Analysis of COVID-19 Vaccination Behavior and Its Influencing Factors Among Older Adults in Four Regions of China: A Postprint

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Abstract

Background: The elderly are a key target population for COVID-19 vaccination, which can effectively reduce their risk of developing severe or critical illness and even death after infection with SARS-CoV-2. Currently, the COVID-19 vaccination rate among the elderly in China is relatively low, and few researchers have explored vaccination behavior in this population.

Objective: To analyze COVID-19 vaccination behavior and its influencing factors among the elderly in China, so as to provide references for improving vaccination rates in this population.

Methods: From August 3 to 14, 2022, a stratified random sampling method was used to select 1323 elderly individuals aged 60 years and above from Wujin District of Changzhou City, Zhongmu County of Zhengzhou City, Chengzhong District of Xining City, and Linkou County of Mudanjiang City as study subjects, who were surveyed using a self-designed questionnaire. Binary logistic regression was used to analyze factors influencing the elderly's receipt of the first dose of COVID-19 vaccine, completion of the full vaccination series, and receipt of booster doses.

Results: 96.60% (1278/1323) of the elderly had received the first dose of COVID-19 vaccine, 91.76% (1214/1323) had completed the full vaccination series, and 79.67% (1054/1323) had received booster doses. Binary logistic regression analysis showed that, compared with elderly individuals aged 60-64 years, those aged $ $75 years were less likely to receive the first dose of COVID-19 vaccine [OR (95% CI) = 0.27 (0.11, 0.62), $P < 0.05$]; compared with those with chronic diseases, those without chronic diseases were more likely to receive the first dose [OR (95% CI) = 2.07 (1.12, 3.84), $P < 0.05$]; and elderly individuals with higher perceived benefit levels were more likely to receive the first dose [OR (95% CI)

= 1.39 (1.07, 1.79), P < 0.05]. Compared with elderly individuals aged 60-64 years who maintained regular physical exercise, those aged $ $75 years [OR (95% CI) = 0.34 (0.19, 0.59), P < 0.05] and those who did not maintain regular physical exercise [OR (95% CI) = 0.64 (0.42, 0.96), P < 0.05] were less likely to complete the full vaccination series; compared with those with chronic diseases, those without chronic diseases were more likely to complete the full series [OR (95% CI) = 1.59 (1.05, 2.40), P < 0.05]. Compared with elderly individuals aged 60-64 years from the central region, those aged $ $75 years [OR (95% CI) = 0.55 (0.36, 0.86), P < 0.05] and those from the eastern region [OR (95% CI) = 0.47 (0.34, 0.64), P < 0.05] were less likely to receive booster doses; compared with those with chronic diseases, those without chronic diseases were more likely to receive booster doses [OR (95% CI) = 1.54 (1.15, 2.06), P < 0.05]; and elderly individuals with higher perceived severity levels were more likely to receive booster doses [OR (95% CI) = 1.06 (1.00, 1.11), P < 0.05]. Subgroup analysis showed that, compared with elderly individuals with chronic diseases aged 60-64 years from the central region, those aged $ $75 years [OR (95% CI) = 0.35 (0.19, 0.65), P < 0.05] and those from the eastern region [OR (95% CI) = 0.49 (0.29, 0.83), P < 0.05] were less likely to receive booster doses; elderly individuals with chronic diseases who had higher perceived severity levels were more likely to receive booster doses [OR (95% CI) = 1.09 (1.01, 1.18), P < 0.05]. Compared with elderly individuals without chronic diseases from the central region, those from the eastern region were less likely to receive booster doses [OR (95% CI) = 0.44 (0.29, 0.68), P < 0.05].

Conclusion: In the process of implementing COVID-19 vaccination for the elderly, special attention should be paid to those of advanced age and those with chronic diseases. Through strengthening publicity and education on COVID-19 vaccine knowledge, the vaccination rate among the elderly can be further improved.

Full Text

COVID-19 Vaccination Behavior and Its Influencing Factors among the Elderly in Four Regions of China

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Abstract

Background: The elderly represent a priority population for COVID-19 vaccination, as vaccination effectively reduces their risk of developing severe illness, critical conditions, or death following SARS-CoV-2 infection. However, vaccination rates among older adults in China remain relatively low, and few studies have examined their vaccination behavior.

Objective: To analyze COVID-19 vaccination behavior and its influencing factors among elderly individuals in China, providing evidence to improve vaccination coverage in this population.

Methods: From August 3–14, 2022, we conducted a survey of 1,323 adults aged 60 years and older selected through stratified random sampling from Wujin District (Changzhou), Zhongmu County (Zhengzhou), Chengzhong District (Xining), and Linkou County (Mudanjiang). A self-designed questionnaire was administered. Binary logistic regression was used to identify factors influencing first-dose vaccination, full-course completion, and booster dose uptake.

Results: Among participants, 96.60% (1,278/1,323) had received the first vaccine dose, 91.76% (1,214/1,323) completed the full vaccination course, and 79.67% (1,054/1,323) received a booster dose. Binary logistic regression revealed that, compared with those aged 60–64 years, individuals aged $ $75 years were less likely to receive the first dose [OR (95%CI) = 0.27 (0.11, 0.62), P<0.05]. Those without chronic diseases showed higher first-dose uptake than those with chronic conditions [OR (95%CI) = 2.07 (1.12, 3.84), P<0.05], and higher perceived benefit scores were associated with increased first-dose vaccination [OR (95%CI) = 1.39 (1.07, 1.79), P<0.05].

For full-course completion, individuals aged $ $75 years [OR (95%CI) = 0.34 (0.19, 0.59), P<0.05] and those not engaging in regular physical exercise [OR (95%CI) = 0.64 (0.42, 0.96), P<0.05] were less likely to complete vaccination compared with those aged 60–64 years who exercised regularly. Participants without chronic diseases demonstrated higher completion rates [OR (95%CI) = 1.59 (1.05, 2.40), P<0.05].

Regarding booster doses, individuals aged $ $75 years [OR (95%CI) = 0.55 (0.36, 0.86), P<0.05] and those from eastern regions [OR (95%CI) = 0.47 (0.34, 0.64), P<0.05] were less likely to receive boosters compared with those aged 60–64 years from central regions. Participants without chronic diseases showed higher booster uptake [OR (95%CI) = 1.54 (1.15, 2.06), P<0.05], and higher perceived severity scores were associated with increased booster vaccination [OR (95%CI) = 1.06 (1.00, 1.11), P<0.05].

Subgroup analysis indicated that among elderly individuals with chronic diseases, those aged $ $75 years [OR (95%CI) = 0.35 (0.19, 0.65), P<0.05] or from eastern regions [OR (95%CI) = 0.49 (0.29, 0.83), P<0.05] were less likely to receive boosters compared with those aged 60–64 years from central regions. Higher perceived severity was associated with increased booster uptake among those with chronic diseases [OR (95%CI) = 1.09 (1.01, 1.18), P<0.05]. Among those without chronic diseases, individuals from eastern regions showed lower booster uptake than those from central regions [OR (95%CI) = 0.44 (0.29, 0.68), P<0.05].

Conclusion: COVID-19 vaccination efforts should prioritize elderly individuals who are of advanced age and those with chronic diseases. Strengthening health education about COVID-19 vaccines can further improve vaccination rates among older adults.

Keywords: COVID-19; COVID-19 vaccines; Vaccination behavior; Elderly; Root cause analysis

Introduction

The COVID-19 pandemic poses a substantial threat to global health, particularly among older adults [1-2]. Due to relatively weaker immune function, elderly individuals are more susceptible to SARS-CoV-2 infection. Moreover, the high prevalence of chronic diseases in this population further elevates their risk of developing severe illness, critical conditions, or death following infection [3-4]. Data from the Chinese Center for Disease Control and Prevention indicate that among confirmed COVID-19 cases and deaths in China, individuals aged 60 years and older account for 31% and 81% of the total, respectively [5]. Prior to vaccine availability, the mortality probability among infected individuals aged $ $60 years exceeded 1%, substantially higher than that among 7-year-olds (0.0023%) and 30-year-olds (0.0573%) [4]. These findings underscore that the elderly constitute a high-risk group requiring prioritized attention in pandemic prevention and control efforts.

Research demonstrates that COVID-19 vaccination effectively reduces the risk of severe illness, critical conditions, and death among older adults [6-7], with booster doses providing additional protection [8]. During the large-scale outbreak in Hong Kong from January to March 2022, unvaccinated individuals aged $ $60 years faced a 21.3-fold higher mortality risk compared with those who had received two or more vaccine doses [9]. As of November 28, 2022, 90.69% of Chinese adults aged $ $60 years had received their first vaccine dose, 86.42% completed the full vaccination course, and 180 million had received booster doses [10]. As China continues to optimize its COVID-19 prevention and control measures, vaccination of older adults has become a public health priority. On November 29, 2022, the State Council's Joint Prevention and Control Mechanism issued the "Work Plan for Strengthening COVID-19 Vaccination Among the Elderly" [11], highlighting the importance of accelerating vaccination coverage to protect older adult health and establish robust population immunity. However, current research on COVID-19 vaccination among Chinese older adults remains limited. This study investigates vaccination behavior and its determinants among adults aged $ $60 years to inform strategies for improving vaccination rates.

Methods

1.1 Study Participants We conducted a cross-sectional survey from August 3–14, 2022, using stratified random sampling to select participants from four regions: Wujin District (Changzhou, Jiangsu Province), Zhongmu County (Zhengzhou, Henan Province), Chengzhong District (Xining, Qinghai Province), and Linkou County (Mudanjiang, Heilongjiang Province). The sampling procedure followed the National Bureau of Statistics' classification of eastern, central, western, and northeastern regions [12]. We randomly selected one province from each region, then one city from each province, followed by one district/county from each city, and finally at least two villages or communities from each district/county. Within selected households, we recruited adults aged $ $60 years. Exclusion criteria included: (1) severe cognitive impairment, (2) poor communication ability, and (3) local residence duration <6 months. The study protocol was approved by the Zhengzhou University Life Science Ethics Committee (Approval No: 2021-01-12-05), and all participants provided informed consent.

Sample size was calculated using the cross-sectional study formula $n = z^2 \times p(1-p)/d^2$, where $\alpha = 0.05$ ($z = 1.96$), $d = 0.1p$ (allowable error), and $p = 0.61$ (expected vaccination rate based on national data showing 180 million booster doses administered among 290 million eligible older adults as of May 5, 2022 [13]). The initial calculation yielded $n = 246$. Accounting for a 15% invalid response rate, the minimum required sample was 283. During sampling, we exceeded this minimum to maximize representation.

1.2 Survey Instruments **1.2.1 General Information Questionnaire:** Developed by our research team to collect demographic data (age, gender, marital status, education level, regular physical exercise, chronic disease status) and COVID-19 vaccination history.

1.2.2 COVID-19 Vaccine Perception Scale: Developed based on existing literature [14-15], this 12-item scale assesses four dimensions: perceived severity (3 items), perceived susceptibility (2 items), perceived barriers (4 items), and perceived benefits (3 items). Perceived severity refers to the perceived threat of SARS-CoV-2 infection to personal health; perceived susceptibility reflects the perceived likelihood of infection; perceived benefits indicate the perceived advantages of vaccination; and perceived barriers represent anticipated difficulties following vaccination. All items use a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), with dimension scores calculated by summing relevant items. Cronbach's α coefficients were 0.879 for perceived severity, 0.865 for perceived susceptibility, 0.907 for perceived benefits, and 0.927 for perceived barriers.

1.2.3 Trust in Doctors and Vaccine Developers Questionnaire: Adapted from the Oxford University instrument [16] and validated in Chinese populations [17-18], this 14-item questionnaire assesses trust in doctors (9 items) and vaccine developers (5 items). Items use a 5-point Likert scale (1 = strongly disagree to

5 = strongly agree), with higher scores indicating greater trust. Cronbach's α coefficients were 0.859 for doctor trust and 0.871 for vaccine developer trust.

1.3 Survey Procedure and Quality Control The finalized questionnaire was administered via the "Wenjuanxing" platform. Community workers and village doctors served as surveyors and received standardized training on questionnaire content and survey procedures. Participants completed questionnaires independently. For those without smartphones or experiencing difficulty, surveyors conducted one-on-one interviews, reading questions aloud and recording responses. Quality control measures included: (1) explaining the study background and objectives to ensure informed voluntary participation; (2) assigning unique codes to participants; (3) conducting one-on-one interviews when needed; and (4) reviewing and cleaning data post-survey, excluding responses with coding errors, mismatched names, or logical inconsistencies.

1.4 Statistical Analysis Data were entered using Excel 2019 and analyzed using SPSS 23.0. Categorical variables were described using frequencies and percentages, with between-group comparisons performed using ^{2} tests. Continuous variables were expressed as mean ± standard deviation (x̄ ± s), compared between groups using independent samples t-tests. Binary logistic regression analyzed factors influencing first-dose vaccination, full-course completion, and booster uptake. Continuous variables were z-standardized before inclusion in logistic models. Statistical significance was set at $P<0.05$ (two-tailed). Regression results were visualized using forest plots.

Results

2.1 Participant Characteristics We recruited 1,323 adults aged $ $60 years (mean age 67.4 ± 6.1 years; 48.53% male). Most were married (95.16%), had junior high school education or lower (76.42%), resided in communities (53.89%), and engaged in regular physical exercise (57.75%). Chronic diseases were present in 37.49% of participants. Vaccination coverage was 96.60% for the first dose, 91.76% for full-course completion, and 79.67% for booster doses.

2.2 Scale Scores Mean scores on the COVID-19 Vaccine Perception Scale were: perceived severity 10.49 ± 3.26, perceived susceptibility 4.61 ± 2.00, perceived benefits 12.12 ± 2.49, and perceived barriers 7.99 ± 3.39. Mean trust scores were 35.82 ± 5.39 for doctors and 20.41 ± 3.43 for vaccine developers. Significant differences in perceived benefits emerged between those who did and did not receive the first dose ($P<0.05$). Full-course completers showed higher perceived benefits and doctor trust compared with non-completers ($P<0.05$). Booster recipients demonstrated higher perceived severity, perceived benefits, and trust in both doctors and vaccine developers compared with non-recipients ($P<0.05$) .

2.3 Vaccination Status by Participant Characteristics First-dose vaccination differed significantly by age and chronic disease status (P<0.05). Full-course completion and booster uptake varied significantly by age, region, regular exercise status, and chronic disease status (P<0.05) .

2.4 Factors Influencing Vaccination: Binary Logistic Regression Multicollinearity diagnostics showed variance inflation factors (VIF) ranging from 1.016 to 3.391 (all <5.000) and tolerance values >0.100, indicating no multicollinearity.

First-dose vaccination: Compared with those aged 60–64 years, individuals aged $ $75 years were less likely to receive the first dose [OR (95%CI) = 0.27 (0.11, 0.62), P<0.05]. Those without chronic diseases showed higher uptake [OR (95%CI) = 2.07 (1.12, 3.84), P<0.05], and higher perceived benefits increased vaccination likelihood [OR (95%CI) = 1.39 (1.07, 1.79), P<0.05].

Full-course completion: Individuals aged $ $75 years [OR (95%CI) = 0.34 (0.19, 0.59), P<0.05] and those not exercising regularly [OR (95%CI) = 0.64 (0.42, 0.96), P<0.05] were less likely to complete vaccination compared with those aged 60–64 years who exercised regularly. Participants without chronic diseases demonstrated higher completion rates [OR (95%CI) = 1.59 (1.05, 2.40), P<0.05].

Booster uptake: Compared with those aged 60–64 years from central regions, individuals aged $ $75 years [OR (95%CI) = 0.55 (0.36, 0.86), P<0.05] and those from eastern regions [OR (95%CI) = 0.47 (0.34, 0.64), P<0.05] were less likely to receive boosters. Participants without chronic diseases showed higher uptake [OR (95%CI) = 1.54 (1.15, 2.06), P<0.05], and higher perceived severity increased booster likelihood [OR (95%CI) = 1.06 (1.00, 1.11), P<0.05] .

2.5 Subgroup Analysis of Booster Uptake by Chronic Disease Status Given that chronic disease status independently predicted booster uptake, we conducted subgroup analyses. Among participants with chronic diseases, those aged $ $75 years [OR (95%CI) = 0.35 (0.19, 0.65), P<0.05] or from eastern regions [OR (95%CI) = 0.49 (0.29, 0.83), P<0.05] were less likely to receive boosters compared with those aged 60–64 years from central regions. Higher perceived severity increased booster uptake [OR (95%CI) = 1.09 (1.01, 1.18), P<0.05]. Among those without chronic diseases, individuals from eastern regions showed lower booster uptake than those from central regions [OR (95%CI) = 0.44 (0.29, 0.68), P<0.05] [Figure 1: see original paper].

Discussion

This study found high first-dose (96.60%) and full-course (91.76%) vaccination coverage among older adults, with 79.67% receiving booster doses—rates slightly exceeding national averages [10]. This may reflect effective vaccination promotion in surveyed areas. However, substantial proportions remain unvaccinated or under-vaccinated, particularly regarding booster doses. Advanced age ($ $75 years) consistently predicted lower likelihood of first-dose vaccination, full-course completion, and booster uptake, aligning with national reports [11]. Possible explanations include declining immune function with age, heightened concerns about adverse effects, and reduced perceived infection risk among homebound elderly individuals.

Regional differences emerged, with eastern region residents showing lower booster uptake compared with central region residents, consistent with WANG et al. [20]. This may reflect greater economic development and healthcare resources in eastern regions, fostering confidence in treatment availability should infection occur. Chronic disease status significantly influenced all vaccination outcomes; those without chronic conditions were 2.07, 1.59, and 1.54 times more likely to receive first doses, complete full courses, and receive boosters, respectively. Previous studies similarly reported low vaccination rates among Chinese cancer patients [21-22]. Elderly patients with chronic diseases often avoid vaccination due to concerns about disease exacerbation or temporary ineligibility during acute illness phases [23].

Regular physical exercise predicted full-course completion, consistent with research on influenza vaccination among coronary heart disease patients [24]. Health-conscious behaviors may reflect stronger preventive care attitudes. Perceived benefits predicted first-dose uptake, while perceived severity influenced booster decisions—higher perceived threat of COVID-19 increased booster acceptance [25-26]. Notably, perceived barriers and trust in doctors/vaccine developers did not significantly affect vaccination behavior, possibly because large-scale vaccination campaigns had already established vaccine safety and efficacy, altering these perceptions [27].

Subgroup analyses revealed that among chronically ill elderly, those aged $ $75 years or from eastern regions showed lower booster uptake, while higher perceived severity increased acceptance. These findings align with studies of diabetic patients in Saudi Arabia [28] and research showing that elderly patients with multiple comorbidities have poorer health status and greater vaccine safety concerns [29-30].

Limitations: First, this cross-sectional design precludes causal inference. Second, selecting only one city per region may limit generalizability. Third, the sample included relatively few western region residents, potentially limiting representativeness. Fourth, data collection occurred before China's shift to "Class B management" on January 8, 2023; vaccination rates may differ under current policies.

In conclusion, while first-dose coverage is high among Chinese older adults, full-course and booster completion require improvement. Age, region, chronic disease status, physical exercise, perceived benefits, and perceived severity represent key influencing factors. Vaccination strategies should prioritize advanced-age and chronically ill elderly populations while strengthening health education to enhance vaccination coverage.

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Author Contributions: WU Jian and FU Xiaoli conceived and designed the study. YANG Yinmei conducted feasibility analysis. XIA Qingyun collected literature and data. YU Chengcheng drafted the manuscript. WU Jian and YU Chengcheng revised the manuscript. LI Quanman revised the English language. WU Jian supervised quality control and review. FU Xiaoli provided overall supervision.

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Note: Figure translations are in progress. See original paper for figures.