) (Table 3).

Comparison of Adverse Effects by Gender

Women: Table 4 shows gender-specific comparisons. Among women, injection-site pain was the most frequent adverse effect with Sputnik (77 participants, 76.2%), followed by fever (44, 44%), myalgia (49, 48%), fatigue (59, 57.8%), headache (40, 39.2%), chills (32, 31.4%), and arthralgia (29, 28.4%).

For AstraZeneca, injection-site pain was reported by 72 women (96%), and fatigue by 68 (88.3%). For Sinopharm, injection-site pain was reported by 53 women (69.7%), and fatigue by 29 (37.2%). Women generally experienced more severe reactions than men, particularly for fever, chills, injection-site pain, and headache.

Men: In men, AstraZeneca was associated with the highest frequency of adverse effects in the first dose. Injection-site pain (66 participants, 91.7%) and fever (55, 75.3%) were most common. AstraZeneca was also the only vaccine associated with thrombosis (2 participants, 2.75%).

For Sputnik, injection-site pain (35 participants, 66%) and chills (16, 47.6%) were most frequent. For Sinopharm, injection-site pain (27 participants, 46.6%) and fatigue (21, 41.3%) were most common.

Overall, men experienced fewer adverse effects compared to women. After the second dose, adverse effects decreased in both genders, with significant differences observed in common symptoms (injection-site pain, fever, chills, headache, myalgia, arthralgia, fatigue) (Table 4).

Discussion

In this cross-sectional study, we examined the adverse effects of Sinopharm, AstraZeneca, and Sputnik V vaccines, which were among the most widely used COVID-19 vaccines administered to healthcare workers in Iran. A total of 456 participants who had received both doses were included in the analysis.

For the first dose, significant differences were observed only in mild systemic symptoms such as injection-site pain, fever, chills, headache, myalgia, arthralgia, nausea, and fatigue. Based on both frequency and severity of adverse effects, Sinopharm demonstrated the lowest rates and was identified as the safest vaccine. In contrast, AstraZeneca was associated with the highest overall frequency of adverse effects. Sputnik V showed predominantly moderate adverse effects,

Online

except for injection-site pain, which was more frequently reported as severe. AstraZeneca demonstrated a similar pattern, though with a higher proportion of severe responses compared to Sputnik V.

Sputnik V: The first vaccine analyzed was Sputnik V. Initial evidence of its safety and efficacy was established through a phase 3 randomized controlled trial conducted by Logunov et al. in Moscow, involving 21,977 adults. The trial reported an efficacy rate of 91.6% and no serious adverse events[18], findings consistent with our study. The most common adverse effects observed in our population— injection-site pain, fatigue, myalgia, and headache—were similar to those reported following Pfizer-BioNTech and Oxford-AstraZeneca vaccination[4, 19].

Zare et al. in Iran[20] also reported injection-site pain as the most frequent local reaction, while systemic reactions included myalgia, fatigue, fever, chills, and headache, aligning with our findings. Comparable results were reported by Baba Mahmoudi et al. in Iran[21] and Pagotto et al. in Argentina[22], both focusing on healthcare workers. However, Montalti et al.[23] observed increased adverse effects after the second dose of Sputnik V, whereas our study demonstrated a reduction in adverse effects after the second dose. Similarly, Menni et al.[19] reported increased systemic adverse effects after the second dose of Pfizer-BioNTech in the UK, which contrasts with our findings. Consistent with Baba Mahmoudi[21] and Pagotto[22], our study also showed that women experienced a higher frequency of adverse effects than men.

Sinopharm: Overall, Sinopharm demonstrated the lowest frequency of adverse effects across both doses, confirming its relatively safe profile. This finding is consistent with Oghazian et al. in Iran[24], who compared Sputnik V, Sinopharm, AstraZeneca, and Covaxin. A recent meta-analysis of clinical trials also indicated that inactivated vaccines such as Sinopharm are associated with the lowest risk of adverse effects[25].

Injection-site pain was the most common adverse effect, consistent with findings from Qabees Saeed in the UAE[10], Abu-Hammad in Jordan[1], and Almufty in Iraq[7]. Other common adverse effects in our study included headache, fatigue, myalgia, and fever, similar to previous reports[24, 7, 26, 27]. Women consistently reported more adverse effects than men, in line with studies conducted by Saeed[10] and Babayi[26].

AstraZeneca: Due to the 8–12 week interval between AstraZeneca doses[28], many studies have focused primarily on adverse effects following the first dose[19, 20, 29]. Our study found that AstraZeneca was associated with the highest frequency of adverse effects across both doses.

A survey among healthcare workers in Jordan[1] reported that AstraZeneca had the highest frequency of adverse effects after the first dose compared to Pfizer-BioNTech and Sinopharm. Similarly, a large-scale UK study[19] demonstrated that systemic adverse effects after the first dose of AstraZeneca were significantly higher than those observed with Pfizer. However, an Iranian study[26] reported that Sputnik V was associated with more adverse effects than AstraZeneca and Sinopharm.

In our study, the most common adverse effects of AstraZeneca included injection-site pain, fatigue, fever, chills, myalgia, and headache. The order and severity of these symptoms varied between doses. A large UK study[19] identified headache, fatigue, and chills as the most frequent systemic adverse effects, while injection-site pain was the most common local reaction. Similarly, Ramasamy et al.[31] reported injection-site pain, fatigue, headache, fever, and myalgia as the most frequent adverse effects in a phase 2/3 clinical trial. Importantly, unlike some previous reports[32], our study did not identify any vaccine-related deaths associated with AstraZeneca.

Strengths and Limitations: A key strength of this study is that, in addition to documenting adverse effects, we also assessed their severity. Furthermore, limited research has been conducted on Sinopharm despite its widespread use in several countries, making our findings particularly valuable. Another strength is that participants were healthcare workers, who were expected to provide accurate information based on their scientific background.

However, several limitations must be acknowledged. The relatively small sample size restricted the scope of our cross-sectional analysis. The use of a survey-based approach may have introduced self-selection bias, as highly motivated individuals may have been more likely to participate. Moreover, participants were limited to those with internet access, which may have introduced sampling bias. Recall bias is another limitation, as participants were asked to report past adverse effects. External validity was limited due to

unequal gender distribution. This study has several limitations that should be considered when interpreting the findings. The cross-sectional design precludes causal inference and limits assessment of long-term or rare adverse events. Data were self-reported, which may introduce recall and reporting bias. Sampling was conducted online and was restricted to healthcare workers, potentially limiting generalizability to the broader population. In addition, unequal sample sizes between vaccine groups and the absence of prospective follow-up may have reduced the ability to detect rare but serious adverse events. Future studies using prospective designs and more representative sampling are warranted to enhance external validity. Potential confounding variables including age, sex, comorbidities, and prior COVID-19 infection were descriptively analyzed and stratified where appropriate; however, multivariable regression analyses were not performed. Residual confounding cannot therefore be excluded.

Conclusion

The expectations of most healthcare workers regarding vaccine side effects were consistent with the typical adverse reactions associated with vaccination. However, some participants perceived vaccine-related adverse effects as serious and potentially life-threatening, which prompted us to evaluate their frequency and severity. Overall, Sinopharm was associated with the lowest frequency and severity of adverse effects among the three vaccines studied, and thus appeared to be the safest option. In contrast, AstraZeneca demonstrated the highest overall frequency of adverse effects, with a greater proportion of severe responses compared to Sputnik V. For Sputnik V, aside from injection-site pain, which was more frequently reported as severe, most other adverse effects were of moderate intensity. Sinopharm consistently showed the lowest severity of adverse effects, reinforcing its comparatively favorable safety profile.

Further studies are required to assess rare and long-term adverse effects of COVID-19 vaccines. Such investigations are essential to strengthen public confidence in vaccination programs and to provide a deeper understanding of potential risk factors associated with vaccine-related adverse events.

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Conflict of Interest

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