



## Original Article

## Vaccination coverage and timely vaccination with valid doses in Malawi

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## ABSTRACT

**Introduction:** A cluster vaccination coverage survey was conducted in two districts, Dowa and Ntchisi, in Malawi to measure the vaccination coverage of children 12–23 months old and identify factors impacting the utilization of vaccination service.

**Methods:** A cross-sectional descriptive cluster survey with 30 clusters and 10 children per cluster was administered in each district including a total of 601 children surveyed. 57 village heads and 60 health surveillance assistants (HSAs) were also interviewed.

**Findings:** The vaccination card availability was very high in both districts (94%). Vaccination coverage by card plus history of mothers was very high, above 93% for all antigens, and the coverage by card alone was also high with a range of pentavalent<sub>1</sub> coverage of 91% in Ntchisi and 83% in Dowa to measles coverage of 81% and 83% in Dowa and Ntchisi respectively. However, the percentage of valid doses administered to fully immunized children was low (60% in Dowa and 49% in Ntchisi). About 10% of the pentavalent<sub>1</sub> doses in Dowa and 9% in Ntchisi were administered before six weeks of age and 7% and 8% of the pentavalent<sub>3</sub> doses in Dowa and Ntchisi districts respectively were administered in less than 28 days after pentavalent<sub>2</sub>. Similarly, 15% of measles doses in both Dowa and Ntchisi districts were administered before 270 days. The main reason for no vaccination was vaccine stock outs at health facility level. The majority of village heads are satisfied with the vaccination service in their communities. Health surveillance assistants (HSAs), village heads and religious leaders all play major roles in mobilization for vaccination service in the two districts.

**Conclusion:** Dowa and Ntchisi districts have high vaccination coverage, however many children receive invalid doses. This finding calls for immediate action to educate the service providers on administration of valid doses.

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## 1. Introduction

Vaccination is the most cost-effective public health intervention and Malawi has been successful in achieving high routine coverage. The WHO-UNICEF estimate for infant pentavalent<sub>3</sub> vaccination coverage was above 90% nationally for five consecutive years (2008–2012), with every district having achieved at least 80% coverage [1]. In 2006, Malawi conducted a multiple indicator coverage survey (MICS) for all districts and the national coverage using card plus history for pentavalent<sub>3</sub> was 84% and fully immunized children coverage was 61% [2]. Dowa district achieved infant pentavalent<sub>3</sub> coverage of 81% and fully immunized coverage of 71% while Ntchisi achieved pentavalent<sub>3</sub> coverage of 76% and fully immunized coverage of 60% [2]. Malawi also conducted a

Demographic and Health Survey (DHS) in 2010 and the national coverage for pentavalent<sub>3</sub> and fully immunized children for children 12–23 months by card alone any time before the survey were 79% and 74% respectively [3]. A Millennium Development Goal (MDG) end line survey was conducted in 2014 and the national level pentavalent<sub>3</sub> coverage by card and plus history for children 12–23 months old was 91% and fully immunized by one year of age coverage was 72%. [4]. The fully immunized coverage from the MDG end line survey was lower than both the WHO/UNICEF estimated coverage in 2012 and 2013 and the DHS in 2010.

The fully immunized children coverage in all mentioned surveys indicated all doses by 12 months of age; however, there is no information on whether the invalid doses within one year of age, were considered as invalid doses and excluded. Research has shown that many children in Africa and other countries receive inappropriately timed vaccine doses [5–12]. Most of these studies examined delayed vaccinations, i.e. vaccinations administered at

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older ages than recommended which resulted in prolonged risk of exposure to infection. Other ways vaccines are administered in an untimely way are doses administered earlier than recommended, and vaccinations administered with inappropriately short intervals between vaccine doses. Both may result in a suboptimal vaccine response. The World Health Organization (WHO) classified those vaccination doses as invalid doses [13]. The validity of childhood vaccinations have been evaluated in studies conducted in South Africa [8], Kenya [12], Nigeria [10], Uganda [7], Ethiopia [6], China [9] and USA [11] and children received many invalid doses, including premature administration, short intervals between doses, and late administration of doses beyond 12 months of age.

The MOH of Malawi requested partners to support the vaccination program to improve vaccination coverage and the USAID funded Maternal and Child Survival Program (MCSP) was requested to provide support in two low performing districts, Dowa and Ntchisi, to implement the Reaching Every Community (REC) approach. This survey was conducted as a baseline for a new project with the objectives of measuring the vaccination coverage of children 12–23 months old and identifies factors impacting the utilization of vaccination service following the WHO cluster survey reference manual [13].

## 2. Methods

### 2.1. Study design

The survey was cross-sectional, descriptive, and used a two-stage cluster sampling. The first stage was the sampling of enumeration areas (EAs) and the second stage was the sampling of households for the interviews. EAs in each district were listed with their 2008 projected population and the sampling was done using random number and sampling interval.

### 2.2. Study area and sampling

The survey was conducted in Dowa and Ntchisi districts in the central region of Malawi. A total of 601 mothers with children of 12–23 months old were interviewed in the two districts. From each district, 30 clusters were sampled and from each of the clusters 10 children aged 12–23 months were sampled.

In each cluster, the first village to be visited was chosen at random after listing names of the villages in the EA and the first households in the village was chosen after determining the direction of movement following the spinning of a bottle. There is no list of households in the two districts and resource did not allow developing the list.

### 2.3. Data collectors training

Expanded Program on Immunization (EPI) officers from neighboring districts were trained as data collectors while the MOH/EPI team and the MCSP officers supervised the data collection. Each district had three teams comprising of a supervisor and two data collectors. Vaccination experts from the MOH/EPI, MCSP and a local consultant facilitated two day training for the data collectors including use of the data collection instruments, as well as data collection procedures, interview techniques, consent procedures and research ethics.

### 2.4. Data collection

Standard WHO Expanded Program on Immunization (EPI) cluster survey paper data collection forms were used for the coverage survey. Local chiefs and health surveillance assistants (HSAs), who

provide vaccination services to those villages, were interviewed regarding the delivery of vaccination services in their communities. Mothers and/or caretakers of children aged 12–23 months were asked to show child health passports/vaccination cards for their child and the dates of vaccination were recorded from the cards on to the data collection forms. Where vaccination cards were reported not available, the maternal report of vaccination was recorded. Presence of a Bacillus Calmette-Guerin (BCG) scar was observed in the children who were surveyed. Reasons for not being immunized and/or not completing the vaccination schedule were asked for those not fully vaccinated.

### 2.5. Data analysis

The data were entered and cleaned using version 7 of EPI-Info while analysis of the data was done using STATA version 12.2.5.1.

The following operational definitions were used:

- *Vaccinated by card only*: Only doses documented inside the child health passport were considered.
- *Vaccinated by card plus history*: Both documented doses and doses reported by mother to be received were considered.
- *Valid doses*: Doses that were administered when the child had reached the minimum age for the vaccine, were administered with the proper spacing according to the national schedule, and before one year of age. (denominator = those with child health passport for that antigen).
- *Fully immunized child (FIC)*: A child who received all 13 doses included in the national schedule: a dose of BCG; 3 doses each of pentavalent, oral polio and pneumococcal; two doses of rotavirus; and one dose of measles vaccines.
- *Fully immunized child before one year of age*: A child who received all 13 doses before the age of one year as documented in the health passport.
- *Fully immunized child before one year of age with valid doses*: A child who received all 13 doses as valid doses as recorded in the child health passport. (denominator = children fully immunized with health passport before one year of age).

## 3. Findings

### 3.1. Child health passport/vaccination card

A total of 601 children 12–23 months old were included in the survey: 302 in Dowa and 299 in Ntchisi. There were equal number of boys and girls in the survey, 50% each. Card availability was very high (94%) in both districts. In Malawi, the vaccination card is referred to as a “health passport” and when the health facilities are out of stock of passports, private suppliers print and sell the cards with a reasonable price. This may have contributed to the high proportion of mothers with cards. Twenty-five (8.3%) children in Dowa and nine (3%) children in Ntchisi had health passports but with no recorded vaccination doses.

### 3.2. Vaccination coverage

Almost all children were vaccinated with card and history combined in both districts, ranging from 100% for BCG and pentavalent<sub>1</sub> to 93% for measles (Table 1). A BCG scar was also observed in 96% of children in Dowa and 93% in Ntchisi districts.

Access to vaccination service documented by first doses of multiple doses by card alone by the time of the survey was also high. Pentavalent<sub>1</sub> coverage was 83% in Dowa and 91% in Ntchisi and the coverages for PCV<sub>1</sub>, OPV<sub>1</sub> and rota<sub>1</sub> were not different from the pentavalent<sub>1</sub> coverage (Table 1). The utilization of the

**Table 1**  
Summary of vaccination coverage survey results among children 12 to 23 months of age in Dowa and Ntchisi districts, Malawi, February 2015.

Antigen	Variables	Dowa		Ntchisi	
		Number (302)	%	Number (299)	%
Card	Availability of card	284	94%	280	94%
BCG*	Card + History	299	99%	299	100%
	Card	258	85%	269	90%
Pentavalent <sub>1</sub>	BCG scar	289	96%	278	93%
	Card + History	297	98%	299	100%
Pentavalent <sub>3</sub>	Card	252	83%	271	91%
	Card + History	297	98%	292	98%
PCV <sub>1</sub> **	Card	252	83%	265	88%
	Card + History	297	98%	297	99%
PCV <sub>3</sub>	Card	253	84%	268	90%
	Card + History	296	98%	291	97%
Rota <sub>1</sub>	Card	250	83%	263	88%
	Card + History	291	96%	295	99%
Rota <sub>2</sub>	Card	244	81%	265	89%
	Card + History	291	96%	291	97%
OPV <sub>1</sub> ***	Card	238	79%	261	87%
	Card + History	296	98%	296	99%
OPV <sub>3</sub>	Card	253	84%	266	89%
	Card + History	290	96%	278	93%
Measles	Card	245	81%	245	82%
	Card + History	284	94%	279	93%
FIC****	Card	244	81%	248	83%
	By the time of survey (card + history)	261	87%	262	88%
	By the time of survey (card alone)	204	68%	225	75%
	By card before one year of age	187	62%	211	71%

\* BCG = Bacillus Calmette and Guérin.  
 \*\* PCV = Pneumococcal conjugate vaccine.  
 \*\*\* OPV = Oral polio vaccine.  
 \*\*\*\* FIC = fully immunized children.

vaccination service indicated by low dropout rates, less than 10%, was very good. Pentavalent<sub>3</sub> coverage was 83% in Dowa and 88% in Ntchisi. The measles coverage by card was similar as the other antigens, 81% in Dowa and 83% in Ntchisi. For most antigens, Ntchisi district produced better coverage than Dowa district.

Fully immunized children coverage status by the time of the survey by card and history was 87% in Dowa and 88% in Ntchisi; however, fully immunized child by card was low, 68% in Dowa and 75% in Ntchisi. The fully immunized by one year of age was lower, 62% in Dowa and 71% in Ntchisi.

### 3.3. Valid doses

The Malawi vaccination schedule recommends all vaccination doses be administered in accordance to the schedule to be valid dose and any dose administered outside the schedule is considered invalid.

Valid dose coverage for individual antigens was high (Table 2), ranging from 100% for BCG in both districts to 81% in Dowa and 79% in Ntchisi for measles. This is because the denominator used is only for those children with a health passport for a particular dose, i.e. to calculate the pentavalent<sub>1</sub> valid dose the denominator is the number of children vaccinated with pentavalent<sub>1</sub> dose as proved by card. The fully vaccinated valid dose coverage was much lower, 60% in Dowa and 49% in Ntchisi.

This survey identified 10% and 9% of pentavalent<sub>1</sub> doses for Dowa and Ntchisi respectively were administered before 42 days of age. While the national schedule recommends Rota<sub>1</sub> vaccine be given between six weeks and 15 weeks, the survey discovered 10% in Dowa and 9% in Ntchisi infants were vaccinated before six weeks of age and 5% in Dowa and 3% in Ntchisi vaccinated after

**Table 2**  
Valid dose coverage only in children with card, Malawi, February 2015.

Antigen	Valid doses in Dowa		Valid doses in Ntchisi	
	Number	%**	Number	%**
BCG	256	100%	269	100%
Pentavalent <sub>1</sub>	224	89%	247	91%
Pentavalent <sub>3</sub>	232	92%	243	92%
PCV <sub>1</sub>	221	88%	244	91%
PCV <sub>3</sub>	230	90%	241	92%
Rota <sub>1</sub>	207	85%	234	88%
Rota <sub>2</sub>	220	92%	228	87%
OPV <sub>1</sub>	219	87%	241	89%
OPV <sub>3</sub>	226	93%	227	93%
Measles	197	81%	197	79%
Fully immunized child with valid dose*	113	60%	104	49%

\* The denominator is the number of fully vaccinated children by one year of age as proved by card.

\*\* The denominator is the number of children vaccinated with card for each dose in Table 1.

**Table 3**  
Invalid doses administered, Malawi, February 2015.

Indicators	Dowa		Ntchisi	
	No.	%*	No.	%*
Pentavalent <sub>1</sub> before 6 weeks	26	10%	24	9%
Pentavalent <sub>2</sub> <28 days after pentavalent <sub>1</sub>	22	9%	31	12%
Pentavalent <sub>3</sub> <28 days after pentavalent <sub>2</sub>	17	7%	20	8%
1st dose of measles				
Before 9 months of age	36	15%	38	15%
After one year of age	10	4%	13	5%
Rota <sub>1</sub>				
Before 6 weeks of age	24	10%	23	9%
After 15 weeks of age	12	5%	7	3%
Rota <sub>2</sub>				
<28 days after rota <sub>1</sub>	12	5%	31	12%
after 32 weeks of age	5	2%	1	<1%

\* Denominator = doses administered proved with card for that particular antigen.

15 weeks of age. WHO guidelines recommends that 1st dose of rotavirus vaccine can be given after 15 weeks of age and the last dose after 32 weeks while emphasizing on timely vaccination of infants to reduce risk of exposure to the disease. Many children also received measles doses before 270 days of age (9 months) and some after 365 days of age (Table 3).

### 3.4. Reasons for missing vaccination

Caretakers of under and/or unimmunized children were asked why children were not vaccinated and close to half of mothers

**Table 4**  
Reasons children did not receive vaccination services, Malawi February 2015.

Reason	%
Vaccine not available	49.2
Mother too busy	13.8
Unaware of the need to return for subsequent doses	9.2
Child ill brought but not given	6.2
Family problem	3.1
Child ill – not brought	3.1
Unaware of the need for vaccination	1.5
Fear of side reaction	1.5
Other information-related reasons	1.5
Postponed until another time	1.5
No faith in vaccination	1.5
Rumors	1.5
Other motivation related reasons	1.5
Vaccinator absent	1.5
Mother ill	1.5
Religious reasons	1.5

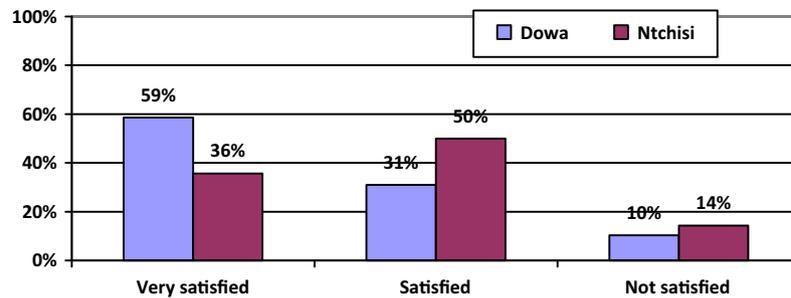


Fig. 1. Village heads satisfaction of vaccination services, Malawi February 2015.

(49.2%) reported that vaccines were not available when they visited the health facilities; 13.8% reported the mother was too busy, 9.2% of mothers were unaware of the need to return and 6.2% reported a child was brought to the facility, but was not given a vaccine because he/she was ill (Table 4).

### 3.5. Vaccination sites and strategies

Mothers were asked where children received their vaccinations and half (50.2%) reported children received BCG from MoH health centers. Approximately half of the subsequent doses were administered through outreach facilities staffed by health surveillance assistants (HSAs). The role of the private (fee for service) sector is very minimal in providing vaccination service (<0.5%) and the role of Christian Health Association of Malawi (CHAM) is also limited to about 6% of the vaccination services provided.

### 3.6. Satisfaction of vaccination service among village chiefs

One village chief from each cluster, 57 in total, (three were not in the vicinity) were interviewed about their satisfaction with vaccination services and mobilization of clients for vaccination services. As presented in Fig. 1, more Dowa chiefs (58.6%) than Ntchisi chiefs (35.7%) were very satisfied with the services while a slightly higher proportion of chiefs in Ntchisi were not satisfied at all with the services (14.3% compared to 10.3%).

The chiefs were also asked about mobilization of parents for vaccination services in their villages. All 29 chiefs interviewed in Dowa reported there is an HSA assigned to work in their villages. In Ntchisi, chiefs reported 82.1% of villages had an HSA assigned. The findings suggest several players take part in mobilizing parents to take their children for vaccination service. Fig. 2 indicates 69% of mobilizers were HSAs in Dowa and 79% in Ntchisi, followed by 62% were village chiefs in Dowa and 75% in Ntchisi. Religious leaders

were also identified as mobilizers for vaccination, 69% in Dowa and 50% in Ntchisi.

Home to home visits were the commonly mentioned mobilization strategy, followed by announcements during village meetings and religious sermons. During village clinics and vaccination sessions, mothers are also reminded by the HSAs to come for the next vaccination session if they are due.

## 4. Discussion and conclusion

The availability of vaccination card/health passport was very high in both districts. This was a result of ample supply by the MOH/EPI, the private sector printing and selling health passports at a reasonable price, and above all the commitment of mothers to buy and retain the card. Similar high level card availability was documented in the previous surveys in Malawi [2,3]. 8.3% of children in Dowa and 3% in Ntchisi had vaccination card but no vaccination doses were recorded in it and this shows missed opportunities for vaccination services. The persons distributing and selling cards and health workers providing other health services should be oriented to inform the mothers that the availability of the card alone is not enough that, the children should be vaccinated.

The pentavalent<sub>3</sub> coverage for Ntchisi and Dowa districts had increased significantly from 77% and 81% in MICS 2006 to 98% in both districts in this survey by card plus maternal report. The pneumococcal and rotavirus vaccines introduced in 2011 and 2012 respectively have achieved comparable vaccination coverages to the pentavalent and oral polio vaccine (OPV) vaccines. Comparable, high coverage findings have also been documented in other surveys in Malawi [2,4].

Adhering to the national vaccination schedule in the administration of doses is very critical for maximum epidemiologic impact.

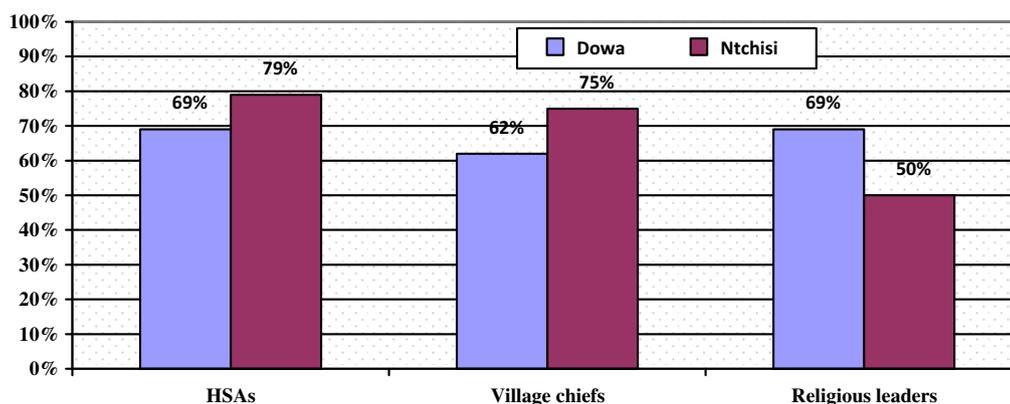


Fig. 2. Mobilization of communities for vaccination services, Malawi February 2015.

**Table 5**  
Sources of vaccinations for children who were surveyed (%), Malawi, February 2015.

Place of vaccination	BCG	Pentavalent <sub>1</sub>	Pentavalent <sub>2</sub>	PCV <sub>1</sub>	PCV <sub>3</sub>	Rota <sub>1</sub>	Rota <sub>2</sub>	OPV <sub>1</sub>	OPV <sub>3</sub>	Measles
Outreach MoH	24.3	47.4	49.2	48.1	49.0	48.0	49.1	48.5	49.5	48.5
Outreach CHAM	1.7	2.3	2.4	2.3	2.4	2.4	2.4	2.4	2.3	2.5
Hospital MoH	19.3	8.0	7.6	8.7	7.8	8.8	8.3	8.1	6.7	7.8
Hospital CHAM	1.8	1.3	0.8	0.7	0.7	0.7	1.2	1.4	1.6	2.1
Health center MoH	50.2	38.5	37.7	37.7	38.1	38.1	37.1	37.3	38.4	36.9
Health center CHAM	2.5	2.0	2.0	2.2	1.9	1.7	1.7	2.0	1.6	2.0
Private hospital/health center	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	1.0	0.2

PCV = Pneumococcal conjugate vaccine, OPV = Oral polio vaccine.  
CHAM = Christian Health Association of Malawi, MOH = Ministry of Health.

In this survey, only doses administered following the national vaccination schedule were considered as valid doses and the rest were considered as invalid. Sub-optimal capacity of vaccinators could be the reason for the high number of invalid doses, which calls for proper training of health workers and follow-up by supervisors. If every dose was given at the correct minimum age with correct minimum interval between subsequent doses and all administered before 12 months of age, then each value in Table 2 should have been 100% as with BCG. The authors are aware that doses administered after 12 months of age are also epidemiologically valid and prevent vaccine preventable diseases, however timely vaccination is very important to reduce the potential exposure of infants to the vaccine preventable diseases. (Table 5)

Malawi has documented high infant vaccination coverage for many years confirmed by population based surveys [1–4], this survey also documented similar findings; however this survey analyzed valid and invalid doses for each antigen and the fully immunized valid doses for overall. The findings indicated that even though the coverages both by card and mothers report were high, the fully immunized valid dose coverage is much lower. For example, in Ntchisi out of surveyed 299 children, all 299 were reported as vaccinated with pentavalent<sub>1</sub> by card and mother's report, but by card alone the number was less by 20 children and children vaccinated with pentavalent<sub>3</sub> by card were only 265 and only 243 doses were valid doses. The children received all doses as valid dose were much lower, 35% of those reported as vaccinated by card and mothers report. This survey documented the invalid doses based on time of vaccination; however there are many reasons for a dose to be invalid including the correct amount, the correct route of administration, the correct cold chain and others. Therefore, it is timely to monitor not only the number of doses administered and the coverage but also the validity of the administered doses.

Although most children had been vaccinated and the default rate is lower, this study indicates stock outs of vaccines at health facility level is the primary reason for children not completing the vaccination service and appropriate action should be taken to address this problem. All responsible should support services providers for timely administration of doses.

## Disclaimer

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## Conflict of interest

The authors have no conflicts to disclose related to this work.

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