Determinants of Complete Basic Childhood Vaccination among Children Aged 12–35 Months in Cambodia

Khemrin Pong[1,2*], Heng Sopheab[2], Darapheak Chau[2]

[1]Kandal Provincial Health Department, [2]National Institute of Public Health, Cambodia

ABSTRACT

Introduction

Vaccination is a critical public health intervention to prevent childhood morbidity and mortality. Despite global progress, vaccination coverage in low– and middle–income countries (LMICs), such as Cambodia, remains suboptimal. Studies on the factors associated with complete basic childhood vaccination in Cambodia are limited. This study aimed to assess the determinants of complete basic childhood vaccination among children in Cambodia.

Methods

This study utilized data from the 2021–2022 Cambodia Demographic and Health Survey (CDHS). Children aged 12–35 months were included. We performed weighted analysis via descriptive statistics, bivariate analysis, and multivariate logistic regression. Statistical significance with a p value <0.05 and an AOR with a 95% CI were calculated to measure the strength of the association between completing basic childhood vaccination and independent predictors.

Results

A total of 3,065 children were included, 49.6% of whom were girls, with a mean age of 23 months (SD=6.9). Overall, 66.3% of the children received complete basic childhood vaccinations, with Ratanakiri (23.1%) and Koh Kong provinces (38.9%) having the lowest rates. Lower basic childhood vaccinations were associated with higher birth order (≥4th) (AOR=0.55, 95% CI: 0.36–0.84) and fewer ANC visits (<4) (AOR=0.55, 95% CI: 0.39–0.77). Higher basic childhood vaccinations were observed in children with birth weights ≥2.5 kg (AOR=1.72, 95% CI: 1.11–2.54), wealthier households (AOR=1.53, 95% CI: 1.13–2.06), mothers who received PNC (AOR=1.29 CI: 1.03–1.62) and mothers aged ≥40 years (AOR=2.23, 95% CI: 1.04–4.78). Regional disparities were significant, with greater coverage in the plain region, Tonle Sap region, and mountain region than in the coastal/sea region.

Conclusion

Overall, complete basic childhood vaccination was lower than the national target, particularly in Koh Kong and Ratanak Kiri provinces. Lower vaccination rates were associated with higher birth orders, fewer ANC visits, and no PNC visits, whereas higher coverage was linked to greater birth weight, wealthier families, older maternal age, and geographical region. Targeted interventions in specific low–rate groups and regions are crucial for improving vaccination coverage and ensuring that targets are met.

*Corresponding author: Khemrin Pong, email: khemrinpong@gmail.com (+855 76 2222 884)

Introduction

Vaccination is one of the most effective ways to protect health and prevent or eliminate serious childhood diseases worldwide (1). The rate of childhood vaccination is steadily increasing worldwide, with more children receiving lifesaving vaccines each year (2). The global under five mortality rate has markedly declined, dropping by 60%, from 93 deaths per 1,000 live births in 1990 to just 37 per 1,000 in 2022 (3). Vaccinations have proven to be an effective tool for safeguarding children in low– and middle–income countries from a range of preventable diseases, including diphtheria, measles, mumps, pertussis, pneumonia, polio, rotavirus–induced diarrhea, rubella, and tetanus (4,5). Among its notable achievements are the eradication of polio, the elimination of measles and maternal and neonatal tetanus (MNT), and significant improvements in vaccination coverage for children and pregnant women (6–8). Basic childhood vaccines, including hepatitis B, BCG, pentavalent (Diphtheria, tetanus, pertussis, hepatitis B, and *Haemophilus influenzae* type b (Hib), polio, and measles, are estimated to prevent 2–3 million deaths among children under five each year (9,10). Despite this childhood prevention annually, vaccine-preventable diseases continue to pose a significant threat in low– and middle–income countries (LMICs) (11).

In 1974, the World Health Organization (WHO) established the Expanded Program on Immunization (EPI) to support the global control of vaccine-preventable diseases (12). The number of children who did not receive any basic vaccines increased from 13.9 million in 2022 to 14.5 million in 2023 (13). Worldwide, measles cases have become significant, increasing from 170,000 in 2022 to over 320,000 in 2023, mainly due to disruptions in routine immunization caused by the COVID–19 pandemic (14).

In Cambodia, the National Immunization Program (NIP) was established in 1986 to reduce the mortality, morbidity, and disability of children from vaccine-preventable diseases. It has worked closely in collaboration with partners such as the WHO, UNICEF, and Gavi to broaden the scope and accessibility of immunization across the country (6). According to Cambodia's NIP, currently, there are twelve types of childhood vaccinations, such as the Bacille Calmette–Guérin (BCG), which is given at birth for tuberculosis; one dose of the hepatitis B vaccine shortly after birth; three doses each of the oral polio vaccine (OPV), pneumococcal conjugate vaccine (PCV), and pentavalent vaccine or Diphtheria, tetanus, pertussis, hepatitis B, and Haemophilus influenza type B (DTP–Hep B–Hib) at 6, 10, and 14 weeks of age; one dose of the inactivated polio vaccine (IPV) at 14 weeks of age; two doses of the measles–Rubella (MR) vaccine at 9 months and 18 months; and one dose of the Japanese encephalitis vaccine (JE) at 9 months (6).

The prevalence of complete basic childhood vaccine coverage varies across countries. In Ethiopia, coverage was reported at 27.4% in 2023 (15); in East Africa, it was 69.2% in 2020 (16); in India, it reached 53% in 2018 (17); in Indonesia, it was 60% in 2021 (18); and in Myanmar, it reported coverage of 55% in 2019 (19), and it was 21.1% in northern Nigeria (20).

Previous studies in many countries have identified several predictor factors associated with complete basic childhood vaccination, including maternal antenatal care (ANC) visits (15,18,19), postnatal care (PNC) visits (16), mothers' age (16,19), mothers' education (16,21), mothers' employment status (15,21), mothers' knowledge of children's vaccination (22), delivery facilities (16,21,22), the tetanus vaccination status of mothers (18), the family wealth index (15,16), the residential area (15,21), health insurance coverage (18), media exposure (16), family religious following (17), the sex of children (17), the birth order interval (16), and birth weight (16).

Although immunization services are free in Cambodia, the country has not yet achieved the anticipated levels of full immunization coverage. In 2022, 76% of children under 1 year of age received all basic vaccines, and approximately 8% remained unvaccinated and were identified as zero–dose children (23). Research on the prevalence and specific determinants of full completion of basic childhood vaccination in Cambodia is limited. Additionally, there is a lack of qualitative research exploring the sociodemographic, cultural, and behavioral factors influencing parental decision–making regarding vaccination (24).

The findings from this study will inform policymakers and program implementers in Cambodia in addressing vaccination barriers through strategies such as strengthening health systems, promoting vaccine acceptance through community education, and improving outreach to underserved areas. Understanding the factors associated with complete childhood vaccination is essential for developing targeted interventions to close the immunization gap in

Cambodia. This study aimed to identify the prevalence and predictive factors of complete basic childhood vaccination among children aged 12-35 months in Cambodia.

Methods

Data source

This study used the children's record dataset (KR file) of the 2021–2022 Cambodia Demographic and Health Survey (CDHS). The CDHS is a nationally representative survey that collects data on key health indicators, including fertility and childhood mortality, vaccination, morbidity, family planning, maternal and child health, knowledge and behaviors regarding HIV/AIDS, and other sexually transmitted infections. A two-stage stratified cluster sampling technique was used to select the study participants. In the first stage, the 709 EAs were stratified by urban–rural areas using probability proportional to cluster size, in which 241 EAs were selected from urban areas and 468 were selected from rural areas. In the second stage, 30 fixed households were selected from each cluster through systematic sampling. Eligible interviews with 19,496 women were subsequently conducted, and the response rate was reported to be 98.2% (25). However, our study restricted the sample to women aged 15–49 years who gave birth within the five years before the survey with their children aged 12-35 months; 3,065 were included.

Measurements
Dependent variable

The dependent variable of this study was the child's complete basic childhood vaccination status, defined as children receiving at least eleven types of vaccines (thirteen doses). These included one dose of Bacille Calmette–Guérin (BCG) at birth for tuberculosis; one dose of hepatitis B vaccine after birth; three doses each of oral polio vaccine (OPV), pneumococcal conjugate vaccine (PCV), and pentavalent vaccine (DTP–Hep B–Hib) at 6, 10, and 14 weeks of age; one dose of inactivated polio vaccine (IPV) at 14 weeks of age; and one dose of measles vaccine at 9 months. A child is considered fully vaccinated if all thirteen vaccination doses are completed. Complete basic childhood vaccination status was coded as one (1), and incomplete status was coded as zero (0).

Independent variables

Child characteristics: The child's age in months was categorized into the following groups: 12–17, 18–23, 24–29, and 30–35, and the child's sex was classified into boys and girls. Birth order was recorded as an ordinal variable, with categories including first child, second to third children, and fourth or higher–order children. The place of delivery was categorized as public, private, or home. Birth weight was categorized into two categories: less than 2.5 kg and 2.5 kg or greater.

Household characteristics: The wealth index was categorized into five quintiles: poorest (1), poorer (2), middle (3), richer (4), and richest (5). However, in this analysis, it was recoded into three categories: poor (combining 'poorest' and 'poorer'), middle, and rich (combining 'richer' and 'richest'). The residential area was categorized into urban and rural areas. Cambodia's domain distributions were categorized into five geographical regions for analysis: Phnom Penh Capital City, Plains, Tonle Sap, Coastal/Sea, and Mountains. The Phnom Penh Capital City region encompasses the capital city of Phnom Penh. The plains region includes Kampong Cham, Tbong Khmum, Kandal, Prey Veng, Svay Rieng, and Takeo. The Tonle Sap region covers Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Battambang, Pailin, and Otdar Meanchey. The coastal/sea region consists of Kampot, Kep, Preah Sihanouk, and Koh Kong. Finally, the mountain region includes Kampong Speu, Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanakiri. Health insurance coverage was classified as either "Yes" or "No." Media exposure was coded as "Yes" for individuals who read newspapers/magazines, listen to the radio, watch television at least once a week, and "No" for those with no exposure or exposure, all of whom are less than once a week. Health care barriers were recorded by assessing four dimensions—permission to seek care, financial constraints, distance to the health facility, and accompanying needs—with "yes" indicating that at least one dimension was a big problem and "no" indicating that none were big problems." Religious affiliations are categorized as "Buddhism" or "Non–Buddhism." Maternal characteristics: Mothers were categorized according to age as 15–19, 20–29, 30–39, or 40+ years. Mothers' education was coded into ordinal-level variables: no education, primary, secondary, and higher. Mothers' Employment was coded into a dichotomous variable: employed and non-employed. Antenatal care (ANC) visits during pregnancy

were categorized as "No ANC," "1–3 times", or more than or equal to 4 times. Postnatal care (PNC) was coded as "yes" or "no."

Data management and statistical analysis

STATA version 17.0 statistical software (Stata Crop 2019) was used to clean, recode, and analyze the data. The data were weighed according to the DHS standard weighting using the sampling weight (v005/1,000,000), primary sampling unit (PSU) (v023), and strata (v021). All estimations were conducted using the survey–specific command "svy." Descriptive statistics summarize the demographic and socioeconomic characteristics, such as the frequency and percentage of the study population. The continuous variables were presented as the means and standard deviations. Bivariate analysis with the chi-square test was conducted to evaluate the initial associations between demographic and socioeconomic factors and complete basic childhood vaccination among children aged 12 to 35 months. Potential confounding factors, such as the mother's age group, residence and all statistically significant factors with a p value<0.10 from the bivariate analysis, were included in the final logistic regression model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were measured to assess the independent effect of the association between its determinants and the outcome variable. Statistical significance was considered at a p value <0.05.

Ethical clearance

The data used for this study were based on CDHS 2021–2022, with National Ethics Committee for Health Research (NECHR) approval and IRB approval from the DHS Program–ICF, USA. The DHS program approved datasets that are publicly accessible and anonymize all personal identifiers of the study participants. This study was also approved by the NECHR (Ref # 464 NECHR).

Results

Sociodemographic characteristics of the samples and prevalence of complete basic vaccination. Approximately half of the samples (50.4%) were boys, with a mean age of 23 months (SD = 6.9). The overall prevalence of complete basic childhood vaccines was 66.3% (95% CI: 63.7%-68.8%). Fewer than 2.0% of them were born at home, and 93.6% had a birth weight of ≥ 2.5 kg. A total of 39.6% were from poor families, and 58.4% came from rural areas. Less than 2.0% did not receive antenatal care during pregnancy, and 61.5% did not receive postnatal care after delivery (**Table 1**).

Table 1: Sociodemographic and economic characteristics of children aged 12–35 months in Cambodia (N=3,065)

Variable	Frequency	(%)
Child characteristics		
Overall complete basic vaccination		
No	1033	33.7
Yes	2032	66.3
Age (months)		
Mean (± SD)	23 (± 6.9)	
Age group (months)		
12-17	784	25.6
18-23	819	26.7
24-29	778	25.4
30-35	683	22.3
Sex		
Boys	1546	50.4

Variable	Frequency	(%)
Girls	1519	49.6
Birth order		
1 child	1059	34.6
2-3 children	1704	55.6
≥ 4 children	302	9.8
Place of delivery		
Home	58	1.9
Public	2406	78.5
Private	601	19.6
Birth weight		
< 2.5 kg	191	6.4
≥ 2.5 kg	2793	93.6
Household characteristics		
Wealth index		
Poor	1214	39.6
Middle	531	17.3
Rich	1320	43.1
Residence area		
Urban	1275	41.6
Rural	1791	58.4
Regional distribution*		
Phnom Penh	506	16.5
Plain	1040	33.9
Tonle Sap	935	30.5
Costal/Sea	158	5.2
Mountain	426	13.9
Health insurance coverage		
No	2292	74.8
Yes	773	25.2
Media exposure		
No	2295	74.9
Yes	771	25.1
Healthcare barriers		
No	1301	42.5
Yes	1764	57.5
Religion		
Buddhism	2966	96.8
Non-Buddhism	99	3.2
Mother Characteristics		

Variable	Frequency	(%)
Mother's age (year)		
Mean (SD)	29.41 (± 6.2)	
Mother's age group		
15-19	77	2.5
20-29	1468	47.9
30-39	1326	43.3
40+	194	6.32
Mother's employment		
Unemployed	807	26.8
Employed	2198	73.2
Mother education		
No education	319	10.4
Primary	1259	41.1
Secondary	1253	40.9
Higher	235	7.6
ANC visit		
No	33	1.2
1-3	294	10.4
4+	2488	88.4
PNC visit		
No	1727	61.5
Yes	1081	38.5

Note: *Phnom Penh: capital city; Plains: Kampong Cham, Tbong Khmum, Kandal, Prey Veng, Svay Rieng, and Takeo; Tonle Sap: Banteay Meanchey, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Battambang, Pailin, and Otdar Meanchey; Coastal/sea: Kampot, Kep, Preah Sihanouk, and Koh Kong; Mountains: Kampong Speu, Kratie, Preah Vihear, Stung Treng, Mondul Kiri, and Ratanak Kiri.*

Provinces with the lowest coverage included Koh Kong and Ratanak Kiri, where vaccination rates range between 20% and 40%, and Kampot province falls within the 40%–50% range (**Figure 1**).
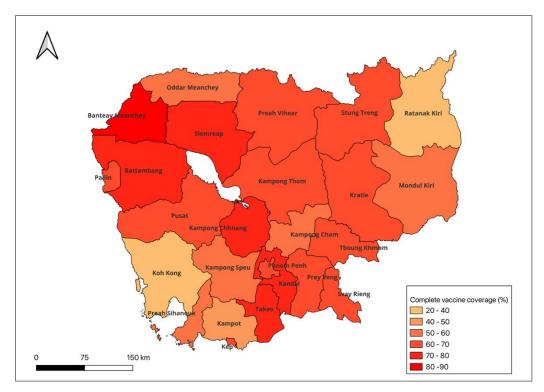
Figure 1: Geographic distribution of complete basic childhood vaccination among children aged 12–35 months by Province in Cambodia (N=3,065)

Bivariate analysis of factors associated with complete basic vaccination

The degree of basic childhood vaccination coverage varied significantly across demographic, socioeconomic, and healthcare-related factors. Coverage was greater for children born in private facilities (71.7%) than for those born in public (65.9%) or home (27%) and for those with normal birth weights (68%) versus low birth weights (52%) (p value<0.001). Wealthier households (71.5%) and urban areas (69.5%) had higher rates than poorer households (60.8%) and rural areas (64%) (p value<0.001), respectively. There were regional disparities, in which the Tonle Sap region had the highest coverage (71.2%) and the coastal/sea areas had the lowest coverage (48.7%) (p value<0.001). Maternal factors, including higher education (75.7%), ≥ 4 ANC visits (69.4%), and PNC visits (70.8%), were strongly associated with better vaccination coverage (p value<0.01) (**Table 2**).

Table 2: Bivariate analysis of the associations between completing basic childhood vaccination and associated factors

Variables	Total (N=3,065)	Complete Basic Vaccination (%)	p value
Child characteristics			
Age (months)			
12-17	784	66.6	0.074
18-23	819	65.8	
24-29	778	70.2	
30-35	683	62.1	
Sex			
Boys	1546	66.4	0.947

Variables	Total (N=3,065)	Complete Basic Vaccination (%)	p value
Girls	1519	66.2	
Birth order			
1 child	1059	65.7	<0.001
2-3 children	1704	68.9	
≥ 4 children	302	53.7	
Place of delivery			
Home	58	27.0	<0.001
Public	2406	65.9	
Private	601	71.7	
Birth weight			
< 2.5 kg	191	52.0	<0.001
≥ 2.5 kg	2793	68.0	
Household characteristics			
Wealth index			
Poor	1214	60.8	<0.001
Middle	531	65.9	
Rich	1320	71.5	
Residence area			
Urban	1275	69.5	0.037
Rural	1791	64.0	
Regional distribution			
Phnom Penh	506	64.9	<0.001
Plain	1040	68.8	
Tonle Sap	935	71.2	
Costal/Sea	158	48.7	
Mountain	426	57.9	
Health insurance coverage			
No	2292	65.3	0.142
Yes	773	69.3	
Media exposure			
No	2295	65.2	0.116
Yes	771	69.7	
Healthcare barriers			
No	1301	69.3	0.019
Yes	1764	64.1	
Religion			

Variables	Total (N=3,065)	Complete Basic Vaccination (%)	p value
Buddhism	2966	66.7	0.167
Non-Buddhism	99	54.8	
Mother characteristics			
Mother's age group			
15-19	77	54.4	0.017
20-29	1468	65.1	
30-39	1326	68.5	
40+	194	65.6	
Mother's employment			
Unemployed	807	64.7	0.413
Employed	2198	67.1	
Mother education			
No education	319	56.5	0.003
Primary	1259	64.5	
Secondary	1253	68.8	
Higher	235	75.7	
ANC visit			
No	33	57.0	<0.001
1-3	294	46.6	
4+	2488	69.4	
PNC visit			
No	1727	64.5	0.009
Yes	1081	70.8	

In multivariate logistic regression, after adjusting for potential confounders, the birth order of a child who is the fourth or higher child had lower odds of having a complete basic childhood vaccination rate than the first child did (AOR=0.55, 95% CI: 0.36–0.84). A birth weight of ≥2.5 kg was associated with greater complete basic childhood vaccination (AOR=1.72, 95% CI: 1.11–2.54) than a birth weight of <2.5 kg. Compared with poor families, rich families were more likely to complete basic childhood vaccinations (AOR=1.53, 95% CI: 1.13–2.06). Families in the plain, Tonle Sap, and mountain regions had higher rates of completing basic childhood vaccinations (AOR=2.39, 95% CI: 1.60–3.57 (AOR=3.18, 95% CI: 2.13–4.76), and AOR=2.12, 95% CI: 1.38–3.27), respectively, than families in the coastal/sea region did. Children whose mothers were aged over 40 years were more likely to have completed basic childhood vaccinations than were those whose mothers were aged 15–19 years (AOR = 2.23, 95% CI: 1.04–4.78). Children whose mothers attended 1–3 ANC visits were significantly less likely to complete vaccinations than those whose mothers attended four or more visits (AOR=0.55, 95% CI: 0.39–0.77). Children whose mothers received postnatal care visits were significantly more likely to complete vaccinations than those whose mothers did not (AOR =1.29, 95% CI: 1.03–1.62) (**Table 3**).

Table 3: Multivariate logistic regression analyses: Association between complete basic childhood vaccination and independent variables (N=3,065)

Variables	AOR	95% CI	p value
Birth order			
1 child	Ref.		
2–3 children	1.05	(0.79–1.38)	0.720
≥ 4 children	**0.55**	**(0.36–0.84)**	**0.006**
Place of delivery			
Home	Ref.		
Public	2.37	(0.85–6.59)	0.097
Private	2.58	(0.86–7.75)	0.090
Birth weight			
< 2.5 kg	Ref.		
≥ 2.5 kg	**1.72**	**(1.11–2.54)**	**0.014**
Wealth index			
Poor	Ref.		
Middle	1.12	(0.83–1.52)	0.379
Rich	**1.53**	**(1.13–2.06)**	**0.005**
Residence area			
Urban	Ref.		
Rural	0.85	(0.63–1.14)	0.286
Regional distribution			
Coastal/Sea	Ref.		
Phnom Penh	1.38	(0.84–2.27)	0.194
Plain	**2.39**	**(1.60–3.57)**	**<0.001**
Tonle Sap	**3.18**	**(2.13–4.76)**	**<0.001**
Mountain	**2.12**	**(1.38–3.27)**	**0.001**
Mother's age group			
15–19	Ref.		
20–29	1.34	(0.75–2.39)	0.271
30–39	1.71	(0.88–3.30)	0.086
40+	**2.23**	**(1.04–4.78)**	**0.038**
Mother education			
No education	Ref.		
Primary	1.06	(0.73–1.56)	0.730
Secondary	1.15	(0.76–1.73)	0.499
Higher	1.40	(0.67–2.93)	0.361
ANC visit			
No	1.07	(0.43–2.67)	0.880
1–3	**0.55**	**(0.39–0.77)**	**0.001**
4+	Ref.		
PNC visit			
No	Ref.		
Yes	**1.29**	**(1.03–1.62)**	**0.024**
Healthcare Barriers			
No	Ref.		
Yes	0.93	(0.74–1.16)	0.528

Discussion

This study revealed relatively high complete basic childhood vaccination coverage (66.3%) among children aged 12-35 months in Cambodia but a disproportionate provincial distribution, such as lower coverage in Koh Kong and Ratanakiri provinces. The seven main determinants of completed basic childhood vaccination included birth order, birth weight, family wealth index, regional distribution, mother's age, ANC visits, and PNC visits after delivery.

Although vaccination coverage for early doses remains relatively high, the overall prevalence of completed basic childhood vaccination was only 66.3%, indicating significant gaps in immunization; this result was greater than that reported in other countries, such as Ethiopia (27.7%) (15), India (53%) (17), Indonesia (60%) (18), and Myanmar (55%) (19), but lower than East Africa (69.2%) (15), indicating suboptimal coverage compared with the global target of 90% set by the World Health Organization, followed by the EPI program strategy goal in Cambodia (26). Moreover, this finding is almost identical to that reported nearly two decades ago in 2006, when 67% of children were reported as fully immunized (27). Although there has been a slight increase of 6% compared with the 2014 CDHS, which reported a full immunization rate of 60.5% (25), progress has remained insufficient over the past decade. Notably, the CDHS 2014 did not include the IPV as part of the basic immunization schedule.

The rate of completing basic childhood vaccination in Koh Kong and Ratanakiri provinces is lower than that in other provinces in Cambodia. Both provinces are predominantly located in remote, rural areas with high poverty rates and limited access to healthcare services (28), which increases the time, cost, and logistical difficulties for both healthcare providers and families seeking vaccinations. Similar findings have been reported in other settings where geographical isolation contributes to reduced vaccination coverage (26). Additionally, low community awareness and limited communication regarding the importance of vaccination further exacerbate the problem in Koh Kong. Effective health communication strategies have been shown to improve vaccine uptake in remote settings (29). The extremely remote nature of many communities in Ratanakiri and Koh Kong poses logistical challenges and inadequate healthcare infrastructure, including a shortage of health centers and medical personnel, which limits access to immunization services.

Compared with the first child in the family, the fourth or more children had a lower rate of completing basic childhood vaccines, and this result is consistent with the findings of a previous multi–analysis study in Ethiopia (28). The possible reason is that parents might gain confidence in managing their child's healthcare through their experience with older children, leading them to undervalue the significance of immunization (28). Conversely, it is possible that the first-born child experienced an adverse reaction to immunization, causing the parents to perceive it as unsafe (28).

Children with a birth weight ≥ 2.5 kg were significantly more likely to complete basic vaccination. This finding aligns with studies showing that low birth weight is a barrier to vaccination due to perceived vulnerability or frequent illnesses (30,31). The perceived vulnerability of low-birth-weight infants, combined with their greater susceptibility to frequent illnesses, may lead caregivers to delay or abstain from vaccinations, and this finding is consistent with a previous study in East Africa (16).

Children from wealthier households were significantly more likely to have completed basic vaccinations than those from poorer families were (AOR=1.53, p value=0.005). This finding is consistent with previous studies conducted in low– and middle–income countries (LMICs) (15,16), where economic barriers often limit access to immunization services, aligning with global evidence that socioeconomic status influences healthcare access and immunization uptake (32). Children from low–income households may be less accessible to health workers, and parents with limited financial resources may face greater challenges in accessing health facilities than those from wealthier families, especially in rural areas (33). Moreover, individuals with higher incomes tend to exhibit improved health-seeking behaviors and enjoy better overall health (34).

Older mothers aged more than 40 years were more likely to complete the basic childhood vaccine for their children than younger mothers aged 15–19 years were. This finding was consistent with several previous studies in Ethiopia and East Africa (16,19). This could be linked to better use of maternal health services, such as ANC visits, health facility deliveries, and PNC visits, which often serve as starting points for childhood vaccinations as mothers grow

older (35). Additionally, they are aware that severe childhood diseases can be prevented by basic childhood vaccination as the mother's age increases.

Mothers who used healthcare services such as ANC visits more than three times during pregnancy and PNC visits after delivery had higher odds of receiving fully basic childhood vaccination than mothers who did not use them. This finding aligns with previous studies reported in Ethiopia (15), East Africa (16), Indonesia (18), and Myanmar (19); this might be because women who attended ANC check-ups and had PNC visits may have received detailed advice about vaccination from healthcare providers.

Strengths and Limitations

This study's analysis utilized the 2021–2022 CDHS dataset, which is the most recent and nationally representative dataset. Moreover, the data were weighed before analysis. The large sample size enabled the simultaneous analysis of numerous potential predictors and increased the validity of our findings. However, our results have several possible limitations. First, this study used a dataset from a cross-sectional survey; therefore, inferring causality between socioeconomic factors and completing basic childhood vaccination is difficult. Second, some of the vaccination data relied on mothers' reports when yellow vaccination records were unavailable, which could introduce recall bias.

Conclusion

Overall, the prevalence of basic childhood vaccination was low compared with the national target, particularly in Koh Kong and Ratanak Kiri provinces. Lower vaccination rates were associated with higher birth orders, fewer ANC visits, and no PNC visits, whereas higher coverage was linked to greater birth weight, wealthier families, older maternal age, and the plain, Tonle Sap, and mountain regional distributions. Targeted interventions in specific low–rate groups and regions are crucial for improving vaccination rates and ensuring equitable coverage.

Author contributions

Khemrin Pong conceptualized and analyzed the data and wrote the first draft of the full manuscript. Assistant Professor Darapheak Chau and Professor Heng Sopheab contributed to the review and editing of the manuscript.

Acknowledgments

Funding

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

References

[1] World Health Organization. Vaccines and immunization [Internet]. [cited 2025 Jun 25]. Available from: https://www.who.int/health-topics/vaccines-and-immunization

[2] Organization WH. WHO vaccine-preventable diseases: monitoring system: 2009 global summary. 2009 [cited 2025 Jun 25]; Available from: https://iris.who.int/handle/10665/70149

[3] Child Mortality [Internet]. UNICEF DATA. [cited 2025 Jun 25]. Available from: https://data.unicef.org/topic/child-survival/under five-mortality/

[4] Wondwossen L, Gallagher K, Braka F, Karengera T. Advances in the control of vaccine preventable diseases in Ethiopia. The Pan African Medical Journal [Internet]. 2017 Jun 9 [cited 2025 Jun 25];27(Suppl 2):1. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC5578722/

[5] Eh L, Rf L, I M, A K, Td E, M B, et al. *Haemophilus influenzae* type b conjugate vaccine is highly effective in the Ugandan routine immunization program: a case–control study. Tropical medicine & international health: TM & IH [Internet]. 2008 Apr [cited 2025 Jun 25];13(4). Available from: https://pubmed.ncbi.nlm.nih.gov/18312475/

[6]   National Immunization Programme (NIP) [Internet]. National Maternal and Child Health Center (NMCHC). [cited 2025 Jun 25]. Available from: https://nmchc.gov.kh/en/training/national-immunization-programme-nip/

[7]   Keegan R, Bilous J. Current issues in global immunizations. Semin Pediatr Infect Dis [Internet]. 2004 Jul [cited 2024 Aug 13];15(3):130–6. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7129521/

[8]   Division CD of H and ACPH. Polio eradication [Internet]. Commonwealth Department of Health and Aged Care; [cited 2024 Aug 13]. Available from: https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-pubs-cdi-1999-cdi2303-cdi2303e.htm

[9]   Oliwa JN, Marais BJ. Vaccines to prevent pneumonia in children - a developing country perspective. Paediatr Respir Rev. 2017 Mar;22:23–30.

[10]   Whitney CG, Zhou F, Singleton J, Schuchat A, Centers for Disease Control and Prevention (CDC). Benefits from immunization during the vaccines for children program era - United States, 1994-2013. MMWR Morb Mortal Wkly Rep. 2014 Apr 25;63(16):352–5.

[11]   World Health Organization. Immunization coverage [Internet]. [cited 2025 Jun 25]. Available from: https://www.who.int/news-room/fact-sheets/detail/immunization-coverage

[12]   Keja K, Chan C, Hayden G, Henderson RH. Expanded programme on immunization. World Health Stat Q. 1988;41(2):59–63.

[13]   Global childhood immunization levels stalled in 2023, leaving many without life-saving protection [Internet]. [cited 2025 Jun 25]. Available from: https://www.who.int/news/item/15-07-2024-global-childhood-immunization-levels-stalled-in-2023-leaving-many-without-life-saving-protection

[14]   Cambodia Launches National Measles-Rubella Vaccination Campaign to Protect Over 1.5 million Children [Internet]. [cited 2025 Jun 25]. Available from: https://www.unicef.org/cambodia/press-releases/cambodia-launches-national-measles-rubella-vaccination-campaign-protect-over-15

[15]   Mihret Fetene S, Debebe Negash W, Shewarega ES, Asmamaw DB, Belay DG, Teklu RE, et al. Determinants of full immunization coverage among children 12–23 months of age from deviant mothers/caregivers in Ethiopia: A multilevel analysis using 2016 demographic and health survey. Front Public Health [Internet]. 2023 Feb 28 [cited 2024 Aug 17];11:1085279. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10011448/

[16]   Tesema GA, Tessema ZT, Tamirat KS, Teshale AB. Complete basic childhood vaccination and associated factors among children aged 12-23 months in East Africa: a multilevel analysis of recent demographic and health surveys. BMC Public Health. 2020 Dec 1;20(1):1837.

[17]   Francis MR, Nohynek H, Larson H, Balraj V, Mohan VR, Kang G, et al. Factors associated with routine childhood vaccine uptake and reasons for non-vaccination in India: 1998-2008. Vaccine. 2018 Oct 22;36(44):6559–66.

[18]   Hardhantyo M, Chuang YC. Urban–rural differences in factors associated with incomplete basic immunization among children in Indonesia: A nationwide multilevel study. Pediatr Neonatol. 2021 Jan;62(1):80–9.

[19]   Nozaki I, Hachiya M, Kitamura T. Factors influencing basic vaccination coverage in Myanmar: secondary analysis of 2015 Myanmar demographic and health survey data. BMC Public Health. 2019 Feb 28;19(1):242.

[20]   Babalola S. Determinants of the uptake of the full dose of diphtheria-pertussis-tetanus vaccines (DPT3) in Northern Nigeria: a multilevel analysis. Matern Child Health J. 2009 Jul;13(4):550–8.

[21]   Setiawan MS, Wijayanto AW. Determinants of immunization status of children under two years old in Sumatera, Indonesia: A multilevel analysis of the 2020 Indonesia National Socio-Economic Survey. Vaccine. 2022 Mar 15;40(12):1821–8.

[22]   Zemariam AB, Kibret Abebe G, Kassa MA, Alamaw AW, Molla RW, Abate BB, et al. Correction: Immunization coverage and its associated factors among children aged 12-23 months in Ethiopia: An umbrella review of systematic review and meta-analysis studies. PLoS One. 2024;19(4):e0302715.

[23]   Progress from the pandemic: | UNICEF Cambodia [Internet]. [cited 2024 Aug 19]. Available from: https://www.unicef.org/cambodia/stories/progress-pandemic

[24]   The State of the World's Children 2019 | UNICEF [Internet]. 2019 [cited 2025 Jan 28]. Available from: https://www.unicef.org/reports/state-of-worlds-children-2019

[25]   National Institute of Statistics - Copyright © 2017, NIS, MOP, Government of Cambodia - Cambodia Demographic and Health Survey 2021-22 [Internet]. [cited 2025 Jun 27]. Available from: https://www.nis.gov.kh/index.php/km/17-cdhs/123-cambodia-demographic-and-health-survey-2021-22

[26]   Immunization Agenda 2030: A Global Strategy To Leave No One Behind [Internet]. [cited 2025 Jun 27]. Available from: https://www.who.int/publications/m/item/immunization-agenda-2030-a-global-strategy-to-leave-no-one-behind

[27]   Cambodia achieves significant boost in immunization [Internet]. [cited 2025 Jun 27]. Available from: https://www.path.org/our-impact/media-center/cambodia-achieves-significant-boost-in-immunization/

[28]   Abadura SA, Lerebo WT, Kulkarni U, Mekonnen ZA. Individual and community level determinants of childhood full immunization in Ethiopia: a multilevel analysis. BMC Public Health. 2015 Sep 28;15:972.

[29]   Brewer NT, Chapman GB, Rothman AJ, Leask J, Kempe A. Increasing Vaccination: Putting Psychological Science Into Action. Psychol Sci Public Interest. 2017 Dec;18(3):149–207.

[30]   Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013 Aug 3;382(9890):427–51.

[31]   Oyo-Ita A, Oduwole O, Arikpo D, Effa EE, Esu EB, Balakrishna Y, et al. Interventions for improving coverage of childhood immunization in low- and middle-income countries. Cochrane Database Syst Rev [Internet]. 2023 Dec 6 [cited 2025 Jan 19];2023(12):CD008145. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10698843/

[32]   Gender and immunization [Internet]. 2025 [cited 2025 Jun 27]. Available from: https://www.gavi.org/our-alliance/strategy/gender-and-immunization

[33]   Case A, Lubotsky D, Paxson C. Economic Status and Health in Childhood: The Origins of the Gradient. Am Econ Rev. 2002;92(5):1308–34.

[34] Case A, Lee D, Paxson C. The income gradient in children's health: a comment on Currie, Shields and Wheatley Price. J Health Econ. 2008 May;27(3):801–7.

[35] Sondaal SFV, Browne JL, Amoakoh-Coleman M, Borgstein A, Miltenburg AS, Verwijs M, et al. Assessing the Effect of mHealth Interventions in Improving Maternal and Neonatal Care in Low- and Middle-Income Countries: A Systematic Review. PLoS One. 2016;11(5):e0154664.