



## Survey on Vaccination and Infection of Middle School Students After the Full Liberalization of COVID-19

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**Abstract: Objective** To explore the situation of COVID-19 vaccination and infection among middle school students after the full liberalization of COVID-19 restriction, and to provide theoretical basis and support for health reflection after the epidemic. **Methods** On the basis of convenient sampling, A cluster sampling method was adopted. In February 2023, a survey was carried out among all the students in a town level middle school in the southeast of Henan Province in China. Their general information, COVID-19 vaccination and infection data were obtained in the form of questionnaire stars. To explore the vaccination and infection of COVID-19 among middle school students with different characteristics, and to conduct multifactor logistic regression analysis on the independent variables of different grades of middle school students, the length of sleep every day, daily exercise duration, whether they have underlying diseases, monthly families income, and the vaccination status as independent variables. and the dependent variables of infection such as those who have not been infected with COVID-19, who have been infected with COVID-19 once, who have been infected with COVID-19 twice, and who have symptoms but have not undergone nucleic acid testing. **Results** After the COVID-19 pandemic, there were 57 middle school students receiving the COVID-19 vaccine  $\leq 1$  dose, accounting for 4.54%. 794 people (63.32%) were inoculated with 2 doses; 403 patients received 3 doses, accounting for 32.14%. The number of people who were not infected was 413, accounting for 32.93%; The number of people who were infected for first-time was 697, accounting for 55.58%; 29 people were re-infected, accounting for 1.99%; There were 119 patients with unwell symptoms but no nucleic acid test, accounting for 9.49%. Through correlation test and multivariate logistic analysis, it was found that senior grades and underlying diseases were the possible factors that caused the infection and severity of COVID-19. **Conclusion** The overall vaccination of middle school students in the region is relatively good. Grade and whether there is a basic disease are related to whether they are infected with COVID-19, and whether there is a basic disease is related to reinfections. It is recommended to pay attention to the basic diseases of middle school students and maybe explore the opening of 12-year compulsory education in response to the severe infection situation in third grade. At the same time, we should carry out scientific, effective and dynamic closed-loop health management for middle school students.

**Key words:** COVID-19 vaccine; 1 infection; Reinfection; Health management

### Introduction

At the end of 2022, the Joint Prevention and Control Mechanism Comprehensive Group of the State Council issued the Notice on Further Optimizing the Implementation of the Prevention and Control Measures for the COVID-19, marking the full liberalization of China's three-year (from the end of 2019 to the end of 2022) epidemic control [1]. However, this does not mean the end of the epidemic. With the constant mutation of the novel coronavirus strain, a "pandemic" of COVID-19 infection appeared in a short period of time. When the outbreak was released in the Lunar New Year, the number of positive cases and critically ill patients in the whole population of Chinese Mainland increased dramatically. From Dec 8, 2022 to Jan 12, 2023, a total of 59,938 deaths related to COVID-19 occurred in hospitals across the country. An increase in the number of infections in short time of school students Through a search of domestic and foreign literature, no investigation has been found on COVID-19 infection among middle school students. Therefore, As the hope and future of the motherland, middle school students are also an important stage to enter early adulthood. The vaccination and infection status of this group should be paid particular attention.

On a global scale, sequential vaccination has long been regarded as an important public health strategy to contain the spread of infectious diseases [2-3]. The outbreak of the COVID-19 in a short period of time around the world and lasting for three years also promoted the research and development of vaccines. However, due to the relatively short time for clinical verification, vaccine "resistance" and vaccine "hesitation" were not active in vaccination all over the country [4-5]. An analysis of middle school students' willingness to vaccinate COVID-19 vaccine in four cities of China shows that middle school students' acceptance rate of COVID-19 vaccine accounts for about 3/5, vaccine hesitation rate accounts for about 1/3, and vaccine resistance rate is 8.36% [6]. This study retrospectively investigated the situation of middle school students in a township in southeast Henan Province in central China, with a view to understanding the situation of COVID-19 vaccination and infection among middle school students in the region, and providing reference for health reflection and health policy formulation.

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## **1 Object and Method**

### **1.1 Research object**

All students at a township level middle school in southeastern Henan Province, China.

### **1.2 Research Methods**

In order to describe the relationship between certain factors or characteristics of middle school students and COVID-19 infection, and to determine infection-related risk factors, cross-sectional investigation was adopted in this study.

The questionnaire was compiled by Delphi method, and the panel consisted of 10 clinical pediatricians, nurses, public health physicians, and school related personnel. All participants had associate senior titles. The subject of the letter is the general information of middle school students and their vaccination and infection status. The consensus was reached after four rounds of opinion solicitation. General information of individuals included: gender, grade, body mass index, average cumulative sleep time and average daily exercise time before and after the outbreak; The nature of my household registration, the per capita monthly income of my family, and the main caregivers before and after the implementation of the COVID-19 pandemic; Questions related to COVID-19 are: The number of vaccination shots I received, whether I had underlying diseases when the coronavirus was released, and whether I was infected after the release.

### **1.3 Data Collection and Quality Control**

During the on-site investigation, the questionnaire will be conducted in the form of a star, and the corresponding content will be set as mandatory according to the situation, requiring all students in the school to fill in. Participants scanned the QR code of the questionnaire using the mobile phone of school parents or caregivers and completed it within 4 days. If the filling time is less than 50 seconds and the questionnaire is the same option, it will be excluded.

### **1.4 Statistical Methods**

SPSS26.0 statistical software was used for data cleaning and analysis. The statistical data were represented by component ratio. Firstly, relevant statistical analysis was performed on the influencing factors of COVID-19 vaccination and the infection situation of middle school students in the region after the release of COVID-19. After that, multiple Logistic regression analysis was carried out on the infection of COVID-19 among middle school students in this region according to the relevant influencing factors. The test level was  $p < 0.05$ .

## **2. Results**

### **2.1 General situation**

A total of 1268 questionnaires were actually collected, and 14 invalid questionnaires were excluded, resulting in a total of 1254 questionnaires, with an effective rate of 98.89%. Personal basic information: From the perspective of gender ratio, there are 663 male students in this school, accounting for 52.87%; 591 girls, accounting for 47.13%, with slightly more boys than girls. From a grade perspective, the school has 476 first-year students, accounting for 37.96%; 397 (31.66%) in the second grade; There are 381 students (30.38%) in third grade, showing a gradual downward trend.

### **2.2 Univariate analysis of COVID-19 vaccination and infection of middle school students with different characteristics**

After the full liberalization of the COVID-19, the vaccination status of middle school students in this area is as follows: 57 (4.54%) were vaccinated  $\leq 1$ ; 794 patients received 2 doses of corona vaccine and 403 patients received 3 doses, accounting for 95.46% of the total. The data showed that gender ( $P < 0.01$ ), average daily sleep time ( $P < 0.01$ ), average daily exercise time ( $P < 0.01$ ), primary caregiver ( $P < 0.01$ ) and residence registration ( $P < 0.05$ ) were the factors that caused the differences in COVID-19 vaccination status. The COVID-19 infection: 413 people were uninfected, accounting for 32.93%; 697 first-time infected individuals, accounting for 55.58%; 29 people were infected twice, accounting for 1.99%; 119 people (9.49%) had symptoms of discomfort but did not undergo nucleic acid testing. The analysis showed that grade ( $P < 0.01$ ), average daily sleep time ( $P < 0.05$ ), average daily exercise time ( $P < 0.05$ ), whether suffering from basic diseases ( $P < 0.05$ ), and per capita monthly income of families ( $P < 0.01$ ) were correlated with COVID-19 infection (see Table 1).

### **2.3 Multiple Logistic regression analysis of COVID-19 vaccination and factors related to COVID-19 infection in middle school students**

With COVID-19 infection as the dependent variable, multiple logistic regression analysis was used to compare the differences among the four groups: uninfected, infected once, infected twice, and unwell people without nucleic acid detection. Taking the group with symptoms of discomfort but no nucleic acid testing as a reference, the first and second grade uninfected individuals have an advantage over the third grade students. Compared to the third grade students, the first grade students have 2.395 times more uninfected individuals than the third grade students, and the second grade students have 1.639 times more infected individuals than the third grade students; People without underlying diseases are more likely to have uninfected symptoms, and the risk of secondary infection with COVID-19 is 3.061 times higher than those without underlying diseases (see Table 2).

Table 1 General characteristics of middle school students in this area of the situation of COVID-19 vaccination and COVID-19 infection

group	classification	number	Vaccination status			COVID-19 infection			
			Vaccinated on $\leq 1$ dose	Inoculated with 2 doses	Inoculated with 3 doses	uninfected	First-time infection	reinfection	discomfort but not tested
gender	schoolboy	663(52.87%)	33(5.0%)	391(59.0%)	239(36.0%)	227(34.2%)	364(54.9%)	11(1.7%)	61(9.2%)
	schoolgirl	591(47.13%)	24(4.1%)	403(68.2%)	164(27.7%)	186(31.5%)	333(56.3%)	14(2.4%)	58(9.8%)
statistics	$\chi^2$		11.464			1.756			
	p		0.003			0.624			
grade	first grade	476(37.96%)	26(5.5%)	291(61.1%)	159(33.4%)	182(38.2%)	253(53.2%)	5(1.1%)	36(7.6%)
	second grade	397(31.66%)	17(4.3%)	251(63.2%)	129(32.5%)	135(34.0%)	216(54.4%)	8(2.0%)	38(9.6%)
	third grade	381(30.38%)	14(3.7%)	252(66.1%)	115(30.2%)	96(25.2%)	228(59.8%)	12(3.1%)	45(11.8%)
statistics	$\chi^2$		3.121			21.681			
	p		0.538			0.001			
weight	Low weight(< 18.5)	83(6.62%)	2(2.4%)	57(68.7%)	24(28.9%)	28(33.7%)	40(48.2%)	3(3.6%)	12(14.5%)
	Normal weight(18.5-23.9)	970(77.35%)	38(3.9%)	615(63.4%)	317(32.7%)	320(33.0%)	545(56.2%)	16(1.6%)	89(9.2%)
	Overweight(24-27.9)	201(16.03%)	17(8.5%)	122(60.7%)	62(30.8%)	65(32.3%)	112(55.7%)	6(3.0%)	18(9.0%)
statistics	$\chi^2$		9.499			5.900			
	p		0.05			0.435			
Average sleep time per day (hours)	< 8	404(32.22%)	26(6.4%)	273(67.6%)	105(26.0%)	126(31.2%)	223(55.2%)	14(3.5%)	41(10.1%)
	8-10	697(55.58%)	26(3.7%)	432(62.0%)	239(34.3%)	225(32.3%)	399(57.2%)	7(1.0%)	66(9.5%)
	> 10	153(12.2%)	5(3.3%)	89(58.2%)	59(38.6%)	62(40.5%)	75(49.0%)	4(2.6%)	12(7.8%)
statistics	$\chi^2$		14.458			13.412			
	p		0.006			0.037			
Daily exercise time (hours)	< 1	349(27.83%)	24(6.9%)	232(66.5%)	93(26.6%)	114(32.7%)	182(52.1%)	13(3.7%)	40(11.5%)
	1-2	678(54.07%)	29(4.3%)	423(62.4%)	226(33.3%)	214(31.6%)	394(58.1%)	9(1.3%)	61(9.0%)
	> 2	227(18.10%)	4(1.8%)	139(61.2%)	84(37.0%)	85(37.4%)	121(53.3%)	3(1.3%)	18(7.9%)
statistics	$\chi^2$		14.195			12.986			
	p		0.007			0.043			
Mother's educational background	Technical secondary school, high school below	1202(95.85%)	57(4.7%)	755(62.8%)	390(32.4%)	395(32.9%)	667(55.5%)	25(2.1%)	115(9.6%)
	College degree or above	52(4.15%)	0	39(75.0%)	13(25.0%)	18(34.6%)	30(57.7%)	0	4(7.7%)
statistics	$\chi^2$ (Fisher's)		4.495			0.506			
	p		0.106			0.925			
Father's	Technical secondary	1175(93.70%)	56(4.8%)	735(62.6%)	384(32.7%)	393(33.4%)	650(55.3%)	23(2.0%)	109(9.3%)

educational background statistics	school, high school below College degree or above	79(6.30%)	1(1.3%)	59(74.7%)	19(24.1%)	20(25.3%)	47(59.5%)	2(2.5%)	10(12.7%)
	$\chi^2$		5.431			2.732			
	p		0.066			0.435			
Marital status of parents	in marriage non-marital	1174(93.62%) 80(6.38%)	53(4.5%) 4(5.0%)	737(62.8%) 57(71.3%)	384(32.7%) 19(23.8%)	383(32.6%) 30(37.5%)	655(55.8%) 42(52.5%)	24(2.0%) 1(1.3%)	112(9.5%) 7(8.8%)
	$\chi^2$		2.759			0.973			
	p		0.252			0.808			
My registered residence registration	non-agricultural rural area	69(5.5%) 1185(94.5%)	7(10.1%) 50(4.2%)	48(69.6%) 746(63.0%)	14(20.3%) 389(32.8%)	18(26.1%) 395(33.3%)	46(66.7%) 651(55.6%)	0 25(2.0%)	5(7.2%) 114(9.5%)
	$\chi^2$		8.676			4.497			
	p		0.013			0.213			
Primary carer	parents grandparents other relatives	743(59.25%) 486(38.76%) 25(1.99%)	30(4.0%) 24(4.9%) 3(12%)	495(66.6%) 291(59.9%) 8(32.0%)	218(29.3%) 171(35.2%) 14(56.0%)	240(32.3%) 163(33.5%) 10(40.0%)	417(56.1%) 270(55.6%) 10(40.0%)	15(2.0%) 8(1.6%) 2(8.0%)	71(9.6%) 45(9.3%) 3(12.0%)
	$\chi^2$ (Fisher's)		17.348			6.301			
	p		0.002			0.353			
underlying disease statistics	yes no	67(5.34%) 1187(94.66%)	3(4.5%) 54(4.5%)	44(65.7%) 750(63.2%)	20(29.9%) 383(32.3%)	13(19.4%) 400(33.7%)	44(65.7%) 653(55.0%)	0(%) 25(2.1%)	10(14.9%) 109(9.5%)
	$\chi^2$		0.178			8.847			
	p		0.915			0.031			
Per capita monthly household income	< 1000 1001-2000 2000-5000 5001-10000 > 10000	172(13.72%) 308(24.56%) 518(41.31%) 203(16.19%) 53(4.23%)	8(4.7%) 15(4.9%) 23(4.4%) 9(4.4%) 2(3.8%)	126(73.3%) 178(57.8%) 323(62.4%) 133(65.5%) 34(64.2%)	38(22.1%) 115(37.3%) 172(33.2%) 61(30.0%) 17(32.0%)	80(46.5%) 91(29.5%) 157(30.3%) 68(33.5%) 17(32.1%)	74(43.0%) 179(58.1%) 300(57.9%) 115(56.7%) 29(54.7%)	6(3.5%) 10(3.2%) 5(1.0%) 2(1.0%) 2(3.7%)	12(7.0%) 28(9.1%) 56(10.8%) 18(8.9%) 5(9.4%)
	$\chi^2$		13.019			28.821			
	p		0.111			0.004			
Total			57(4.54%)	794(63.32%)	403(32.14%)	413(32.93%)	697(55.58%)	25(1.99%)	119(9.49%)

Table 2 Multi Logistic regression analysis of factors related to COVID-19 infection among middle school students in this area (n=1254)

independent variable	option	uninfected			First-time infection			reinfection		
		OR(OR 95%CI)	value	P	OR(OR 95%CI)	value	P	OR(OR 95%CI)	value	P
grade	first grade	2.395(1.429-4.013)	0.001	0.00	1.466(0.903-2.381)	0.122	0.122	0.432(0.136-1.373)	0.224	0.224
	second grade	1.639(0.980-2.742)	0.060	0.06	1.153(0.715-1.860)	0.559	0.559	0.703(0.254-1.944)	0.643	0.643
	third grade	1.00			1.00			1.00		
Average sleep time per day (hours)	< 8	0.719(0.338-1.532)	0.393	0.39	0.983(0.474-2.041)	0.964	0.964	0.643(0.162-2.555)	0.530	0.530
	8-10	0.772(0.379-1.573)			1.012(0.508-2.018)	0.972	0.972	0.290(0.068-1.229)	0.093	0.093
	> 10	1.00			1.00			1.00		
Daily exercise time (hours)	< 1	0.548(0.283-1.061)	0.074	0.07	0.624(0.332-1.173)	0.143	0.143	2.292(0.532-9.871)	0.266	0.266
	1-2	0.727(0.393-1.347)	0.311	0.31	0.923(0.512-1.664)	0.789	0.789	1.361(0.310-5.975)	0.683	0.683
	> 2	1.00			1.00			1.00		
underlying disease	yes	0.350(0.148-0.825)	0.016	0.01	0.732(0.356-1.503)	0.395	0.395	3.061(1.891-4.723)	<	0.001
	no	1.00			1.00			1.00		
Per capita monthly household income	< 1000	1.632(0.497-5.358)	0.420	0.42	0.958(0.306-2.998)	0.941	0.941	1.264(0.177-9.007)	0.815	0.815
	1001-2000	0.875(0.291-2.631)	0.813	0.81	1.046(0.371-2.950)	0.932	0.932	1.053(0.168-6.611)	0.956	0.956
	2000-5000	0.713(0.246-2.062)	0.532	0.53	0.850(0.312-2.314)	0.750	0.750	0.241(0.035-1.645)	0.146	0.146
	5001-10000	0.998(0.319-3.127)	0.997	0.99	1.026(0.439-3.020)	0.962	0.962	0.281(0.030-2.635)	0.267	0.267
	> 10000	1.00			1.00			1.00		
COVID-19 vaccination (unit: dose)	status ≤1(0-1)	2.791(0.786-9.908)	0.112	0.11	2.035(0.589-7.031)	0.261	0.261	4.436(0.596-33.005)	0.174	0.174
	2	1.270(0.818-1.971)	0.288	0.28	1.263(0.818-1.910)	0.268	0.268	1.629(0.592-4.482)	0.352	0.352
	3	1.00			1.00			1.00		

### 3 Discussion

Throughout human history, every outbreak of disease has driven medical progress to some extent. Vaccine is an effective means to prevent and respond to viruses. The pandemic of COVID-19 has also promoted the research and development of COVID-19 vaccine in many countries [7-8]. However, in practice, the comprehensive promotion and clinical application of new vaccines still face practical problems such as vaccine hesitation and vaccine resistance [9-10].

As the future of the nation, middle school students take this opportunity to carry out patriotic health education on epidemic prevention and control, and to a certain extent promote the vaccination of COVID-19 vaccine [11]. At the same time, teenagers, as the group in the second stage of vaccination, are also actively implementing the goal of "receiving as many vaccinations as possible" [12-13]. The data of this study showed that 24 (1.91%) of secondary school students were not vaccinated; 33 (2.63%) were vaccinated with 1 dose; and 1197 (95.46%) were vaccinated with 2-3 doses. 95% or more of them achieved the task of "catching all".

Analysis of the data showed that there was no significant relationship between COVID-19 vaccination and infection among secondary school students. This may also be related to a small sample size, or the location in the Central Plains region of China, which is relatively underdeveloped and has relatively few foreign exchange activities, which cannot represent the overall level of middle school students in the country. But it may also be related to the group of middle school students, whose life trajectory is relatively simple compared to other groups, so it is not possible to infer the overall infection situation of the population. However, the study concluded that grade and underlying diseases are the probability of whether COVID-19 infection and reinfections, so this study still has some reference value.

Overall, about one-third of the middle school students in the area are not infected; About half of the population are primary infections, and about 2% are reinfections. Multivariate linear regression analysis found that both the underlying diseases and the grade of school were correlated with COVID-19 infection, and the number of uninfected persons in the first grade ( $P=0.001$ ) and the second grade ( $P=0.060$ ) was significantly higher than that in the third grade. In terms of underlying diseases, the number of uninfected people without underlying diseases was different from that with underlying diseases ( $P=0.016$ ). At the same time, those with no underlying disease had a lower risk of reinfection than those with underlying disease ( $P < 0.001$ ). To some extent, this indicates that the higher the grade, the greater the academic pressure, the continuous pressure of the third grade students may bring adverse physical and mental health, increase the risk of infection and the severity of symptoms. In particular, students in the third grade of middle school are most affected by COVID-19 as they have experienced the virus throughout their entire middle school years.

This study also has certain limitations. First, in the data collection stage, it is found that some questionnaires take too long to fill in, so it can be inferred that there may be interruption in the filling process, and whether it may bring bias is still a phenomenon to be considered. Second, this study is a retrospective study, which may have recall bias, thus affecting the accuracy of the outcome. Third, the questionnaire was filled out at home, and there may be a mixed bias such as interference from family members in the filling environment.

#### 4 Conclusion and Outlook

Whether middle school students in this area are infected with COVID-19 is related to their grade and basic diseases. In terms of reinfections, it is only related to whether they have basic diseases. Therefore, it is recommended that in the context of a healthy China, middle school students should enhance their awareness of physical and mental health; Schools should make efforts in health education and promotion; At the government level, explore how to reduce the pressure on junior high school students to pursue higher education; At the level of social medicine, establish a biological psychological social health perspective, and pay attention to groups with underlying diseases and high-risk factors. At the same time, targeted and effective, scientific and standardized, dynamic closed-loop health management should be carried out, or exploration should be made to include secondary school stage in compulsory education.

Author's contribution:

Liu Yanping was responsible for conception, questionnaire collection and the first draft; Zhao Tengfei was responsible for the revision

Declaration of Conflict of Interest: There is no conflict of interest in this article

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