Ann Ig. 2024 May-Jun 36(3): 335-352. doi: 10.7416/ai.2023.2590. Epub 2023 Dec 14.

Expanded vaccination practice in 2-year-old children and maternal knowledge on expanded vaccination in Tien Giang, Vietnam

Giau Le Ngoc Nguyen[1], Giang Vu Truong Nguyen[2], Mai Thi Nhu Nguyen[3], Doi Van Nguyen[4], Ngoc Trung Thi Phan[1], Van De Tran[5], Trung Tin Pham[5], Minh Huu Le[6], Dat Tan Nguyen[7], Tam Thi Pham[8]

Keywords: Expanded vaccination; knowledge; 2-year-old children; Vietnam
Parole chiave: Vaccinazione ampliata; conoscenza; bambini di due anni; Vietnam

Abstract

Background. *Vaccination plays a central role in protecting children against severe diseases and preventing child mortality.*
Objectives. *This study aimed to determine the rate and factors associated with complete and timely vaccination in 2-year-old children, as well as maternal knowledge on expanded vaccination in Go Cong Tay district, Tien Giang province, Vietnam.*
Methods. *A cross-sectional descriptive study was conducted on 558 2-year-old children and their mothers residing in Go Cong Tay district, Tien Giang province, Vietnam. The study employed a systematic random sampling method from June to September 2021.*
Results. *The rate of complete vaccination in children was 74.7%. Factors associated with the rate of complete vaccination were occupation (OR=0.3; 95%CI: 0.1-0.7; p=0.006), economic status (OR=3.8; 95%CI: 1.7-8.6; p=0.001), and maternal general knowledge on expanded vaccination (OR=1.7; 95%CI: 1.1-2.6; p=0.01). The rate of timely vaccination was 47.8%. Factors associated with the rate of timely vaccination were maternal age group (OR=3.1; 95%CI: 1.6-6.0; p=0.001; OR=3.0; 95%CI: 1.3-6.6; p=0.006) and economic status (OR=0.4; 95%CI: 0.2-0.9; p=0.04). The rate of both complete and timely vaccination was 22.6%. Factors associated with the rate of complete and timely vaccination were maternal age group (OR=3.1; 95%CI: 1.3-7.2; p=0.009; OR=3.3; 95%CI: 1.2-9.1; p=0.02) and maternal general knowledge on expanded vaccination (OR=1.5; 95%CI: 1.0-2.4; p=0.03). The rate of maternal general knowledge on expanded vaccination was 57.5%.*
Conclusion. *The rates of complete and timely vaccination are still low, and various factors influence expanded vaccination. Therefore, it is crucial to continue health education campaigns to improve knowledge on expanded vaccination, remind mothers of vaccination schedules, strengthen confidence in vaccination programs and vaccine safety, attract customers to vaccination services, provide adequate healthcare for children, and ensure vaccination activities during disease outbreaks.*

[1] *Department of Environmental Health, Can Tho University of Medicine and Pharmacy, Can Tho City, Vietnam*
[2] *Go Cong Tay District Health Center, Tien Giang Province, Vietnam.*
[3] *Can Tho Preventive Health Center, Can Tho City, Vietnam*
[4] *Department of Histology and Embryology, Can Tho University of Medicine and Pharmacy, Can Tho City, Vietnam*
[5] *Department of Health Organization and Management, Can Tho University of Medicine and Pharmacy, Can Tho City, Vietnam*
[6] *Department of Epidemiology, Can Tho University of Medicine and Pharmacy, Can Tho City, Vietnam*
[7] *Department of Biostatistics and Demography, Can Tho University of Medicine and Pharmacy, Can Tho City, Vietnam*
[8] *Department of Nutrition and Food Safety, Faculty of Public Health, Can Tho University of Medicine and Pharmacy, Can Tho, Vietnam*

The authors (Giau Le Ngoc Nguyen and Giang Vu Truong Nguyen) contributed equally to the study and share the first authorship.

Annali di Igiene : Medicina Preventiva e di Comunità (Ann Ig)
ISSN 1120-9135 https://www.annali-igiene.it

Introduction

Since 1981, the Ministry of Health initiated the Expanded Immunization Program with the aim of expanding and developing immunization services for all children in developing countries, with the support of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF). The program has gradually expanded in terms of geographical coverage and target population. Since 1985, all children under the age of 2 have been included in the national expanded immunization program in Vietnam, providing them with access to immunization services. Expanded immunization is one of the most successful national community healthcare and protection programs in Vietnam (1-3).

Children under 2 years old in Vietnam receive free immunization with twelve types of vaccines, including tuberculosis, diphtheria, pertussis, tetanus, measles, polio, hepatitis B, Haemophilus influenzae type B, Japanese encephalitis, typhoid fever, paratyphoid fever, and rubella (3).

The Immunization System in Vietnam is a collaboration of state management at various administrative levels, extending from communes to districts, provinces, and the entire nation (Ministry of Health). It also operates in conjunction with national target programs and projects (Figure 1, 2). Vaccines are distributed nationwide from a central warehouse to local sites. Vaccination for children and pregnant women is free, occurring monthly at designated sites. Additionally, a private vaccination system exists in Vietnam. Before vaccination, private providers must notify the Department of Health and meet specific requirements. They purchase and supply vaccines, charging parents for their children's vaccinations, even if they miss their scheduled appointment.

The Expanded Immunization Program faces new challenges in maintaining the achievements gained and reaching communities with low immunization coverage. At present, coverage in mountainous areas, remote regions, and ethnic minority populations remains low. There are also concerns about vaccine hesitancy, where some parents lack trust in the quality of vaccines, fueled by misinformation. Erosion of public trust often occurs after rare adverse events following immunization (4). The COVID-19 pandemic resulted in 23 million children missing essential vaccines in 2020, nearly 4 million more than in 2019. The global coverage rate for the third dose of diphtheria-tetanus-pertussis vaccine (DTP3) decreased from 86% in 2019 to 83% in 2020. The

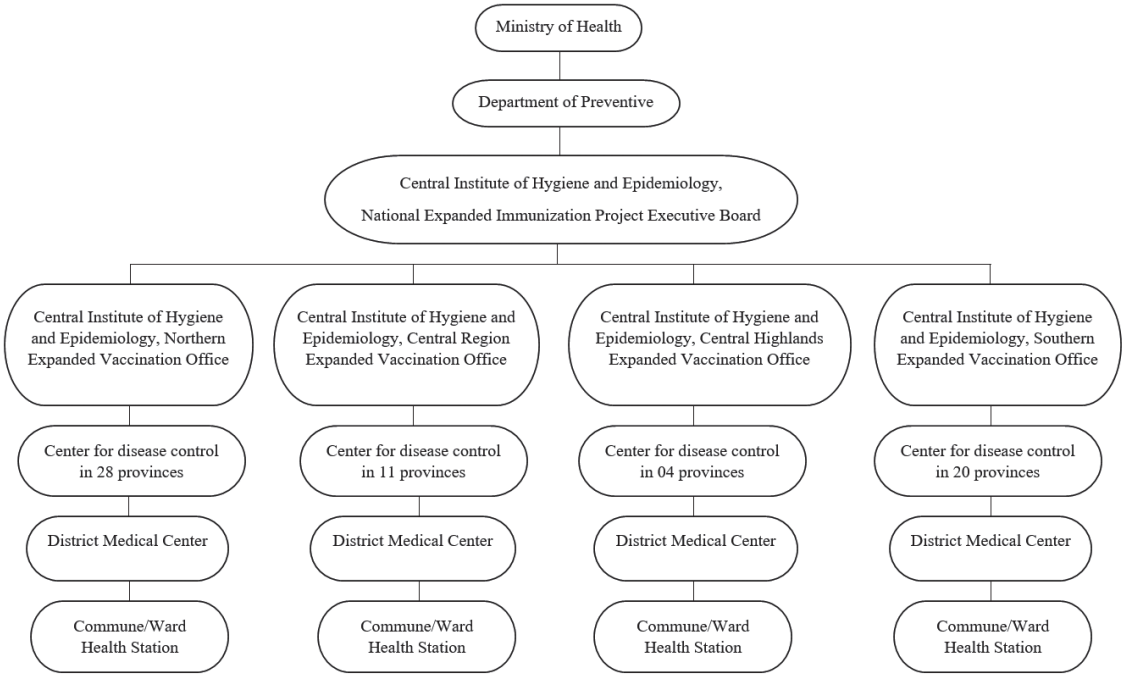

Figure 1 - Organizational chart of the expanded vaccination system

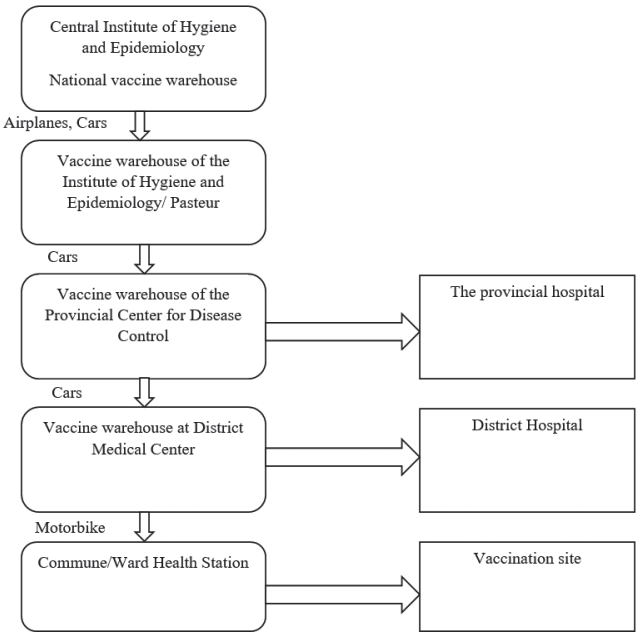

Figure 2 - Vaccine transport and storage chain system

latest WHO/UNICEF report on immunization coverage also showed that 90% of reporting countries in 2020 had stagnating or decreasing DTP3 coverage compared to 2019, with nearly 30% being the highest reduction since 2008. Even before the coronavirus pandemic, over 14 million children did not receive any vaccines, and 19 million children under 1 year old were not vaccinated against measles, polio, and other preventable diseases in 2019. Continuous disruptions and low immunization coverage in children can lead to devastating outbreaks (5-8).

The study conducted by Wang et al, 2014 (9) in China revealed that the willingness of parents to vaccinate their children increased from 51.3% initially to 67.4%, and the coverage rate of a measles vaccine dose increased from 83.8% initially to 90.1% (9). Vanderslott et al (10) highlighted the significant reduction in disease rates worldwide since the invention of vaccines, emphasizing their effectiveness and cost-effectiveness as a disease prevention measure. Increasing vaccine coverage has led to a decrease in diseases. 9 out of 10 people worldwide believe that immunization for children is important. However, the coverage rates for many vaccines are still too low, and we are missing the opportunity to save more lives (10). The studies affirm the importance of vaccines and immunization for children. Muhoza's et al, 2021 (11) research on global coverage rates for the third dose of Diphtheria-Pertussis-Tetanus vaccine (DPT3), Polio vaccine (Pol3), and the first dose of measles vaccine (MCV1) remained at 84% to 86% between 2010 and 2019. Fully recovering from the disruptions caused by COVID-19 will require targeted strategies, interventions to minimize immunization gaps, monitoring of coverage, and addressing program failures (11).

In Vietnam, Dang's study, 2019 (12) conducted in Huong Long Ward, Hue City, revealed that the rate of children receiving timely vaccinations was 67% and the factors influencing timely immunization were: illness of the child (73.5%), mothers' fear of adverse events (46%), family business (23%), and mothers' lack of knowledge about the next vaccination schedule (15.9%) (12). Nguyen and colleagues' research, 2021 (13) in Hai Phong showed a low rate of complete immunization at 70.77%. The main reasons for missed vaccinations were mothers' lack of knowledge (25.93%) and concerns about vaccine safety (48.15%). Only 15.38% of children received all 8 vaccines on schedule (13). Tran and colleagues' research, 2021 (14) in Quan Trieu Ward, Thai Nguyen City, showed a complete vaccination rate of 99.05% and an on-schedule vaccination rate of 57.14% for 8 vaccines (14).

Previous studies mainly focused on children under 1 year old, stopping at the Measles vaccine when the child reached 9 months. Our study on the 2-year-old age group aims to evaluate the effectiveness of an expanded immunization program, which includes all recommended booster vaccinations for Diphtheria-Pertussis-Tetanus, Hepatitis B, Haemophilus influenzae type b; Measles at 18 months, and Japanese encephalitis at 24 months. Our research also found no existing data or studies on the vaccination rates for 2-year-old children specifically conducted in Go Cong Tay district, Tien Giang province. Our study will explore and analyze the complete and on-schedule vaccination rates, the knowledge of mothers regarding expanded immunization, and examine factors influencing and interrupting the implementation of immunization for 2-year-old children. Additionally, recent unfavorable factors such as post-vaccination reactions, the change from Quinvaxem to Combe Five in the 5-in-1 vaccine (ComBE Five vaccine is a "5 in 1" combination vaccine DPT-HBV-Hib including diphtheria and tetanus toxoids, inactivated pertussis bacteria, hepatitis B virus antigens and viral antigens, *haemophilus influenzae* type b) (15), the COVID-19 pandemic, and economic difficulties have significantly affected the implementation of the immunization

program. To determine the current situation, reasons, and related factors contributing to the protection and improvement of community health, we have decided to conduct this research project. The study aims to determine the complete and on-schedule vaccination rates for 2-year-old children, assess the knowledge of mothers regarding expanded immunization, and analyze factors related to the complete and on-schedule vaccination rates for 2-year-old children in Go Cong Tay district, Tien Giang province in 2021.

Methods

Study setting, sample size, and sampling method

Our study conducted a descriptive cross-sectional analysis on 558 2-year-old children and their mothers residing in 13 communes and townships of Go Cong Tay district, Tien Giang province, Vietnam. The study was carried out from January 2021 to July 2022. Go Cong Tay district is a new rural standard district consisting of 13 communes and townships, with an area of 18,447.61 hectares and a population of 127,753. Therefore, the expanded immunization coverage in children has always been one of the key strategies for the economic, political, and social development of Go Cong Tay district, Tien Giang province, Vietnam.

Our study selected 2-year-old children as of the survey date, with birth dates ranging from June 1, 2019, to August 31, 2019, and their mothers whose names were on the management list and had permanent residency in Go Cong Tay district, Tien Giang province, and had lived in the area for more than 6 months at the time of the study. The mothers were required to consent to participate in the study and have the ability to communicate. The study excluded children who were contraindicated for vaccination in the expanded immunization program, mothers who were absent from home after three consecutive visits, mothers who lost their vaccination cards/records, and mothers who did not directly care for and raise their children during the first 24 months after birth.

The study applied the formula for estimating sample size for a proportion with an absolute precision of and a 95% confidence level, allowing for a 4% margin of error (16). The estimated proportion of children with complete and on-schedule immunization according to a study by Mekonnen et al in 2020 in Northwest, Ethiopia, was 64.3%, so we chose p=0.64 (17). Substituting the values into the formula, we obtained a sample size of 553. Therefore, the final sample size obtained was n=558 2-year-old children and their mothers, which was considered appropriate.

The study used a systematic random sampling method. In Step 1, a list was made of all 2-year-old children with birth dates from June 1, 2019, to August 31, 2019, and their mothers who met the sampling criteria. In Step 2, 2-year-old children were selected for the study through the sampling coefficient k=N/n (where N is the total number of 2-year-old children who met the study criteria, and n is the study sample size). In Step 3, the first child was selected by random drawing (with x ranging from 1 to k); in this case, k=960/558=1.7. In Step 4, the subsequent children were selected for the study by adding x to the increment of k: the second child was selected as x + k, the third child as x + 2k, and so on until the required number of 2-year-old children for the study was reached. Simultaneously with the selection of a 2-year-old child for the study, the mother of the child was also chosen to participate in the study on knowledge of expanded immunization for children. In cases where the selected subject met the exclusion criteria or refused to participate in the study, the adjacent subject on the list was chosen. In cases where a mother had two children meeting the study criteria, only one child was randomly selected to participate in the study. The distribution of participants according to sampling results by location is as follows: Thanh Tri commune (3 hamlets) with 39 samples, Binh Phu commune (4 hamlets) with 42 samples, Thanh Nhut commune (4 hamlets) with 53 samples, Thanh Cong commune (8 hamlets) with 22 samples, Vinh Binh town (6 neighborhoods) with 40 samples, Vinh Huu commune (5 hamlets) with 48 samples, Binh Tan commune (5 hamlets) with 49 samples, Long Vinh commune (6 hamlets) with 26 samples, Binh Nhi commune (3 hamlets) with 46 samples, Long Binh commune (8 hamlets) with 58 samples, Dong Thanh commune (6 hamlets) with 66 samples, Yen Luong commune (4 hamlets) with 16 samples, and Dong Son commune (4 hamlets) with 53 samples (Figure 3) (18).

Research Content

The Vietnamese questionnaire consists of three parts and is used for direct interviews with the participants. The first part includes questions about sociodemographic characteristics of the child, including general information: gender (male, female); place of birth (hospital, other); health status of the child at birth (good health, congenital disease); general information about the mother: age group (18 to 25 years old, 25 to 35 years old, 35

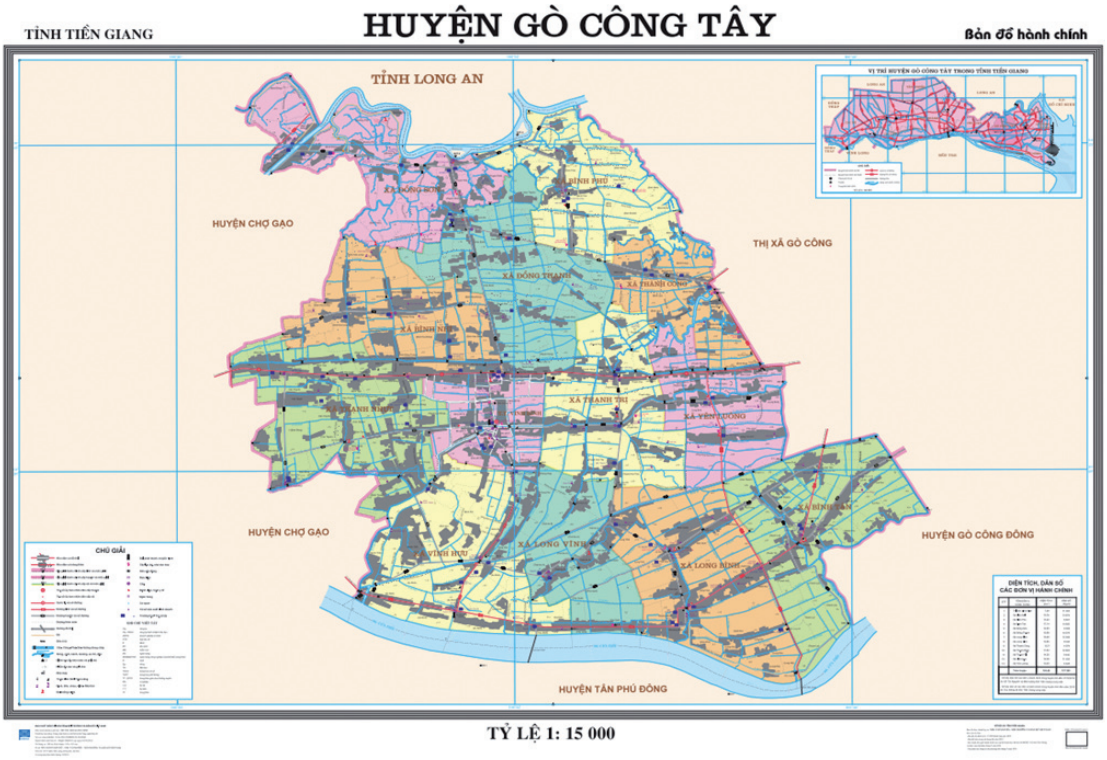

Figure 3 - Schematic diagram of the sampling method to participate in the sudy. (Source: https://gocongtay.tiengiang.gov.vn/ban-o-ia-gioi-hanh-chinh)

years old and above); educational level (elementary school, middle school, high school, vocational school, college, university); occupation (officer, civil servant; housewife, business, worker, other); number of children (1 child; 2 children; 3 or more children); economic status (poor, near poor, average, wealthy) Standard household has an average number: Rural areas: Are households with average income per capita/month over 1.5 million VND to 2.25 million VND; Urban areas: Are households with average income per capita/month over 2 million VND to 3 million VND; Standard household has a wealthy income (higher than average income) (19); ethnicity (Kinh, other).

The second part collects information on the child's vaccination history through a question on whether the child has received various vaccines. The vaccination history is collected by recording the vaccination dates based on the child's vaccination card, immunization management book at the health station, and national expanded immunization software. The actual vaccination dates of the child are then compared with the allowable time for each vaccine dose according to the regulations of the Ministry of Health to determine whether the vaccinations were given on schedule, off schedule, or not given (Table 1). For cases where no vaccine doses have been received, further investigation is conducted to understand the reasons for non-vaccination. The reasons for non-vaccination are explored using a multiple-choice question (vaccine not available, child is ill, mother is afraid of adverse events and does not vaccinate the child, mother switches to private vaccination services for the child, mother forgets the vaccination schedule, impact of the Covid-19 pandemic).

The third part assesses general knowledge about expanded immunization through 20 questions. The overall knowledge score is calculated as the sum of all correct answers, ranging from 1 to 23. A higher knowledge score indicates better knowledge of expanded immunization among the participants. Based on the knowledge score, participants are divided into two groups: "correct knowledge" and "incorrect knowledge." Mothers are classified as "correct" if their knowledge score is higher than 75% of the overall knowledge score of all participants, and "incorrect" if their score is lower than this threshold.

Table 1 - The vaccine program in Vietnam

Ordinal number	Child's age	Vaccination
1	Newborn	- BCG vaccine - Hepatitis B vaccine at birth within the first 24 hours
2	Children are 02 months old	- DPT-HepB-Hib vaccine dose 1 - OPV vaccine dose 1
3	Children are 03 months old	- DPT-HepB-Hib vaccine dose 2 - OPV vaccine dose 2
4	Children are 04 months old	- DPT-HepB-Hib vaccine dose 3 - OPV vaccine dose 3
5	Children are 05 months old	- IPV vaccine
6	Children are 09 months old	- Measles vaccine
7	Children are 18 months old	- DPT-HepB-Hib vaccine dose 4 - Measles – Rubella (MR) vaccine
8	Children are 12 months old	- Japanese encephalitis dose 1 - Japanese encephalitis dose 2 (1-2 weeks after dose 1) - Japanese encephalitis dose 3 (1 year after dose 2)

This questionnaire was developed based on the Vietnamese Ministry of Health's guidelines on expanded immunization and relevant reference materials and research (20-24). The questionnaire was pilot-tested on 20 eligible mothers and then modified to be suitable for use in this study.

Data Collection Tools and Methods: The researchers visited the homes of the study participants according to the sampling method. The study participants agreed to dedicate their time and feel comfortable during the interview process. Information about mothers' knowledge of expanded immunization for 2-year-old children was collected through direct interviews using a pre-designed questionnaire, and the child's vaccination data was recorded. If a mother refused to participate in the study after explanation and persuasion and the adjacent participant on the list was not available, the researchers moved to the next participant to achieve the desired sample size.

Data Processing Method: Data were entered using Microsoft Excel 2021 software and analyzed using SPSS version 20.0. Descriptive statistics were used to calculate the frequency and percentage of 2-year-old children vaccinated and mothers' correct knowledge of immunization. The two-tailed chi-square test was used to determine the relationship between vaccination rates and sociodemographic factors. Multivariate logistic regression model was used to estimate the odds ratio, 95% confidence interval, and statistical significance ($p \leq .05$). Only the significant covariates at the univariate analysis were included in the multivariate analysis.

Ethics in Research: Before conducting the study, the research topic was approved through Ethics Approval Form No. 97/PCT-HDDĐ dated March 30, 2021 by the Ethics Committee in Biomedical Research, Can Tho University of Medicine and Pharmacy. The study was also granted permission to be conducted at Go Cong Tay District Health Center, Tien Giang Province. The study was carried out with the informed consent of the participants through a consent form. The interview process was conducted conveniently and comfortably for the participants, without involving sensitive or private issues that could affect the health or psychological well-being of the participants. The personal information of the participants was kept confidential. This study aimed to protect and improve the health of the community and had no other purposes.

Results

General characteristics of the research object

The proportion of male children is 51.6%. All children were born in hospitals. Regarding the health status of newborns, 99.5% of them were born in good health. In terms of the mother's age group, the highest percentage, 74.4%, falls in the age group of 25-35 years old. In terms of the mothers' educational level, the majority, 60.2%, have at least a high school education. Among the mothers' occupations, the majority, 42.5%, are workers. In terms of the number of children, 48.9% of mothers have one

child, while 49.5% have two children. The majority, 99.8%, of mothers belong to the Kinh ethnic group. In terms of economic status, the highest percentage, 76%, represents mothers with average economic conditions, and 20.8% have relatively wealthy economic conditions. Regarding general knowledge about expanded immunization, 57.5% of mothers have correct knowledge. The proportion of children who receive complete vaccinations is 74.7%, and the proportion of children who receive vaccinations on schedule is 47.8%. The proportion of children who receive both complete and on-schedule vaccinations is 22.6% (Table 2).

Vaccine coverage rates estimates

In terms of the vaccination status of children, the BCG vaccine has the highest vaccination rate, with 99.5% of children receiving the full dose. The proportion of children who receive the full dose of the Hepatitis B vaccine at birth is 97.0%. For the ComBE Five vaccine, the proportion of children receiving the full dose is 84.4%. The proportion of children receiving the full dose of the OPV vaccine is 84.4%. The proportion of children receiving the full dose of the IPV vaccine is 80.5%. For the measles vaccine, the proportion of children receiving the full dose is 95.2%. For the MR vaccine, the proportion of children receiving the full dose is 90.7%. The proportion of children receiving the full dose of the SII vaccine is 90.7%. The Japanese encephalitis vaccine has a proportion of 95.1% for children receiving the full dose (Figure 4).

Determinants for delay

The main reasons for children not receiving complete vaccinations are mothers switching to private vaccination services for their children, accounting for 67.4%, and the impact of COVID-19, accounting for 39.5%. Next is the child being sick, accounting for 27.7%, followed by the unavailability

Table 2 - General information of 2-year-old children, general information, knowledge and practice of vaccination of mothers (n=558)

Variables		Frequency (n)	Ratio (%)
General information of children			
Health status at birth	Good healthy	555	99.5
	Congenital disease	3	0.5
Mother's General Information			
Mothers' educational level	≤ Middle School Education	174	31.2
	≥ High School Education	384	68.8
Mothers' occupations	Office	56	10.1
	Labor	502	89.9
Mother's number of children	1 child	273	48.9
	2 children	276	49.5
	Over 3 children	9	1.6
Mother's Ethnic	Kinh	557	99.8
	Other	1	0.2
Mother's economic status	Poor	442	79.2
	Near-Poor		
	Average		
	Wealthy	116	20.8
Knowledge and practice of vaccination			
Mother's general knowledge	Correct	321	57.5
	Not Correct	237	42.5
Complete vaccinations	Yes	417	74.7
	No	141	25.3
Vaccination on schedule	Yes	267	47.8
	No	291	52.2
Complete and on-schedule vaccinations	Yes	126	22.6
	No	432	77.4

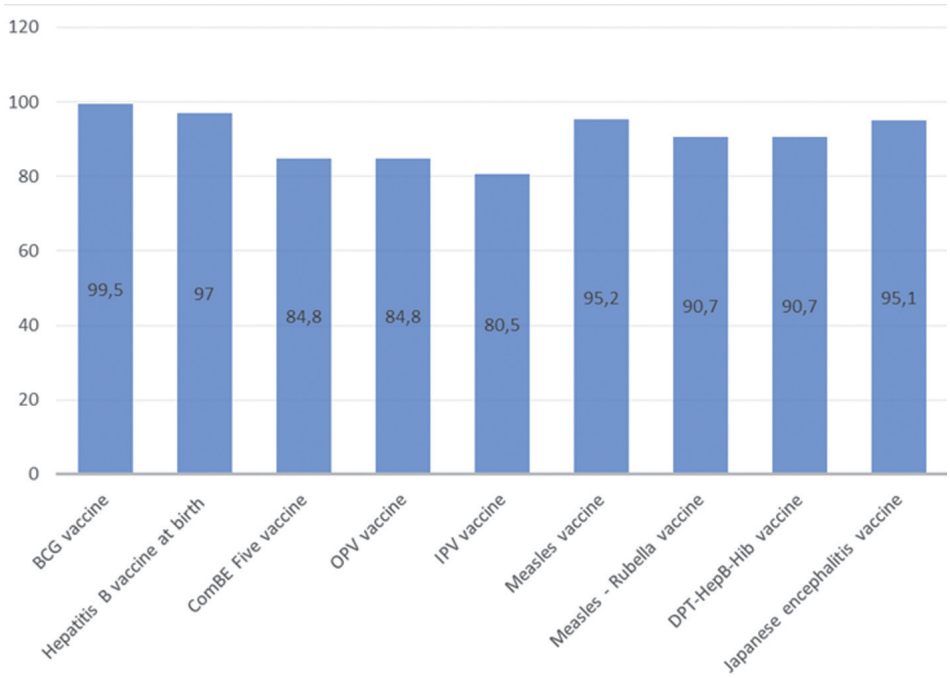

Figure 4. Ratio (%) of vaccinations with full doses of vaccines

of vaccines, accounting for 17.7%. Mothers not knowing/forgetting the vaccination schedule account for 17.7%, and mothers being afraid of adverse events and not vaccinating their children account for 5.7% (Table 3).

The main reasons for children not receiving on-schedule vaccinations are the impact of COVID-19, accounting for 69.1%, and the child being sick, accounting for 68%. Next is mothers not knowing/forgetting the vaccination schedule, accounting for 20.6%. The unavailability of vaccines accounts for 4.5%, and mothers switching to private vaccination services for their children account for 0.3% (Table 3).

Factors related to children's vaccination rate in univariate analysis

Here are the results of univariate analysis on the correlation with the full immunization rate of 2-year-old children. Regarding occupation, children of mothers who worked as manual laborers had a higher rate of full immunization at 76.3% compared to

Table 3 - Some reasons why children are not fully vaccinated and not on-schedule

Some reasons	Children are not fully vaccinated (n=141)		Children are not vaccinated on-schedule (n=291)	
	Frequency (n)	Ratio (%)	Frequency (n)	Ratio (%)
Vaccines are not available, vaccine shortage	25	17.7	13	4.5
Children are not healthy enough to be vaccinated or children are sick	39	27.7	198	68
Mothers are afraid of vaccination accidents, so they do not vaccinate their children	8	5.7	0	0
Mothers switch to private vaccination system for children	95	67.4	1	0.3
The mother does not know/forgot the vaccination schedule	25	17.7	60	20.6
Due to the impact of the Covid-19 epidemic	56	39.5	201	69.1

mothers working in offices at 60.7% with an odds ratio (OR) of 0.4 and p-value of 0.01. In terms of economic status, children of mothers with average economic conditions had a higher rate of full immunization at 77.8% compared to mothers with relatively high economic status at 62.9% with an OR of 2.0 and p-value of 0.001. Regarding general knowledge, children of mothers with accurate knowledge of expanded immunization had a higher rate of full immunization at 79.4% compared to mothers with inaccurate knowledge at 68.4% with an OR of 1.7 and p-value of 0.003 (Table 4).

Here are the results of univariate analysis on the correlation with the on-time immunization rate of 2-year-old children. Regarding the age group of mothers, children of mothers in the age groups >25-35 and >35 had a higher rate of on-time immunization compared to mothers in the age group 18-25, with ORs of 2.6 and 2.3, and p-values of 0.002 and 0.02, respectively (Table 4).

Factors related to children's vaccination rate in multivariate analysis

Factors related to the full immunization rate of mothers with 2-year-old children in multivariable logistic regression analysis: Mothers working in office occupations had a lower rate of full immunization at 60.7% compared to mothers in manual labor occupations, with an OR of 0.3, 95% confidence interval (CI): 0.1-0.7, and p-value of 0.006. Mothers with average economic conditions had a higher rate of full immunization at 77.8% compared to mothers with relatively high economic conditions at 62.9%, with an OR of 3.8, 95%CI: 1.7-8.6, and p-value of 0.001. Mothers with accurate general knowledge had a higher rate of full immunization at 79.4% compared to mothers with inaccurate general knowledge at 68.4%, with an OR of 1.7, 95%CI: 1.1-2.6, and p-value of 0.01 (Table 5).

Factors related to the on-time immunization rate of mothers with 2-year-old children in multivariable logistic regression analysis. Mothers in the age groups >25-35 and >35 had a higher rate of on-time immunization at 50.6% and 47.7%, respectively, compared to mothers in the age group 18-25 at 28.0%, with ORs of 3.1, 95%CI: 1.6-6.0, p=0.001, and 3.0, 95%CI: 1.3-6.6, p=0.006. Mothers with average economic conditions had a lower rate of on-time immunization at 45.7% compared to mothers with relatively high economic conditions at 56%, with an OR of 0.4, 95%CI: 0.2-0.9, and p-value of 0.04 (Table 5).

Discussion

Gender characteristics of 2-year-old children participating in the study showed that the proportion of male children was 51.6% and female children was 48.4%. Our research results align with the actual situation in our country, where the male-to-female ratio at birth is higher by female. All the children in the study were born in public or private hospitals, and none were born at health stations or private clinics. This indicates that most mothers are concerned about reproductive health and choose good and safe places for delivery. The majority of children born in the study had good health conditions suitable for immunization. Additionally, our study also recorded some characteristics of the participating mothers. Among them, the majority of mothers had a high school education, accounting for 60.2%. Higher education levels facilitate the acquisition and practice of knowledge about childhood immunization. This is crucial for disseminating knowledge, attitudes, and practices related to immunization and community disease prevention.

Furthermore, the results showed that the economic conditions of the families in the study were mostly average or above average, accounting for 96.8%, with 76% having average economic conditions and 20.8% being relatively affluent. Indeed, family economics also influence immunization efforts, as families with stable incomes tend to pay more attention to the health of their children and themselves. Therefore, mothers facing economic difficulties should receive more attention in immunization efforts for their children.

According to the recommendations of the World Health Organization (WHO), the hepatitis B vaccine should be administered as early as possible, preferably within 24 hours of birth, especially in countries with a high risk of vertical transmission from mother to child during the perinatal period, including Vietnam (25). The Ministry of Health has issued Decision 2620/QD-BYT providing guidelines for administering the hepatitis B vaccine to newborns and requires that the proportion of hepatitis B immunization within the first 24 hours reach 65% or higher (26). In our study, 97% of children received the full dose of the hepatitis B vaccine at birth. These rates were higher than those reported by Luu (45%) and Pham et al (46.6%) (27, 28). These results are consistent with the high level of knowledge about neonatal immunization, good care provided to pregnant women, healthy childbirth, and the availability of vaccines in healthcare facilities.

Table 4 - Analysis of some factors related to full vaccination rate; vaccination on schedule; Fully vaccinated, on schedule for children 2 years old

Related factors		Complete vaccinations		OR (KTC 95%)	p	Vaccination on schedule		OR (KTC 95%)	p
		Yes	No			Yes	No		
Child's gender	Male	216 (75.0)	72 (25)	1.0 (0.7-1.5)	0.88	135 (46.8)	153 (53.2)	0.9 (0.6-1.2)	0.63
	Female	201 (74.0)	69 (26.0)			132 (48.9)	138 (51.1)		
Mother's age group	18 - 25 years old	48 (84.2)	9 (15.8)	1	-	16 (28.0)	41 (72.0)	1	-
	> 25 - 35 years old	305 (73.5)	110 (26.5)	0.5 (0.2-1.0)	0.08	210 (50.6)	205 (49.4)	2.6 (1.4-4.8)	**0.002**
	> 35 years old	64 (74.4)	22 (25.6)	0.5 (0.2-1.2)	0.16	41 (47.7)	45 (52.3)	2.3 (1.1-4.7)	**0.02**
Mothers' educational level	≤ Middle School Education	130 (74.7)	44 (25.3)	0.9 (0.6-1.5)	0.99	86 (49.4)	88 (50.6)	1.0 (0.7-1.5)	0.61
	≥ High School Education	287 (74.7)	97 (25.3)			181 (47.1)	203 (52.9)		
Mothers' occupations	Office	34 (60.7)	22 (39.3)	0.4 (0.2-0.8)	**0.01**	33 (58.9)	23 (41.1)	1.6 (0.9-2.8)	0.08
	Labor	383 (76.3)	119 (23.7			234 (46.6)	268 (53.4)		
Mother's number of children	1 child	206 (75.5)	67 (24.5)	0.8 (0.1-4.3)	0.87	137 (50.1)	136 (49.9)	2.0 (0.4-8.2)	0.32
	2 children	204 (73.9)	72 (26.1)	0.8 (0.1-3.9)	0.79	127 (46.1)	149 (53.9)	1.7 (0.4-6.9)	0.45
	Over 3 children	7 (77.8)	2 (22.2)	1	-	3 (33.3)	6 (66.7)	1	-
Mother's economic status	Poor Near-Poor Average	344 (77.8)	98 (22.2)	2.0 (1.3-3.2)	**0.001**	202 (45.7)	240 (54.3)	0.6 (0.4-0.9)	0.47
	Good, Rich	73 (62.9)	43 (37.1)			65 (56.0)	51 (44.0)		
Mother's general knowledge	Correct	255 (79.4)	66 (20.9)	1.7 (1.2-2.6)	**0.003**	148 (46.1)	173 (53.9)	0.8 (0.6-1.1)	0.33
	Not Correct	162 (68.4)	75 (31.6)			119 (50.2)	118 (49.8)		

Table 5 - Some factors related to complete vaccination rate; vaccination on schedule; Complete, on-time immunization of 2-year-old children on multivariate logistic regression analysis model

Related factors		Complete vaccinations		OR (KTC 95%)	p	Vaccination on schedule		OR (KTC 95%)	p
		Yes	No			Yes	No		
Child's gender	Male	216 (75.0)	72 (25.0)	0.9 (0.6-1.4)	0.74	135 (12.2)	153 (53.1)	1.0 (0.7-1.4)	0.83
	Female	201 (74.4)	69 (25.6)			132 (48.9)	138 (51.1)		
Mother's age group	18 - 25 years old	48 (84.2)	9 (15.8)	1	-	16 (28.0)	41 (72.0)	1	-
	> 25 - 35 years old	305 (73.5)	110 (26.5)	0.5 (0.2-1.2)	0.14	210 (50.6)	205 (49.4)	3.1 (1.6-6.0)	**0.001**
	> 35 years old	64 (74.4)	22 (25.6)	0.6 (0.2-1.6)	0.33	41 (47.7)	45 (52.3)	3.0 (1.3-6.6)	**0.006**
Mothers' educational level	≤ Middle School Education	130 (74.7)	44 (25.3)	1.6 (0.6-4.4)	0.33	86 (49.4)	88 (50.6)	1.0 (0.4-2.3)	0.98
	≥ High School Education	287 (74.7)	97 (25.3)			181 (47.1)	203 (52.9)		
Mothers' occupations	Office	34 (60.7)	22 (39.3)	0.3 (0.1-0.7)	**0.006**	33 (58.9)	23 (41.1)	1.6 (0.8-3.2)	0.13
	Labor	383 (76.3)	119 (23.7)			234 (46.6)	268 (53.4)		
Mother's number of children	1 child	206 (75.5)	67 (24.5)	0.6 (0.1-3.3)	0.56	137 (50.1)	136 (49.9)	2.7 (0.6-12.3)	0.17
	2 children	204 (73.9)	72 (26.1)	0.6 (0.1-3.4)	0.58	127 (46.1)	149 (53.9)	1.8 (0.4-8.0)	0.40
	Over 3 children	7 (77.8)	2 (22.2)	1	-	3 (33.3)	6 (66.7)	1	-
Mother's economic status	Poor Near-Poor Average	344 (77.8)	98 (22.2)	3.8 (1.7-8.6)	**0.001**	202 (45.7)	240 (54.3)	0.4 (0.2-0.9)	**0.04**
	Good, Rich	73 (62.9)	43 (37.1)			65 (56.0)	51 (44.0)		
Mother's general knowledge	Correct	255 (79.4)	66 (20.9)	1.7 (1.1-2.6)	**0.01**	148 (46.1)	173 (53.9)	0.9 (0.6-1.3)	0.68
	Not Correct	162 (68.4)	75 (31.6)			119 (50.2)	118 (49.8)		

Children are typically born in hospitals, so the coverage of the hepatitis B vaccine at birth and BCG depends on the facilities where the vaccines are administered. Subsequent vaccines are given to children at the Commune Health Station, and the vaccine coverage relies on both the vaccination points at the Commune Health Station and the vaccine supply from higher levels. However, if the expanded vaccination facilities experience a short-term vaccine shortage, parents can choose to wait to continue vaccinating their children, although this might affect the vaccination schedule. In cases of long-term vaccine shortages at the expanded vaccination facilities, while the private vaccination system consistently provides an abundant vaccine supply, parents may opt for the private vaccination system to ensure their children receive complete and on-schedule vaccinations.

Regarding the DPT-HepB-Hib vaccine, the on-schedule immunization rate for the 4-dose series was 46.4%, and the full completion rate was 81.5%. The on-schedule immunization rate gradually decreased from the first to the third dose, with rates of 74.2%, 65.9%, and 55.9% respectively. The rate for the fourth dose was 90.7%. The highest reasons for incomplete or off-schedule vaccinations were the impact of the COVID-19 pandemic, followed by illness in children missed opportunity for vaccination, mothers switch to private vaccination system for children, unavailability of vaccines, and maternal fear of adverse events (Table 3). Nguyen's study also gave the reasons why children were not vaccinated, including: children with inadequate health (59.5%), vaccination services (20.2%) (29). These findings indicate that mothers have become more concerned about immunization, provide better care for their children, and pay more attention to vaccination schedules. Additionally, they demonstrate the significant impact of the COVID-19 pandemic on completing immunizations on time.

The proportion of children who received the full course of OPV and IPV was 80.3%, which is higher than the findings reported by Sreevatsava et al, where no region achieved the 80% coverage target for any routine antigen (30). This indicates that we have achieved community immunity coverage for polio prevention. For measles vaccination, the on-schedule immunization rate for the 2-dose series was 59%, and the full completion rate was 81.5%. Among them, the proportion of children vaccinated with the measles vaccine was 95.2%. For the MR vaccine, the proportion of children receiving the vaccine was 90.7%. The immunization rates for various vaccines in our study were relatively high compared to the national immunization rates in 2021 (MR vaccine coverage was 84.9%) (31).

Although many countries worldwide have demonstrated the effectiveness of vaccination, implementing immunization programs still faces numerous challenges. In 2019, the COVID-19 pandemic emerged from the city of Wuhan, China, and spread globally. Our country has also experienced four waves of the COVID-19 outbreak, particularly the fourth wave, which significantly affected the study area. Through a study conducted on 558 2-year-old children and their mothers, the results showed that the proportion of children receiving complete immunization was 74.7%, on-schedule immunization was 47.8%, and complete, on-schedule immunization was 22.6%. These results are similar to the study by A.G. Mekonnen et al. (complete immunization rate of 75.6%) and Tu's study (complete immunization rate of 88.8%, on-schedule immunization rate of 43.9%, and off-schedule immunization rate of 44.9%) (32, 33). From the reasons identified in the study, the low rates of complete and on-schedule immunization are primarily influenced by the COVID-19 pandemic. The prolonged duration of the pandemic, social distancing measures, economic difficulties, and interrupted vaccination activities have greatly impacted the rates of complete immunization for children, particularly on-schedule immunization. Additionally, the expansion of vaccination funding and the potential shortage of vaccine supply due to the diversion of resources for COVID-19 control and the provision of free COVID-19 vaccines for the entire population could also affect the vaccination coverage. Our study was conducted under extremely challenging circumstances, which could explain the lower figures compared to other studies, and this is reasonable. When children are ill, they cannot receive vaccinations. A study by Mekonnen et al revealed that a common reason given by mothers for incomplete immunization was that their children had previously experienced illness after vaccination (17). Therefore, effective interventions are needed to ensure immunization during outbreaks, provide good healthcare for children to prevent illness during vaccination appointments, enhance communication to improve mothers' knowledge and awareness of vaccination schedules, and emphasize the importance of on-schedule vaccination rather than merely completing the required doses. Research by K.H. Nguyen et al and reports by Hill et al indicated that parents and other caregivers must be prepared and committed to taking children for vaccination (34, 35). Estimates suggested that 6.5%-31.3% of unvaccinated

children may be due to parental hesitation, depending on the vaccine type. Hence, to reassure mothers and encourage them to choose expanded immunization programs over private vaccinations, effective counseling should be provided to help mothers understand the equal efficacy of vaccines in terms of protection. Expanded immunization may result in more post-vaccination reactions compared to private vaccinations, but these reactions are typically mild and self-resolve. Expanded immunization also saves time and money by avoiding the need to travel to private vaccination centers and reducing vaccine costs. Improving the quality and safety of immunization, providing spacious and comfortable waiting and post-vaccination areas, will also build trust among mothers.

The general correct knowledge rate of mothers regarding expanded immunization is 57.5%, higher than the study conducted by Le (46.3%) and similar to the study by Tu (63.6%) (33, 36). The overall low knowledge level of mothers may be attributed to the fact that the majority of them have only completed high school education, with average family economic conditions, and engaged in manual labor occupations, thus having limited awareness of immunization. However, they are generally aware of the expanded immunization program due to the achieved vaccination outcomes. Therefore, it is necessary to further strengthen communication efforts and effectively manage mothers from pregnancy to childbirth, providing information, counseling, and scheduling vaccination appointments to ensure that children receive immunization.

Through analysis in the multivariate model, there is a significant correlation between occupational factors, economic conditions, general knowledge, and the complete immunization rate of children. Mothers with office jobs have a lower rate of complete immunization for their children compared to mothers engaged in manual labor occupations. This is likely because mothers with office jobs may not have the time to take their children for immunization, opt for vaccine-preventable diseases to reduce the number of shots for their children and save waiting time, thereby affecting the rate of complete and timely immunization for children. Children of mothers with average economic conditions have a significantly higher rate of complete immunization compared to children of mothers with relatively higher economic conditions, up to 3.5 times. This is because even though mothers with average economic conditions may have lower financial resources, their understanding and concern for the immunization program are relatively high, and they are unable to afford private vaccinations. On the other hand, mothers with relatively higher economic conditions often choose private vaccinations for their children to reduce the number of shots and waiting time. Therefore, healthcare staff need to pay special attention to the issue of communication, building trust in the program, emphasizing the equal effectiveness of vaccines, and improving the organization of vaccination sessions while ensuring safety.

Mothers with correct general knowledge about expanded immunization have a significantly higher rate of complete immunization for their children, 1.7 times higher than mothers with incorrect knowledge. This is evident as mothers with higher knowledge and awareness about immunization are more likely to have higher rates of complete and timely immunization for their children. This is one of the key content areas of the health promotion communication program to contribute to achieving the national immunization rate. Negussie et al 's study also demonstrated a significant association between incomplete immunization of children and the mothers' lack of understanding about the benefits of immunization and their negative perception of vaccine side effects (37). Indeed, mothers with a correct understanding of vaccination and its purpose increase the likelihood of complete vaccination for their children. When mothers are aware of the benefits of vaccines, including the diseases they can prevent, the vaccination schedule, and the number of doses required, they can effectively ensure complete vaccination for their children. A study by Mebrate et al also demonstrated a positive correlation between a good knowledge of the vaccination schedule and complete vaccination status (38). Therefore, in addition to providing information to mothers about vaccination knowledge for their children, it is crucial to inform them about the vaccination schedule and the number of doses required for children under 2 years of age. This is one of the key components of the communication program to enhance the knowledge of the population and contribute to achieving national vaccination coverage. Therefore, maternal understanding is one of the critical factors in improving the rate of complete vaccination.

Through multivariate analysis, there is a significant correlation between factors such as maternal age groups and the rate of timely vaccination for children. Mothers in the age groups of >25-35 and >35 years have higher rates of timely vaccination for their children compared to mothers in the age group of 18-25 years, with rates 3.1 times and 3.0 times higher,

respectively. Our study aligns with the research by Milkessa Mebrate, which found a positive association between younger maternal age groups and complete vaccination status, while contradicting the findings of Mekonnen et al (17), where caregivers above 35 years of age were negatively associated with complete vaccination status. This is because older mothers tend to have stable jobs, more experience, knowledge, and greater concern for adhering to their children's vaccination schedules to ensure that vaccinations are administered not only with the appropriate dosage but also on time to ensure disease immunity. This can be attributed to the fact that mothers engaged in manual labor often have to work to support their livelihoods and tend to have lower educational levels, which can affect the completion of vaccinations for their children. Therefore, healthcare workers at the grassroots level should pay special attention to mothers with low education levels, and predominantly manual labor occupations.

Several determinants are significant in the multivariate analysis: Intervention for mothers in younger age groups to promote full vaccination. Intervention for mothers working in offices to ensure their children are taken for vaccination, favoring expanded vaccination over private vaccination. Intervention for mothers with good economic conditions, encouraging them to choose expanded vaccination instead of private vaccination. Communication intervention aimed at improving mothers' knowledge about expanded vaccination.

Additionally, the expanded vaccination system must ensure an adequate vaccine supply to meet the vaccination needs of children at various sites. It is evident that significant differences exist among the municipalities considered. Consequently, the status of expanded vaccination for children varies between different cities. This variation is attributed to factors such as socio-economic development conditions, accessibility to expanded vaccination, the prevalence of private vaccination facilities, economic conditions, and parental preferences for services, among others. Notably, these differences are even more pronounced when comparing urban areas to rural, remote, and mountainous regions.

Limitations of the Study

Our study did not deeply investigate factors related to infants, such as birth weight (low birth weight or ≥ 2500g), delivery method (vaginal delivery or cesarean section), postnatal health of the child (healthy, robust, excessive crying, or preterm birth), postnatal care (being with the mother or staying in a separate room for newborns), etc., to analyze the factors associated with BCG and Hepatitis B vaccination in newborns. This also stimulates further research to elucidate these factors.

The vaccination coverage rates for each vaccine were high, but the maternal knowledge rate about expanded immunization was only 57.5%, which may be attributed to the questionnaire design not being closely aligned with reality. Mothers already had vaccination records that included the type of vaccine administered and the vaccination appointment dates, so they did not need to remember. Therefore, the question about the vaccination schedule may not have been appropriate for the study area. Questions about cases of vaccination delay or contraindications require specialized knowledge beyond the mothers' understanding, and when taking the child for vaccination, there was an initial screening by a doctor. Additionally, the study by Mebrate et al found positive associations between the intention to conceive, having at least four antenatal care visits, and postnatal care with complete vaccination status. These are also factors of note for future studies that can focus on further exploring the reasons why children are not vaccinated and provide appropriate intervention measures to improve and maintain vaccination rates for children.

The results of our study provided a comprehensive view of the complete and timely vaccination rates in 2-year-old children, along with some reasons for children not receiving vaccinations, to contribute to the evaluation of immunization activities at the local level and propose appropriate interventions. The World Health Organization (WHO) and UNICEF have also warned about the decline in vaccination coverage during COVID-19 (39). The study also revealed that the COVID-19 pandemic has significantly impacted the complete and timely vaccination rates in 2-year-old children. Our study recorded cases of children being vaccinated at immunization service points, but because the scope of the study only focused on expanded immunization coverage, our study did not consider these service injections in the calculation of the complete and timely vaccination rates. In today's socio-economic development, busy individuals who cannot take their children for vaccination on schedule at the commune health station can still go to immunization service points to receive additional injections easily. Furthermore, the presence of good infrastructure and services at these immunization service points is also a reason why mothers prefer this

service. Therefore, future studies can explore the topic of vaccination to include injections under the expanded immunization program but administered at different immunization service points such as provincial disease control centers, VNVC vaccination centers, Pasteur Institute, etc. Although not administered on schedule, these injections can reflect the effectiveness of disease prevention for 2-year-old children.

Our study was conducted in the specific context of the impact of the COVID-19 pandemic on the complete and timely vaccination rates, so some related factors may not truly correspond to reality. Subsequent studies should be mindful when using the data from our study for reference and comparison.

Conclusion

Vaccination rates for expanded immunization among children are low, particularly for complete and timely vaccination. The coverage rates for individual vaccines are relatively high, achieving community immunity rates. The main reason for children not receiving vaccinations is the impact of the Covid-19 pandemic. The pandemic has led to children not receiving vaccinations on schedule or even missing vaccine doses, significantly affecting the vaccination status of children and resulting in low rates of complete and timely vaccination. The overall knowledge level of mothers regarding expanded immunization is only average. Factors related to the child's complete vaccination rate include occupation, economic conditions, and mothers' general knowledge of expanded immunization. Factors related to the child's timely vaccination rate include the mother's age group and economic conditions. High rates of expanded immunization among children are associated with mothers' accurate general knowledge of expanded immunization, mothers engaged in manual labor, and average or lower economic conditions. It is necessary to continue strengthening the communication network, health education, and mothers' knowledge regarding the purpose and benefits of vaccination for children. Health stations should effectively implement nutrition programs, provide guidance on proper childcare, and remind mothers of vaccination schedules. The health department should support the improvement of immunization infrastructure, enhance the quality of healthcare personnel at the grassroots level, and attract parents with higher incomes. The provincial disease control center should organize and maintain training courses for healthcare staff, particularly community collaborators, to improve their understanding of vaccination and disseminate knowledge and advice to the public.

Acknowledgements: We acknowledge the Can Tho University of Medicine and Pharmacy and participants who partnered with us in the study.
Funding: There was no external funding for this research.
Conflicts of interest: The authors have no conflicts of interest to declare.
Ethics approval: The study was approved by the Medical Ethics Council of Can Tho University of Medicine and Pharmacy, Can Tho, Vietnam. Participants were informed that taking part in the study was voluntary.
Availability of data and material: The data that support the findings of this study are available from the corresponding author, Minh Huu Le upon reasonable request.
Author roles: Conceptualization: G.L.N.N., G.V.T.N., H.M.L., M.T.N.N., N.T.T.P., D.V.N.; Methodology: G.L.N.N., G.V.T.N., T.T.P., H.M.L., D.T.N.; Investigation: G.L.N.N., G.V.T.N., T.T.P., D.V.N., N.T.T.P.; Resources: G.L.N.N., G.V.T.N., T.T.P., D.T.N., M.T.N.N.; Writing – original draft: G.L.N.N., G.V.T.N., V.D.T., M.T.T.N., H.M.L., D.T.N.; Writing – review & editing: G.L.N.N., G.V.T.N., V.D.T., H.M.L., D.T.N.

Riassunto

La pratica della vaccinazione ampliata in bambini di due anni e le conoscenze materne a proposito di tale vaccinazione a Tien Giang, Vietnam

Premessa. La vaccinazione svolge un ruolo centrale nel proteggere i bambini da malattie gravi e nel prevenire la mortalità infantile.

Obiettivi. Questo studio mira a determinare il tasso e i fattori associati alla vaccinazione completa e tempestiva nei bambini di 2 anni, nonché le conoscenze materne sulla vaccinazione ampliata nel distretto di Go Cong Tay, provincia di Tien Giang, Vietnam.

Metodi. È stato condotto uno studio descrittivo trasversale su 558 bambini di 2 anni e sulle loro madri residenti nel distretto di Go Cong Tay, provincia di Tien Giang, Vietnam. Lo studio ha utilizzato un metodo di campionamento casuale sistematico e si è svolto tra il giugno ed il settembre 2021.

Risultati. Il tasso di vaccinazione completa nei bambini è stato del 74,7%. I fattori associati al tasso di vaccinazione completa erano l'occupazione (OR=0,3; IC 95%: 0,1-0,7; p=0,006), la situazione economica (OR=3,8; IC 95%: 1,7-8,6; p=0,001) e la conoscenza generale delle madri sulla vaccinazione ampliata (OR=1,7; IC 95%: 1,1-2,6; p=0,01). Il tasso di vaccinazione tempestiva è stato del 47,8%. I fattori associati al tasso di vaccinazione tempestiva erano l'età materna (OR=3,1; 95%CI: 1,6-6,0; p=0,001; OR=3,0; 95%CI: 1,3-6,6; p=0,006) e la situazione economica (OR =0,4; IC al 95%: 0,2-0,9; p=0,04). Il tasso di vaccinazione, sia completa che tempestiva è stato del 22,6%. I fattori associati al tasso di vaccinazione completa e tempestiva erano la fascia di età materna (OR=3,1; IC 95%: 1,3-7,2; p=0,009; OR=3,3; IC 95%: 1,2-9,1; p=0,02) e il tasso di vaccinazione generale, la conoscenza materna sulla vaccinazione estesa (OR=1,5; IC 95%: 1,0-2,4; p=0,03). Il tasso di conoscenza generale materna sulla vaccinazione estesa è stato del 57,5%.

Conclusione. I tassi di vaccinazione completa e tempestiva sono ancora bassi e vari fattori influenzano la diffusione della vaccinazione. Pertanto, è fondamentale continuare le campagne di educazione sanitaria per migliorare le conoscenze sulla vaccinazione ampliata, ricordare alle madri i programmi di vaccinazione, rafforzare la fiducia nei programmi di vaccinazione e nella sicurezza dei vaccini, attirare i clienti verso i servizi di vaccinazione, fornire assistenza sanitaria adeguata ai bambini e garantire attività di vaccinazione durante le epidemie.

References

1. Children's Hospital 1 (Vietnam). Pediatrics treatment regimen. 8th ed. Medical Publishing House; 2013.
2. World Health Organization (WHO). The Expanded Programme on Immunization. Vaccines and Biologicals. 2021.
3. Expanded Program on Immunization and Ministry of Health. Achievements of 25 years of Expanded Immunization in Vietnam. 2012.
4. UNICEF. Immunization. 2020. Available on: https://www.unicef.org/vietnam/immunization [Last accessed: 2023 Aug 11].
5. UNICEF. Immunization. 2021. Available on: https://data.unicef.org/topic/child-health/immunization/ [Last accessed: 2023 Aug 11].
6. World Health Organization (WHO). Progress and Challenges with Achieving Universal Immunization Coverage. 2020. Available on: https://cdn.who.int/media/docs/default-source/immunization/coverage/who-immuniz.pdf?sfvrsn=72fd7237_2&download=true [Last accessed: 2023 Aug 11].
7. World Health Organization (WHO). Immunization and vaccin-preventable communicable diseases. 2021.
8. World Health Organization (WHO). Immunization dashboard Global. 2021.
9. Wang LD, Lam WW, Wu JT, et al. Chinese immigrant parents' vaccination decision making for children: a qualitative analysis. BMC Public Health. 2014 Feb 7; **14**(133). doi: 10.1186/1471-2458-14-133.
10. Vanderslott S, Dadonaite B, Roser M. Vaccination. Our World in Data. October 2022.
11. Muhoza P, Danovaro-Holliday MC, Diallo MS, et al. Routine Vaccination Coverage - Worldwide, 2020. Centers for Disease Control and Prevention. Morb Mortal Wkly Rep. 2021 Oct 29; **70**(43): 1495-1500. doi: 10.15585/mmwr.mm7043a1.
12. Dang KC. Immunization status on schedule of children under 2 years old and some related factors in Huong Long ward, Hue city in 2017. Vietnam J Prev Med-VJPM. 2019; **29**(5).
13. Nguyen BT. Vaccination status of children under 1 year old in Thuy Son commune, Thuy Nguyen district, Hai Phong city in 2019. Vietnam J Prev Med-VJPM. 2021; **31**(1).
14. Tran MTP. Current status of full and on-time expanded vaccination among children under 12 months old in Quan Trieu ward, Thai Nguyen city. Vietnam J Prev Med-VJPM. 2021; **62**(4): 147-52.
15. Expanded Program on Immunization. Some questions and answers about converting 5-in-1 vaccines in the Expanded Program on Immunization. 2020.
16. Linh Van Pham. Health Science Research Methods (first edition, revised). Hue University Publishing; 2010.
17. Mekonnen ZA, Gelaye KA, Were MC, et al. Timely completion of vaccination and its determinants among children in northwest, Ethiopia: a multilevel analysis. BMC Public Health. 2020 Jun 11; **20**(1): 908. doi: 10.1186/s12889-020-08935-8.
18. People's Committee of Go Cong Tay district. Electronic information page of Go Cong Tay district, Tien Giang province. 2023. Available on: https://gocongtay.tiengiang.gov.vn/ban-o-ia-gioi-hanh-chinh [Last accessed: 2023 Aug 11].
19. Government. Decree 07/2021/ND-CP on regulating multi-dimensional poverty standards for the period 2021 - 2025. 2021.
20. Ministry of Health. Decision 2535/QD-BYT on the promulgation of "Guidelines for monitoring, care and handling of post-vaccination reactions. 2014
21. Ministry of Health. Circular 38/2017/TT-BYT dated October 17, 2017 promulgating the list of infectious diseases, scope and subjects subject to compulsory use of vaccines and medical biological products. 2017.
22. Ministry of Health. Circular 51/2017/TT-BYT dated December 29, 2017 guiding the prevention, diagnosis and treatment of anaphylaxis. 2017.
23. Ministry of Health. Circular 34/2018/TT-BYT detailing a number of articles of the Government's Decree No. 104/2016/ND-CP dated July 1, 2016 on vaccination activities. 2018.
24. Ministry of Health. Decision 2470/QD-BYT on the issuance of Guidelines for pre-vaccination screening for children. 2019.
25. World Health Organization (WHO). Practices to improve coverage of the hepatitis B birth dose vaccine. 2013.
26. Ministry of Health. Decision 2620/QD-BYT on the promulgation of "Guidelines for the implementation of neonatal dose hepatitis B vaccination. 2012.
27. Luu PB. Research on hepatitis B vaccination in newborns in the first 24 hours and mothers' knowledge and attitudes in An Binh ward, Ninh Kieu district, Can Tho city in 2014. Thesis of Doctor of Preventive Medicine. Can Tho University of Medicine and Pharmacy. 2015.
28. Pham TT, Le HM, Nguyen DT, et al. Assessment of the timely administration of the hepatitis B and BCG birth does and the primary infant vaccination schedule in 2015-2016 in the Me Kong Delta, Viet Nam. Vaccine. 2018 Sep 11; **36**(38): 5760-5. doi: 10.1016/j.vaccine.2018.08.002.
29. Nguyen MH. Current status of full and timely vaccination of 8 vaccines in children under 1 year of age and some related factors in O Cho Dua ward, Dong Da district, Hanoi in 2019. Master of Public Health's Thesis. Thang Long University. 2019.

30. Sreevatsava M, Burman AL, Wahdan A, et al. Routine immunization coverage in Pakistan: a survey of children under 1 year of age in community-based vaccination areas. BMC Public Health. Vaccine. Jun 9, 2020; **38**(28): 4399-404. doi: 10.1016/j.vaccine.2020.04.068. Epub 2020 May 8.
31. Department of Preventive Medicine. Preliminary conference on expanded vaccination work in 2021. 2022.
32. Mekonnen AG, Bayleyegn AD, Ayele ET. Immunization coverage of 12-23 months old children and its associated factors in Minjar-Shenkora district, Ethiopia: a community-based study. BMC Pediatrics. 2019 Jun 14; **19**(1): 198. doi: 10.1186/s12887-019-1575-7.
33. Vy Lan Tu. Research on the situation and factors related to expanded immunization for children under 1 year old of mothers with children aged 12-24 months in Cho Moi district, An Giang province. Can Tho J Med Pharm. 2019; **37:** 104-10.
34. Nguyen KH, Srivastav A, Vaish A, Singleton JA. Population Attributable Fraction of Nonvaccination of Child and Adolescent Vaccines Attributed to Parental Vaccine Hesitancy, 2018–2019. Am J Epidemiol. Aug 22, 2022; **191**(9): 1626-35. doi: 10.1093/aje/kwac049.
35. Hill HA, Chen M, Elam-Evans LD, Yankey D, Singleton JA. Vaccination Coverage by Age 24 Months Among Children Born During 2018-2019 - National Immunization Survey–Child, United States, 2019–2021. Morb Mortal Wkly Rep. 2023 Jan 13; **72**(2): 33-8. doi: 10.15585/mmwr.mm7202a3.
36. An Nguyen Viet Le. Survey on expanded immunization status of children under 1 year old in Dong Thanh commune, Chau Thanh district, Hau Giang province in 2016. Thesis of Doctor of Preventive Medicine. Can Tho University of Medicine and Pharmacy. 2017.
37. Negussie A, Kassahun W, Assegid S, Hagan AK. Factors associated with incomplete childhood immunization in Arbegona district, southern Ethiopia: a case – control study. BMC Public Health. 2016 Jan 12; **16**: 27. doi: 10.1186/s12889-015-2678-1.
38. Mebrate M, Workicho A, Alemu S, Gelan E. Vaccination Status and Its Determinants Among Children Aged 12 to 23 Months in Mettu and Sinana Districts, Oromia Region, Ethiopia: A Comparative Cross Sectional Study. Pediatric Health Med Ther. 2022 Sep 23; **13**: 335-48. doi: 10.2147/PHMT.S380303.
39. World Health Organization (WHO). WHO and UNICEF warn of a decline in vaccinations during COVID-19. 2020.

Corresponding author: Minh Huu Le, Department of Epidemiology, Can Tho University of Medicine and Pharmacy, Can Tho City, 900000 Vietnam.
e-mail: lmhuu@ctump.edu.vn.

ANNEX QUESTIONNAIRE

NO	Question	Answer	Note
A. GENERAL INFORMATION OF CHILDREN AND MOTHERS			
A1	The Child's gender is	1. Male 2. Female	
A2	Place of birth	1. Hospital 2. Other	
A3	Health status at birth	1. Healthy enough 2. Congenital diseases	
A4	Child's date of birth		
A5	Mother's age	1. 18 – 25 years old 2. > 25 – 35 years old 3. > 35 years old	
A6	Mother's education level	1. ≤ Middle School Education 2. ≥ High School Education	
A7	Mother's occupation	1. Office 2. Labor	
A8	Number of children of the mother	1. 1 Children 2. 2 Children 3. Over 3 children	
A9	Ethnicity	1. Kinh 2. Other	
A10	Family economic status	1. Poor, Near-Poor, Average 2. Wealthy	
B. EXPANDED VACCINATION STATUS FOR CHILDREN UNDER 2 YEARS OLD			
B1	Do you administer BCG Vaccination to children? (vaccination book) Date of: ……...	1. Get vaccinated, on schedule 2. Got an injection, not on schedule 3. Do not inject	
B2	Do you administer newborn HBV vaccination to children? (Vaccination book) Date of injection:……..	1. Get vaccinated, on schedule 2. Got an injection, not on Schedule 3. Do not inject	
B3	you vaccinate children with DPT-HBV-Hib (5 in 1) doses 1,2,3? (vaccination book) Date of injection:……... Date of injection:……... Date of injection:……...	1. Get vaccinated, on schedule 2. Got an injection, not on schedule 3. Do not inject	
B4	How do you give children OPV vaccine? (vaccination book? Date of injection:……... Date of injection:……... Date of injection:……..	1. Drink on Schedule 2. Drinking, not on schedule 3. Do not drink	
B5	How do you administer IPV vaccination to children? (vaccination book) Date of injection:……...	1. Get vaccinated, on schedule 2. Got an injection, not on schedule 3. Do not injec	
B6	How do you vaccinate children against Measles? (vaccination book) Date of injection:……...	1. Get vaccinated, on schedule 2. Got an injection, not on schedule 3. Do not inject	
B7	How do you vaccinate children with DPT-HB-Hib 4 vaccine? (vaccination book) Date of injection:……..	1. Get vaccinated, on schedule 2. Got an injection, not on schedule 3. Do not inject	
B8	How do you administer MR vaccination to children? (vaccination book) Date of injection:……...	1. Get vaccinated, on schedule 2. Got an injection, not on schedule 3. Do not inject	
B9	How do you vaccinate children for JE? (vaccination book) Date of injection:……... Date of injection:……... Date of injection:……...	1. Get vaccinated, on schedule 2. Got an injection, not on schedule 3. Do not inject	
B10	The reason why you do not vaccinate your child on schedule or not vaccinate at all	1. Medical staff do not provide. 2.Vaccines are not available. 3. Children are not healthy enough to be vaccinated or children are sick. 4. Mothers are afraid of vaccination accidents, so they do not vaccinate their children. 5. Mothers switch to private vaccination system for children. 6. The mother does not know or remember the vaccination schedule. 7. Due to the impact of the Covid-19 epidemic. 8. Other:……	From B1 to B9 with answer 2 or 3, answer B10. Select multiple answers.