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## Factors associated with routine immunization coverage of children under one year old in Lao People's Democratic Republic

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## ABSTRACT

**Background:** Routine vaccination is administered free of charge to all children under one year old in Lao People's Democratic Republic (Lao PDR) and the national goal is to achieve at least 95% coverage with all vaccines included in the national immunization program by 2025. In this study, factors related to the immunization system and characteristics of provinces and districts in Lao PDR were examined to evaluate the association with routine immunization coverage.

**Methods:** Coverage rates for Bacillus Calmette-Guerin (BCG), Diphtheria-Tetanus-Pertussis-Hepatitis B (DTP-HepB), DTP-HepB-Hib (*Haemophilus influenzae* type B), polio (OPV), and measles (MCV1) vaccines from 2002 to 2014 collected through regular reporting system, were used to identify the immunization coverage trends in Lao PDR. Correlation analysis was performed using immunization coverage, characteristics of provinces or districts (population, population density, and proportion of poor villages and high-risk villages), and factors related to immunization service (including the proportions of the following: villages served by health facility levels, vaccine session types, and presence of well-functioning cold chain equipment). To determine factors associated with low coverage, provinces were categorized based on 80% of DTP-HepB-Hib3 coverage (<80% = low group; ≥80% = high group).

**Results:** Coverages of BCG, DTP-HepB3, OPV3 and MCV1 increased gradually from 2007 to 2014 (82.2–88.3% in 2014). However, BCG coverage showed the least improvement from 2002 to 2014. The coverage of each vaccine correlated with the coverage of the other vaccines and DTP-HepB-Hib dropout rate in provinces as well as districts. The provinces with low immunization coverage were correlated with higher proportions of poor villages.

**Conclusions:** Routine immunization coverage has been improving in the last 13 years, but the national goal is not yet reached in Lao PDR. The results of this study suggest that BCG coverage and poor villages should be targeted to improve nationwide coverage.

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### 1. Introduction

The Expanded Program on Immunization (EPI) was established by the World Health Organization (WHO) in 1974 [1], and was introduced in Lao People's Democratic Republic (Lao PDR) in 1979 [2]. The National Immunization Program was launched with the introduction of six vaccines (Bacillus Calmette-Guerin [BCG],

Diphtheria, Tetanus, Pertussis, Polio, and Measles [MCV1]) in 1984, in two provinces. The program was gradually extended to all provinces by 1994. Hepatitis B vaccine (HepB) was introduced in 2001 as part of the tetravalent diphtheria-tetanus-pertussis-hepatitis B (DTP-HepB), followed by DTP-HepB-Hib (*Haemophilus influenzae* type B) vaccine in 2009. Table 1 shows the immunization schedule in Lao PDR [3,4]. However, the policy on BCG vaccination is at any time before one year old, not only at birth, because most newborns are delivered at home. Although vaccination is performed free of charge for all children under one year old in Lao PDR, it can be applied to children up to five years old if they have not been vaccinated.

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**Table 1**  
Vaccine schedule in the Expanded Programme on Immunization in Lao PDR.

Vaccine	Age
Hepatitis B	Birth
BCG	Birth
DTP-HepB-Hib	6, 10, and 14 weeks
OPV	6, 10, and 14 weeks
Measles	9 months

BCG, Bacillus Calmette-Guérin vaccine; DTP-HepB-Hib, diphtheria-tetanus-pertussis-hepatitis B-*Haemophilus influenzae* type B vaccine; OPV, oral polio vaccine.

Vaccination coverage is a key indicator of vaccination program performance, and achieving very high vaccination coverage of routine vaccines is necessary for eliminating vaccine preventable diseases. In Lao PDR, the goal for vaccination coverage was at least 90% in 2015 and is at least 95% in 2025 [5,6]. It is reported that routine vaccination coverage remains low in many areas in Lao PDR and that there have been measles, diphtheria, and vaccine-derived poliovirus outbreaks [7–10]. Previous studies which were conducted in some districts or provinces suggested that factors related to low immunization coverage were, poor knowledge among child caretakers, difficulties in access, ethnic minority, lack of advice on vaccine, lack of vaccine supply, difficulty in maintaining the cold chain, and lack of availability and competence among healthcare workers [4,7,11]. To address these issues, the National Immunization Program (NIP) and the government have taken many actions, such as, using materials translated in the local languages to educate the community, training on vaccine management and cold chain maintenance, and the development of a vaccine supply system.

To improve routine immunization coverage nationally, factors affecting coverage in provinces or districts with low coverage should be identified. In Lao PDR, vaccination activities are mostly carried out by mobile teams due to unavailability of cold chain systems as well as distance to health facilities. Vaccination by mobile teams is provided quarterly and health centers have to deliver a notice to the chief of the village and health volunteers, to ensure that villagers with children in the targeted population are notified to attend the immunization sessions, and to gather the targeted children. The aim of this study was to identify factors associated with immunization coverage among children under one year old at provincial and district levels.

## 2. Materials and methods

### 2.1. Reporting system of immunization data in Lao PDR

The regular reporting system of immunization data in Lao PDR is well established. Health centers report the number of children who were vaccinated to the district health offices every month. The compiled data are then reported to provincial health departments, and finally to NIP. NIP aggregates, analyzes the data, and reports to the Ministry of Health annually.

For this analysis, national data from the immunization system based on the coverage of BCG, 3 doses of OPV (OPV3) and MCV1 from 2002 to 2014, 3 doses of DTP-HepB (DTP-HepB3) from 2002 to 2008, and 3 doses of DTP-HepB-Hib (DTP-HepB-Hib3) from 2009 to 2014 in all districts and provinces collected through the regular reporting system, were used. The data of immunization coverage before 2002 were incomplete. The Ministry of Health defines immunization coverage as the number of children who received vaccination by age of one year divided by the estimated

number of children surviving to their first birthday. Dropout rate of DTP-HepB-Hib was derived as the difference between DTP-HepB-Hib1 and DTP-HepB-Hib3 coverage in 2014.

### 2.2. Characteristics of provinces

The National Statistics Bureau of Laos and the Poverty Reduction Office are responsible for collecting data on population, poor districts, poor villages, and high-risk villages. A family was rated as poor when the family's monthly income per person was lower than the poverty criteria; under 192,000 Kip (24 USD) nationally, under 180,000 Kip (22.5 USD) in rural areas and under 240,000 Kip (30 USD) in urban areas (Prime Minister's Decree No. 309 issued on November 14, 2013). Poor villages are defined meeting all the following five criteria: (1) over 50% of the total families are poor families, (2) no primary school, or has a school in the nearest village by walking over an hour, (3) no village drug kit or health center or when the nearest health center or district hospital can only be reached by walking for more than two hours, (4) no access to clean water, or (5) no road access or has road access only in dry season. The criterion for poor districts is that over 51% of total villages in the district are poor villages. High-risk villages are defined as villages in rural remote or border areas with migrant workers, refugees, and ethnic minority groups.

### 2.3. Categories of villages by vaccine providing session types

There are three vaccine-providing session types to each village: fixed site, outreach, and overnight. Fixed site villages are located approximately within 10 km from the health facility but require 30 min or less for the target population to reach either by walking or by using any kind of vehicle. Outreach villages are located around 5–10 km from the health facility but require more than one hour to reach. Overnight villages have difficulty in access, communication or service delivery due to the socio-economic, cultural, or traditional beliefs. The health workers drive to outreach and overnight villages but cannot return to the facility on the same day after the completion of the vaccination session in overnight villages. Although there were 148 districts, the data on session type were only available for 145 districts.

### 2.4. Cold chain equipment

Cold chain equipment are refrigerators and freezers which are used to keep vaccines at the health centers or used in carrying vaccines to villages. Depending on the conditions of all cold chain equipment at health centers, three categories are identified: well-functioning, functional but in need of repairs, and not functional as a result of breakages. Each health center reports to the EPI unit of the province through the district. The data on cold chain equipment in 2015 were used for this study because the data in 2014 were incomplete.

### 2.5. Statistical analyses

Data collected in 2014 were used in this study except for the data on cold chain. Correlation analysis was performed to measure the relationship between factors related to the immunization system, vaccine coverage, and characteristics of provinces or districts. Comparisons of continuous variables between two groups were performed using *t*-test. SPSS version 24.0 (IBM Corp., Armonk, New York) was used for all data analysis. A *P*-value of <0.05 was regarded as significant.

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