Postprint: A Qualitative Study of Inhaled COVID-19 Vaccination Experiences Among Frontline Pandemic Response Personnel Aged $ $18 Years in Guiyang City

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Date: 2023-05-08T00:00:00+00:00

Abstract

Background The recombinant inhaled COVID-19 vaccine (adenovirus type 5 vector) (hereinafter referred to as inhaled COVID-19 vaccine) is the first inhaled COVID-19 vaccine approved in China, featuring advantages of good immunogenicity, painless administration, and higher accessibility. It has been included in the WHO Emergency Use Listing and China's list of vaccines for the second booster immunization. Due to limited public awareness, research on its real-world application warrants attention. Objective To gain in-depth understanding of the real experiences of frontline anti-epidemic workers aged $\geq$ 18 years in Guiyang with the inhaled COVID-19 vaccine, providing reference for its promotion and administration. Methods Using purposive sampling, vaccine recipients who completed emergency administration of the inhaled COVID-19 vaccine at a vaccination site in Guiyang in October 2022 were selected as study subjects according to booster immunization principles. Sample size was determined based on data saturation (when no new information emerged), with a total of 17 recipients interviewed. Semi-structured interviews were conducted, beginning with face-to-face interviews to understand immediate vaccination experiences, followed by telephone interviews 5–7 days post-vaccination as agreed. Data were organized and analyzed using Colaizzi's seven-step analysis method. Results Five themes were summarized and extracted: convenient vaccination, good vaccination experience, low psychological burden, low vaccine hesitancy, and uncertain protective efficacy. Convenient vaccination included simple and time-saving procedures, rapid administration, low cost, and no impact on nucleic acid testing. Good vaccination experience included comfortable administration, harmonious observation atmosphere, few adverse reactions, and no impact on daily life. Low psychological burden included reduced anxiety and nervousness

about vaccination, better mental health maintenance, and elimination of injection fear through non-invasive administration. Low vaccine hesitancy included high vaccination accessibility, improved vaccine acceptance, and increased public perception of epidemic risk due to outbreaks. Uncertain protective efficacy included uncertainty about whether injection or inhalation offered better protection and whether the inhaled vaccine provided good protection against variant strains. Conclusion The inhaled COVID-19 vaccine offers convenient administration with few adverse reactions, and frontline anti-epidemic workers aged ≥ 18 years in Guiyang show high acceptance and good vaccination experience.

Full Text

The Experience of Inhaled COVID-19 Vaccination among First-line Epidemic Prevention Personnel Aged $ $18 Years in Guiyang City: A Qualitative Study

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Funding: Youth Research Startup Fund Project of Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine (GZEYK-Y[2022]17); Guizhou Provincial Science and Technology Plan Project (Qiankehe Support [2021] General 035)

Abstract

Background: The inhaled recombinant COVID-19 vaccine (type 5 adenoviral vector) is China's first approved inhaled COVID-19 vaccine. With advantages of good immunogenicity, painless administration, and higher accessibility, it has been included in the WHO Emergency Use Listing and China's list of second-dose booster vaccines. However, public understanding remains limited, warranting attention to its real-world application.

Objective: To deeply understand the authentic experiences of frontline epidemic prevention personnel aged $ $18 years in Guiyang who received the inhaled COVID-19 vaccine, providing reference for promoting this vaccine type.

Methods: Using purposive sampling based on booster immunization principles, we selected recipients who completed emergency vaccination with the inhaled COVID-19 vaccine at a Guiyang vaccination site in October 2022. Sampling continued until data saturation (no new information emerged), yielding 17 interviewees. Semi-structured interviews were conducted: face-to-face interviews assessed immediate vaccination experiences, with follow-up telephone interviews scheduled 5–7 days post-vaccination. Data were analyzed using Colaizzi's seven-step method.

Results: Five themes emerged: (1) vaccination convenience, (2) good vaccination experience, (3) light psychological burden, (4) low vaccine hesitancy, and (5) uncertain protective efficacy. Convenience encompassed simple/time-saving processes, rapid administration, low cost, and no interference with nucleic acid testing. Good experience included comfortable sensation, harmonious observation atmosphere, few adverse reactions, and no disruption to daily life. Light psychological burden involved reduced vaccination-related anxiety and elimination of injection fear through non-invasive delivery. Low hesitancy stemmed from high accessibility, increased acceptance, and heightened pandemic risk perception during outbreaks. Uncertain protective efficacy reflected questions about comparative effectiveness versus injection and protection against variants.

Conclusion: The inhaled COVID-19 vaccine offers convenient administration with minimal adverse reactions. Frontline epidemic prevention personnel in Guiyang aged $ $18 years show high acceptance and positive experiences with this vaccine.

Keywords: COVID-19; SARS-CoV-2; Adenovirus vaccines; COVID-19 vaccines; Immunization, secondary; Inhalants; Qualitative research

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Introduction

The COVID-19 pandemic remains severe and complex. Effective personal protection and vaccination represent the most effective measures for preventing severe illness and death [1]. Although China's full-course vaccination rate has reached 89% [2], new variants continue to emerge [3], and antibody levels and protective efficacy gradually decline over time, necessitating booster immunization to elevate neutralizing antibody levels and maintain vaccine effectiveness [4]. On September 5, 2022, Guiyang intensified temporary static management in certain areas [5], transitioning to normalized pandemic management on October 5 [6]. According to Document No. 3 from Guizhou Provincial COVID-19 Prevention and Control Leadership Group, the inhaled recombinant COVID-19 vaccine (type 5 adenoviral vector) was prioritized for booster immunization in frontline epidemic prevention personnel aged $ $18 years (medical staff, police officers, community workers, and other key groups). Approved in China in September 2022 as a booster [7], this vaccine delivers aerosolized particles via the respiratory tract to directly trigger mucosal immunity, achieving triple

immune protection (mucosal, humoral, and cellular) [8]. Compared with intramuscular injection, it offers better immunogenicity [8], painless administration, and higher accessibility. Current research on vaccination experiences with the inhaled vaccine remains limited. This study examined frontline epidemic prevention personnel in Guiyang who received emergency vaccination with the inhaled vaccine to inform its application in booster immunization.

Methods

Study Participants Using purposive sampling based on booster immunization principles, we selected recipients who completed emergency vaccination with the inhaled COVID-19 vaccine at a Guiyang vaccination site in October 2022. Inclusion criteria were: (1) individuals who completed primary immunization with inactivated COVID-19 vaccines (Sinopharm Beijing/Wuhan or Beijing Sinovac) or CanSino's adenovirus vector vaccine $ $6 months prior, or those who completed booster immunization with inactivated vaccines $ $6 months prior; (2) frontline epidemic prevention personnel aged $ $18 years; and (3) completion of inhaled COVID-19 vaccination. Sampling continued until data saturation (no new information emerged). A total of 17 recipients we
years). This study was approved by the Ethics Committee of Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine (Approval No. KYW202008). All participants voluntarily enrolled and provided informed consent. Basic participant information is presented in .

Data Collection Based on literature review, we developed a semi-structured interview guide through brainstorming. Two vaccine recipients participated in pilot interviews, after which the guide was refined. During the observation period, research team members explained the interview purpose and methods, guaranteed confidentiality, and obtained consent. Face-to-face interviews assessed immediate vaccination experiences, with telephone interviews conducted 5–7 days post-vaccination. Total interview duration was 25–40 minutes.

Face-to-face interview guide: (1) How did you learn about the inhaled COVID-19 vaccine? (2) Why were you willing to receive it? (3) How did you feel during vaccination? Any discomfort?

Telephone interview guide: (1) Having experienced both injection and inhalation methods, what is the biggest psychological difference? (2) Have you experienced any adverse reactions after receiving the inhaled vaccine? (3) Would you recommend the inhaled or injectable vaccine to friends/family for booster doses? Why?

Data Analysis Within 24 hours of each interview, recordings were transcribed verbatim. The research team analyzed data using Colaizzi's phenomenological method: (1) reading all transcripts thoroughly; (2) extracting significant

statements; (3) coding and categorizing recurrent viewpoints; (4) analyzing coded perspectives; (5) describing findings comprehensively; (6) summarizing themes and identifying similar viewpoints; (7) returning to participants for validation.

Quality Control Research team members had systematic training in qualitative research theory and practical interview skills. Two members conducted interviews (face-to-face during observation; telephone at 5–7 days post-vaccination). One member transcribed recordings, while two others verified accuracy through repeated reading, analysis, coding, and synthesis. Disagreements were resolved through group discussion to finalize themes.

Results

Through data analysis, vaccination experiences among Guiyang's frontline epidemic prevention personnel were synthesized into five themes: vaccination convenience, good vaccination experience, light psychological burden, low vaccine hesitancy, and uncertain protective efficacy.

Theme 1: Vaccination Convenience Simple and time-saving process: The inhaled vaccine is delivered via the respiratory tract. Recipients simply exhale deeply, inhale the aerosolized vaccine from a cup under healthcare worker guidance, hold breath for 5 seconds, and complete vaccination. This eliminates cumbersome injection procedures. N01: "While you were loading the vaccine, you explained the exhale-inhale-hold method. It felt very simple and convenient." N02: "Like smoking—just swallow the mist and hold your breath." N07: "I worried it would be difficult to inhale, but it was actually very simple—just breathe in and hold." N12: "It felt like pouring a drink. Put the cup on the outlet, press the button, and it's done—so convenient."

Rapid administration: From aerosol preparation to completion, the entire process takes <20 seconds, compared to >30 seconds for injection. Without needing to undress or apply pressure, time is saved. N03: "From exhaling to inhaling to holding breath, just a few seconds." N05: "Inhalation vaccination is incredibly fast—from when you took out the cup for aerosolization to when we finished holding breath, only about 10 seconds." N06: "Inhalation is: exhale, inhale, hold breath. Unlike before when you had to wait for medication preparation, disinfection, injection, then pressure and dressing—very time-consuming. Inhalation is much faster." N11: "Now that it's getting colder and people wear more layers, the inhalation method saves time changing clothes."

Low cost: The inhaled vaccine dose is only 1/5 of injectable vaccines (0.1 mL vs. 0.5 mL), reducing vaccine costs and eliminating medical consumables like alcohol, cotton swabs, and syringes. N04: "I administer vaccines. Injectable COVID-19 vaccines are 0.5 mL; inhaled is 0.1 mL—greatly reducing costs."

N16: "Inhaled vaccines don't need alcohol, cotton swabs, or as many syringes, so vaccination costs are much lower." N10: "The cup feels better quality than a milk tea cup, but it must be cheaper than syringes, reducing costs."

No interference with nucleic acid testing: Inactivated COVID-19 vaccines retain relatively complete viral nucleic acid fragments, posing contamination risks that may cause false-positive nucleic acid test results for vaccinators, recipients, and the environment [9]. The inhaled vaccine lacks nucleic acid testing targets [10], preventing false positives. N01: "Previously, doctors advised no nucleic acid testing within 48 hours post-vaccination, but with the inhaled vaccine, you can test after just 2 hours." N06: "After administering injectable vaccines, I always tell people not to test within 48 hours to avoid false positives. Inhaled vaccines don't affect results." N10: "Our patrol team requires daily testing. Only the inhaled vaccine doesn't interfere."

Theme 2: Good Vaccination Experience Comfortable sensation: Oral inhalation eliminates injection discomfort, feeling relaxed and comfortable. N02: "Although I didn't taste or feel anything, I thought the method was cool." N05: "It tasted slightly sweet—I quite liked it." N08: "It had a slightly sweet taste, very pleasant." N09: "I have pharyngitis; it felt cool, like mint, very comfortable." N13: "It felt like drinking milk tea, with a milky aroma." N16: "Like drinking water with a sweet taste—very light and comfortable."

Harmonious observation atmosphere: The non-invasive method avoids awkward clothing changes and allows direct disposal of aerosol cups in the vaccination room, reducing aerosol contamination from discarded cotton swabs in observation areas. N11: "Previously in observation rooms, people were either pressing injection sites or dressing—chaotic and unseemly." N14: "Before, some complained or even reported nurses due to injection pain. Now it's much more harmonious." N15: "After injectable vaccines, some discarded cotton swabs on chairs or floors, creating contamination risks."

Few adverse reactions: Recipients reported fewer adverse reactions compared to injectable vaccines. N05: "I felt no discomfort at all afterward—very good." N09: "Only slight dry mouth on vaccination day, nothing since." N13: "Previously I felt dizzy after injectable vaccines; with this one, no discomfort so far." N14: "Previously the injection site hurt for a day or two; this had no reaction." N17: "I had slight headache the evening of vaccination, gone by next day—no local pain like injectable vaccines."

No disruption to daily life: Injectable vaccines advise against bathing for 24 hours to prevent infection; the non-invasive inhaled vaccine doesn't affect fitness, bathing, or other routines. N02: "We run around daily, covered in sweat, and shower when home." N07: "I contact many people and am used to daily showers. I could shower the night of inhalation vaccination; with injection I'd worry about infection." N12: "Last time I showered after vaccination without protecting the site, and it was red and swollen for two days." N15: "I exercise

nightly and shower; inhalation vaccination doesn't affect my routine at all."

Theme 3: Light Psychological Burden Reduced vaccination anxiety, better mental health: Compared to injectable vaccines, inhalation avoids needle-related tension and anxiety. N07: "People see us as heroic, but I'm really afraid of needles—my muscles tense up at the sight. Inhalation eliminates this negative emotion." N15: "In others' eyes we're brave, but I truly fear needles. Inhalation relieved my vaccination anxiety." N17: "Last time a young woman fainted from nervousness during injection. Today everyone was chatting and laughing—no needle fainting worries."

Non-invasive delivery eliminates injection fear: The aerosol method eliminates injection pain and associated negative psychological responses. N03: "The inhalation method is great—painless. I'm more willing to get vaccinated." N08: "Several colleagues came immediately upon hearing it was inhalation, thinking it wouldn't hurt." N10: "Honestly, I'm not afraid of bullets, but I am afraid of injections." N11: "My main reason for delaying boosters was fear of needles and pain."

Theme 4: Low Vaccine Hesitancy High accessibility increases acceptance: Inhaled vaccination is more convenient and faster. N04: "Inhaling the white mist until the cup turns clear is convenient—I'm willing to recommend it to family." N08: "My wife faints at needles. She collapsed after last injection, scaring us. I'll take her for inhalation when available to others." N16: "We healthcare workers have high infection risk. With constant viral mutations, we may need annual vaccination like influenza. More people would accept boosters if inhalation is used."

Pandemic outbreak heightened risk perception: In September 2022, Guiyang implemented high/medium-risk area management [11], sharply increasing public risk perception. N04: "I always thought Guiyang was safe, but this outbreak hit close to home—vaccination is necessary." N08: "Without Guiyang's outbreak, I'd definitely have hesitated about this booster." N09: "I trust the government. After experiencing this outbreak, I'll get vaccinated if they recommend it." N14: "During the pandemic, we collected nucleic acid samples from close contacts—high risk. Another booster is safer." N17: "During lockdown, our neighborhood committee worked with community doctors until midnight daily—our infection risk was enormous."

Theme 5: Uncertain Protective Efficacy Uncertain comparative effectiveness: While inhaled vaccines align with global mucosal vaccine trends, real-world efficacy research is nascent and public understanding is limited. N01: "I didn't feel anything during or after inhalation—unsure if it worked, worried about efficacy." N06: "With over 10 years in vaccination, this is my first time seeing inhaled vaccines—unsure if efficacy matches claims." N12: "Uncertain about the protective effect—a bit worried." N14: "I researched that inhaled

vaccines can produce mucosal immunity, which should be superior to injection, but I'm not certain." N15: "I saw news reports that this was developed by Academician Chen Wei's team, with inhalation being superior to injection."

Uncertain protection against variants: COVID-19 variants continue emerging globally. N03: "The virus mutates so fast—unsure if the inhaled vaccine protects against variants." N04: "This outbreak's cases were all mild or asymptomatic, showing vaccines work, but variant effectiveness needs official data." N13: "This is my fourth COVID-19 vaccine dose—unsure about protection against Omicron or duration."

Discussion

Good Experience Reduces Vaccine Hesitancy Since COVID-19 emerged, continuous viral mutations [12] have necessitated booster doses to improve variant protection [13]. However, vaccine hesitancy hinders booster uptake, impeding herd immunity and vaccine effectiveness [14]. Studies show COVID-19 vaccine hesitancy positively correlates with concerns about adverse reactions [15]. The inhaled vaccine eliminates needle-related tension, anxiety, and fear during waiting and administration, while avoiding injection-site pain, redness, and associated negative emotions [16], significantly improving willingness [17]. Zhang et al. [18] found Chengdu residents' lowest satisfaction aspect was long waiting times. The inhaled vaccine's simple, rapid process reduces waiting and administration time, decreases adverse reactions, improves satisfaction, and lowers hesitancy.

No Interference with Nucleic Acid Testing and Higher Accessibility Injectable COVID-19 vaccines require no nucleic acid testing within 48 hours post-vaccination to avoid affecting results [19]. During high infection risk periods, vaccination conflicts with testing requirements, particularly for high-risk occupations requiring 24-hour testing. The inhaled vaccine lacks nucleic acid testing target open reading frames 1ab and nucleocapsid protein [20-21], allowing testing 2 hours post-vaccination without affecting results, making it more practical for high-risk personnel needing emergency boosters.

Better Cost-Effectiveness Than Injectable Vaccines This study shows the inhaled vaccine is well-tolerated with no serious adverse reactions, consistent with Wu et al. [22], reducing economic and social burdens from adverse reaction management. Additionally, the dose is only one-fifth of injectable vaccines, saving vaccine and vial costs while reducing syringe, cotton swab, and alcohol consumption, substantially lowering costs and demonstrating superior cost-effectiveness.

Better Immunogenicity of Inhaled Vaccine Compared with inactivated injectable vaccines, the inhaled vaccine induces higher neutralizing antibody lev-

els lasting >6 months [8] and triggers mucosal immunity [23], generating triple immune responses (cellular, humoral, mucosal) that block viral transmission and diffusion at infection sites [24], rapidly establishing immune barriers. This makes its immunogenicity superior to injectable vaccines, aligning with future vaccine development trends.

Study Limitations

1. Telephone interviews could not capture micro-expressions or gestures, lacking these details during transcription.
2. Conducted shortly after Guiyang lifted temporary static management, with the inhaled vaccine newly authorized for emergency booster use, the study only included frontline personnel aged $ $18 years, limiting age range and occupational scope and potentially restricting generalizability.

Conclusion

Frontline epidemic prevention personnel aged $ $18 years in Guiyang report positive experiences and high acceptance of the inhaled COVID-19 vaccine. With lower adverse reaction rates and faster antibody production than injectable vaccines, it is more suitable for large-scale emergency vaccination. To promote broader understanding, continuous active monitoring of adverse reactions with timely data disclosure is needed to address public concerns. Strict control of vaccination scope is recommended, deferring vaccination for those with chronic underlying conditions or contraindications, particularly respiratory conditions (rhinitis, asthma, pulmonary fibrosis) or abnormal lung function that may preclude inhalation, to avoid coincident adverse events and further improve booster uptake.

Author Contributions

YU Na proposed the research objectives, designed and implemented the study, and drafted the manuscript. BAI Xiaoling was responsible for study design, manuscript review and revision, quality control, and overall accountability. PANG Jin, NIU Yutian, and HU Qing conducted literature searches, interviews, and transcription, verification, and analysis of interview data. WANG Yuanfang and YANG Rongze designed the preliminary interview outline, conducted pilot interviews, and refined the interview guide.

Conflict of Interest Statement: The authors declare no conflicts of interest.

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Received: February 15, 2023; Revised: April 12, 2023
Edited by: CUI Sha