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Immunisation status and determinants of left-behind children aged 12–72 months in central China

Z.L. NI, X.D TAN*, H.Y. SHAO AND Y. WANG

School of Public Health, Wuhan University, Wuhan 430071, Hubei, China

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SUMMARY

Many parents move from rural China to urban areas in search of job opportunities, and leave their children behind to be raised by relatives. We aimed to assess the immunisation coverage, including the 1:3:3:3:1 vaccine series (one dose of Bacilli Chalmette–Guérin vaccine; three doses of live attenuated oral poliomyelitis vaccine; three doses of diphtheria, tetanus and pertussis combined; three doses of hepatitis B vaccine; and one dose of measles-containing vaccine), in children aged 12–72 months and identify the determinants of immunisation uptake among left-behind children in Hubei Province, Central China, in 2014. In this cross-sectional study using the World Health Organization's cluster sampling technique, we surveyed 1368 children from 44 villages in 11 districts of Hubei Province. The socio-demographic and vaccination status data were collected by interviewing primary caregivers using a semi-structured questionnaire and reviewing the immunisation cards of the children. Univariate and multivariate analyses were used to identify the determinants of complete vaccination and age-appropriate vaccination. For each dose of the five vaccines, the vaccination coverage in the left-behind and non-left-behind children was >90%; however, the age-appropriate vaccination coverage for each vaccine was lower in left-behind than in non-left-behind children. For the five vaccines, the fully vaccinated rate of left-behind children were lower than those of non-left-behind children (89·1%, 92·7%; $P = 0{\cdot}013$) and age-appropriate immunisation rate of left-behind children were lower than those of non-left-behind children (65·7%, 79·9%; $P < 0{\cdot}001$). After controlling for potential confounders, we found that the parenting pattern, annual household income and attitude of the primary caregiver towards vaccination significantly influenced the vaccination status of children. Moreover, we noted a relatively high prevalence of delayed vaccination among left-behind children. Hence, we believe that the age-appropriate immunisation coverage rate among left-behind children in rural areas should be further improved by delivering and sustaining primary care services.

Key words: Determinants, immunisation (vaccination), left-behind children.

INTRODUCTION

The migration of labour is a crucial consequence of economic development in many countries. An increasing number of adults migrate to urban areas to seek job opportunities in these locations [1]. Over the last decade, China has achieved marked economic growth through development of the market economy [2]. As in other countries, there is a large regional income

* Author for correspondence: X. Tan, School of Public Health, Wuhan University, Wuhan 430071, Hubei, China. (Emails: xiaodongtan0604@sina.com, xiaodongtan@yahoo.com)

imbalance has developed in China, which remains the key factor driving massive internal migration. The number of rural-to-urban migrants increased from 77 million in 1990 to 221 million in 2010, thus accounting for, 16·5% of the total population of China [3]. As most of these migrant workers perform low-paying jobs, they usually leave behind close relatives, including children, spouses and parents. Thus, a large number of children in rural areas are increasingly becoming 'left-behind', and are raised by relatives [4].

Parental migration from rural to urban areas often leads to higher incomes and enhanced socio-economic status. However, reduced parental care, in the absence of one or both parents, negatively influences development in children [5]. The adverse effects of parental separation over an extended period on the psychological, behavioural and educational outcomes have been characterised in several studies. However, only a few studies have examined the immunisation status and determinants of left-behind children in rural areas.

Communicable diseases have major impacts on health among young children, particularly in less-developed areas. At present, hepatitis B and tuberculosis are significant causes of mortality and morbidity in children [6]. Vaccination is the most effective measure for protecting children from infectious diseases [7]. The immunisation of a child lowers the likelihood of infecting other children, family members or closely connected individuals [8]. In fact, immunisation is the most cost-effective health intervention worldwide. The World Health Organization (WHO) estimated that 17% of global annual under-five mortality could be prevented by increasing routine vaccination coverage, including 5·4% through pneumococcal vaccination, 5·2% through rotavirus vaccination, 2·3% through Hib pertussis vaccination, 2·2% through pertussis vaccination, 1·3% through measles vaccination and 0·7% through tetanus vaccination [7]. However, immunisation in children is impeded by many factors, such as education and low parental knowledge [9], late birth order [10], family income [11] and even population mobility [12].

The National Immunization Program (NIP) was established in China in 1978. The 1:3:3:3:1 series includes a birth dose of Bacilli Calmette–Guérin (BCG) vaccine, three doses of oral poliovirus vaccine (OPV1 at 2 months, OPV2 at 3 months and OPV3 at 4 months), three doses of diphtheria–tetanus–pertussis vaccine (DTP1 at 3 months, DTP2 at 4 months and DTP3 at 5 months); three doses of hepatitis B vaccine (HepB1 at birth, HepB2 at 1 month and HepB3 at 6 months), and one dose of measles-containing vaccine (MV at 8 months), it is purchased by the government and provided to all children free of charge, without any extra service fees. According to the National Immunization Coverage Survey conducted in 2012, the coverage of these five types of vaccines of children aged 12–24 months are 99·79%, 99·74%, 99·44%, 99·42% and 99·49%, respectively, in China; the coverage of complete vaccination (all five vaccines) was 98·74% [13]. However, the problem of low immunisation coverage of left-behind children should be clearly recognised.

Hubei is a big multi-ethnic province with a large fluid population. It is located in the middle part of China, and plays an important part in economic and social development. Hubei Province is also a major agricultural province in the middle part of China, with 70% of the population residing in rural areas. Many rural labourers from Hubei Province acquire jobs in other areas. Consequently, approximately 30% of children in Hubei Province are left behind by parents to be raised by grandparents or other relatives. Therefore, a study of the vaccination coverage of the five basic vaccines among left-behind children in Hubei Province is important.

In the present study, we aimed to assess the age-appropriate coverage of the five vaccines among the left-behind children and non-left-behind children in Hubei, and explore the determinants associated with complete and age-appropriate immunisation coverage in left-behind children.

METHODS

Target population

In this study, the target population included children, who were born between 1 January 2008 and 31 December 2013 in Hubei Province, and their primary caregivers. Children were categorized into left-behind and non-left-behind children. We defined a left-behind child as a child residing in the family household for a period of at least 6 months with parents who were migrant workers currently working away from their hometown for a period of at least 6 months. Children who had been residing in the province for <3 months were excluded. Based on the guidelines of China's Ministry of Health on the evaluation of immunisation rate, primary immunisation was considered as age-appropriate vaccination with the five types of vaccines at the required doses within the first 12

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months. In rural areas, most children aged 72 months or more would enter primary schools and should be excluded to avoid the impact on our results of immunisation requirements of the primary schools.

In the present study, a primary caregiver was defined as a person responsible for caring for the left-behind child on a daily basis, for a period of at least 6 months, which comprised activities such as arranging daily schedules, preparing or ensuring access to meals, taking the child for immunisation, looking after the child when he/she is sick.

Sample design and investigations

A cross-sectional study was conducted using the multi-stage stratified sampling method based on the WHO-advocated cluster sampling technique [14]. In China, the smallest administrative rural population unit is the 'village unit'. In the first stage, a total of 103 counties in Hubei Province were stratified by terrain: plains, hills and mountains. Thereafter, nine districts, including three districts from each terrain, were identified from the 103 districts via simple random selection. In the second stage, four villages were randomly selected from each district. Accordingly, 36 villages were selected as clusters. By reviewing the measles vaccination coverage of the children aged 0–6 years in Hubei Province in 2010 (86%) [15], using a desired precision of ±5% with 95% confidence intervals, and assuming a design effect of 2, we obtained the required number of surveyed children per cluster for a variable number of clusters, according to the table recommended by the WHO manual [14]. The final sample size was determined as a total of 31 children per cluster for 36 clusters. Thus, the final population included 1116 children in nine districts covering 72 villages. The sampling weights were calculated for each county based on the distribution of left-behind and non-left-behind children. One household per sampled village was chosen as the starting point, and the investigators were divided into four groups for conducting household surveys from the centre of the village to all directions in concentric circles.

Information on the demographic and socio-economic characteristics (age, gender, education, occupation, income, ethnicity, attitudes towards vaccination, distance from home to the immunisation centre, etc.) of the primary caregivers was collected via a face-to-face interviewer-administered questionnaire. Immunisation status data were obtained by reviewing the child's home immunisation certificate or by reviewing the child's immunisation card at the immunisation station if the certificate was not available. If neither were available, the registry of the village doctor was reviewed, and the names of the children and parents, as well as the birth date of the children, were recorded after surveying the essential information. Moreover, the immunisation status was assessed online via the system of the expanded NIP in Hubei Province to complete the questionnaires. In the absence of any information, the child's immunisation status was recorded as 'unvaccinated' or 'unknown'. Moreover, to explore the reason why the children were not fully vaccinated, we also examined the caregivers whose children were not fully vaccinated.

Variable definitions and data analysis

There were two outcomes in the present study: (1) the full vaccination rate was considered in children who received all the vaccine series at the required doses, regardless of the age at each dose, whereas the incomplete vaccination rate was considered in children who did not receive any vaccinations or did not receive all the doses for each vaccination; and (2) the age-appropriate immunisation rate was defined as the percentage of children who received all the vaccines at the required dose and at the appropriate age.

The individual-level variables included parenting style (both-parenting, grand-parenting or single-parenting); gender (male, female); and HuKou (rural, urban); only child (yes, no). The household-level variables included parenting style, caregiver education level, caregiver occupation, family income (the annual income of all family members), caregiver attitude and knowledge of vaccination. The socio-demographic variables comprised terrain (plains, mountains and hills); economic condition (developed, middle and underdeveloped); and residential status (local and recurrent population).

All data were individually uploaded twice to the database using Expanded Program on Immunization (EPI) Data 3·02 software, and were reviewed by a different person. Statistical analyses were performed using SPSS (Statistical Package for Social Sciences) version 21·0 and Excel 2007 software. By using complete vaccination as a reference, statistical analysis, including descriptive analysis, was performed to determine the coverage of various vaccines in left-behind and non-left-behind children. The χ^2 tests were used to evaluate the relationship between vaccination status

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and each factor. A stepwise regression method for two-way selection was used to repeatedly exclude non-significant variables, thus yielding a local optimum regression equation. Multivariate forward logistic regressions were used to identify the factors independently associated with complete vaccination and the timeliness of vaccination.

RESULT

Socio-demographic characteristics

A total of 1368 children and their primary caregivers participated in the study. The children had different primary caregivers, including both parents in 725 (52·99%) non-left-behind children, grandparents in 366 (26·72%) left-behind children with both parents working outside the village and 278 (20·29%) left-behind children with one parent working outside the village.

A similar gender disaggregation profile was observed in both non-left-behind and left-behind children (55·85% male and 44·15% female). At the time of the survey, 36·62% children were aged 12–24 months, whereas 34·72% children were aged 25–48 months. Moreover, 623 children (45·54%) were the only child in the household. More than half of the caregivers had attended middle school (58·26%), and a relatively small proportion (7·38%) received a high school education or greater. The other socio-demographic characteristics of the participants are listed in Table 1.

Immunisation coverage for each dose of the primary course in left-behind and non-left-behind children

The immunisation rate for each dose of the five vaccines is listed in Table 2. The first-dose hepatitis B vaccination rates among left-behind and non-left-behind children were the highest (98·2% and 98·7%, respectively). The immunisation rates for HepB, BCG, OPV, DPT, and MCV ranged from 90·8% to 97·5% in left-behind children and 92·1% to 98·7% in non-left-behind children. Non-left-behind children (92·7%) were more likely to receive complete vaccination as compared with left-behind children (79·9%); the difference was statistically significant (χ^2=35·2, $P < 0·001$). Moreover, the coverage for each of the five vaccines decreased with each subsequent dose. The coverage gap between the first and third dose of HepB ranged from 6·7% among left-behind children to 4·6% among non-left-behind children. Moreover, for the all five vaccines, the age-appropriate immunisation rates of all children were lower than the vaccination coverage. In addition, the age-appropriate immunisation rates for almost all the doses exhibited significant differences between left-behind and non-left-behind children.

Determinants of complete vaccination and age-appropriate vaccination

Multivariate forward logistic regression was used to identify the factors independently associated with the complete immunisation and age-appropriate immunisation. Multinomial logistic regression analyses indicated significant differences in the coverage of full immunisation status and the timeliness of vaccination, parenting style, age, caregiver education, annual household income, awareness of the importance of immunisation, knowledge of the vaccination programme and satisfaction with immunisation station service. The results of multivariate forward logistic regression showed that, compared with the non-left-behind children (both-parenting), children with single-parenting and grand-parenting styles were less likely to receive complete vaccination and more likely to receive delayed immunisation. Compared with children aged 1–2 years, children aged 3–6 years exhibited lower complete vaccination and age-appropriate immunisation rate. An education level of middle school or high school and above increased the likelihood of receiving complete immunisation and age-appropriate immunisation. Moreover, an increase in household income had a positive influence on vaccination coverage and age-appropriate immunisation. If the primary caregiver was aware of the importance and schedule of immunisation, the child was more likely to be fully vaccinated and receive age-appropriate immunisation.

The results of multivariate forward logistic regression with OR values of children receiving full immunisation and age-appropriate immunisation are listed in Table 3.

DISCUSSION

The EPI has been implemented for 9 years in China, since 2005, and has eliminated the fee for immunisation services; thus, the immunisation coverage has improved. However, the incidence of some related infectious diseases remains high, and the outbreak of epidemics, such as that of measles, remains an actual

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Table 1. *Socio-demographic characteristics of participants in our study*

	Left behind		Not left behind		Total	
	N	%	*N*	%	*N*	%
Parenting style						
Single-parenting	278	43·23	–	–	–	–
Grand-parenting	365	56·77	–	–	–	–
Gender						
Boy	352	54·74	412	56·83	764	55·85
Girl	291	45·26	313	43·23	604	44·15
Child's age (months)						
12–24	235	36·55	307	42·34	542	39·62
25–48	211	32·81	264	36·41	475	34·72
49–72	197	30·64	154	21·24	351	25·66
Only child						
Yes	280	43·55	343	47·31	623	45·54
No	363	56·45	382	52·69	745	54·46
Caregiver's education						
No schooling	97	15·09	98	13·52	195	14·25
Elementary school	126	19·60	149	20·55	275	20·10
Middle school	378	58·79	419	57·79	797	58·26
High school and above	42	6·53	59	8·14	101	7·38
Caregiver's age (years)						
<30	110	17·11	322	44·41	432	31·58
31–40	121	18·82	281	38·76	402	29·39
41–50	124	19·28	76	10·48	200	14·62
>51	288	44·79	46	6·34	334	24·42
Annual household income (Yuan per year)						
<5000	121	18·82	160	22·07	281	20·54
5000–8000	323	50·23	359	49·52	682	49·85
>8000	199	30·95	206	28·41	405	29·61
Terrain						
Plain area	283	44·01	332	45·79	615	44·96
Hilly area	151	23·48	165	22·76	316	23·10
Mountainous area	209	32·50	228	31·45	473	31·94
Awareness of the importance of immunisation						
No	122	18·97	133	18·34	255	18·64
Yes	521	81·03	592	81·66	1113	81·36
Knowledge of the vaccination programme						
No	269	41·84	288	39·72	557	40·72
Yes	374	58·16	437	60·28	811	59·28
Satisfied with the immunisation station service						
No	76	11·82	90	12·41	166	12·13
Yes	567	88·18	635	87·59	1202	87·87
Total	643	47·01	725	52·99	1368	100

threat [6]. From 2006 to 2012, Hubei experienced nine outbreaks of measles with 209 cases [16]. From 2005 to 2014, in Hubei, there are 219 outbreaks of mumps with 9213 cases [17]. Hence, it is vital to understand the actual vaccination status of the children and assess the behaviour and beliefs of parents towards vaccination.

Due to rapid economic growth and urbanisation, China has recently experienced unprecedented urbanisation and changes in the structure of society [4]. The number of individuals migrating from rural areas to urban areas is markedly increasing. The low vaccination coverage of migrant children has been examined in China and other developing countries [18]. However, the low immunisation rate and low age-appropriate immunisation rate of left-behind children remains unclear. The differences in the immunisation rate, particularly the age-appropriate

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Table 2. *Recommended childhood primary immunisation schedule in China and coverage of the immunisation status for each vaccine (%)*

	Vaccination coverage %				Age-appropriate vaccination coverage %			
Vaccine 1	L-b children	N-l-b children	χ^2	*P*	L-b children	N-l-b children	χ^2	*P*
BCG	97·5	98·7	3·832	0·041	92·1	93·5	1·076	0·176
OPV1	95·5	96·8	1·322	0·125	82·6	86·7	4·611	0·019
OPV2	92·4	94·5	2·474	0·072	81·7	85·8	4·322	0·023
OPV3	91·3	92·1	0·221	0·319	77·4	82·5	5·420	0·021
DPT1	93·7	94·1	03·22	0·319	73·5	81·2	11·575	<0·001
DPT2	91·7	93·2	0·117	0·409	79·9	86·7	11·537	<0·001
DPT3	90·8	93·1	1·085	0·174	75·4	81·2	6·826	0·005
HepB1	98·2	98·9	1·047	0·193	91·1	96·5	17·742	0·023
HepB2	93·2	94·5	1·039	0·182	81·5	91·7	23·386	<0·001
HepB3	91·5	94·3	3·955	0·023	80·1	90·3	29·391	<0·001
MV	91·5	93·9	2·403	0·037	70·5	80·2	17·328	<0·001
All-course	89·1	92·7	5·320	0·013	65·7	79·9	35·162	<0·001

BCG, Bacilli Calmette–Guérin vaccine; OPV, oral poliovirus vaccine; DPT, diphtheria–tetanus–pertussis vaccine; HepB, hepatitis B vaccine; MV, measles-containing vaccine; L-b, left-behind; N-l-b, non-left-behind.

immunisation rate, suggest a marked inequality between left-behind and non-left-behind children.

Data of children aged 12–72 months ($n = 1368$) were collected in this survey. The immunisation coverage rate of the 1:3:3:3:1 vaccine series in the left-behind and non-left-behind children was >90%. The goal of immunisation coverage in China for 2005 was set at 90% for the 1:3:3:3:1 vaccine series. Although the goal was reportedly achieved, we found that the immunisation rates of vaccines, particularly among left-behind children, were lower than the national immunisation rates described by the National Immunization Coverage Survey [13]. Based on the results of surveys in the neighbouring provinces of Hubei, we noted that the five-vaccine all-course vaccination coverage in left-behind children in the present study (79·9%) was lower than that in Hunan (96·0%) [19] and higher than that in Hebei [20] and Anhui (72·7%) [21]. Moreover, the first dose of these five vaccines was most likely to be administered in an age-appropriate manner, and the age-appropriate immunisation rates decreased by dose. These results were consistent with previous studies, which indicated that high coverage estimates mask the shortfalls in timeliness as well as within- and between-country disparities. Hence, great efforts are needed to improve the age-appropriate immunisation rate of these five vaccines, particularly among left-behind children. By reviewing the coverage reported in our study, and extrapolating the values to the entire Hubei Province, we estimate that approximately 10 000 children would not be fully vaccinated. It can also be assumed that there are a greater number of children who do not receive age-appropriate vaccination, compared with that reported currently. By analysing the immunisation coverage rate, we found that the factors associated with the immunisation status for the five-vaccine series were related to parenting style, child's gender and age, socio-economic conditions, terrain and primary caregiver's education and attitude towards vaccination. Compared with children residing with both parents, left-behind children tend to have a higher incidence of missing immunisation. Consistent with most previous surveys [21, 22], children from non-migrant families had better vaccination outcomes as compared with children from migrant families. Moreover, non-left-behind children were more likely to receive age-appropriate immunisation than left-behind children. Furthermore, in the present study, there was a difference in the birth doses of HepB between both groups of children. We also found that many left-behind children were born in the field by their mothers. In China, newborns are mandated to receive the first dose of HBV vaccine within 24 h after their birth in the hospital. Based on this, we think one potential reason for this difference is that a written record of immunisation history was missing during migration, and hence, the child would be regarded as unvaccinated and the immunisation procedure would be restarted when they returned to

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Table 3. *Factors associated with the five-vaccine all-course vaccination rate in binary logistic regression analysis*

	Immunisation rate			Age-appropriate immunisation rate		
	OR	95% CI	*P*	OR	95% CI	*P*
Parenting style						
Single-parenting	0·55	0·37–0·81	<0·001	0·37	0·30–0·73	<0·001
Grand-parenting	0·41	0·15–0·77		0·25	0·13–0·50	
Both-parenting	Ref			Ref		
Gender						
Boy	Ref		0·250	Ref		0·510
Girl	0·81	0·61–1·35		0·89	0·77–1·21	
Children age (months)						
12–24	Ref		0·031	Ref		0·015
25–48	0·71	0·53–0·89		0·516	0·37–0·81	
49–72	0·62	0·44–0·82		0·308	0·27–0·74	
Only child						
Yes	0·53	0·44–0·62	<0·001	0·46	0·32–0·62	<0·001
No	Ref			Ref		
Caregiver's education						
No schooling	Ref		<0·001	Ref		<0·001
Elementary school	1·14	0·69–1·41		1·21	0·78–1·97	
Middle school	2·23	2·01–3·57		2·15	1·19–5·36	
High school and above	3·15	1·37–5·13		2·89	1·62–6·05	
Caregiver's age (years)						
<30	Ref		0·751	Ref		0·574
31–40	0·89	0·65–1·20		1·01	0·72–1·23	
41–50	0·91	0·78–1·35		1·12	0·84–1·46	
>51	0·73	0·46–1·75		0·85	0·37–1·75	
Annual household income (Yuan per year)						
<5000	0·49	0·31–0·67	0·021	0·32	0·11–0·65	<0·001
5000–8000	0·78	0·54–0·86		0·45	0·23–0·79	
>8000	Ref			Ref		
Terrain						
Plain area	Ref		0·037	Ref		<0·001
Hilly area	0·80	0·65–0·99		0·75	0·56–0·95	
Mountainous area	0·62	0·41–0·94		0·54	0·24–0·89	
Awareness of the importance of immunisation						
No	0·76	0·53–0·97	0·028	0·45	0·25–0·79	<0·001
Yes	Ref			Ref		
Knowledge of the vaccination programme						
No	0·69	0·49–0·96	0·032	0·23	0·11–0·53	<0·001
Yes	Ref			Ref		
Satisfied with the immunisation station service						
No	0·85	0·61–1·21	0·79	0·82	0·57–1·35	0·56
Yes	Ref			Ref		

their home villages. Therefore, the age-appropriate immunisation coverage for the first dose of the HBV vaccine series was most likely to be underestimated.

However, in 2013, approximately 65 million children were 'left behind' in rural areas, and most were raised by their grandparents. It is noteworthy that the main cause for incomplete vaccination is the lack of an individual to take the child to the immunisation station. A survey of individuals in the Hubei Province shows that left-behind children have poor living conditions, lag in educational attainment, insecurity and difficultly in communication [23]. Moreover, the left-behind children may have reduced sources of information and a lower acceptance of medical care in general, and preventive health services in particular.

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In the present study, the primary caregiver education level and awareness of the importance of immunisation were significantly associated with the children's immunisation status. Parental knowledge of vaccination may lead to improved sustainable management of a child's immunisation at the appropriate age. As most primary caregivers of left-behind children were grandparents who did not complete middle school, they were unware of the importance of immunisation to the child's health, and hence, they did not precisely follow the immunisation schedules. The current results indicated that a higher level of awareness of vaccination in the primary caregiver led to better vaccination status among children in rural China. This suggests that improving caregiver knowledge and practices may help improve a child's immunisation rate. Interventions for caregivers have been proven to be effective for improving the vaccination outcomes of preschool children in China [18]. Hence, these interventions are urgently required for younger children who are left behind. Based on the answers to questions of awareness of the importance of immunisation and knowledge of the vaccination programme in our survey, we found that, compared with parents, grandparents had a relatively lower level of vaccination-related health literacy, and that a caregiver's age was inversely correlated with health literacy. These findings are consistent with the results of a previous study, which indicated that targeted interventions should specifically meet the needs of non-parent caregivers [24].

Consistent with previous studies [25, 26], the geographic region of the present study had a significant effect on the childhood full immunisation status. The proportion of fully vaccinated children was higher in plain areas than in mountainous and hilly areas. First, the children who live in poor rural areas, usually in mountainous areas, are very difficult to reach, particularly for health services. Second, it is known that health resources are unevenly distributed in different areas; high healthcare quality resources are primarily concentrated in urban areas and are relatively scarce in rural areas. Vaccination services are provided daily in cities; however, children in mountainous areas are usually vaccinated at an immunisation station on a single day in the month.

In addition, family income is significantly correlated with the vaccination status in children. The vaccination coverage and timeliness of vaccination of the five-vaccine series among the children from high-income families were better than those among children in low-income families. We hypothesised that the caregivers are under pressure to receive income, and are hence too busy to take children to receive vaccines. Accordingly, we found that women and children from low-income families were at a disadvantage in terms of access to healthcare in rural China [27].

Similar to other studies [28] there was no significant gender-related difference in immunisation in the present study. This phenomenon suggests that there is no sex-related bias in vaccination. However, compared with children who were an only child, those who were not the only child had markedly worse vaccination status. A major reason was that parents in China pay more attention to the care of children in families with one child than in families with many children. This finding is consistent with previous studies [29, 30], wherein children born to parents with two or three children were found to have a lower likelihood of receiving full vaccination as compared with children born to families with only one child.

In China, the government conducts immunisation programmes as social public welfare undertakings. Hence, the government should increase the investment in the programme and offer policy support to cover the immunisation programme and personnel expenses. It is also necessary to strengthen policy coordination among various departments, actively mobilise the participation of the civil society, and expand the coverage of the public health service system. The government should also pay more attention to the management of left-behind children, and enhance the standards and system of immunisation services. Vaccination inspection of enrolled children and improvement of the revaccination service model in unvaccinated school children are essential to implement revaccination services [31]. The developments made in the information age should be embraced, and measures to broaden the public knowledge of preventive immunisation, establish immunisation programmes via the short message service (SMS) platform, and send reminder messages to caregivers whose children drop out from vaccination, should be initiated. In particular, the SMS platform is an appropriate method for reminding parents in mountainous areas to take their children for vaccination. Vaccination clinics are the primary location for immunisation, and the building of standardised vaccination clinics is important to improve vaccination rates as well as the satisfaction of patients with the vaccination clinics [32]. In the present survey, we found that some parents were still concerned about adverse reactions to vaccination. First, vaccines need to be stored and managed

appropriately, or they would lose potency and become less effective. Second, the knowledge of vaccines should be imparted routinely to ensure that a greater number of individuals become aware that vaccines used as part of China's EPI are safe and effective, and that these vaccines have eliminated polio and neonatal tetanus and reduced vaccine-preventable diseases to very low levels in China. During 2010–2014, the incidence of hepatitis B was 110 per 1 00 000 whereas that of tuberculosis was 78 per 100 000 [9, 33]. Considering the increase in the number of children requiring vaccination, the creation of vaccination centre with electronic information system is important to ensure an appropriate quality of immunisation and an increase in the immunisation rate. Moreover, healthcare education should be amended to convey the benefits of the NIP policy and vaccination-related knowledge to the masses. Last but not least, the national immunisation research network should be established to seek to implement an effective surveillance method to measure immunisation coverage and adverse events to provide correct information to public health authorities in time [34].

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AUTHOR CONTRIBUTIONS

Z.L.N., X.D.T., H.Y.S. and Y.W. contributed to the conception, design and interpretation of data. Z.L.N. and X.D.T. wrote the manuscript. All authors read and approved the final manuscript.

DECLARATION OF INTEREST

None.

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