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Research Article

Exploring Varicella Vaccine Coverage and Influencing Factors in Rural and Pastoral Children of Qinghai Province: A Cross-Sectional Catch-Up Vaccination Study

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Abstract

Background: Varicella is a respiratory infectious disease caused by varicella-zoster virus (VZV) infection. Varicella vaccine has been shown to be highly effective in preventing varicella disease, however it is not included in Qinghai Province's local immunization planning program and must be paid for by families. Its use in local areas is options instead of compulsory, so high coverage is difficult to guarantee. Starting in October 2021, one dose of live attenuated varicella vaccine was recommended at lest for 3-17-year-old children in Qinghai. In 2022, it was conducted that an investigation of varicella vaccine coverage and factors influencing coverage among children in rural rural and pastoral areas to determine the impact of this VarV catch-up policy. *Objective: T*o explore varicella vaccine coverage and factors influencing caverage among 3-17-year-old children in rural and pastoral areas of Qinghai province. *Methods:* A stratified cluster sampling method was used to select children aged 3-17 years from kindergartens and primary /secondary schools in rural and pastoral areas of Qinghai province for a questionnaire-based survey of their guardians. Coverage levels of one and two doses of VarV ($VarV_1$ and $VarV_2$) before and after a catch-up vaccination activity initiated in October 2021, and identified factors influenceing $VarV_1$ coverage. *Results:* $VarV_1$ and $VarV_2$ coverage levels after the catch-up activity were 79.06% (676/855) and 43.79% (363/829), respectively, and increased by 34.38 and 24.13 percentage points compared with before the catch-up activity. Multivariate logistic regression showed that $VarV_1$ coverage was higher in rural areas than in pastoral areas (OR=4.63, 95%*CI*: 2.91-7.39), and higher among children whose guardians scored 4-6 or 7-10 points on knowledge about varicella and VarV than among children whose guardians scored 0-3 points (OR=8.61, 95%*CI*: 4.73-15.69, OR=2.86, 95%*CI*: 1.69-4.84). the main reasons for non-vaccination were guardians' lack of understanding of VarV (48.6%, 87 children), guardians' unawarness of the need for VarV vaccination (43.6%, 78 children), and unavailability of VarV at vaccination centers (31.3%, 56 children). *Conclusions:* The catch-up activity significantly increased VarV coverage among children in the surveyed areas. It should been strengthened that health education on knowledge about varicella and VarV among guardians of children in Qinghai, especially in pastoral areas, to promote VarV vaccination of age-eligible children.

Keywords

Varicella Vaccine, Coverage, Influencing Factor, Rural and Pastoral Areas, Children

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1. Introduction

Vaccinaion, caused by the varicella-zoster virus, is an acute respiratory infectious disease. It has an incubation period of 10-21 days, with the most common being 14-16 days [1]. Waterpox outbreaks can occur throughout the year. Infection can result in symptoms such as fever and widespread itchy rash, easily leading to outbreaks in schools and childcare facilities [2]. The primary burden of varicella is economic, as there are high number of cases, and parents and caregivers need to spend time caring for sick children. Case without complications often last for up to 2 weeks [3], during which time children are unable to attend daycare or school.

Vaccination with the Varicella vaccine (VarV) is the most effective measure for preventing chichenpox and its complications [4-6]. Although VarV has been widely used since 1974 [7], there are significant differences in public health policies regarding varicella immunization worldwide. Some countries have included varicella vaccine in their national immunization programs [8, 9]. However, in China, VarV is a classified as a Category II vaccine, which means it is voluntary and self-paid [10], making it challenging to achieve high vaccination coverage.

To better protect the health of children in Qinghai Province, the Qinghai Provincial Health Commission, Qinghai Provincial Department of Education, and Qinghai Provincial Department of Finance jointly issued a document in October 2021, recommending that each city and prefecture would autonomously organize the catch-up varicella vaccination for school-aged students. It is recommended that children up to 12 years old receive one dose, and children aged 13 and above receive two doses. Therefore, this study was conducted in the rural and pastoral areas of Qinghai Province in 2022 to investigate the VarV vaccination rate among children and its influencing factors, aiming to provide reference for improving the VarV immunization strategy for children in our province. We report the findings of this investigation.

2. Materials and Methods

2.1. Data Sources

A standardized questionnaire was used for data collection, filled out by guardians of the children through the "Wenjuanxing" platform. The survey included demographic information of the children, VarV immunization history, and the guardians' knowledge about chickenpox and VarV. The VarV immunization history information was based on the children's immunization records, and there were a total of 10 questions on chichenpox and VarV knowledge, with 1 point awarded for each correct answer and no points for wrong or unknown answers.

2.2. Study Subjects and Sampling Methods

Preschool and junior high school children were selected as the study subjects. The sample size was calculated using the formula for calculating sample size in cross-sectional surveys, $n=[Z^2P(1-P)/d^2]Deff$, with an expected VarV vaccination rate P=50%, significance level α=0.05 (Z=1.96), allowable error d=5%, design effect Deff=2, the calculated sample size was 768 cases. Considering a 10% loss to follow-up rate, the sample size was expanded to 845 cases. Stratified cluster sampling was used to select three counties in the rural and pastoral areas of Qinghai Province. One kindergarten, one primary school, and one junior high school were sampled in each county. The study included children in the kindergarden class, third grade of primary school, and eighth grade of junior high school (excluding those with a history of chichenpox).

2.3. Vaccination

VarV is not included in the immunization schedule of Qinghai Province and is administered on a voluntary, self-paid basis. Starting from October 2021, catch-up vaccination of VarV for primary and secondary school students has been implemented in Qinghai Province. Students aged ≤12 years who have not received VarV vaccination in the past, have no contraindications to VarV vaccination, and have no confirmed history of chickenpox are recommended to receive one dose. Students aged ≥13 years are recommended to receive two doses. The vaccine expenses are coordinated by the financial departments at all levels, with both self-paid and free vaccination options are available in the province.

2.4. Statistical Analysis

Microsoft Excel 2016 和 SPSS19.0 software were used for data organization and statistical analysis. The vaccination rates of the first and second doses of VarV ($VarV_1$ and $VarV_2$) among children surveyed before and after the implementation of the catch-up vaccination policy were calculated. Factor influencing the $VarV_1$ vaccination rate were analyzed using the chi-square test, and variables with significance were included in the multivariable logistic regression model for multivariable analysis.

2.5. Ethical Considerations

This study was approved by the Ethics Review Committee of Qinghai Provincial Center for Disease Control and Prevention (Approval No.2022004). Informed consent was obtained from the guardians of the children before the survey.

3. Results

3.1. Basic Characteristics of the Surveyed Subjects

A total of 926 questionnaires were collected, excluding 71 children with a history of chickenpox, resulting in 855 children (92.33%) included in the analysis. Among them, 466 (54.50%) were from rural areas and 389 (45.50%) were from pastoral areas. The study population comprised 438 (51.23%) males and 417 (48.77%) females. The average age of the children was 9.04±3.85 years (range: 3-17years). In terms of guardianship, the surveyed children were mainly cared for by mothers 516 (60.35%), followed by fathers 247 (28.89%), and other guardians 92 (10.76%).

3.2. VarV Vaccination Rate

After the catch-up vaccination, the vaccination rate of $VarV_1$ for children aged 3-17 in rural and pastoral areas of Qinghai Province was 79.06%, which increased by 34.38 percentage points compared to before the catch-up. The increase was 34.77 percentage points in rural areas and 33.94 percentage points in pastoral areas (χ^2=13.99, P<0.001). The increase was 34.93 percentage points for males and 33.81 percentage points for females (χ^2=0.007, P=0.935). Among different age groups, the vaccination coverage for children aged 3-7, 8-12, and 13-17 increased by 32.89, 21.65, and 50.19 percentage point respectively (χ^2=53.53, P<0.001). (Table 1)

After the catch-up vaccination, the vaccination rate of $VarV_2$ for children aged 3-17 in rural and pastoral areas of Qinghai Province was 43.79%, an increase of 24.13 percentage points compared to before the catch-up vaccination. Specifically, the increase was 25.22 percentage points for children in rural areas and 22.82 percentage points in pastoral areas (χ^2=54.42, P<0.001). Moreover, the increase was 24.41 percentage points for males and 23.83 percentage points for females (χ^2=1.91, P=0.38). Among different age groups, the vaccination coverage for children aged 3-7, 8-12, and 13-17 increased by 20.07, 17.55 and 36.08 percentage point respectively (χ^2=32.90, P<0.001).

Table 1. *Vaccination rate of VarV among children aged 3-17 in rural and pastoral areas of Qinghai Province before and after the catch-up in 2022.*

variables	Eligible		Pre-catch-up vaccination				Post-catch-up vaccination			
			$VarV_1$		$VarV_2$		$VarV_1$		$VarV_2$	
	$VarV_1$	$VarV_2$	Vaccinated	Rate (%)	Vaccinated	Rate (%)	Rate (%)	Vaccinated	Vaccinated	Rate (%)
Region										
Rural area	466	452	264	56.65	128	28.32	426	91.42	242	53.54
Pastoral area	389	377	118	30.33	35	9.28	250	64.27	121	32.10
Gender										
Males	438	422	200	45.66	91	21.56	353	80.59	194	45.97
Females	417	407	182	43.65	72	17.69	323	77.46	169	41.52
Aged (year)										
3-7	301	289	135	44.85	70	24.22	234	77.74	128	44.29
8-12	291	285	166	57.04	59	20.70	229	78.69	109	38.25
13-17	263	255	81	30.80	34	13.33	213	80.99	126	49.41
Total	855	829	382	44.68	163	19.66	676	79.06	363	43.79

3.3. Reasons of VarV Non-Vaccination

Among the 179 children who did not receive VarV vaccination, the main reasons for non-vaccination were guardians'lack of understanding of VarV (48.6%, 87 children), guardians' unawarness of the need for VarV vaccination (43.6%, 78 children), and unavailability of VarV at vaccination centers (31.3%, 56 children).

3.4. Factors Influencing VarV1 Vaccination

Univariate analysis revealed significant differences in $VarV_1$ vaccination rates among the surveyed children in different regions, with varying education levels of mothers, different numbers of children in the household, and different scores on guardians' knowledge of chickenpox and VarV. Multivariable logistic regression analysis indicated that the region and guardians'knowledge of chickenpox and VarV were factors influencing the $VarV_1$ vaccination rate among the surveyed children. Specifically, children in rural areas had a higher vaccination rate compared to those in pastoral areas (OR=4.63, 95%*CI*: 2.91-7.39). Additionally, children with knowledge scores of 4-6 and 7-9 on chickenpox and VarV demonstrated higher vaccination rates compared to those with scores of 0-3 (OR=8.61, 95%*CI*: 4.73-15.69, OR=2.86, 95%*CI*: 1.69-4.84). (Table 2)

Table 2. *Factors infuluencing the $VarV_1$ vaccination rate among children aged 3-17 in rural and pastoral areas of Qinghai Province in 2022.*

Variables	Surveyed	Vaccinated	Rate (%)	Single-factor analysis		Multivariable analysis	
				χ^2	*P*	OR	95%*CI*
Regions							
Rural area	466	426	91.42	94.41	0.001	4.63	2.91-7.39
Pastoral area	389	250	64.27			1.00	
Gender							
Males	438	353	80.59	1.27	0.260		
Females	417	323	77.46				
Aged (year)							
3-7	301	234	77.74	0.93	0.628		
8-12	291	229	78.69				
13-17	263	213	80.99				
Father's education level							
Below junior high school	326	258	79.14	2.19	0.533		
High/vocational school	120	93	77.50				
College associate degree	103	86	83.50				
Bachelor's degree or higher	217	179	82.49				
Unknown	89	60	67.42				
Mother's education level							
Below junior high school	316	234	74.05	11.25	0.010		
High/vocational school	114	94	82.46				
Associate degree	94	82	87.23				
Bachelor's degree or higher	241	199	82.57				
Unknown	90	67	74.44				
Number of children in the faminly							
1	212	169	79.72	14.94	0.001		
2	471	389	82.59				
3	172	118	68.60				
Average monthly income per capita of the family							
<3000 yuan	390	296	75.90	4.40	0.111		

Variables	Surveyed	Vaccinated	Rate (%)	Single-factor analysis		Multivariable analysis	
				χ^2	*P*	OR	95%*CI*
3000-4999 yuan	252	207	82.14				
≥5000 yuan	213	173	81.22				
Surveyed guardian's perception of vaccine prices							
Expensive	337	283	83.98	35.423	0.001		
Suitable	248	212	85.48				
Cheap/Does't matter	46	33	71.74				
Unclear	224	148	66.07				
Surveyed guardian's knowledge scores on chickenpox and VarV							
0-3	164	83	50.61	121.23	0.001	1.00	
4-6	304	236	77.63			8.61	4.73-15.69
7-10	387	357	92.25			2.86	1.69-4.84

4. Discussion

Varicella is a highly contagious global epidemic disease that can lead to a significant socioeconomic burden. Vaccination with VarV is the most effective measure to prevent varicella and its complications [2]. In recent years, the incidence of varicella in Qinghai Province has been increasing, with the highest rate reaching 72.0/100,000 [11, 12]. Increasing the vaccination rate of VarV among children can effectively control the varicella epidemic and create herd immunity in the population. This study showed that in 2022, the VarV1 and VarV2 vaccination rates among children aged 3-17 in some rural and pastoral areas of Qinghai Province were 79.06% and 43.79%, respectively. These rates were higher than the national VarV1 and VarV2 vaccination rates among children aged 1-14 (52.72% and 11.43%) [13], but lower than the reported rates in Shanghai [14] Hangzhou, Zhejiang Province [15], and Beijing [16]. WHO recommends that if varicella vaccine is used, coverage should be maintained at 85% to 90% to most effectively protect individes, achieve herd imunity, and avoid increasing the incidence of varicella in order individuals, who tend to have more severe cases [17]. Some studies show that outbreaks can still occur even with ≥90% one-dose coverage [18-20]. If the vaccination rate remains below 80% for an extended period, although the total number of varicella cases may decrease, there may be a shift in the age of onset for varicella [21], resulting in an increased incidence in older age groups.

Qinghai Province implemented a catch-up vaccination policy for VarV among primary and secondary school students in October 2021. Currently, VarV is not part of the national immunization program, and the funding for VarV vaccinationg among children is managed though local-level financial coordination. In some areas, the costs of vaccine administration are covered by local-level financing, while in others, they are borne by parents. The results of this study demonstrate a signigicant increase in the VarV1 and VarV2 vaccination rates among children in rural and pastoral areas of Qinghai Province following the implementation of the catch-up vaccination policy. The vaccination rates increased by 34 and 24 percentage points, respectively, compared to before the policy implementation. The increase in the vaccination rate was higher in rural areas than in pastoral areas, and the proportion of children receiving self-paid vaccination was significantly higher in rural areas. The unequal distribution of VarV vaccination rates among children in rural and pastoral areas is primarily influenced by local economic levels [22]. The study also identified a significant increase in the VarV vaccination rate among children aged 13-17 following the implementation of the catch-up vaccinaton policy, possibly due to differences in catch-up immunization strategies for VarV [23], or it might be linked to heightened parental awareness prompted by frequent campus outbreak [24]. These findings underscore the importance of policy guidance for VarV vaccination among children and recommend adherence to the 2-dose VarV immunization schedule to improve vaccination rates [25], improve vaccine efficacy, and reduce breakthrough varicella cases [26-29]. It is worth noting that administering two doses not only provides better protection than a single dose but also significantly lowers the incidence of varicella compared to a one-dose schedule [30, 31].

The study revealed that the VarV vaccination rate among children in rural areas was significantly higher than that among children in pastoral areas, and it increased with increased knowledge levels of guardians regarding varicella and

VarV. However, family income, number of children in the household, and vaccine prices were not factors influencing the VarV vaccination rate among children. This may be attributed to the implementation of the catch-up vaccination policy, which requires guardians to have their children vaccinated with VarV. Most guardians are willing to self-pay for VarV vaccination to protect their children's health. Lack of knowledge about VarV among guardians, unawareness of the need for VarV vaccination for children, and unavailability of VarV at vaccination centers were the primary reasons for children not receiving VarV vaccination. Therefore, it is feasible to explore the inclusion of VarV in the provincial immunization program based on the needs of varicella control. Further efforts are needed to strenthen the promotion and education of guadians' knowledge regarding varicella and VarV vaccination in vulnerable areas. This can be achieved through collaborative efforts among disease prevention and control departments, education departments, and other stakeholders to promote voluntary self-paid VarV vaccination among parents. Additionally, adjustments to prevention and vaccination service delivery models in rural and pastoral areas, as well as ensuring the availability of VarV in vaccination centers, will improve the accessibility of preventive vaccination services.

A major limitation of this study is that the survey was conducted among children selected from kindergartens and primary and secondary schools in the county where the study was conducted, which may lead to an overestimation of the VarV vaccination rate among children.

5. Conclusions

In conclusion, the implementation of the catch-up vaccination policy in Qinghai Province has contributed to the improvement of VarV vaccination rates among children and has encouraged voluntary and self-paid vaccination among parents to protect their children's health.

Abbreviations

VZV	Varicella-Zoster Virus
VarV	Varicella Vaccine

Author Contributions

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Xie Qingyu: Resources

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Data Availability Statement

The data supporting the outcome of this research work has been reported in this manuscript.

Conflicts of Interest

There is no conflict of interest of the authors in this study.

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