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Dag Roll-Hansen, Susie Cooper, Magnar Lillegård, Jon Erik Finnvold, Ellen Cathrine Kiøsterud, Stein Opdahl, Marianne Tønnessen and Anja Hem

Towards universal childhood immunisation

An evaluation of measurement methods

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Preface

Child immunisation is a life-saving tool which over the last years have reached out to a steady growing number of children. In order to further increase the coverage, we need to know the current one, not only in total numbers, but for each country, district and group of children. As shown by the study of Lim, Stein, Charrow and Murray: "Tracking progress towards universal childhood immunisation and the impact of global initiatives: a systematic analysis of three-dose diphtheria, tetanus, and pertussis immunisation coverage" published in the Lancet (2008) this is however not a straight forward task. Different methods yield often different figures. The study presented in this report aims at contributing towards an even better understanding of the discrepancies between figures based upon administrative data based methods and survey estimates, the two main data sources, by combining a review of the Lin et al. (2008) study and further field studies in four countries.

Susie Cooper and Magnar Lillegård reviewed the Lim et al. (2008) article focusing on statistical methodology. Ellen Cathrine Kiøsterud conducted the field study in Mozambique, Stein Opdahl in Zambia, Marianne Tønnessen in Malawi and Anja Hem in Uganda. Jon Erik Finnvold supplied subject matter input and Dag Roll-Hansen coordinated the effort.

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Contents

Abbreviations

CSO	Central Statistical Office (Zambia)
DHO	District Health Officer
DHS	Demographic and Health Survey
DHT	District Health Team
DQA	Data Quality Audit
DQS	Data Quality Self-assessment
DTP	Diphtheria, tetanus and pertussis vaccine
EPI	Expanded Programme on Immunisation
GAVI	Global Alliance on Vaccines and Immunisation
GoU	Government of Uganda
HC	Health Centre
HMIS	Health Management Information System
HRD	Human Resource Development
HSD	Health Sub-District
HSSP	Health Sector Strategic Plan
INE	Instituto Nacional de Estatística (Moçambique)
MICS	Multiple indicator cluster surveys
MoH	Ministry of Health
NHS	National Health System
Norad	Norwegian Agency for Development Cooperation
NSO	National Statistics Office (Malawi)
PEAP	Poverty Eradication Action Plan
UBOS	Uganda Bureau of Statistics
UNEPI	Uganda Expanded Programme on Immunisation
Unicef	The United Nations Children's Fund
WHO	World Health Organization

1. Executive summary

Childhood immunisation programming is an essential part of every country's health programme to reduce vaccine preventable diseases. The Global Alliance on Vaccines and Immunisation (GAVI) was established to help fund and implement universal childhood immunisation. Funding provided by GAVI through its immunisation service support (ISS) is performance-based, with funds disbursed in proportion to the targeted or reported number of additional children immunised.

In 2008, Lim, Stein, Charrow and Murray published the article "Tracking progress towards universal childhood immunisation and the impact of global initiatives: a systematic analysis of three-dose diphtheria, tetanus, and pertussis immunisation coverage" in the Lancet. In the article, they raise a concern that fewer children have been immunised than officially reported and that this has significant health and financial consequences.

The main findings from the assessment of this study are as follows:

a) The study by Lim et al. (2008) estimates DTP3 coverage using officially reported coverage and survey data for 193 countries. Time-series analysis investigates the association between the presence of GAVI ISS and the difference between countries officially reported and survey based immunisation coverage.
b) In general, vaccination coverage based on administrative data was significantly higher than survey based vaccination coverage estimates. Furthermore, the study showed that 7.4 million additional children were immunised under ISS based on survey data compared to 13.9 million addition children reportedly immunised. This amounts to a difference of around US$140 million in support money.
c) We believe the amount of data analysed in the study is extensive and indicates that results are of a robust nature. The methodology (including the use of self-reported vaccinations) is validated with additional background information and studies supporting the authors' decisions.
d) The study shows that their new imputation method, bidirectional distance-dependent regression (BDDR), performs similarly to the more commonly used multiple imputation method, validating its use. However, we believe in the absence of survey data, quick changes in immunisation coverage may not always be detected by the model, especially in recent estimates where there are no following surveys.
e) The study by Lim et al. (2008) has lumped together investment and reward payments for countries receiving GAVI ISS, which we believe may be problematic due to the differing nature of payment calculations.
f) Additionally, we believe vulnerable groups may be less likely to participate in surveys and similarly be difficult to reach for preventive health care programmes. This implies survey data may overestimate immunisation coverage.

In order to learn more about potential disparities between vaccination coverage reported in surveys and administrative data we have carried out case studies in four countries. Despite the existence of clearly defined administrative routines, the overall impression is that administrative data are subject to considerable uncertainty.

a) The countries selected for field studies all experienced high staff turnover and vacancies. There was a lack of relevant personnel and inadequate resources both in the organisations set up to give vaccines and to record the administrative data.
b) A lack of understanding for the importance of accurate reporting of vaccinations was often observed.
c) Measures of the target population (the number of children to be vaccinated) are often uncertain.

d) Cross border migration, and vaccinations of children in older age groups, can result in vaccinations given to children not included in the target population.
e) It is possible that population growth is higher than the projections used in the construction of coverage estimates. If the population growth is underestimated, the gap between survey data and administrative data will be overestimated.

Based upon the review and the case studies our recommendations for improving the quality of data reports on vaccination coverage are as follows:

a) Re-analyse all available data using methods similar to Lim et al. for chosen countries to improve the current knowledge base without collecting new data.
b) Implement small annual household surveys of selected vaccines (e.g. DTP) to provide general basis for vaccination coverage.
c) Small annual household surveys are also recommended to improve population estimates and thereby improve the estimation of the target group.
d) Replicate the study done in Mozambique by Mavimbe, Braa and Bjune (2005) on record keeping, reporting and the support mechanism to ensure quality data on vaccination. This ought to be done in selected countries to address differences between regions and over time. As a part of this, discussions on what appears to be success stories and failures would be initiated.
e) Implement a full analysis of the existing reporting systems in order to establish more user-friendly, simple and standardised systems.
f) Building Human resources. The quality of the statistics depends on the ability of the staff members who produce it. This both addresses subject matter training and introducing work modes were the employees do not fear their superiors. If you are afraid of your boss, you may report false not to get into trouble.
g) Evaluate the administrative and survey based vaccination coverage through time (for specific countries) to identify the points in time when different sources of data are becoming more in line with each other. Reasons for data becoming more similar can then be investigated.
h) Evaluate the effects of changes in data collection methods through time. This can give us more knowledge on which quality improvement measures that may be effective.

In order to further contribute towards improved data quality on vaccination coverage the following studies may be considered undertaken by Statistics Norway or others:

a) A literature review and re-analyses of data can improve the current knowledge base without collecting new data. We suggest a search for all available data on chosen countries and a re-analysis, using similar methods to Lim et al. (2008) (i.e. BDDR), adding more recent data. An analysis separating the investment phase from the reward payments would provide a clearer picture.
b) It is possible to measure the vaccination coverage in annual small surveys. Keeping the size of such surveys to a minimum makes them affordable and possible to process rapidly. If one vaccine can be seen as having a coverage representative for other vaccines or if it is particularly important, it can be used as a proxy for the coverage rate of other vaccines. Secondly, calculations of vaccination coverage are sensitive to the estimated population size. Small surveys (and other surveys between censuses) can also be used to improve the estimated population size. We suggest a pilot to evaluate what effects a small annual survey can have on the quality of vaccination coverage data.
c) Evaluation of different data collection methods. The data gathered for the Lim et al. (2008) study should be evaluated to identify points in time where survey and administrative data converge. And thus, reasons for data converging ought to be established. We also recommend investigating the effects of changes in data collection methods through time. It will e.g. be useful to identify changes in data collection that happens at the same time as changes in the time series. This can give us more knowledge on which quality improvement measures may be effective.

2. Introduction

2.1. Background

Childhood immunisation programmes are an essential part of every country's health programme to reduce vaccine preventable diseases. The vaccination for diphtheria, tetanus, and pertussis (DTP3) is administered in three doses to children, usually before they are 12 months old at the same time as polio vaccinations. The monitoring of immunisation coverage is important to assess the success of immunisation programmes and to identify additional needs. Differences between reported and survey based estimates of immunisation coverage have been identified in a recent study by Lim, Stein, Charrow and Murray (2008). It combines administrative data and survey data to estimate the vaccination coverage for diphtheria, tetanus and pertussis (DTP3). Previous research (Murray, Shengelia, Grupta, Moussavi, Tandon and Thieren (2003) has also identified differences, prompting a concern over the validity of officially reported coverage.

We are trying to catch the actual number of children receiving vaccinations. To find this number we are using two fundamentally different perspectives. First, we are looking at it from above. We look down through the administrative system, to see how many children are receiving vaccinations. Second, we go out among the people to ask the parents whether their children have received vaccinations or not. We look at the phenomenon from below. The two different approaches are used for different purposes; they have different advantages and challenges. There is no surprise that the results they provide are different. In this report we will look into what causes the differences.

The Global Alliance on Vaccines and Immunisation (GAVI) was established to help fund and implement universal childhood immunisation. Funding provided by GAVI through its immunisation service support (ISS) is performance-based, with funds disbursed in proportion to the targeted or reported number of additional children (less than 1 year of age) immunised. Lim et al. (2008) raises a concern that fewer children have been immunised than officially reported and that this has significant health and financial consequences. The study is based on official reports on coverage from 193 countries, during the period 1986 to 2006. The official reports are compared with corresponding estimates of survey coverage. The study concluded that countries receiving GAVI ISS tended to have relatively large differences between officially reported coverage and coverage as measured by surveys. A widening gap over time between officially reported and survey coverage was also observed. Based on *surveys* from the 51 countries receiving ISS funding, it was estimated that 7.4 million additional children were immunised in the period. According to corresponding *official reports* to GAVI, 13.9 million additional children were immunised in the same countries during the same period.

Following publication in *The Lancet*, several critical comments have been voiced in the journal (issues of 13 December 2008, 17 January 2009, 25 April 2009, 02 May 2009). Some of the reactions stated that household surveys generally underestimate the true level of coverage due to respondent recall bias. Others were concerned with the use of imputation methods in the study of Lim et al. (2008) to construct missing survey observations.

The Norwegian Agency for Development Cooperation (Norad) has asked Statistics Norway to investigate three aspects of vaccination coverage in response to the study of Lim et al. (2008). Firstly, to give an assessment of the study's methods, analyses, interpretations and conclusions as well as the responses put forward by WHO/Unicef and GAVI. Secondly, to study the data gathering process in selected countries. Finally, Norad requested for some recommendations on how to improve the quality of data reports.

2.2. Key issues

Review of Lim et al. (2008)

The extensive study by Lim et al. (2008) compares the officially reported DTP3 vaccination coverage in 193 countries with coverages based on survey data. The amount of data analysed in the study is extensive and indicates that results are of a robust nature. The methodology is validated with additional background information supporting the authors' decisions. A new imputation method, bidirectional distance-dependent regression (BDDR) is used to predict the survey based vaccination coverage when survey data is not available. This method is validated through comparisons with the more commonly used multiple imputation method. Results comparing the modelled and administrative vaccination coverages show in general significantly higher coverage rates for the latter. Confidence intervals (95 per cent) are given for modelled coverage and additional children immunised estimates providing uncertainty levels in the model.

However, in the absence of survey data, we believe quick changes in immunisation coverage may not always be detected by the model, especially in recent estimates where there are no following surveys. Additionally, the study by Lim et al. (2008) has lumped together investment and reward payments for countries receiving GAVI ISS. Investment payments are received by countries in their first 2 years of ISS and are based on the targeted number of additional children immunised. The reward phase payments are based on the achieved number of additional children vaccinated. We believe it is problematic to lump these together because of the differing nature of payment calculations. If the immunisation coverage is over-reported in the investment phase, it should not be treated as an over-payment because the amount a country receives during this time is not calculated on this value. Despite these issues, the difference between administrative and survey based coverage appears to be 'real' and needs further address.

With some exceptions, the literature on the validity of surveys concluded that respondents' information about their children's vaccination is reliable. Accordingly, it is not likely that vaccination coverage is underestimated by self-reported vaccinations. Additionally, we believe vulnerable groups (such as orphans) may be less likely to participate in surveys and may also be difficult to reach for preventive health care programmes. In this case, survey data may indeed overestimate coverage, meaning the gap is larger than predicted here.

Case studies in four countries

Four countries were selected for field studies lasting between 1 and 2 weeks: Uganda, Malawi, Mozambique and Zambia. The studies were aiming at finding the cause of the problems pointed to by Lim et al. (2008). The countries were chosen because they were indicated to have a degree of over-reporting in the study by Lim et al. (2008). Including as many as four countries were assumed to reveal many reasons for erroneous report. In addition the countries were time- and cost-effective for us to study. Methods included personal interviews, observations and review of existing relevant documentation. Reporting routines are largely in place. Despite the existence of clearly defined administrative routines, the overall impression is that the administrative data are subject to considerable uncertainty. This uncertainty has two main causes: errors relating to the collection of the number of vaccinations actually delivered, and errors relating to how the target population is estimated (denominator problems).

It is difficult to isolate the performance of the reporting routines from the functioning of the health care system in general. The countries selected for field studies all experienced staff turnover and vacancies, a lack of relevant personnel and inadequate resources. These are all factors limiting the potential of the reporting routines. In addition, a lack of understanding for the importance of accurate reporting of vaccination, was often observed.

Measures of the target population, the number of children to be vaccinated, are often uncertain. Cross border migration, and vaccinations of children in older age groups, can result in vaccinations given to children not included in the denominator. It is possible that population growth is more extensive than projections, used in the construction of coverage estimates, predict. If the population growth is underestimated, the gap between survey data and administrative data will be overestimated.

To be addressed

Here we give a brief overview of some of the issues addressed in this report. For a more comprehensive presentation of recommendations, please see chapter five in this report.

There is scope for improving both the collection of data, and the population projections used as the denominator. Important improvements may include a survey-methodological analysis of the existing reporting systems, in order to establish more user-friendly, simple and robust versions. Population projections used as the denominator can be improved by refining projection models incorporating information from surveys. This can be a valuable spin-off from introducing a programme of small (annual) household surveys (light-surveys) in-between censuses, or from more extensive surveys.

Several of our field studies find that important regional variations in vaccination coverage exist. Regarding improvements in the actual knowledge base, however, there is a general lack of scientific studies that, explicitly address validity problems in the administrative data collection process. One notable exception is Mavimbe, Braa and Bjune (2005). They used a combination of qualitative and quantitative approaches to study the quality of administrative vaccine information. They found low consistency between the recorded number of vaccines given and the reported number at the health facility level. As the information was reported upwards in the system, more errors were introduced. The researchers also found that pressure to meet targets in the administrative system encouraged over-reporting. The research design used could be replicated to investigate possible changes over time. The design could also be applied in other regions of Mozambique, or other countries. To maximise the chance of identifying errors, it may be interesting to choose regions with high and low recorded rates of vaccination.

The value of surveys that address social and regional variations in vaccination coverage can be substantially increased if information from official records is added to the data. Also, available epidemiological information about regional variations in epidemic diseases can add to the relevance of both survey analyses and administrative coverage estimates. E.g. less is known about vaccination coverage among vulnerable sub-groups such as orphans or families with lone fathers. Surveys that address variations in coverage between social groups can improve estimates of vaccination coverage. Surveys that address inequalities between groups and regions can also provide valuable information for administrative levels, and suggest areas or groups with insufficient coverage.

3. A review of Lim et al: Tracking progress towards universal childhood immunisation

The study by Lim et al. (2008) investigates differences between officially reported and survey based diphtheria, tetnus and pertussis (DTP3) immunisation coverage. They use administrative data in the form of vaccination coverages reported to WHO/UNICEF and data from various multi-country and national surveys for 193 countries. Survey based immunisation coverage are estimated for years when no survey exists through a new imputation method called bidirectional distance-dependent regression (BDDR). The association between GAVI immunisation services support (ISS) and over-reporting vaccination coverage is assessed through time series analyses. They found a general trend for higher reported vaccination coverages compared to survey based estimates. The 51 countries analysed in the study receiving ISS reported 13.9 million additional children immunised under the GAVI support programme. The survey based estimate for the number of additional children immunised was estimated at 7.4 million in the study giving a difference of around US$140 million in support payments.

This chapter gives a description and an assessment of the statistical methods used by Lim et al. (2008), some strengths and weaknesses of the models used, as well as a review of the data, interpretations and conclusions. It also gives an assessment of the response put forward by WHO/Unicef and GAVI concerning the methods.

3.1. Data

There are two main sources of data in the study: administrative and survey based.

Administrative data

Administrative data used in Lim et al. (2008) is based on information provided by health service registries, reported at a national level to WHO/Unicef since 1999. Prior to this, officially reported coverage is used as the only available substitute for administrative data. Officially reported coverage may include some combination of survey and administrative data. The administrative data reported to WHO/Unicef is usually in the form of national coverage estimates (Burton, Monasch, Lautenbach, Gacic-Dobo, Neill, Karimov, Wolfson, Jones and Birmingham, 2009).

Lim et al. (2008) also uses the number or coverage of children immunised, reported to GAVI. This administrative data is different to the officially reported or coverage reported to WHO/Unicef in some cases. For example, in 2004, India reported to WHO/Unicef a coverage of 87 per cent (WHO Reported Coverage, 2009) but reported to GAVI a coverage of only 63.6 per cent (GAVI Progress Report - India, 2005). It is sometimes unclear in the study by Lim et al. (2008) whether the officially reported data refers to that reported to WHO/Unicef or GAVI.

The denominator for the administrative data coverage estimates does not appear to be reported to WHO/Unicef and may vary between the different administrative data (and survey data). WHO/Unicef use the World Population Prospectus to extrapolate estimates for regional coverage and the number immunised (WHO/Unicef Estimates Methods, 2009). Countries reporting to GAVI may use a different source for their denominator. For example, in 2004, India used the SRS Bulletin Oct. 2002, to estimate the number of children surviving to 1 year of age (GAVI Progress Report – India, 2005). Target population estimates may differ depending on the method of estimation (High, medium, low variant) and data source. For example based on the period 2000-05, the number of births for 2004 in India was 25.2 million with a infant mortality of 64 per 1000 giving a target population of 23.6 million (World Population Prospects: the 2002 revision, 2003). However, based on the SRS bulletin Oct. 2002 and projection tables used in India's GAVI progress report (2005), the target group is 25.7 million. This difference in

denominators used may contribute to some (but probably not all) of the differences in the coverage rates among various administrative data.

Survey data

Extensive use of sample surveys has been used in Lim et al. (2008). This has included standardised multicountry surveys such as the demographic and health surveys (DHS) and multiple indicator cluster surveys (MICS), as well as country specific surveys. Lim et al. (2008) divides the survey data into four categories:

1. 225 standardised multicountry surveys for which the microdata are in the public domain.
2. 78 standardised multicountry surveys for which results and sample size are reported but microdata were not available.
3. 142 national surveys that measured immunisation coverage reported in the WHO and Unicef vaccine coverage database. Results and sample size reported.
4. 145 national surveys for which results are available, but no sample size reported.

The standardised multicountry surveys (including DHS and MICS) are supposed to provide reliable measurements for a range of health indicators. Both DHS and MICS, appear to have standardised and robust procedures of a high calibre (Rutstein and Rojas, 2006; United Nation's Children Fund, 1995). The quality of country-specific surveys is sometimes less certain due to an absence of documentation and criticism of methods, and are used more cautiously in Lim et al. (2008). There may still be problems associated with the coverage of DHS and MICS surveys and their use to observe longitudinal trends in the context of immunisation coverage. There have been a number of rounds of DHS's and methods have been revised and improved (DHS Analytical Reports, 1997). While this means that more recent surveys are likely to produce better representations of the true population coverage, it also decreases the validity of longitudinal trends. For example, under-coverage was believed to be a particular problem in many of the first DHS (called DHS-I) with 22 of 28 surveys investigated in a DHS Analytical report (DHS Analytical Reports, 1997) believed to show under-coverage. With improved mapping techniques and GPS devices this has been reduced in subsequent surveys. If key groups have been missed from earlier surveys and not accounted for in analyses, these early results may be biased. If we compare recent more accurate studies with these, we may observe a trend that is not there (or miss a trend that is present).

Coverage estimates have been calculated for surveys with microdata in the Lim et al. (2008). They have been analysed taking into account the multistage sampling design for each survey. This is not described in detail in this report. There are a number of known factors which are correlated to immunisation coverage. This includes positive associations with health worker density and female adult literacy and negative correlations with land area (Anand and Bärnighausen, 2007). These are factors which are measured in the surveys and perhaps specific methods to calculate total estimates could incorporate this information as well as standard population sizes of clusters.

The denominator for the survey based estimates in Lim et al. (2008) come from the UN population division statistics. The source provided for these data (World Population Prospects: the 2006 revision. New York: United Nations, 2007) as far as we can tell, does not provide annual, under 1 year of age estimates so it is unclear what has been used as the denominator. It is important to note that these estimates of the target population may be different to those used for the administrative data.

DHS and MICS surveys are household surveys, with interviews generally targeted for women only. Originally these surveys interviewed only married women who stayed in the house the night before the interview. The criteria for eligible

participants have now been extended to all women in the house at the time of the interview. This was adjusted to include women who are not married but have children and to reduce discrepancies observed between the numbers of visiting women and women away. There may still be groups of the target population (children under 1 years of age) that are not being sampled that may (or may not) cause bias in the survey results. For example children with solo fathers and orphans may not be captured. Note: the percentage of orphans in Malawi exceeds 11 per cent in regions (Benson, 2002).

3.2. Methods

Methods summary

This study by Lim et al. (2008) tries to estimate the coverage of three doses of diphtheria, tetanus, and pertussis vaccine (DTP3) for children younger than 1 year of age. The DHS and MICS are supposed to provide reliable measurements for a range of health indicators, while the quality of country-specific surveys is sometimes less certain due to absence of documentation and criticism of methods. By comparing coverage estimated from DHS and country-specific surveys with administrative data, 88 outliers from country-specific surveys are identified. As a consequence, they are excluded from the statistical analysis.

For some children, immunisation status was not identified by immunisation card, but on maternal self-report. Lim et al. (2008) refers to previous studies (e.g. Suarez, Simpson and Smith, 1997) showing that self-reporting does not seem to introduce any bias in the estimates. In 16 comparisons, self-reporting underestimated the coverage in five cases, overestimated in seven cases, and gave statistically the same result in four cases.

Furthermore, the Lim et al. (2008) assessed the intersurvey reliability of coverage estimates by comparing coverage rates for the same cohort with overlapping data from two consecutive DHS. E.g. the coverage for Indonesia in 1990 was estimated from a DHS in 1991 and a DHS in 1994. In the first DHS they used responses for children aged 12-23 months, while in the latter DHS they used responses for children aged 48-59 months. In nine of 11 instances there was an overlap between the 95 per cent confidence intervals for the coverage from one DHS and the coverage from the other DHS. The conclusion of this was that the surveys provide a robust estimation of the changes in immunisation over time.

The study assessed two approaches to fill in time-points with missing survey-based coverage. The first was a method developed by them, called bidirectional distance-dependent regression (BDDR). Formally, it estimates survey coverage S for country i at a given time using survey coverage p years in the past, survey coverage f years in the future and administrative data at the same time, that is

$$S_i = \beta_{0pf} + \beta_{1pf} S_{ip} + \beta_{2pf} S_{if} + \beta_{3pf} A_i + \varepsilon$$

Separate regressions were performed for all unique combinations of p years in the past and f years in the future. This included combinations for which there was no survey estimate in the past or no survey estimate in the future. For one regression data were pooled across all countries and all years, but only survey estimates based on their own analysis of microdata were included. E.g. for $p = f = 1$ this meant a total of 426 available observations, that is 426 observation where there exists a survey estimate one year in the past and a survey estimate one year in the future. A vital assumption for this approach is that there is an average relationship between survey data in a given year, in the past and in the future, and that this is independent over time.

To account for the fact that the relationship between survey and administrative data are unlikely to be constant over time, the administrative data were adjusted for the mean difference between survey and administrative data, specific to country, but it is not exactly clear how this is done. To constrain values of coverage between 0 and 1, the survey and administrative data were logit-transformed, the regression applied, and the predicted valued re-transformed to determine the predicted survey coverage.

A separate regression model for every choice of *p* and *f* imply that there can be several predicted values for each missing survey coverage. How Lim et al. (2008) treats this is not clear from the text. It is also difficult to say why they use the average estimate (variance weighted) when both observed and predicted estimates exist, and not just the observed value.

The second approach was multiple imputation. This was implemented with the Amelia program (Honaker, Joseph, King, Scheve and Singh (1999), a general-purpose imputation model for missing data. This approach is hard to examine in detail (a 'black box'), but the method is partly justified by the fact that it generates very similar estimates to the BDDR approach.

The study also investigated the association between the presence of GAVI ISS and the difference between officially reported coverage and survey-based coverage. 51 countries receiving ISS funding have been used in this section of analyses. An ordinary least squares model, with panel corrected standard errors and the lag of the dependent variable was used to allow for the dynamic nature of the data. The difference between the officially reported (to GAVI) coverage of children immunised and the survey based coverage by country and year was used as the dependent variable. Independent variables included: GAVI ISS presence, time since baseline year (first year of the GAVI ISS program), baseline year, country and calendar year. Both BDDR and multiple imputation were used to fill in the missing values of survey coverage.

Data quality audit (DQA) is a procedure to test the quality of administrative coverage estimates through a re-count of paper records in randomly selected health centres. The re-count to original coverage ratio is then used to re-weight the national coverage estimate. This ratio is called the DQA national verification factor. Lim et al. (2008) uses the ratio of survey-based coverage over administrative data coverage (by country and year) as a corresponding verification factor. The correlation between DQA national verification factors and the corresponding verification factors is tested in the study.

Finally, two sets of sensitivity tests were performed. First, the entire analyses, using all surveys were compared to analyses performed using only multicountry surveys with microdata available. Second, the variance of the estimated coverage was assumed to be the same as the variances predicted from BDDR. Analyses in this case were compared with multiple imputation analyses.

Strengths of methods

The authors of the study have gone to extensive lengths to ensure their statistical methods are sound. They have acquired a large amount of data to analyse, providing results that represent a broad range of countries.

In a number of cases they have provided background information to validate their methods. For example, the use of surveys based on maternal-self report was analysed using 7 previous studies (e.g. Suarez et al., 1997). This showed that while maternal self-report was not particularly accurate, there doesn't appear to be a strong bias. This validates their use of maternal self-report surveys.

They have justified using older children (3-4 years) to estimate previous years immunisation coverage through intersurvey comparisons. If considerable numbers of children were dying or migrating with a bias nature (for example if many children who were not immunised died) between the age of 1 and 4, the coverage estimates would not be accurate for previous years' estimates. The intersurvey results showed this was not playing a large effect on the survey data and validates the methods used.

Lim et al's (2008) new bidirectional distance-dependent regression (BDDR) appears to be a good method for filling in time series data with missing values. Out-of-sample methods used to test validity in the study involved randomly holding out 20 per cent of the survey estimates, and using the remaining survey estimates to generate the predictions for that sample. The BDDR approach showed similar out-of-sample results to those from the more standard multiple imputation. The study used BDDR for the main body of analyses because standard multiple imputation generated trends that lacked face validity when survey data were scarce.

Weaknesses of methods

The BDDR method's ability to detect quick changes in immunisation coverage in the absence of survey data will rely very much on the assumption that the model is good. For example, Cambodia (see Appendix 5 in the study) showed a remarkable increase in immunisation coverage between 1999 and 2001, based on survey data. If the 2001 (and beyond) survey data was not available, the model would not be able to pick this trend up. Burkina Faso is an example where there is no survey data between 2003 and 2006, and the official report shows an increase which is not covered by the BDDR 95 per cent confidence intervals.

We would suggest that the model is very good at predicting coverage between survey years but needs to be used with caution for predicting coverage after or before survey periods when significant changes may have occurred. Therefore, it is advisable when new programmes are implemented which may significantly change vaccination coverage rates, that they are supported with surveys for monitoring. WHO/Unicef coverage estimates attempt to include local knowledge of events within the immunisation system (Burton et al., 2009). This type of information on such events can be used to support or challenge changes in coverage but need to be incorporated in a more replicable way than at present.

The methods used in this study to calculate whether countries have received over payments due to incorrect coverage reporting is problematic. Lumping together the investment and reward payments is misleading due to the differing nature of payment calculations. Investment payments are received by countries in their first 2 years of ISS and are based on the targeted number of additional children immunised. The reward phase payments are based on the achieved number of additional children vaccinated. If the immunisation coverage is over-reported in the investment phase, it should not be treated as an over-payment because the amount a country receives during this time is not based on the reported number of children immunised.

Additionally, the presentation of potential over (and under) payments for individual countries is misleading (table 2 of the study). Confidence intervals are not given for individual country survey based estimates of overpayments in the main sections of the study and interpretation at this level requires caution (95 per cent confidence intervals are, however, shown in webappendix 8 of the study). There are countries listed as overestimating the number of children immunised, (therefore receiving over-payments) whose officially reported numbers fall within the 95 per cent confidence interval of the survey based estimate (e.g. Sudan). In this case, officially reported numbers should be given the benefit of the doubt and regarded as consistent with survey data.

We detected one country omitted (for unknown reasons) from the analyses (it is not mentioned in table 2 of the study) that had received ISS payments prior to 2004 - Madagascar (an ISS recipient since 2000). With ISS payments totalling a little over $3 million (GAVI Madagascar Information, 2009) it's absence is unlikely to influence results significantly.

3.3. Results and inferences

The study describes many trends observed in the results. In general, administrative data appears to be higher than survey estimates. They observed two trends relating to over-reporting of the performance indicator in association with GAVI ISS; 1) a downward trend in officially reported coverage at the baseline year, and 2) an overestimation of DTP3 coverage after the baseline year. They emphasise that not all GAVI recipients show this trend. BDDR modelling indicated that global DTP3 coverage has increased steadily at about 1 per cent per year between 1986 and 2006, but not to the level suggested by countries' official reports or WHO and Unicef estimates.

They also observe an increase in the gap between survey and reported DTP3 coverage, since the launch of GAVI in 1999. Over-reporting tended to increase with time under the GAVI ISS programme with beta-coefficients significant in the sixth and seventh year of participation in GAVI ISS. In 51 countries (between 1999 and 2006), the reported number of additional children immunised was 13.9 million, at a cost of US$290 million. Based on surveys, 7.4 million (5.7million - 9.2million) additional children were immunised. This gives a difference in payments of US$140 million ($105million – $175million) based on $20 per additional child immunised. Of the 51 countries in the study, 39 are identified as overestimating their coverage.

The study also observes a negative correlation between the DQA verification factor and the survey-based verification factor indicating that DQAs are not capturing the differences between administrative and survey-based coverage.

Notes

Lim et al. (2008) reports several trends in DTP3 coverage for GAVI ISS countries (e.g. a decline in official coverage during GAVI base year) that are not seen in all countries. As the authors emphasise, it is important to assess each country separately to avoid over generalizing. It is interesting to note that even though some countries show a decline in officially reported coverage at the base year, the regression analyses in the study show no significant over-reporting (or under-reporting) at this time (figure 6 in the study). This indicates that officially reported coverage is fairly consistent with survey coverage during this base period.

The gap between GAVI reported immunisation numbers and those based on survey data appears to increase with time from the base year. This is a concern as reward payments begin from the third year after the base year and officially reported coverage needs to be accurate to ensure payments are issued correctly. However, recent estimates based on modelled data are likely to be less responsive to sudden coverage changes as no surveys in the future exist.

Despite this, the difference between reported numbers of additional children immunised and survey-based numbers is vast (6.5 million) and even the conservative WHO/Unicef estimate (of 9.5 million additional children immunised) is outside the 95 per cent confidence interval presented in this study. The transparent and robust nature of DHS and MICS, suggests that differences are, at least in part, due to problems within the official reporting system. The case study in Mozambique by Mavimbe et al. (2005), identified problems at facility, district and national levels for reported data. Issues included: a lack of or inadequate organisational supplies, high incentives to achieve targets, a lack of data quality

control, inadequate staffing at the facility level and supervision based on criticism. These problems are likely to occur in systems of other districts and countries.

The goal for DQA is generally to ensure that management of immunisation services and the allocation of GAVI funding are based on sound and accurate data (GAVI DQA, 2003). This is done through examining data and the information systems used at all administrative levels. The difference between DQA verification factors and survey-based verification factors shown in the study indicates that DQAs are not effectively assessing officially reported data. The Data Task Team has proposed to GAVI alliance a cross-country appraisal of the DQA to improve and strengthen the tool (GAVI Data Task Team Report, 2009).

3.4. GAVI response

Statement - 20th January 2009

GAVI and WHO identified only 8 (+4 others in question) countries who may have received "overpayments". There is no evidence of misappropriation of funds. GAVI consciously made the decision to use government statistics rather than creating a parallel system and emphasise that their payments are based on officially reported figures, not modelled survey based data. WHO/Unicef continue to stand behind their estimates. GAVI verified 35 of the 51 ISS countries in 2002-2006, had either similar administrative data to WHO/Unicef or estimates from this study, or did not receive ISS rewards. Three countries had lower estimates and 1 country had similar estimate to WHO/Unicef before it was revised. Overpayments based on WHO/Unicef estimates are around $30-40 million (compared to $140 million in the study). Two of the countries used in the Lim et al. (2008) have never received ISS reward payments and the study has inappropriately lumped investment and reward phases together. GAVI also states that overpayment estimates in this study relied on modelled data with extensive missing values and did not take into account uncertainty in the models.

Our Response

The countries used in this study, all have received ISS funding of some sort according to the GAVI alliance evaluation report (Chee, His, Carlson, Chankova and Taylor, 2007) and the GAVI alliance online information (GAVI Country Information, 2009). We have not identified any countries used in this study that have not received any ISS payments, however, some have not received reward payments (e.g. Cambodia). Investment money is based on the target number of additional children immunised rather than the reported or survey based numbers. Lumping target numbers together with the reward phase is problematic because of the different financial consequences and these figures should be viewed and analysed separately.

We believe this study has taken into account the uncertainty in the models when calculating total overpayment figures. Confidence intervals (of 95 per cent) are given for the estimated number of additional children immunised overall and estimated payment difference between reported and survey based payments. Confidence intervals are not given for individual country survey based estimates of overpayments in the main sections of the study and interpretation at this level requires caution (95 per cent confidence intervals are, however, shown in webappendix 8). This is especially so for countries that are listed (in table 2 of the study) as overestimating the number of children immunised by less than two times, because officially reported numbers may fall within the 95 per cent confidence interval of the survey based estimates. For example, Sudan is listed in table 2 of the current survey as having overestimated the number of additional children immunised by less than two times. Webappendix 8 of the study shows the officially reported number of additional children immunised in Sudan (265 951) sits well within the survey based 95 per cent confidence interval (-203 611, 453 767). In this

case, officially reported numbers should be given the benefit of the doubt and regarded as consistent with survey data.

Statement - 25th March 2009

An independent task team was employed to review the ISS program and provide recommendations. The team stated that DPT3 coverage has increased in 62 countries by 15 per cent overall with the help of ISS. Key recommendations included:

- GAVI uses WHO/Unicef estimates instead of those reported to GAVI
- GAVI supports the strengthening of the estimation process.
- GAVI base rewards in part on proportion of children immunised

Other recommendations included strengthening administrative data systems and methods for measuring immunisation coverage, monitor immunisation coverage disparities, and evaluate the Data Quality Audits (DQA). The suspension of ISS payments has been lifted to all except 7 (originally 12) countries which have been recommended to work with GAVI to resolve discrepancies. GAVI stresses that no misuse of ISS funds has been identified and all payments were made according to the design of the ISS program.

Our Response

While GAVI made a conscious decision to base reward payments on government provided figures, there is evidence from this study (and Murray et al., 2003) that this official data are not always consistent with comprehensive survey based data. For this reason we would support the recommendation to use alternative WHO/Unicef estimates provided they produce replicable procedures for their estimations. The methods for WHO/Unicef coverage estimates provided online this year (Burton et al., 2009) are a starting point but as they state “no attempt is made to fit data points with smoothing techniques or time series methods” and could perhaps be improved and appropriate variance measures for estimations applied.

4. Four countries systems reviewed

A total of four case studies were carried out in July and August 2009, including Uganda, Malawi, Mozambique and Zambia. The main objective of the field studies was to learn about the process establishing the estimates for vaccination coverage. The actors included health workers and representatives at different levels in the organisational hierarchy. The duration of the interviews and field studies was relatively brief, lasting 1 to 2 weeks for each country.

4.1. Administrative data: Strengthening the system

Many informants stressed the lack of capacity in the system for reporting. This refers both to the human and technical capacity, and this will be addressed below. The capacity required depends on the complexity of the task to be solved. The importance of standardisation and keeping the reporting system as simple as possible is addressed in section 4.2.

The following aspects of the *human resource situation* in the health sector seem to influence the administrative information on vaccination.

Overburdened staff: The existing staff are overburdened. Recording and reporting is under-prioritised since clinical matters, after all must come first. Lack of capacity is based on the work-load experienced by the health workers on the ground. Keeping records comes on top of the practical work and many have too much to do just attending to clients. This may lead to less accurate data recording. In Uganda a lot of responsibility is delegated to the health sub-districts (HSDs). The HSD are in general understaffed, staffed by unqualified personnel and overburdened.

Shortage of skilled staff at health centres: Staff posts remain vacant for a long time. This is especially the case for the position as records assistant, especially at the lower levels of the data collection chain. Many facilities experience a lack of skilled personnel.

Working conditions: Low pay, lack of other benefits, and lack of incentives to perform well, create an exodus from the sector, a high degree of absenteeism and for some countries, a brain drain to neighbouring countries.

Lack of training: Lack of training means many health workers do not know how to fill in forms properly. It also means they do not know why this information is important which may lead to giving it less priority. Insufficient frequency and poor quality of training is also an issue. In Uganda it was emphasised by many informants that the current training focuses too little on usability of data compared to the more technical matters. The district level is lacking funds to bee able to initialise their own trainings which leads to ignorance among health centre-staff about the importance of accurate and timely reporting.

Aspects of the political/administrative structure: In Uganda we found challenges specifically caused by the continuous decentralisation process. The number of districts increased from 56 in 2002 to 94 in 2009. 14 of these were created in 2009. This creates serious challenges with regard to establishing reporting and supervision routines.

The main reasons for inaccurate administrative data seems to be lack of capacity, lack of training and lack of understanding for the importance of accurate data. With a human resource crisis in the health system, the health workers often do not have the time to sit down to report.

Failure and delays in supplies to the health facilities also influence the administrative information on vaccination. We present some examples: Many health centres depend on gas to run their freezers. Whenever there is a delay of gas supply to parts of the country this will lead to increased wastage and children not being immunised. To cover up for excessive wastage, this may lead to reporting of immunisations that have not taken place. Shortage of report forms and vaccination cards also cause problems for registering the children that receive vaccinations. So does software and hardware problems, as well as other practical challenges like lack of transport to deliver the forms or lack of basic tools like calculators or pens.

Delays in reported data from the health centres. As a consequence of the issues mentioned above, health centres often face delays with regard to submitting their monthly reports. Incomplete reports are regularly submitted. Even if they are to be updated at a later stage, there is still a risk that the updated results will not be reflected in the national database.

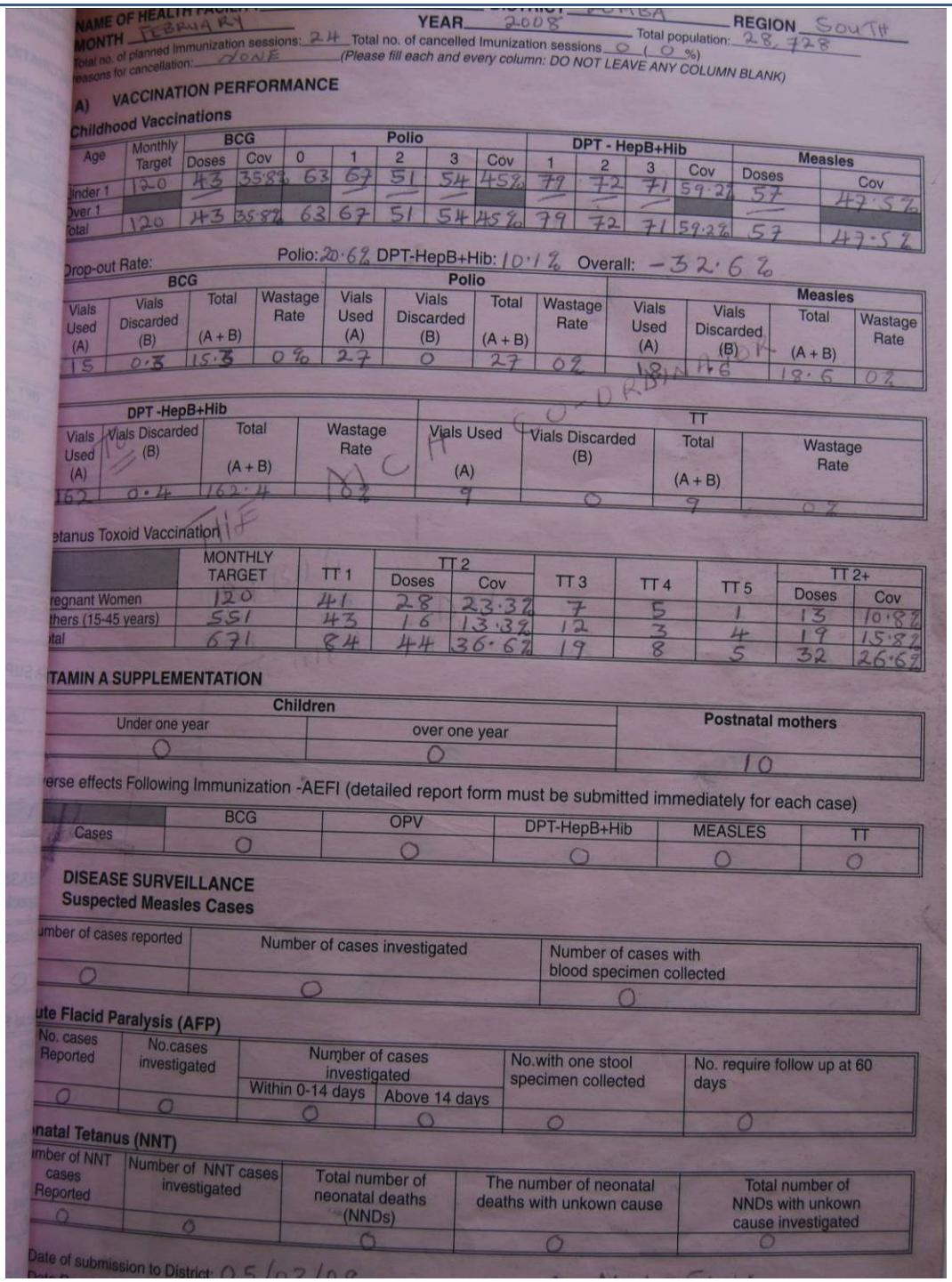
4.2. Gathering administrative data

For many years the implementation of Health Management Information System (HMIS) has been emphasised, focusing on developing routines and standards (HMIS procedure manuals, reporting formats and related guidelines). It has also focused on training and improvements in management procedures, communication between the stakeholders and HMIS and strategies to increase the use of HMIS generated information. This includes monitoring performance of the health services delivery. Challenges still exists, both on improving the quality of administrative data and making them comparable to survey data.

Registering numbers without names. Earlier administrative data on vaccination in Mozambique was collected using tally-sheets only. The principle of these was that the health worker would tick off for every child she or he immunises. At the end of the month, all the vaccinations were summed up in a report to the district level. There was no recording of the child's or her mother's name. (the children have often not been given names when they get the first injection), nor the age of the child. The practice of filling in tally sheets varied. One way that was mentioned which creates over-reporting was when all the vaccination cards were collected to be counted and registered before the child consulted a doctor or a nurse. This implied there will be a registration whether the child needs the vaccine or not. Another approach to filling in the tally sheet was based on memory at the end of each month.

Starting from 2008 the routine changed in Mozambique. A new system was introduced, recording more detailed information. The new system has not been implemented everywhere, and some health stations still use the tally sheets only. Still, the figures based on administrative records and survey data are converging in Mozambique. This implies that the introduction of an improved system for collecting administrative data has improved the quality of the data and made the results more similar to estimates based on surveys.

Figure 1. Tally sheet from health facility to district level used in Malawi



NAME OF HEALTH FACILITY: _____ YEAR 2008 DISTRICT KUMBA REGION South

MONTH FEBRUARY Total population: 28,728

Total no. of planned Immunization sessions: 24 Total no. of cancelled Imunization sessions 0 (0 %)

Reasons for cancellation: NONE (Please fill each and every column: DO NOT LEAVE ANY COLUMN BLANK)

A) VACCINATION PERFORMANCE

Childhood Vaccinations

Age	Monthly Target	BCG		Polio					DPT - HepB+Hib				Measles	
		Doses	Cov	0	1	2	3	Cov	1	2	3	Cov	Doses	Cov
Under 1	120	43	35.8%	63	67	51	54	45%	79	72	71	59.2%	57	47.5%
Over 1														
Total	120	43	35.8%	63	67	51	54	45%	79	72	71	59.2%	57	47.5%

Drop-out Rate: Polio: 20.6% DPT-HepB+Hib: 10.1% Overall: -32.6%

BCG				Polio				Measles			
Vials Used (A)	Vials Discarded (B)	Total (A + B)	Wastage Rate	Vials Used (A)	Vials Discarded (B)	Total (A + B)	Wastage Rate	Vials Used (A)	Vials Discarded (B)	Total (A + B)	Wastage Rate
15	0.3	15.3	0%	27	0	27	0%	18	1.6	18.6	0%

DPT -HepB+Hib				TT			
Vials Used (A)	Vials Discarded (B)	Total (A + B)	Wastage Rate	Vials Used (A)	Vials Discarded (B)	Total (A + B)	Wastage Rate
162	0.4	162.4	0%	9	0	9	0%

Tetanus Toxoid Vaccination

	MONTHLY TARGET	TT 1	TT 2		TT 3	TT 4	TT 5	TT 2+	
			Doses	Cov				Doses	Cov
Pregnant Women	120	41	28	23.3%	7	5	1	13	10.8%
Others (15-45 years)	551	43	16	13.3%	12	3	4	19	15.8%
Total	671	84	44	36.6%	19	8	5	32	26.6%

VITAMIN A SUPPLEMENTATION

Children		Postnatal mothers
Under one year	over one year	
0	0	10

Adverse effects Following Immunization -AEFI (detailed report form must be submitted immediately for each case)

	BCG	OPV	DPT-HepB+Hib	MEASLES	TT
Cases	0	0	0	0	0

DISEASE SURVEILLANCE

Suspected Measles Cases

Number of cases reported	Number of cases investigated	Number of cases with blood specimen collected
0	0	0

Acute Flacid Paralysis (AFP)

No. cases Reported	No.cases investigated	Number of cases investigated		No.with one stool specimen collected	No. require follow up at 60 days
		Within 0-14 days	Above 14 days		
0	0	0	0	0	0

Neonatal Tetanus (NNT)

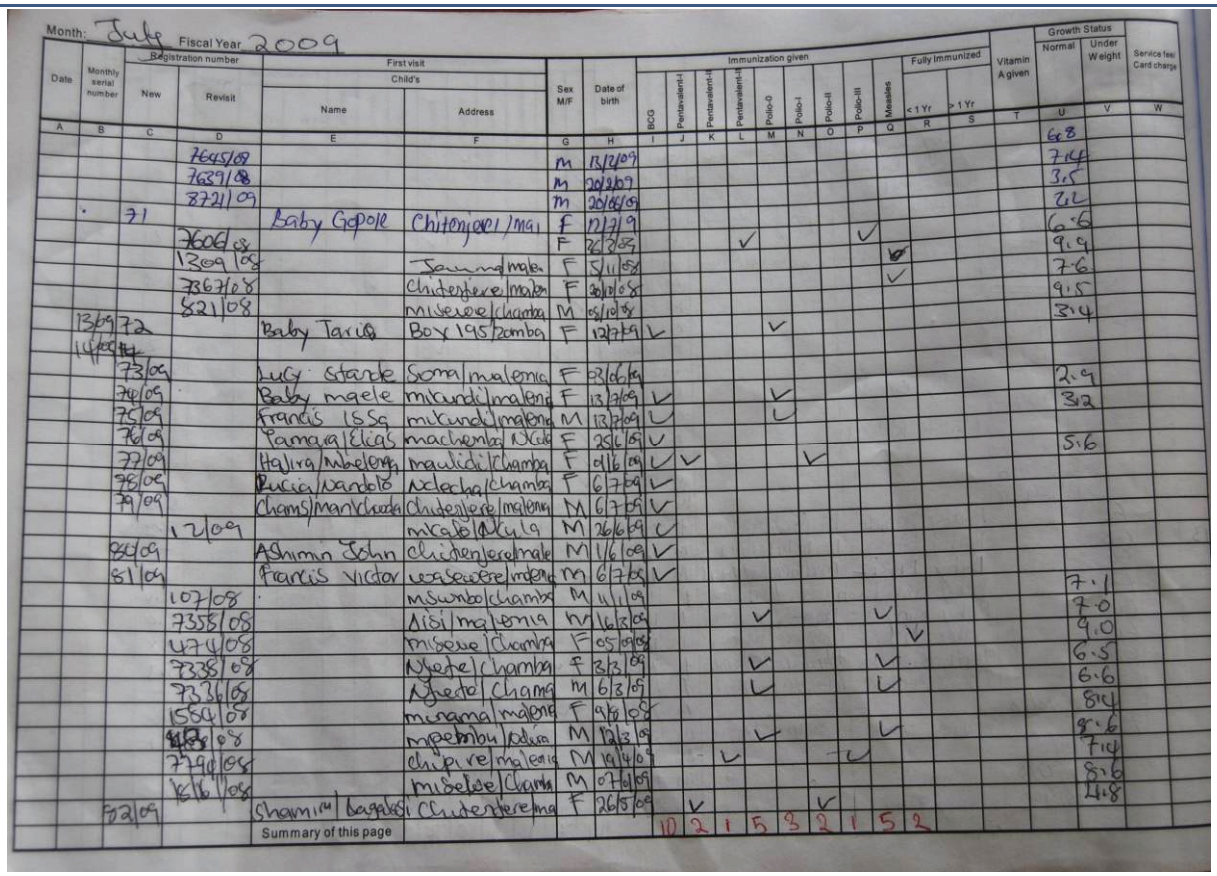
Number of NNT cases Reported	Number of NNT cases investigated	Total number of neonatal deaths (NNDs)	The number of neonatal deaths with unkown cause	Total number of NNDs with unkown cause investigated
0	0	0	0	0

Date of submission to District: 05/03/08

The gap between survey data and administrative data in Malawi is not huge, although some differences do exist. In particular, the administrative data have a larger variation from year to year than Lim et al's (2008) estimates based on survey data.

In Malawi vaccination of children is supposed to be recorded in a registration book, as show below. The child's name, address, sex and date of birth are recorded, along with the immunisations received that day. Each new child is also given a registration number, which is restated when the child comes back for new vaccinations. At a hospital we visited in Malawi, the registration book was filled in just before and in the same room as the vaccinations were given. This is important to make sure to count all children.

Figure 2. Registration book at health facility for children under one year of age



Double immunisation. If a child's health passport is lost, and neither the health personnel nor the mother/caretaker are sure of which vaccines the child has received, it is common to give an immunisation just to be on the safe side. In Malawi 4 in 5 children actually have a health passport, so this is probably not very common, but it may cause some over-reporting in the EPI figures.

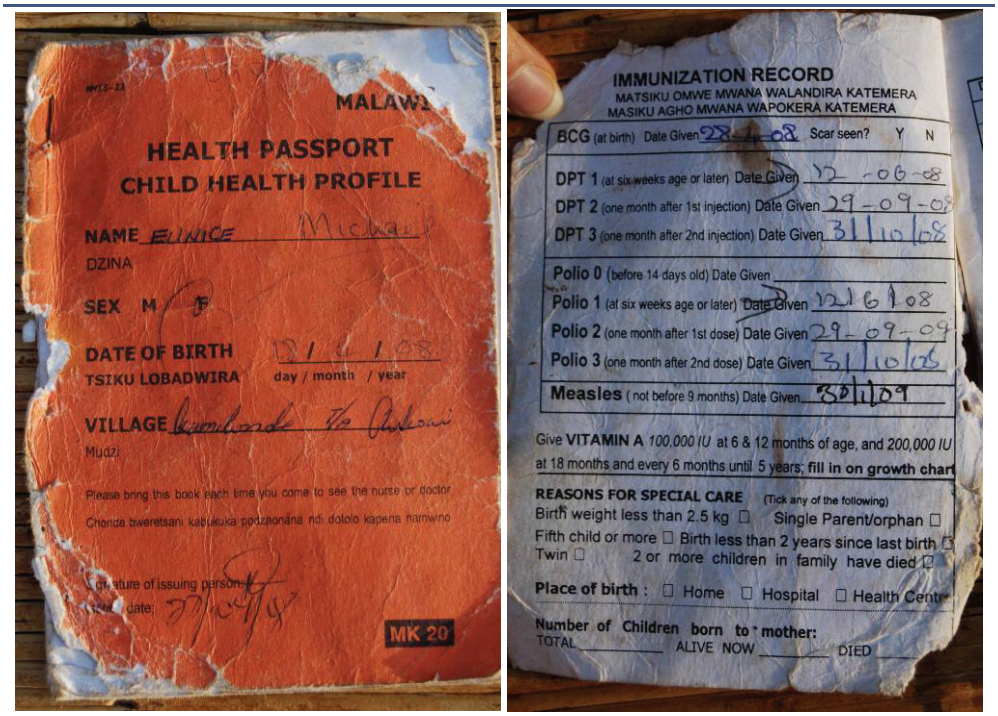
4.3. Collecting survey data

Data from surveys are of varying quality. They also have different objectives for gathering information on vaccination coverage, using different definitions, different ways of asking and different ways of analysing the data and presenting the results

About 80 per cent of the children are accounted for by vaccination cards. Card data are assumed to be reliable. For the remaining 20 per cent one will expect more errors, be it whether immunisation has been done or the timing. Random errors will not affect the rates, but contribute to increased variance. Non-random errors will lead to bias. It is a risk that the quite extensive probing may lead to some over-reporting, as intentions may be memorised as actions. Even though non-recall or biased answers may be higher in the remaining 20 per cent, they are too few to constitute a major challenge to the quality of data.

It is also a sad fact that a number of mothers die from their children. Children with no female caretaker will not be included in the survey. Single fathers are unfortunately not asked this information.

Figure 3. Malawi Children's health passport



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A general problem with survey data is that they often can not supply data on an annual basis. Later we will suggest a way to address this issue on the country level.

4.4. The population size: Children in the target population

Calculations of vaccine coverage are sensitive to the estimated population size. This applies both for the total population figures and the way the age group in question is calculated as a part of the population. Survey coverage rates are to be inflated with population estimates to find the number of children vaccinated. If the population estimate is too low, the estimated number of children will also be too low. If you use a too low population estimate as the denominator when calculating an administrative vaccination rate, you will get a rate that is too high. Hence, caution should be used when comparing results form administrative data and survey data if population estimates are inaccurate. These problems are generally all referred to as the denominator problem.

The quality of population estimates may be reduced due to migration, uncertainty about the size of the target group, or because of the time that has passed since the last census or due to the quality of the last census. Underestimation of the number of children to be vaccinated is also found to be a source of error, as this will give a coverage rate that is higher than in reality.

On the other hand, overestimation of the number of children in the target group will give us a calculated coverage rate that is lower than the actual rate. This means that the difference between the administrative rate and the survey rate is actually larger than it seems. We will present evidence that this may be the case in Mozambique in the country report presented later in this report.

Often a flat rate is used to identify the target population for vaccination. The percentage of infants will wary between different parts of a country, typically being lower in urban areas. This will also be exemplified in the country report from Mozambique. In the most extreme example, updating the number of infants for Maputo City with the recently released census data changes the coverage rate from 66 per cent to 120 per cent.

Different organisations have been using different denominators to calculate coverage rate. The problem have been drawn attention to and hence reduced, but it still exists.

Immunisation of children from Mozambique in Malawi. Because immunisations are free of charge in Malawi, it is relatively common along the Mozambique border that mothers cross the border to have their children vaccinated in Malawi. This will lead to higher figures from the health facilities than what is captured in a survey visiting only Malawian households. Hence, one would expect the gap between EPI and survey data to be higher in the southern districts bordering Mozambique than in other districts. And in fact, the six districts with highest gap between survey (MICS 2006) and EPI data for 2005 (Machinga, Phalombe, Mwanza, Chikwawa, Mulanje and Dedza) all have borders with Mozambique.

Refugees are reported to cause similar effects in Uganda and Zambia. Cross border movements creates an increasing demand on vaccination services were people are migrating.

Updating population estimates. A census is often produced every 10th year. To conduct them is very demanding, both in human resources and funding, and to have them more frequent is unrealistic. It is a growing challenge to produce reliable population estimates as census results are getting older.

4.5. The treatment of age

How data are collected influences the results. If we ask in a different manner, we may include children that would otherwise not be registered. The methods used e.g. often have implications for how children over the recommended age for vaccination are registered.

Comparisons based on different age groups

Survey data are often based on question that relates to children aged 1 to 4 years. Administrative data often address children below 1 or 2 years of age. Even though we can adjust for age and year, we will reach two different groups of children. Comparing these may be problematic. The mode of registration will probably influence which children are registered. Most health personnel would tend to include children slightly above one year among the registered children if this is the only way to registered them as vaccinated. Failing to register them first would leave them counted as un-vaccinated, it would not justify the use of the dosages vaccines and it would not make the work of health personnel visible. These issues ought to be taken into consideration when deciding which age group to be addressed and how to collect the information. Asking questions about what happened to children up to four years raise the challenge of counting children that dies before being surveyed. Unfortunately, this may be a substantial number influencing the results.

Many die within the first year

An other important issue is how the infant mortality rate is taken into account. The infant mortality rate in the four countries assessed varies from 103 to 130 per 1000 live births. DPT3 vaccination is using surviving infants as denominator in the WHO/Unicef report form. Since DPT3 ideally is given after 14 weeks, the number of infants in the real target group (those who survive to 14 weeks) will be higher than those who survive to one year. With infant mortality rates above 10 per cent, this has significant influence on the calculated coverage rate, which in this case will be too high. However, it also happens that the number of live births is used as denominator. Further, it is common that the vaccinations take place later than the ideal schedule. In such cases we get the opposite effect and coverage rates become lower.

The definitions and methods used in different types of data collection ought to be Standardised as far as possible. If administrative records a count children in a specific way, surveys should use an as similar approach as possible, to have comparable data. If data form administrative records e.g. count all children vaccinated but only report on a specific age group, survey data should do the same.

4.6. Feedback to raporteurs

Reporting ought to be part of the routines associated with the actual act of vaccination. If registering the vaccinated children is done later the numbers often will be unreliable. If the medical personnel giving the vaccines do not see any use of providing reliable information, data quality often will be low.

We often found a lack of effective control mechanisms and feedback systems. Hence, mistakes are rarely discovered. It was further pointed out that there is lack of communication between the different levels of the administrative system. Our respondents reported that feedback often were given in an unpleasant manner.

4.7. Systematic over-reporting?

Staff at lower levels are in general not familiar with national ranking and incentive systems, and are usually unaware of performance-based funding initiatives like GAVI. Still they may respond to pressure from central actors caused by this incentive structure. Informants at a health centres generally seems to get feedback only if the figures look too low and not if they are too high. Hence, corrective action is rarely taken when the figures appear too high. This will lead to a systematic over-reporting. A performance-oriented support system like in GAVI may contribute to this trend. It will change the results, making the figures look higher than they actually are.

Calculating this often rather small numbers in two different ways and comparing them, makes the analysis sensitive to the errors associated with the different methods.

On the other hand there are checkpoints which would limit such over-reporting: Several tools for validation of recording at each health centre, like child registry, tally sheets and materials control books. The knowledge of potential validation exercises also contributes to prevent deliberate over-reporting.

Another mechanism which seems to lead to over-reporting is covering up for wastage. As it is seen as problematic to report wastage, people may over-report the number of vaccinated children in order to cover up for it. This has also been found by Mavimbe et al. (2005) in their assessment of immunisation data quality from routine reports in Mozambique.

5. Recommendations for improving the quality of data reports on vaccination coverage

We are proposing the following suggestions to improve the monitoring of vaccination coverage.

5.1. Re-analyse specific country immunisation coverage using existing data

Analyses are always sensitive to the methods used and the data included. It will be fruitful to repeat the analyses of Lim et al. (2008), using updated data and improved methods. If the results turn out to be consistent, you have a good argument that what you have found is true.

The validity of data on social and regional variations in vaccination coverage can be substantially increased by supplementary information. This could include information like the civil status and education of the caretaker and available epidemiological information about regional variations in epidemic diseases. This can add to the relevance of both survey analyses and administrative coverage estimates.

First one must do a full search for all available data on selected countries. Data ought to be re-analysed in a similar method that is used in the Lim et al. study (2008) - BDDR. Estimates incorporating the use of other correlated factors ought to be re-calculated, such as maternal education level. Further literature research should be done on any missing groups of the surveys (e.g. children with only fathers and orphans). Over-estimates excluding investment phase should be re-analysed. DQA reports available should be investigated. Pakistan may be a good case for this: Pakistan has generally shown large disparities between official and survey data between 1985-2006. In around 2003, officially reported coverage dropped to the level seen in surveys. This occurred at the same time as the DQA. However, in 2005-2006 the officially reported coverage has risen steeply and is not consistent with recent surveys.

Expected outcomes of a literature and re-analysis approach
This will investigate analyses of survey data and perhaps identify areas of improvement of analyses and collection specific to immunisation coverage. Looking at specific countries may identify other factors than the ones already identified.

5.2. Use annual small household surveys to give estimates on vaccination coverage for a selected vaccine and improve population estimates

Conducting small annual surveys, would provide vaccination coverage for specific vaccines. If this can be seen as having a coverage representative for other vaccines, it can be used as a proxy for the coverage of other vaccinations. Keeping the size of the survey to a minimum, will make it affordable and possible to process rapidly.

Calculations of vaccination coverage are sensitive to the estimated population size. This applies for both the total population and the target population for vaccinations (young children).

Often the target population for vaccination is calculated as a percentage of the total population. The percentage we have found to define the population below one year varies from 3.9 to 5.0 per cent. If these percentages are not accurate, they will introduce errors.

Most countries carry out a population and housing census every 10 years. However, after some years the figures will be outdated even as approximations, model based population projections are used. These projections will be ever more uncertain by time elapsed since the previous census.

Nationwide household surveys will provide information about the current population structure. A programme of annual small surveys has been advocated as an appropriate instrument for monitoring poverty, school attendance rates etc. in-between censuses and expensive traditional household surveys. As a spin-off one can have, on a frequent (annual) basis, updated information on population parameters that can help refine projection models and produce more reliable population estimates.

Surveys often do not give frequent and updated information. Selecting one vaccine for a small annual survey can help this. Censuses are usually centred around the turning of a decennium. If the quality of population data is influencing the vaccination coverage to a substantial degree, the gap between survey data and administrative data would be expected to be the least when new population data have been presented, e.g. in the beginning of each decennium.

A pilot ought to be launched, preferably in a country already conducting small annual surveys. The aim of the pilot would be to produce coverage estimates for a selected vaccine, and update population estimates.

Expected outcomes of introducing annual small household surveys
Annual updated information on the coverage of a selected vaccine. Better population projections and annual survey data on vaccination. It will also give regularly updated information on other central variables, like the development of poverty.

5.3. Use the same definitions and methods for surveys and administrative data

Like administrative systems differ between countries, surveys are not alike. The methodology used and the questions posed differ, as well as what information is presented.

This in general raises two challenges: The question of quality and the question of comparability. In general we will recommend using questions and survey methodology from standardised multicountry surveys, such as the Demographic and health surveys (DHS) and the Multiple indicator cluster surveys (MICS). These are well tested and will give internationally comparable information. It also seems they are quite successful in having mothers supply vaccination information through vaccination cards or certificates.

The way data are collected influences the results. Asking in a slightly different manner may include a child that would otherwise not be registered. The methods used e.g. often have implications for how children over the recommended age for vaccination are registered.
Many children do not get their vaccinations at the recommended age. For the figures from different data collection methods to be comparable, it is essential to gather data the same way. If you only allow for children at the age of the target group to be reported, you may stimulate health personnel to also record older children to account for vaccines used.

As far as possible, methods for both definitions and methods for collecting data ought to be standardised. One should strive to make data as comparable as possible.

Expected outcomes of standardising data collection methods, definitions and concepts
More comparable data on vaccination coverage between administrative and survey-based estimates.

5.4. Evaluation of different data collection methods

Different types of data collection have different strengths and weaknesses. Hence, they generally will give different results. But, assuming that there is one true value we are trying to establish, we should make an effort to minimise the weaknesses and build on the strengths in the data collection systems we are relating to. One way of doing this is to look for changes in the data gathering systems that makes data from different sources more comparable.

The data gathered for the Lim et al. (2008) study should be evaluated to find time series were survey data and data from administrative sources converge. Reasons for data becoming more similar should be established.

Expected outcomes of evaluating data collection methods
To learn more about what causes differences and changes in reported vaccination rates, in order to be able to produce comparable data.

5.5. Evaluation of recommendations: Follow the time series

Action taken to improve data quality may change the estimates. Improving the quality of the data we are collecting hence will change the comparability over time. The development of the figures for vaccinated children must be monitored closely, in order to identify what measures seems to improve the quality of our data. That a corrective action leads to improvement in data quality in one country may be a reason to also take similar action in another.

5.6. Re-visit the Mozambique study

Mavimbe et al. (2005), identified several issues influencing the quality of administrative data on vaccination coverage in Mozambique in their 2005 report "Assessing immunisation data quality from routine reports in Mozambique". After a failed DQA in around 2002, officially reported coverage dropped to within the 95 per cent confidence level calculated in the Lim et al. (2008) study. Since 2006 it has risen again, well above the survey based model. Changes in the system for reporting of administrative data were made from 2008, resulting in a drop in reported vaccinations, giving results more in line with survey data.

The Mavimbe et al. (*2005)*, study ought to be repeated, to see if the initial problems have been resolved. It may also be worthwhile finding out whether their findings are valid for other countries: Organise and conduct a similar style case study to that used by Mavimbe et al. (2005), choosing a district to attain recounts and preferably interviews and observations. Investigate differences in counts of official coverage at different administrative levels. Interviews with the people creating reports and immunisation tally sheets could be performed to determine if there are similar problems to those experienced in Mozambique.

Expected outcomes of a survey and interview approach
This could address whether systems have changed in response to suggestions proposed in the previous case study of this area. It would also provide more information on the processes (and any breakdowns) in the administrative process of collection and reporting of administrative data.

5.7. Simplify and standardise the reporting system

Gathering administrative data is challenging. Often there is a lack of trained staff to do the reporting and data management. The health workers' primary task is provision of health services. Their focus is not on data compiling and analysis. Shortage of time and resources in general, and insufficient skills in data interpretation and analysis is quite normal. In a busy working day, the reporting and cross checking of data is not always given priority. Hence, filling in must be made easy. In order to achieve this, an evaluation of the reporting system in specific problem countries should be undertaken to identify difficulties. This can be compared to countries where the system is running smoothly to base improvements on.

The system produces enormous quantities of data, but the required time, software and outlook to extract essential and relevant information is scarce. The system produces enormous quantities of data, but the required time, software and outlook to extract essential and relevant information is scarce.

In Mozambique, the administrative data showed high and increasing immunisation coverage until 2007. The next year, the system for gathering administrative data was improved, leading to a dramatic decrease in the reported figures. The survey data and data from administrative sources are beginning to converge.

The systems for gathering administrative data must be made simple and robust enough to give precise estimates even though resources often will be scarce. This implies that the forms used must be easy to understand and to fill in. The entire data gathering chain must be searched for bottlenecks. Looking into how people reason when they fill in forms generally is important to explain the results we get. A survey methodological analysis of the reporting system will serve to establish a simple and robust reporting system.

Expected outcomes for simplifying administrative reporting routines
This would improve present routines for reporting data. A survey methodological analysis will make it possible to find out what kind of information the health personnel have access to and how they should be asked to report it in a correct manner. This analysis aiming to simplify administrative reporting routines should first be done in one country with a particularly challenging system. Experiences will partially be transferable between countries and systems.

5.8. Building human resources

Nothing is as important for a producer of statistics as the staff. The difference between a well-organized, strongly motivated and technically competent staff and one that displays these attributes only to a very modest extent is the difference between a good and credible office and one that is second-rate. Expenditure on staff accounts for a dominant fraction of the budget in a statistical agency. In a sample of offices representing a broad array of sizes and stages of development, salaries accounted for approximately 70 per cent or more of the total budget. In addition, heads of agency tended to devote more time to staff problems than to any other issue (United Nations Statistics Division 2003). We are not producing maize or building houses. Our raw material is human beings. That is what we have to develop.

The core idea of Human Resource Development (HRD) is to manage staff the best possible manner, in order to produce high quality statistics. Development and management of competence is a key aspect in this. If an organisation is governed by fear, it is often difficult for the staff to record a result that is not in line with what they think the managers would want. This can easily induce erroneous reporting. Suggestions for how to support the

human resource situation in the system for gathering administrative information on vaccination in Uganda is given in section 6.1 in this report.

The main challenge in collecting high quality administrative data seems to be building capacity, giving training and creating an understanding for the importance of accurate data. Often the organisations were the data are collected often do not manage to bring out the best in the staff. Initiating teamwork, delegating tasks and motivating staff are serious challenges to the performance of organisations. Building capacity in the existing staff is often cost-effective, compared to requiting new employees. Recruiting new staff members often also will be necessary.

Expected outcomes of building human resources
Organisations with a motivated and skilled staff of sufficient size, generally achieve good results.

5.9. Give feedback to improve performance

Providing the personnel with feedback on their performance may lead to more focus on the importance of accurate reporting. A structured reporting forum should be implemented to provide feedback to personnel including: the number of children vaccinated, the percentage of children in the target group vaccinated and the wastage rate of the centre. If a centre also gets figures from comparable units it may induce competition between them and give a potential self-interest in reporting the numbers. The other units may be of the same size, from the same geographical area or with similar available resources. Staff and the system would benefit if staff were made more aware of how the data may be useful in their daily work.

The goal is to give the reporters information they can use in their work, e.g. for planning purposes. The centres performing particularly well could be invited to share their experiences with others. The focus should be on positive feedback and encourage communication channels.

Expected outcomes of implementing a structured feedback forum
To supply health personnel a tool to perform better and advocate the need for reliable data.

5.10. Country-specific challenges

It is important that the reporting to GAVI is given individual attention for each country. Some countries may have old census data or population estimates that are known to be highly uncertain/contested. Poor population estimates is negative for both register data and surveys. A survey may well find the right vaccination rate in an area, but using it to predict the amount of children who have received a vaccine requires that the survey is based on good census data. The problems created by migration also vary significantly between regions and countries. The quality of register data varies in the same way. Some countries need to improve the system of collecting data, while others have good systems, though they are maybe struggling with implementation. Different countries have different challenges in reporting data.

5.11. Potential further contribution by Statistics Norway

Statistics Norway is interested in contributing to improve the quality of data on vaccination. We consider the following fields to be of relevance:

1. A literature review and a data re-analyses of data can improve the current knowledge base without collecting new data: We suggest a search for all available data on chosen countries. The aim would be to re-analyse data in a

similar method to Lim et al. (2008) (i.e. BDDR), adding more information on selected countries and trying to separate the investment phase from the reward payments in the analysis.

2. It is possible to measure the vaccination coverage in annual small surveys. Keeping the size of such surveys to a minimum makes them affordable and possible to process rapidly. If one vaccine can be seen as having a coverage representative for other vaccines or if it is particularly important, it can be used as a proxy for the coverage rate of other vaccines. Secondly, calculations of vaccination coverage are sensitive to the estimated population size. Small surveys (and other surveys between censuses) can also be used to improve the estimated population size. We suggest a pilot to evaluate what effects a small annual survey can have on the quality of vaccination coverage data.
3. Evaluation of different data collection methods. The data gathered for the Lim et al. (2008) study should be evaluated to points in time were survey data and data from administrative sources are becoming more similar. Reasons for data converging ought to be established. We also recommend an evaluation of the effects of changes in data collection methods: We are constantly working to improve data quality. If we achieve a successful improvement of data quality, we probably will see a changing pattern in the time series. It will be useful to identify changes in data collection that happens at the same time as changes in the time series. This can give us more knowledge on which quality improvement measures that may be effective.

Statistics Norway will be happy to discuss these or other issues further.

6. Case studies

The case studies aimed at generating hypotheses regarding differences in vaccine coverage

One important conclusion that follows from this study of Lim et al. (2008) is that errors can occur at the lowest geographical level of observation. A particular focus on the face-to-face interaction between health personnel and families receiving vaccines - and information about how the vaccination activity is reported at facility level – was expected to give important insights into how administrative reports in vaccination are generated:

- How do the actors (midwifes, nurses, health visitors) at the local and district level perceive the vaccination process? Issues such as the availability of resources and facilities to report vaccines, how the raw-data are Organised and stored etc.
- Local actors experiences with surveillance activities from higher levels in the health system
- To what extent are the local health workers perceptions consistent with actors in more aggregated levels of the health systems?
- To what extent are local data on vaccines controlled or checked by administrative representatives?

Another issue is related to the quality of information about the target population available at the lowest geographical level about the target population:

- How accurate is the information that health workers and midwifes have about the number of births in the districts they are supposed to cover?
- How old is the demographic information that they relate to?

It is also important to gain insight into the flow of information from local to aggregate levels:

- Do important variations exist between countries in the way that routine data are reported from the local to the national level?
- To what extent is information collected at local levels available in disaggregated form at higher levels in the health system?

The investigations were of an explorative character, aiming at generating hypothesis about possible weaknesses in information systems that generate estimates on vaccination coverage. The systems to study were chosen to illuminate a spectre of challenges to collecting reliable data.

6.1. Uganda

About the Ugandan National Health System (NHS) and the Uganda National Expanded Programme on Immunisation (UNEPI)

Along with the Constitution of Uganda and the National Health Policy of 1999 (a new policy is just about to be finalised), the Poverty Eradication Action Plan (PEAP) and the Health Sector Strategic Plan II (HSSPII) provide guidelines and principles for the health sector's development. DPT3 coverage (of children 0-11 months) is included as an indicator in both PEAP and HSSPII.

Immunisation is a nationwide programme carried out under UNEPI, targeting mainly infants and women of childbearing age. Its goal and objective in HSSPII is to ensure that all children are fully immunised against the targeted vaccine preventable diseases before their first birthday and all babies born protected against neonatal tetanus.

Immunisation coverage in children declined in 2008. The percentage of children <1 year receiving 3 doses of DPT/Pentavalent vaccines was reduced to 82 per cent in Fiscal year (FY) 2007/08, from 90 per cent obtained in 2006/07. Various explanations for this decline are touched upon below.

The Government of Uganda (GoU) provides 100per cent of funds required for procurement of BCG, OPV, TT and measles. DPT_HepB+Hib has largely been provided by GAVI (in-kind) GAVI has also been a major financial source for the operational budget through the Immunisation Services Support (ISS) fund. Other development partners have contributed in areas like the cold chain system and vaccine management.

In 2007 GAVI funds (except for the provision of DTP_HepB+Hib) to Uganda were suspended due to allegations of mismanagement of ISS funds by the Ministry of Health (MoH). GoU and some involved individuals have later had to reimburse GAVI of the missing funds, estimated at $500,000. In addition, measures have been established as to avoid such cases in the future.

An integrated Health Management Information System (HMIS) was introduced in 1996 as the official MoH reporting system with the aim of replacing all pre-existing routine reporting systems for a number of vertical programmes including UNEPI. This process is now well consolidated and HMIS tools for collecting, reporting and monitoring activities are used at the various levels. There are, however, still a range of challenges as to how to ensure consistency and correct employment of the tools.

The NHS is decentralised in matters relating to disbursements of funds, reporting, supervision and monitoring. The responsibility in a district lies on the District Health Team (DHT) located at the Health Department of the District Headquarters. The DHT is headed by a District Director of Health Services (also known as the District Health Officer (DHO)). Within a district there are health sub-districts (HSDs), with a health centre IV as the lead. The health centres (HC) in Uganda are labelled II, III and IV indicating the level of services provided[1]. Immunisation takes place at other facilities than health centres. However, in the study we focused on health centres so the findings may be limited to them.

Fact findings

Facts about recording, reporting and interrelated matters

The child immunisation schedule:

Vaccine	**Age of child**
Polio0 and BCG	At birth or 1st clinical contact
Polio1 and DPT1 (from 2002 the pentavalent vaccine DPT1-HepB+Hib)	6 weeks
Polio2 and DPT2 (from 2002 the pentavalent vaccine DPT2-HepB+Hib)	10 weeks
Polio3 and DPT3 (from 2002 the pentavalent vaccine DPT3-HepB+Hib)	14 weeks
Measles	9 months

The ideal recording routines at the health centres

Every child is provided a child health card at birth. The card should follow the child up to the age of six. Children who are not born in a health facility are sought captured through outreach programmes carried out by outreach workers. The child health card would provide dates for when a child has been immunised, the date for the next visit at the HC and advice/reminders to the parents.

[1] Uganda's government health system consists of the district health system (village health teams (VHTs), HCs II, III and IV and district general hospitals) and regional and national referral hospitals, which are self accounting and autonomous institutions, respectively.

In addition to the child health card the immunisation is recorded in:

A. The child registry. This includes columns for: the name of the child, of the parents, address, date of the particular immunisation and comments
B. A tally sheet. This would usually be lying next to the child registry. The various vaccines are listed and a line is drawn for each vaccine. A tally sheet (or more if needed) applies to one month.
C. The UNEPI Vaccine and Injection Materials Control Book. Should be updated at the end of the day. It contains columns for: stocks at hand at the beginning of the day, dozes issued, dozes used, wastage and the balance.

The ideal reporting routines (for decentralised health services – primarily child and maternal health) from a health centre to MoH

1. By primarily using the tally sheets, form HMIS 105 (”Monthly report of health facility”) is completed. The child registry and the UNEPI Control Book would be used for validation. In addition, some HCs would use an intermediate form: UNEPI monthly report (I think this is actually outdated) for compilation prior to filling in HMIS 105.

2. HCs II and III deliver their forms to the HSD (a health centre IV) by the 7th of the following month. The HSD compiles all information into a form HMIS 123a.

3. The HMIS 123 of the HSD is delivered to the DHT by the 14th of the following month.

4. The Records Officer/Assistant of the DHT enters the information in the district database.

5. The DHT fills in a form HMIS 123 which contains the aggregated information of the district and submits it to the Resource Centre at MoH by the 28th of the month following the reporting period.

Surveillance and monitoring, incentives and supervision

The ideal routines for supervision and monitoring

Staff of UNEPI and the Resource Centre of MoH monitor and supervise the districts. This is done by:

a) Providing individual feedback on the monthly reports (HMIS 123)
b) Participating in six monthly review meetings
c) Providing data management trainings
d) The District League Table to encourage good performance2

Supervision and monitoring of health facilities’ immunisation activities falls under the responsibility of the DHT. This is done by:

a) Announced routine visits to the HSD every three months
b) Unannounced visits to selected health centres once a week
c) Records assistant providing individual feedback on the monthly report (HMIS 105)
d) Providing data management trainings (funded and organised by the district)

Decentralisation is extending further from the district to the HSD. The HSD is responsible for managing and supervising the health facilities within the HSD. The extent to which the HSDs are functioning varies from district to district and even within a district.

[2] The District League Table was put in place to facilitate: (i) Comparison of sector performance between districts to enable ranking of district performance; (ii) Provision of information to facilitate the analysis of circumstances behind good and poor performance at the district level, and thus to enable appropriate corrective measures; (iii) Design of appropriate corrective measures; (iv) Increase Local Government ownership for achievements; (v) Encourage good practices – e.g. good management, innovations and timely reporting.

Recent assessments and validations
There are various instruments available for assessing the recording and reporting routines as well as the quality of data (as well as performance).

1. The Annual Health Sector Performance Report which states the outputs for the period against the planned targets for the year within the framework of HSSPII.

2. Data Quality Audits (DQAs) which is a GAVI tool. The DQA has been designed to assist the countries receiving GAVI support to improve the quality of their information systems for immunisation data. In addition, it calculates a measure of the accuracy of reporting, the country's 'verification factor' for reported DPT3 vaccinations given to children under one year of age (DPT3 <1). Two DQAs have been carried out in Uganda, in 2001 and 2002 (See the LATH Consortium 2002).

3. Data Quality Self-Assessments (DQS') which is a WHO tool. The tool was introduced in Uganda in 2006 and the plan is to employ it every six months3.

4. Data validation exercises which are initialised by the MoH and managed by the Resource Centre. The goal of this exercise is to ensure that health services and allocation of government funding for health service delivery are based on sound and accurate data. A comprehensive data validation exercise was carried out in 2007/08 (published in October 2008).

Immunisation coverage – DPT3 - in Uganda
Some of the sources do not state whether their figures cover the group below or above 12 months. All of them are inserted in the below table – i.e. also those above 12 months.

	baseline yr 1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Government estimates	60%[1]	58%[2]	61%	72%	81%	88%[3]	85%	80%	86%	79%
Surveys	56%[4]/54%[5]					76,3%[6]	64%[7]			
Unicef/WHO estimates[8]	54	56%	57%	59%	61%	62%	64%	64%	64%	64%
Reported to GAVI								80%[9]	85%[10]	
DQA		57,5%	61,3%							

[1] From Lim et al.
[2] Years 2000-2003 from WHO/Unicef Review of Coverage 1980-2008
[3] Years 2004-2008 from Statistical Abstract 2009, UBOS
[4] From Lim et al.
[5] Demographic and Health Survey (DHS) 2000-01
[6] EPI coverage survey 2005
[7] DHS 2006
[8] All figures from WHO/Unicef Review of Coverage 1980-2008
[9] From 2007 Annual report to GAVI
[10]. From 2007 Annual report to GAVI

The table shows that there was a peak with regard to coverage of DPT3 in 2004 and in 2007 and that there was a decline from 2007 to 2008 (however the Unicef/WHO figures show stable figures). The person interviewed at Unicef was not familiar with the way the estimate was calculated. It is, however, obvious that Unicef/WHO have faith in the survey (DHS) figure of 2005.

The table clearly shows that there is a development towards an increased discrepancy between Government estimates and Unicef/WHO estimates, as well as between survey data and Government estimates (but because surveys have not been carried out since 2006 there is no proof that this would be the case also from 2006 onwards). However, Lim et al. based their analysis on the results of the 2004 (EPI 2005) and 2005 (DHS 2006) surveys.

[3] We were not able to get hold of any DQS'.

Explanations

Results from previous assessments

Despite the lack of survey data there are reasons to believe that there is a gap between the various types of data, as indicated in the table above. There are also reasons to assume that the main problem lies with aspects of the administrative data.

Among previous major assessments of recording and reporting in the field of immunisation in Uganda, both the DQA of 2002 and the more recent Data Validation Exercise of 2008 identified a range of matters that needed to be improved.

The Data Validation Exercise found that:

- 49 per cent out of 720 health unit HMIS monthly reports assessed had data matching with the data captured in the health unit register/tally sheets.
- 50 per cent out of 240 district HMIS 123 reports assessed had data matching with the figures recorded in the district HMIS database.
- 51 per cent (41 districts) out of the then existing 80 districts submitted all the three validated monthly reports in time to the Resource Centre

The data validation exercise further established that the national level estimates for DPT 3 (92 per cent) indicated that there was over-reporting (whereas for some other indicators (deliveries in health units) there was under-reporting). Based on these findings, it was proposed that the DPT3 figures at national level be reduced by 8 (according to table on previous page it might have been reduced even further).

But nevertheless, could there also be challenges with regard to survey data as such?

Challenges with regard to survey data

Most of the people interviewed at the national and district levels doubted whether the discrepancy between survey and administrative data actually was as large as found by Lim. et al.(2008).

Another issue is the scarcity of surveys, which is also indicated in the table above[4.] We have found two surveys of relevance to the issue of immunisation coverage:

- Uganda EPI Plus Coverage Survey (the most recent one carried out in 2005/2006 covering 2004). The survey had a sample size of 232 children, which is very low. As seen from the table on the previous page, Unicef/WHO have not considered this survey when establishing their estimate for 2004.
- Uganda Demographic and Health Survey (DHS) carried out every five-six years, the most recent one in 2006 covering 2005.

The district level representative explained that they include district wise surveys in their annual plans every year but that they rarely manage to conduct them due to financial matters. UNEPI reported that some districts do organise their own surveys.

With regard to the surveys as such all our contacts at the national level, including the representatives from Unicef and WHO, referred to "methodology" matters. These were the methodology matters that were referred to:

A matter relating to the quality of survey data:

Inconsistency between districts with regard to the methodology used in the surveys (checking child health cards or mother's recall) was mentioned as an explanation for poor results in surveys. UBOS rejected this explanation – the interviewers

[4] Unicef Uganda could not explain why they had not carried out Multiple Indicator Surveys (MICS) in Uganda.

would always start by asking for the Health Card and use mother's recall if no such card was available.

Interlinked with this was another argument about DHS only using mother's recall. This is not the case. DHS uses the same method as mothers.

Matters relating to the differences between survey and administrative data:

a) Comparison of surveys data with a main focus on children 1-4 years of age with administrative data for children below 1 year if age.
b) Differences in period of calculation. MoH would calculate numbers and create estimates for the financial year while e.g. UBOS would use the calendar year. This would generate different figures. This is also relates to the denominator. See further discussion below.

The lack of survey data makes it particularly difficult to discuss the differences between such data and administrative data. There is, however, much more to be said about challenges the NHS in Uganda is facing with regard to administrative data – see next section.

Challenges with regard to administrative data and estimates

Explanations provided through interviews

When asked whether errors in administrative data on immunisation as such and DPT3 in specific could occur, our contacts provided the explanations listed in the table below. We have indicated by whom it was launched.

Explanations	By whom
Deliberate over-reporting at HC level	Resource Centre (MoH), WHO
Deliberate over-reporting at district level	Resource Centre (MoH), WHO
Ignorance among HC staff about importance of accurate and timely reporting	WHO, Unicef, MoH (x2), UBOS, DHO. This implies everyone except HC staff themselves.
Overburdened staff/shortage of skilled staff at HCs/competing obligations	WHO, MoH (x2), DHO. Once again not mentioned by HC staff.
Lack of trainings to sensitise staff of HCs and DHO level	All
Different periods for creating estimate (GoU use the fiscal year, other calendar year)	UNEPI (MoH)
Miscalculation of tally sheets	DHO, HCs, MoH
Under-reporting of wastage	HCs
Shortage of child health cards	All HCs, UNEPI, Resource Centre
The denominator (cross border movements, immunisation provided not in district of residence)	UBOS, one HC, Unicef
The decentralisation process (requires a lot of time and resources by those involved, makes it difficult to plan trainings, monitoring etc.)	WHO, DHO, Resource Centre
IT matters (soft- and hardware problems)	DHO, HCs, UNEPI
Late reporting from HCs	DHO, MoH (x2), Unicef
Incomplete reporting from HC	DHO, Unicef
Incomplete reporting from DHO	Resource Centre, Unicef

Explanations from other sources (audit, validations)
Below are some additional explanations derived from previous assessments:

Explanation	Source
Underestimation of denominator	DQA 2002, WHO/Unicef 2009
-Incompleteness of registers especially the maternity register	Validation exercise of 2008
-Records not kept in one central place	
-Poor handwritings in the registers	
-Poor filing practices	
- Lack of complete set of recorded tools (tally sheets) at the health facility level due to poor archiving practices	
- Incomplete recording in the HMIS reports	
- Failure to maintain databases at all levels	

Conclusions (own explanations/assumptions) drawn from the above
Based on the explanations listed above and direct observations in the facilities and offices we visited during the field study, we have concluded on the following explanations/assumptions:

HMIS tools are largely in place. Support for argument:
A1. While EPI reporting was not fully harmonised and integrated in the overall HMIS reporting at the beginning of this decade, there is now a single reporting system.
A2. Over the ten years of HMIS implementation, emphasis has been put on developing routines and standards (HMIS procedure manuals, reporting formats and related guidelines), training and improvements in management procedures, communication between the stakeholders and HMIS and strategies to increase the use of HMIS generated information that includes monitoring performance of the health services delivery.
A3. All HCs and the DHO that we visited were using the same tools.

After ten years of HMIS implementation, it is essential to focus on data quality and on usability .Support for argument:
B1. Tools are in place but the validation exercise showed great discrepancies between data in the HC registers and form HMIS 105 and between the districts' databases and form HMIS 123.
B2. In 2007/08 only 51per cent of 80 districts submitted the monthly reports in time to the Resource Centre.
B3. Trainings so far mostly focus on the technical part. Staff and the system would benefit if staff were made more aware of how the data may be useful in their daily work.

It is quite UNLIKELY that HC staff deliberately inflate figures/over-report immunisation data. Support for argument:

C1. Staff at this level have no or few incentives to over-report. They are not familiar with national ranking and incentive systems, and usually unaware of performance-based funding initiatives like GAVI5.
C2. There are checkpoints which would limit such over-reporting: (1) Several tools for validation of recording at each HC (child registry, tally sheet, materials control book) (2) Usually more than one employee involved in recording and reporting
C3. All recent validation exercises reject this being an issue.

Taken that staff at higher levels are more aware of the incentives and performance-based initiatives, there is a possibility that figures occasionally are inflated at these levels (But we cannot prove that this actually occurs). Support for argument:
D1. Staff at these levels would have more incentives to over-report since they are familiar with the ranking systems etc..
D2. Previous validation exercises have not rejected this (but have at the same time hardly touched upon it).

There are, however, ways to control and limit such potential deliberate over-reporting:

- Individual feedback from MoH to DHOs
- Data Quality Audits (DQA)
- Data Quality Self-Assessments (DQS)
- (Annual) District League Table

Nevertheless, it is obvious that errors might occur and that they most probably do to a rather high degree. The errors are mainly due to:

The critical human resources situation in the health sector;

- Posts remain vacant for long. This is especially the case for the position as records assistant (both at HCs and at the district level).
- The existing staff is overburdened. Recording and reporting is under prioritised since clinical matters after all must go first.
- Working conditions; low pay, lack of other benefits, lack of incentives to perform create an exodus from the sector (including a brain drain to neighbouring countries) and a high degree of absenteeism6.

Lack of data management skills, understanding of importance of high quality data and usability of data;

- Insufficient frequency and poor quality of trainings
- Current trainings focus too little on usability of data compared to the more technical matters
- Lack of funds for district level to initialise own trainings

Features of the political-administrative system

- A lot of responsibility is delegated to the HSD. The HSD may in some cases not be able to manage all its duties due to the high burden on the staff there.
- Uganda and Ugandans are victims of a continuous decentralisation process. The number of districts has increased from 56 in 2002 to 94 in 2009. 14 of these were created in 2009! This creates serious challenges with regard to establishing reporting and supervision routines.

[5] An interesting observation: None of our informants at the HCs were familiar with GAVI!

[6] At Buwambo HC in Wakiso district we were told that the immunisation in-charger was at a workshop. We moved on to the hotel where the workshop was being organised but the person was not present. We did not meet any Record Assistants despite two out of the four HCs informing us that this post was filled.

Failure and delays in supplies to the health facilities

- Many HCs depend on gas to run their freezers. There has been a serious delay of gas supply to many parts of the country which in turn leads to increased wastage and children not being immunised. This could consequently imply reporting of immunisation that has not taken place7.
- For some time there was a shortage of form HMIS 105
- Currently there is a severe shortage of child health cards
- Many DHOs/DHTs face a problem with IT infrastructure and/or software8.

Delays from the side of HCs

- As a consequence of the points above, quite a few HCs get delayed with their monthly reports. The DHT aims at submitting its report to the MoH on time. Incomplete reports are sent off and even though the HSDs submit their reports at a later stage there is a risk that the updated results will not be reflected in the national database.

In addition, there are given explanations with regard to the denominator:

Problems with the denominator
The denominator could cause problems but not the same as some years back. When UNEPI and HMIS were not fully harmonised they used to calculate the denominator differently (UNEPI used 4.7 per cent of the population and HMIS used 5.0 per cent to determine the group below 1 year of age). This created problems at the district level. This is no longer the case and the district would only have to relate to the population projection provided by UBOS and the flat rate (4,7per cent) to calculate the denominator. However this is probably an underestimation for some parts of the country which could lead to an overestimation of coverage.

Other issues that were raised: Cross border movements (from the Democratic Republic of Congo) and vaccinations provided in districts neighbouring the district of residence.

Recommendations

There is obviously a need for improvements at all levels. Below we have listed the most urgent efforts (based on own field work and the validation exercise of 2008):

Health Centre level

- Push for Record Assistant positions to be filled.
- Health Facility In-chargers to ensure that data at the health facility is kept in one central place to ease data accessibility and archiving.
- In-chargers to verify the information in the monthly HMIS reports before submitting it to higher levels.
- In-chargers and Records Assistants (or i.e. secretaries or other clinical staff) to carry out internal data validation and verification of data captured in the registers and information recorded in the monthly HMIS reports

District level (DHT/DHO)

- Ensure provision of child health cards (and other material when shortage) which are now out of stock at the HCs.
- Carry out quarterly data validation and verification exercises to assess the quality of the health data being reported by health facilities.

[7] This was partly created by the lack of GAVI-funds in 2007 creating problems in 2008.

[8] At Wakiso DHO the Records Assistant had a good computer but she was not equipped with the most suitable software nor was she online from her office. She would usually end up entering the data in HMIS 123 manually and going physically to the Resource Centre to hand it over in the end of each month.

- DHO together with the District Service Commissions to fill the Records Assistant positions that are vacant.
- Sensitise health workers on the value of health information through trainings and workshops
- HMIS focal persons at district level to validate the data received from Health Units before aggregating it to generate district summaries.

National (GoU/MoH)
- Develop a specific budget line for HMIS tools at all levels starting from health facility level.
- Increase the number of trainings on data management
- Resource Centre to provide immediate ICT support to districts in case of any system breakdown
- Resource Centre to strengthen supportive supervision to lower levels using Standardised tools and provide written feedback.
- Resource Centre to regularise data validation and verification exercises at all levels to help in improving the quality of data produced within the health sector
- MoH to ensure that the district fills the Record Assistant positions at HCs III and IV

Development partners
- Ensure that validation exercises are carried out prior to disbursing funds. Internal validation exercises of MoH should be carried out every year. However, the DQA is a much better tool through its focus and level of detail, and by the fact that it involves external consultants. DQAs should be undertaken much more regularly than today.

Final remarks
The main challenge with regard to surveys in the field of immunisation in Uganda is the lack of funding and thus the low frequency of surveys.

With regard to administrative data there is a range of challenges, some of which have been discussed in the report.

A main conclusion to be drawn from this exercise is that over- and other faulty reporting does occur. However, there is no evidence that this is due to intended actions at the local (HC) level. We have not found enough evidence in either direction to establish that it does or does not happen at higher levels.

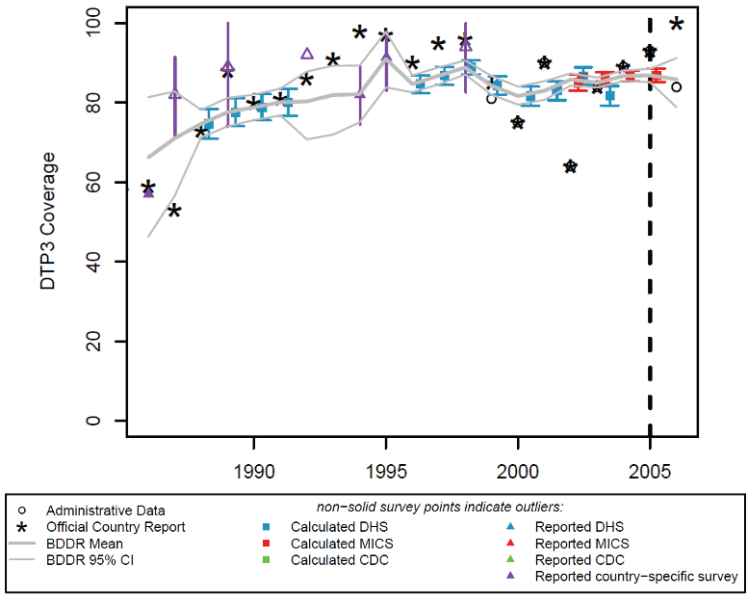
Despite the findings of Lim et al. and the rather poor results of the latest validation exercise (2008), Uganda is on the right track with regard to getting in place an integrated reporting system for immunisation as well as for other health data. The HMIS in Uganda seems to have all the necessary and the routines should be manageable. An effort needs to be done to consolidate it further.

During these two weeks it struck us that many of those involved have faith in administrative data. Only UBOS and Unicef seemed to have a strong belief in the results derived from the surveys. Further, staff realise the importance of good routines. Many also realise the importance of high quality data and are keen to learn more about data management. Due to these findings, we believe it should be possible to implement many of the recommendations listed above.

6.2. Malawi

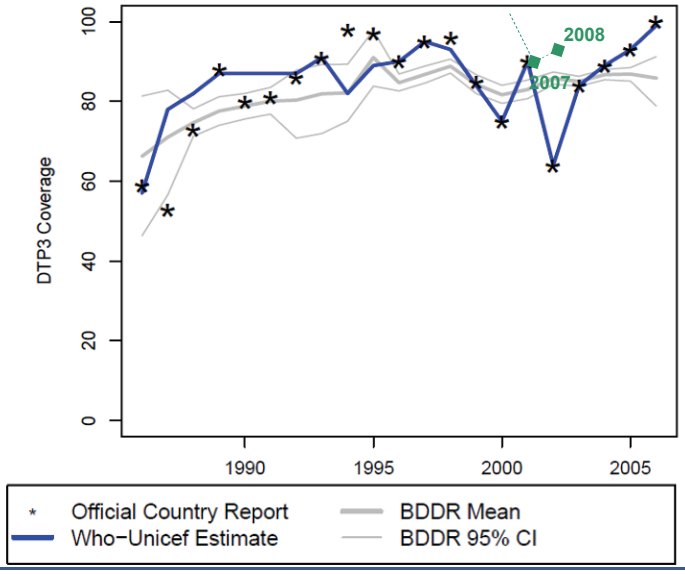
Background
Vaccination coverage in Malawi is generally high compared with many other African countries, measured by both surveys and administrative data. This is also reflected in the figures used by Lim et al. (2008), as shown in Figure 1 and 2:

Figure 4. Estimates of DPT3 coverage in Malawi



Source: Lim et al. (2008), Web appendix 5.

Figure 5. Comparison of survey-based coverage with officially reported, and WHO and Unicef estimates, Malawi



Source: Lim et al. (2008), Web appendix 6. Data for 2007 and 2008 (in green) is taken from www.who.int/immunization_monitoring

In Figure 7, the WHO estimates on Malawian immunisation coverage in 2007 (87 per cent) and 2008 (91 per cent) have been added. Although the gap between survey data and administrative data is not huge, some differences do exist. In particular, the administrative data have a larger variation from year to year than Lim et al's estimates based on survey data.

Differences between survey data and administrative data are also large at district level. In many cases, districts with a high coverage in survey data also have high coverage according to administrative data. For instance, according to the official data, both Ntcheu and Blantyre had a high DPT-3 coverage in 2005, and they were also among the best performers according to MICS figures for children who were one years old in 2006. On the other hand, Nkhotakota and Salima have low coverage in both. In other districts, the official and survey figures differ considerably. Sometimes the official figures are lower than survey figures (e.g. 12 per cent lower in Chiradzulu and 10 per cent lower in Nkatha Bay). In most

districts, however, the official figures are higher than the survey figures (e.g. 30 per cent higher in Machinga, 25 per cent higher in Phalombe and Mwanza).

Administrative and survey data on immunisation in Malawi

Survey data

The two main surveys on vaccination in Malawi lately are the Demographic and Health Survey (DHS) and the Multiple Indicator Cluster Survey (MICS). These are also the surveys used in the article by Lim et al.

The DHS has been conducted in Malawi in 1992, 2000 and 2004. The MICS was conducted in 2006. The two surveys have quite similar design when it comes to immunisation questioning. The mother or caretaker is asked, for each child, to show the immunisation card if there is one. The vaccinations are recorded with date of vaccinations, if available at the card. If there is no card, the mother is asked if the child has received a certain vaccine ('yes', 'no' or 'don't know'), and in the case of for instance DPT-3, how many times the vaccine has been received. The different vaccines are identified by explaining how and when they are given.

Administrative data

The vaccination of children in Malawi is done by local health facilities, either on static clinics or via outreach personnel (including Health Surveillance Assistants, HSAs, who cover every village in Malawi). Each month, these health units are supposed to fill in tally sheets with reports on their immunisations activities. From district level, the information is submitted to the regional EPI (Expanded Programme on Immunisation) officer, who sends the aggregated data to the EPI unit at the Ministry of Health and Population.

Every child in Malawi is expected to have a health passport, and the large majority do. The health passport is sometimes offered for free when the child is delivered at the health facility, and sometimes sold for 20-25 kwacha (around 1 NOK). In the health passport, all vaccinations are recorded at page 2, as shown at the first photos in figure 5 earlier in this report.

Main vaccination units in Malawi are health clinics and outreach service/HSAs. Children are also vaccinated at government hospitals, mission hospitals (organised under Christian Health Association of Malawi, CHAM), as well as private clinics and private hospitals. All health units that offer vaccines supplied by the government, are also obliged to report their immunisation activities.

Vaccination of children is supposed to be recorded in a registration book, as shown at the photo in figure 5 earlier in this report. The child's name, address, sex and date of birth are recorded, along with the immunisations received that day. Each new child is also given a registration number, which is restated when the child comes back for new vaccinations.

At the hospital visited in this study, the registration book was filled in just before and in the same room as the vaccinations were given.

Once a month, the health facilities are supposed to report their immunisations activities in a tally sheet. The number of each vaccination type given is counted from the registration book, and the facility also reports how many doses (vials) of each vaccination that have been used and how many have been discarded. The facility has a monthly target number, based on information from local chiefs' head count registers on the number of children below age 1 in the facility's area. This target is used to estimate the coverage of each immunisation. The tally sheet is sent to the District Health Officer (DHO), and a copy of the sheet is kept in a book at the health facility.

At district level, tally sheets are collected and district figures are worked out and sent, via a regional EPI officer, to the national level.

At the national level, the EPI unit at Ministry of Health and Population, the official figures on immunisation in Malawi are computed. To find the percentage of children immunised, the number of each vaccination type given is divided by an estimate of the number of children below one year. This estimate is found by taking 5 per cent of the estimated whole population, a figure provided by Malawi National Statistical Office (NSO). The same estimation is done to find the coverage in each district – the number of immunisations is divided by 5 per cent of the NSOs populations estimate for that district.

Quality controls
There are several quality control procedures at each level in the reporting line: Staff at local hospitals attend meetings with the DHO every quarter, where also problems with the reports are addressed. Also, if figures look wrong, the DHO may ask for a meeting to find the problem. Informants at a hospital visited told that they in particular get feedback if the figures look too low.
There are quarterly surveillance visits from DHO, and also 'surprise controls'. If the health facility does not send the monthly report, DHO may complain. Or as stated by one informant: 'They are forcing you to give reports on time. They only wait for 2-3 days every month, then they start calling you and forcing you.'

The system of regular meetings and enquiries when figures look strange is also applied further up in the system. The routines are regularly gone through twice a year, and once every 3-5 year a comprehensive EPI review is done with consultants from WHO and Unicef conducting a data quality assessment through the reporting line from local to national level.

The number of used vials/doses is also utilized to cross check the reported number of immunisations. At the tally sheet, each health facility has to state how many vials of each vaccination that are used, how many are discarded (they may for instance be too old or broken), and thus the wastage rate of each vaccine. The vials are sent from national level to the districts and distributed from there to the health facilities, which means that this cross-checking can be done at both local, district and national level.

Since the health facilities are supposed to fill in the registration book for each child they immunize, it is of course easy to cross check the numbers at the tally sheets with the figures from the book. Tally sheets, registers, and health passports should confirm each other and give the same picture.

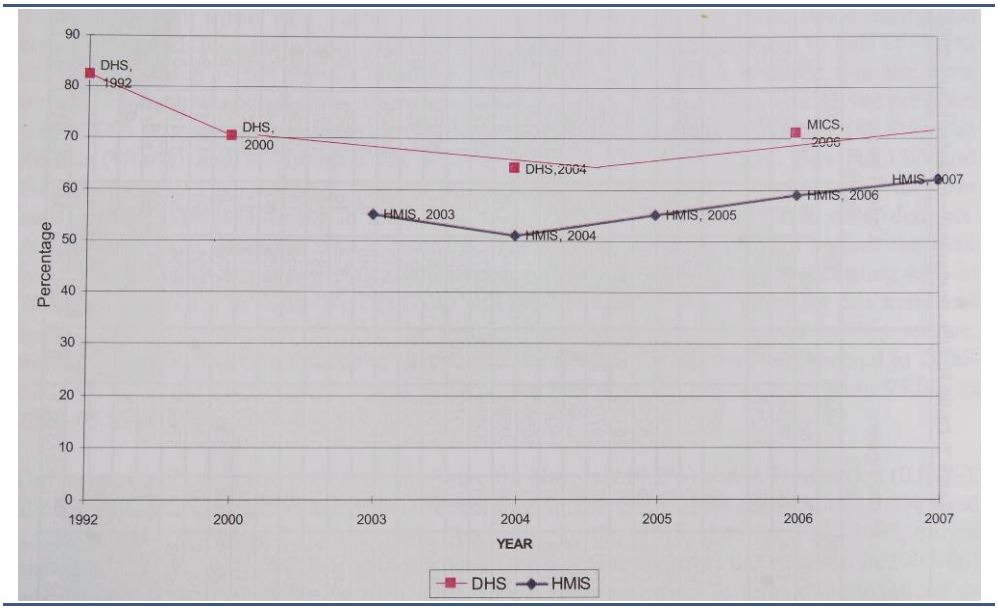
EPI/HMIS data
The national EPI figures are the ones used by international organisations like WHO, Unicef and Gavi. However, Malawi also has a Health Management Information System (HMIS), which collects data quarterly from the health facilities. The HMIS has been implemented since 2002, and also covers immunisation among children below age 1.

The HMIS and EPI figures have differed quite a lot, the HMIS consequently showing an immunisation coverage below the EPI figures. It is even lower than the survey figures, as shown in Figure 3.

According to the Ministry of Health, the gap between EPI and HMIS data may be due to the fact that the data sometimes follow different reporting lines, and that different target populations (denominators) have been used when calculating the coverage. However, the health authorities are trying to coordinate these data systems, for instance by using the same year (previously EPI used July-June while the HMIS used Jan-Dec), and by harmonizing the denominator used. Hence, around 2003, the EPI changed its way of calculating the denominator from 4 per cent of the whole population to 5 per cent. During the implementing of the HMIS,

immunisation data for several months were lost, which may explain the sudden drop in the EPI graph in 2002 (see Figure 2).

Figure 6. Comparative trends in per cent of fully immunised children in Malawi, 1992-2007



Source: Health Management Information Bulletin, MoH 2008

Although the EPI and HMIS figures still differ, it is possible to use the two systems to compare data – the figures from each district should show some of the same tendency.

Possible factors explaining the differences

There are probably several reasons for the differences between administrative and survey data in Malawi. Both systems may have weaknesses. Some of the possible weaknesses and reasons for differences are elaborated below.

- *Lack of vaccination cards* is mentioned by several informants as a source of uncertainty in the survey data. Mothers' memory is not regarded as certain as a health passport. The MICS 2006 found that 76.8 per cent of the children aged 12-23 months had a health card.
  Whether mothers' tend to overstate or understate vaccination of their children when there is no health card, is uncertain, and is discussed in more detail in the article by Lim et al.
  In the surveys, it is also possible to answer 'Don't know'. However, in Malawi this percentage is low, at below 0.3 per cent, which indicates that most mothers are able (or pretend) to remember what vaccinations their children have got.
- *Survey sample size* has also been mentioned as source of errors in survey data, as the surveys only cover a small proportion of the population. Vaccination coverage in surveys is normally presented in percentage among the children aged 12-23 months. In the MICS 2006 and the DHS 2004 this group consisted of 5080 and 2194 children, respectively – which corresponds to roughly 1 and 0.5 per cent of all Malawian children in this age group. It has also been remarked that the surveys are conducted only once every 3-5 year, while the administrative data relies on information reported every month, every year, from every part of the country. The surveys, with their own methodological limitations, thus cannot automatically be used as control data for the administrative data.
- *Incomplete implementation of the existing administrative system.* According to many informants, the immunisation reporting system in Malawi is well designed, but not always properly implemented in the daily work at health facilities. As one informant said: 'The system is in place, but sometimes people are not doing what they are supposed to'. Reports may be written, but not filed

in the right place. The facilities may experience lack of skilled personnel, lack of transport to deliver the tally sheets, lack of report forms or even lack of basic tools like pens. Malawi is a poor country, and with a human resource crisis in the health system the health workers do not always have time to sit down and report. They might give only estimates at the tally sheets. The result is great variations in data quality from facility to facility.
Most additions and calculations at local level are done manually, with risk of errors. Slips of the pen can make the forms and register books difficult to read. And not all health facilities may cross check their figures properly against the number of vials/doses used. Lack of time and resources sometimes also lead to reduced communication and feedback between the levels in the reporting line.
Although this study has found no indications of intentional inflating of figures in Malawian immunisation data reporting system (and according to informants, financial allocations to health facilities is not based on their number of immunisations), the GAVI performance-oriented support system may give an incentive on high level to control check figures that look too low rather than the high ones.

- *Inaccurate denominators.* While the survey data divides the number of children immunised with the number of children surveyed in that age group, the denominator used in the EPI system is calculated based on NSOs estimates for the population. This is an easy way of obtaining the denominator / target group. However, the figures for vaccination coverage will be vulnerable to changes in the way the denominator is calculated. The change from estimating 4 per cent to 5 per cent of the population lead to an artificial fall in the immunisation coverage, and so will any changes in the population estimates from NSO, for instance when new census data are available.
  Also, the demographic composition may vary between the districts – some having a higher percentage below one year than others. And as fertility and life expectancy changes, the percentage below one year will change. The census data for 2008 will, when it is released, show whether 5 per cent is still a reasonable estimate.
- *Different age groups.* Figures for immunisation sometimes show vaccinations of children regardless of whether these children got the vaccine before their first birthday, and some-times the figures are restricted to children who were immunised before one year of age.
  In the registration book at local health facilities, there is a column for 'Fully immunised >1 yr'. However, when summarizing the immunisations given, it is easy to miss the information on children's date of birth, thus adding all immunisations regardless of age (there is no separate registration book for immunisation of children older than one year). So there is reason to believe that the EPI data also include many children above one year.
  The DHS and the MICS operate with both definitions, showing two figures on vaccination coverage. In MICS there is 2 per cent difference between the two, in the DHS they differ by more than 5 percentage points.
  However, from Figure 2 it seems that Lim et al. use the figures on vaccinations regardless of age. Use of different definitions on age groups thus probably does not explain why EPI data are higher than survey data.
- *Double immunisation.* If a child's health passport is lost, and neither the health personnel nor the mother/caretaker are sure of which vaccines the child has got, it is common to give an immunisation just to be sure. Around 4 in 5 children in Malawi do have a health passport, so this is probably not very common, but it may cause some over-reporting in the EPI figures. The Ministry of Health is also aware of possible over-reporting from double vaccinations during immunisation campaigns.
- *Immunisation of children from Mozambique.* Since immunisations are free of charge in Malawi, it is relatively common along the Mozambique border that mothers cross the border to have their children vaccinated in Malawi. This will lead to higher figures from the health facilities than what is captured in a survey visiting only Malawian households. Hence, one would expect the gap between

EPI and survey data to be higher in the southern districts bordering Mozambique than in other districts. And in fact, the six districts with highest gap between survey (MICS 2006) and EPI data for 2005 (Machinga, Phalombe, Mwanza, Chikwawa, Mulanje and Dedza) all have borders with Mozambique. The size of this effect might be better estimated by looking at more disaggregated data, comparing Malawian figures with figures from the Mozambican side and taking into account changes in the health service in the two countries over time.

Means to improve data quality

There are many ways to improve the data quality on immunisations in Malawi. Some initiatives have already been implemented, others are on their way, and others may be ideas for future initiatives.

- *Health passport.* Some years ago, the simple sheet-of-paper vaccination cards in Malawi were replaced by children's health passports, where immunisation records are embedded. Now the government has decided to provide these health passports for free. Both initiatives can improve the number of children who have a complete record of their immunisations (unless the free passport devaluates and is used as a note book for parents, knowing they can always get a new one at next visit to clinic). Better health passport coverage will increase the accuracy of survey data, and it can also improve the administrative figure on vaccination coverage as double immunisations will be less likely.
- *Denominator.* Today's way of estimating the number of children under one year of age, is uncertain, and the coverage figures are vulnerable to changes in the estimates from NSO or the percentage used to calculate population under age one. Population estimates may be incorrect, particularly when a census has not been recently conducted. When the final results of Malawi's Population and Housing Census 2008 are released, a more correct picture can be achieved both on the percentage under age one, and the population in each district. However, after some years, even these estimates will be more uncertain.
- *Register.* Malawi is currently building up a decentralized register system, a village head count, which the chiefs are supposed to maintain. When this system is covering the whole country and well functioning, it can be used for estimating a more correct denominator for the immunisation figures.
  It can also be used to keep record of each child's immunisations. Malawi's health authorities hope to reach one HSA per thousand people. These HSAs would be able to update such an immunisation record in the register, which will be of great help when children need a new health passport and there is uncertainty on which vaccines the child has got. This will, in turn, improve the accuracy in survey data based on health passports.
  Vaccine doses. Today, the number of vaccine doses/vials used is already utilized for checking immunisation data. It may be possible to use this to an even larger extent on each level of the registration line. A good system for reporting makes it possible for each level to check the data they submit. The tally sheets could for instance include a part where vials used is converted into doses (the number of doses per vial differs among the different vaccines) to make any discrepancy between doses and vaccinations more visible.
  Uniform definitions. Many children who are vaccinated after their first birthday are probably included in the EPI figures due to the design of the registration book. The health authorities could improve the accuracy of their figures by either changing the registration book, or changing their definitions to include these children. By changing the definition, there might however be a problem defining the denominator.
- *Mozambican children.* The government of Malawi has initiated talks with authorities in Mozambique on this issue. Studies on a disaggregated level might reveal more of the size of the phenomenon. But as long as Mozambican children are vaccinated in Malawi, and this is recorded in the EPI system, there will be over-reporting. One way to avoid this, is to integrate 'country of residence' as something to be stated in the reporting system.

New surveys. Of course, the uncertainty of immunisation data in Malawi could be resolved by a large immunisation census where each household is visited. However, this is expensive. Anyway, a new DHS is on its way (planned to start in December 2009). This survey will give some useful information on whether the discrepancies are still large. Perhaps it will also provide a more accurate source of information than previous DHSs, due to better coverage of health passports. The DHS of course have a much smaller sample than a census, but it is also less costly.

- *Strengthening the system.* Since some of the uncertainty of the EPI figures can be attributed to lack of resources in the Malawian health system, a strengthening of the system will also benefit the data reporting quality. In general, the reporting system seems well designed, but it suffers from lack of skilled personnel, lack of time to fill in the forms, lack of reporting forms, transport and pens, and lack of feedback and contact between the levels and between different government/private/CHAM players.
  Even small investments like calculators to do the summarizing for the tally sheets or bicycles for the HSAs to deliver their reports could have an impact on the data quality.

Conclusion

Surveys and official data both show relatively high immunisation coverage for Malawi. However, there are discrepancies between the two. The official data show larger variation than the estimates from Lim et al, based on surveys.

Some of this is due to statistical-technical matters, like changes in the way the denominator of the official figures is calculated or loss of data. But these factors do not explain all. There are many other reasons why the official data have a high variation from year to year and why they differ from survey data:

The denominator is relatively roughly calculated, and may be subject to large inaccuracies.
Children from Mozambique immunised in Malawi inflate the figures from border districts. There is probably some over-reporting due to double immunisations. The reporting system routines are not always being implemented, and there are large variations in data quality from facility to facility as well as insufficient contact between the levels.

This study has not found indications of systematic over-reporting of immunisation data, and some districts even have lower official data than survey data. But in a busy working day, the reporting and cross checking of data is not always given priority. With limited capacity to control figures and follow up unexpected figures, a performance-oriented support system like in GAVI may give an incentive to rather check the figures that look too low than the figures that are high. It should be noted, however, that this study found no indications that this is a reason for the relative high official immunisation figures in Malawi.

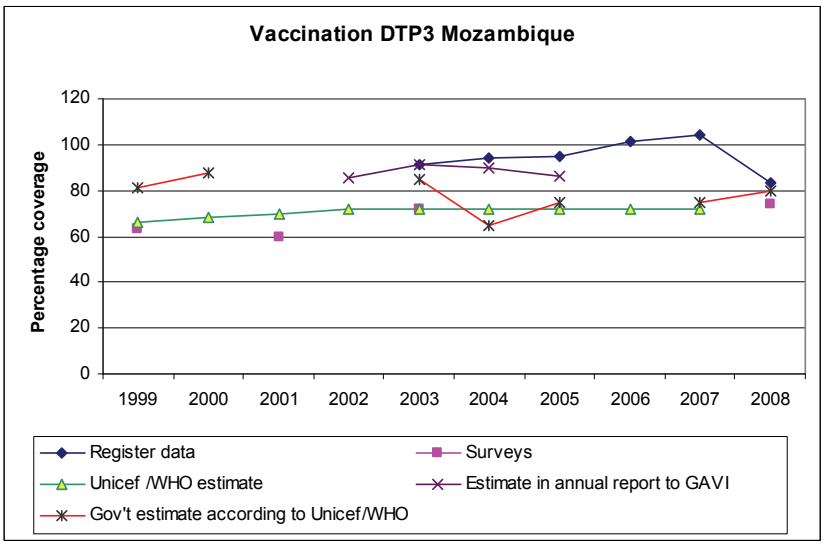
Some initiatives to improve the quality of official data have already been implemented, like new health passports. (This may also improve the quality of survey data, which today may not necessarily be used as a control data for administrative data. Already the DHS 2009/2010 may benefit from some of the improvements described above.) Census data from 2008 (expected any time now) can improve the accuracy of the denominator in the short run, and a national system of registers on village level will probably provide an even more correct target group. A better system for registering children from Mozambique will improve the official coverage figures. And increased use of vaccine doses for cross checking can make the health units better capable of improving their own data. Finally, a strengthening of Malawi's health system in general will of course have positive effects also on the resources for immunisation reporting.

6.3. Mozambique

Available statistics

The following graph and table show the percentage coverage of DTP-HepB 3 in Mozambique as reported by different sources during the fact finding mission in July 2009. The most striking issue is that register data coverage fell from 103,9 per cent in 2007 to 83,4 per cent in 2008. This corresponds with a change in how vaccinations are registered at health station level as well as how the numbers are reported to district, province and national level.

Figure 7. Development of DTP3 in Mozambique[1]



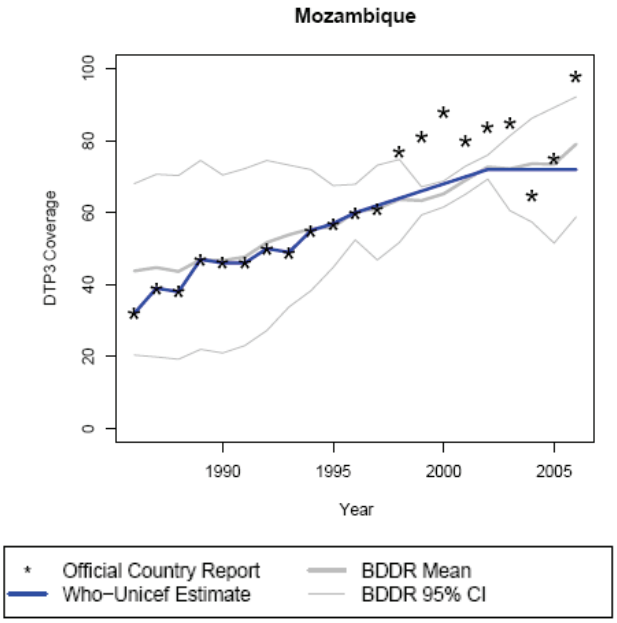
	1999 Base-line	2000	2001	2002	2003	2004	2005	2006	2007	2008
Official statistics	81%[1]				91,1%[2]	93,8%[3]	94,5%[4]	101,2%[5]	103,9%[6]	83,4%[7]
Surveys	63%[8]		60%[9]		72%[10]					74%
Unicef /WHO estimate[12]		68%[13]	70%	72%	72%	72%	72%	72%	72%	
Reported to GAVI				85,7%[14]	91,5%[15]	90,1%[16]	86,1%[17]			
Gov't estimate according to Unicef/WHO[18]	81%	88%			85%	65%	75%		75%	80%[19]

[1] From Lim et al
[2] From Mozambique's Statistical Yearbook (Anúario Estatístico), table from version to be published in 2009
[3] From Mozambique's Statistical Yearbook (Anúario Estatístico), table from version to be published in 2009
[4] From Mozambique's Statistical Yearbook (Anúario Estatístico), table from version to be published in 2009
[5] From Mozambique's Statistical Yearbook (Anúario Estatístico), table from version to be published in 2009
[6] From Mozambique's Statistical Yearbook (Anúario Estatístico), table from version to be published in 2009
[7] From Mozambique's Statistical Yearbook (Anúario Estatístico), table from version to be published in 2009
[8] From Lim et al
[9] From QUIBB 2001 according to the 2004 report to GAVI
[10] From DHS 2003 Final report
[11] MICS 2008
[12] All numbers from Unicef/WHO Immunization Summary 2009 edition CD.
[13] From Unicef/WHO Immunization Summary 2009 edition
[14] From 2003 report to GAVI
[15] From 2003 report to GAVI
[16] From 2004 report to GAVI
[17] From 2005 report to GAVI
[18] All numbers from Unicef/WHO Immunization Summary 2009 edition CD.
[19] From Unicef/WHO spreadsheet with 2008 data, received at Unicef

It is important to take into account that the countries themselves estimate what they believe is the "true" coverage rate in addition to register data. In the case of Mozambique this number is much closer to the survey number than the rather mechanical "vaccinations divided by target group"- number used in the official

statistics. The graph below shows the data for Mozambique as presented in Lim et al.

Figure 8. Development of DTP3 in Mozambique[2]



Register data

Register data for 2008 by provinces

		DPT/Hep.B 3ª DOSE		
Province (Província)	Population (População)	Target group (Gr. Alvo) 3.9%	Vaccinations (Realizado)	Coverage (Cobertura)
NIASSA	1 084 670	42 302	33 833	80,0 %
CABO DELGADO	1 717 427	66 979	68 554	102,4 %
NAMPULA	3 958 890	154 396	128 003	82,9 %
ZAMBEZIA	3 967 135	154 718	118 480	76,6 %
TETE	1 635 769	63 794	54 476	85,4 %
MANICA	1 441 658	56 224	62 858	111,8 %
SOFALA	1 755 829	68 477	59 277	86,6 %
INHAMBANE	1 476 759	57 593	47 016	81,6 %
GAZA	1 391 935	54 285	46 726	86,1 %
MAPUTO PROVINCIA	1 125 174	43 881	25 443	58,0 %
MAPUTO CIDADE	1 298 807	50 653	33 395	65,9 %
Total	20 854 053	813 302	678 061	83,4 %

The above table comes from the Ministry of Health and reflects coverage in 2008 which is the first year of implementing a new system of registration nationwide. Mozambique uses a flat 3,9 per cent of the population to work out the target group[9] in each province. This is lower than for the other countries in this report. They have not taken into account that the population structure might be different between provinces.

In district data for 2008 the variation is more extreme, with coverage varying from 58 per cent to above 200 per cent.

[9] We do not have the definition for this target group. The Unicef/WHO district data (which also comes from the Ministry of Health) uses live births and when those numbers are aggregated the total is 2,5% higher than these estimates. Data for surviving infants from the same source is 10% lower.

Compilation of register data
Register data on vaccination in Mozambique has previously been collected using tally-sheets. The principle of these was that the health worker would tick off for every child s/he immunises. At the end of the month, all the ticks are summed up in a report to the district level. There was no recording of name of the child or its mother (the children have often not been given names when they get the first injection), nor the age of the child.

The practice of filling in tally sheets varies. There are probably many who fill them in correctly, but there are many others as well. One way that was mentioned which creates over-reporting was to collect all the vaccination cards and count them, which means there will be a registration whether the child needs the vaccine or not. Another is to fill in from memory at the end of the month.

In the article "Assessing immunisation data quality from routine reports in Mozambique", Mavimbe et al. (2005), suggest the following:

"A common perception is that to improve accuracy and timeliness of data, redesigning the forms and data collection procedures constitutes the main solution. Using this approach, implementing a register book at the facility level to ensure record keeping, could be a suggestion."

In 2008 this was implemented. A new system was introduced, consisting of a book at health station level where the health worker should record:

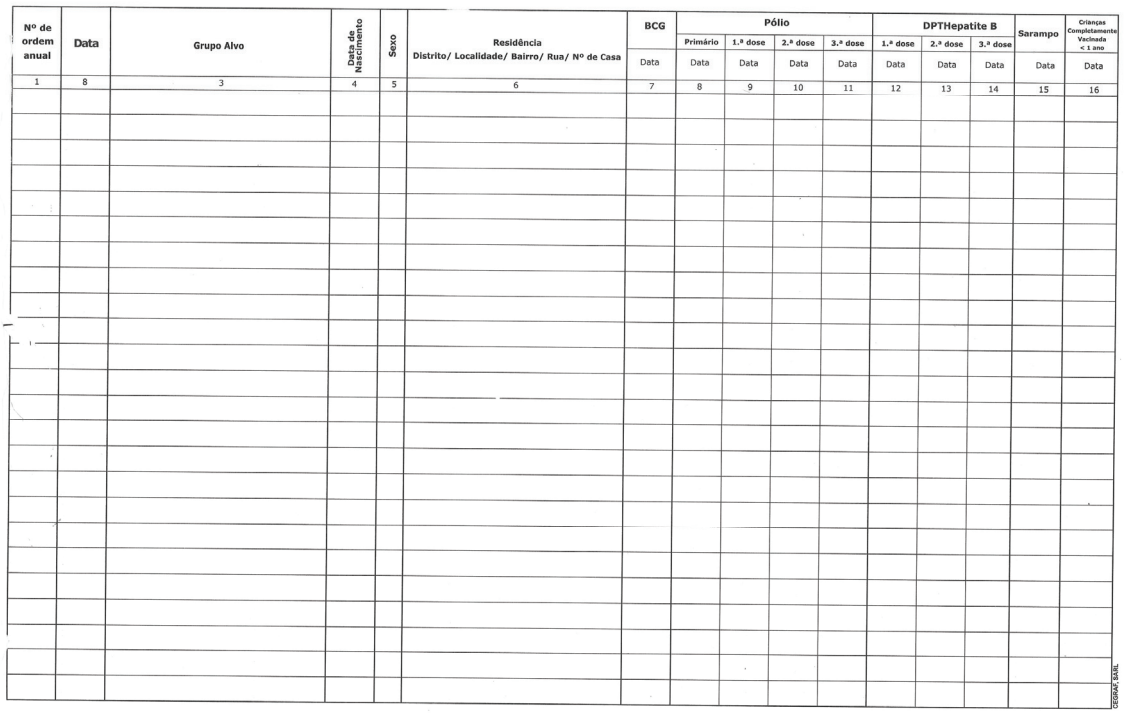
- Date
- Name of child or parent
- Date of birth
- Gender
- Address
- Which vaccine the child received at what date
- Date of completion of the vaccination programme

The vaccines recorded are

- BCG
- Polio primario
- Polio 1
- Polio 2
- Polio 3
- DPT-HepB 1
- DPT-HepB 2
- DPT-HepB 3
- Sarampo (Measles)

The person responsible for vaccinations at the health station fill in another form at the end of each month, counting the vaccinations registered in the book. This form separates children under 1 year from those between 1 and 2 years and reports for both the health stations and the mobile vaccination units. Gender is also recorded. This form is then physically sent to the district level.

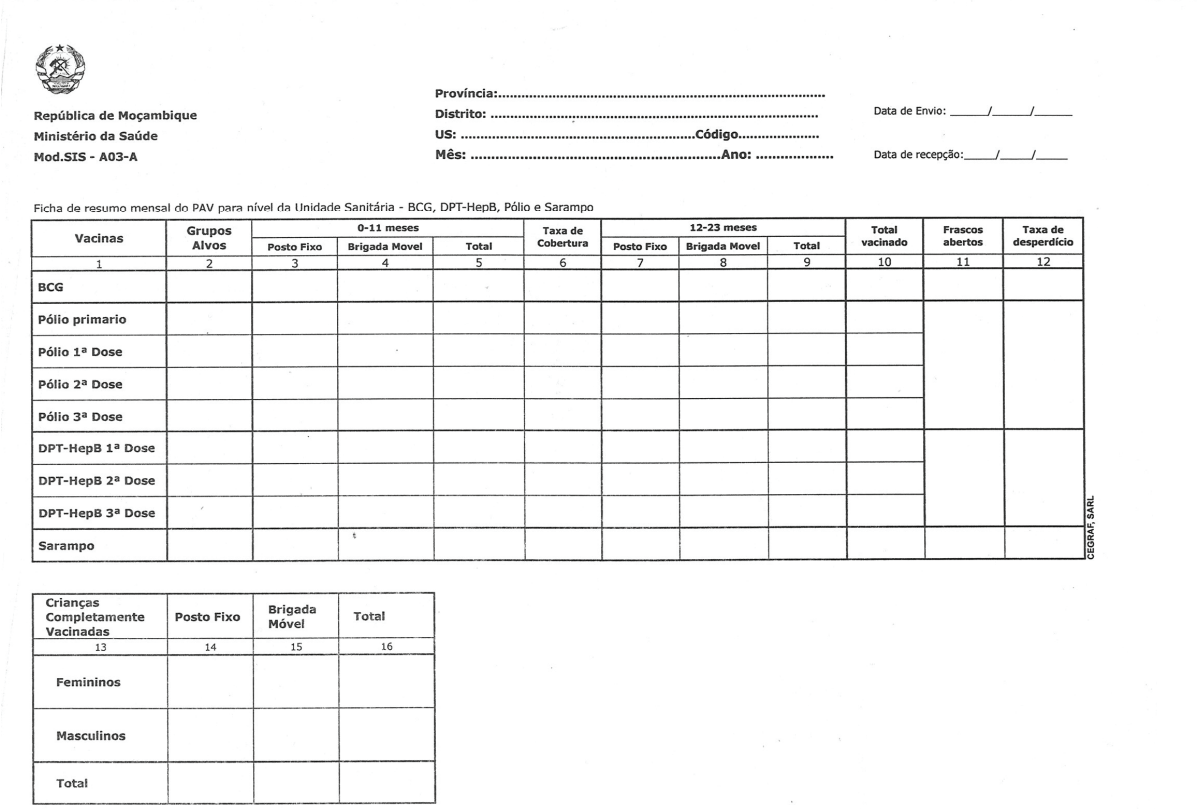
Figure 9. Form for registration of vaccinations at health station level



Nº de ordem anual	Data	Grupo Alvo	Data de Nascimento	Sexo	Residência Distrito/ Localidade/ Bairro/ Rua/ Nº de Casa	BCG	Pólio				DPTHepatite B			Sarampo	Crianças Completamente Vacinada < 1 ano
							Primário	1.ª dose	2.ª dose	3.ª dose	1.ª dose	2.ª dose	3.ª dose		
1	8	3	4	5	6	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data
						7	8	9	10	11	12	13	14	15	16

CEGRAF, SARL

Figure 10. Monthly form for health stations' reports to district level



República de Moçambique
Ministério da Saúde
Mod.SIS - A03-A

Província:.....
Distrito: .....
US: .....Código.....
Mês: .....Ano: .....

Data de Envio: _____/_____/_____

Data de recepção:____/____/____

Ficha de resumo mensal do PAV para nível da Unidade Sanitária - BCG, DPT-HepB, Pólio e Sarampo

Vacinas	Grupos Alvos	0-11 meses			Taxa de Cobertura	12-23 meses			Total vacinado	Frascos abertos	Taxa de desperdício
		Posto Fixo	Brigada Movel	Total		Posto Fixo	Brigada Movel	Total			
1	2	3	4	5	6	7	8	9	10	11	12
BCG											
Pólio primario											
Pólio 1ª Dose											
Pólio 2ª Dose											
Pólio 3ª Dose											
DPT-HepB 1ª Dose											
DPT-HepB 2ª Dose											
DPT-HepB 3ª Dose											
Sarampo											

Crianças Completamente Vacinadas	Posto Fixo	Brigada Móvel	Total
13	14	15	16
Femininos			
Masculinos			
Total			

CEGRAF, SARL

At district level all the reports from health stations go into a new form, still keeping the division between 0-11 months and 12-23 months and whether vaccination took place at the health station or by a mobile unit. The district level shall record this

digitally and send the file to provincial level. This happens physically as the district offices do not have internet.

At provincial level the process repeats itself with district data being aggregated to province level and the monthly data is sent to Ministry of Health by e-mail.

This forms the basis for vaccination register data.

Quality control
Quality control is supposed to take place by province level employees visiting district offices and district level visiting health stations for guidance and control. One purpose is to give feedback to the health workers on the reports to increase the understanding of the use of data and interest in providing good quality reports. Some of these visits are taking place, but the monitoring system is not considered up and going yet.

What was reported to be done in terms of quality control now is only that reports that are obviously incorrect are sent back to the lower level to be corrected.

Training is taking place, but had so far reached a low number of health stations.

Issues of register data
The introduction of this new system corresponds with a dramatic fall in registered vaccinations in Mozambique. Both Ministry of Health and WHO say the new system is the reason. There is however still large problems with the system. The system was scaled up to the whole country after an apparently successful test period. The needed training did not come with it, so wrong use and no use of the forms is still widespread. Many health stations still use the tally sheets only. Some training is taking place now. It is too early to judge whether this will be a success, given that it has not been implemented properly.

It seems that the new system has reduced the problem of over-reporting significantly. Only actual control of what is happening in the field will tell if it means the quality has improved or if there are other reasons why the new system reduced the overall numbers.

Officially over-aged children who are vaccinated are not recorded in the numbers that goes into the vaccination rate, but they are recorded separately to monitor how many children in total who receive the vaccines. In practice many are recorded with the rest (where recording takes place). The way the old tally-sheet system is described does not seem to create any good separation based on age. The new system separates the 0-11 months from the 12 to 23 months. Some children are probably still placed wrongly in the youngest group due to parent/medical worker not knowing the exact age, but the other over-age children (children even older than 23 months) can at least be recorded in the 12 to 23 months group and not in the first group. Vaccination is sometimes extended to up to 4 year old children.

All health stations do deliver reports. Some deliver late, which is a problem for monitoring implementation, but officially they all apparently do. Ministry of Health did not comment on who estimates the data when a record is lost or nobody has kept records. It seems that the estimated numbers when the real records are not there must be made at health station level.

A good indicator of over-reporting is that more than one third of the districts were reported to have negative wastage rate. If the districts were deliberately reporting wrongly, then they would probably avoid such obvious mistakes. Instead it was considered by those interviewed to reflect a lack of accuracy or understanding of the numbers reported.

From the people interviewed the impression is that the main reasons for inaccurate register data is lack of capacity, lack of training and lack of understanding of the importance of accurate data. Mainly at ground level, but also further up in the system. No-one mentioned deliberate cooking of data to receive more funding, but there are other mechanisms which seems to lead to over-reporting which are related, for instance covering up for wastage or trying to look good to protect jobs. Mavimbe et al. (2005) identified more examples of pressure to reach targets in their 2005 report "Assessing immunisation data quality from routine reports in Mozambique".

The Ministry of Health themselves were the only ones pointing out that connecting money with number of vaccinations could lead to deliberate over-reporting to receive funds. The Ministry therefore emphasised that they appreciated a move signalled by GAVI towards using other mechanisms (National plan, needs and 5-year plans) for funding in a recent meeting.

Lack of capacity is based on the work-load experienced by the health workers on the ground. Keeping records comes on top of the practical work and many have too much to do just attending to people/patients. This leads to random and thereby less accurate data recording.

Lack of training means many health workers do not know how to fill in forms properly. It also means they do not know why this information is important which may lead to giving it less priority. The lack of real control mechanisms and feedback also means that mistakes will rarely be discovered. It was further pointed out that there is lack of communication between the different levels in the structure.

Plain problems of computing data and copying correctly from one form to another seem to be an issue. Commenting on the introduction of computers at district level one MoH employee said that "The problem is not the method, it is the attitude. Data is collected faster with the new tools, but the mistakes are not changing."

Survey data

Survey data is collected mainly by recording information from the vaccination cards. In the 2003 DHS 75 per cent of rural and 86 per cent of urban children age 12-23 months have vaccination cards. In MICS 2008 the numbers are 88 and 82 per cent respectively. If the child does not have the card, a number of questions are asked to the parent about the child being vaccinated for different diseases and how many times the child has been vaccinated. From those answers the child's vaccinations are estimated, but the national statistics office (INE) says that this is less accurate due to parents having problems to remember accurately. The number of children being registered vaccinated with DTP 3 based on reports from parents only is however very small.

Note that the DHS and MICS measure vaccination rate for children between 12 an 23 months. The register data is supposed to use the rates for children age 0-11 months. The coverage data for MICS should be higher than for the register data since MICS picks up more of those who get their vaccination later than 12 months.

Comments

Mozambique has a large Health Information System with apparently many problems to it. An issue for the people working with vaccination data was to disconnect vaccination data from this system, being the only way to increase efficiency and quality. It is an interesting dilemma: On the one hand you don't want to create many parallel systems within health data collection. On the other hand, creating a well functioning system for vaccines can maybe be used as a stepping stone towards a more comprehensive quality system of health data management.

The special attention given to vaccination data following GAVI funding may be pushing up the numbers of reported vaccinations without increased funding being the motive. Specific attention to and better systems for delivering reports would probably make more health stations make an effort in reporting than previously.

The fact that register data and survey data has come significantly closer to each other after the new system of registration was introduced does not prove that the register data is correct. The extreme variation between districts and the comments given by those with first hand knowledge from the field indicates that there are still many problems. However, it was agreed that this is a big step in the right direction. It is encouraging that the introduction of the new system has had a large effect.

It is important that the reporting to GAVI is given individual attention for each country. Some countries may have old census data or population estimates that are known to be highly uncertain/contested. Poor population estimates is negative for both register data and surveys. A survey may well find the right vaccination rate in an area, but using it to predict the amount of children who have received a vaccination requires that the survey is based on accurate estimation of the target group. The quality of register data varies between countries in the same way, but those who are improving should not be punished because the majority of countries do not have good systems.

In the case of Mozambique, the impression is that the newly released census data from 2007 is reasonably good. But the overall population data is not very different from the estimates they have used lately. So as much as there is truth to the fact that the target group data for districts are of varying quality, the differences in numbers when aggregated on national level can not be explained by poor census data.

Provincial differences and the importance of updated census data

Comparison of different sources of data

Register data from Ministry of Health for 2008 by provinces					**MICS 2008**	**With updated census data for 2007**						
		DPT/Hep.B 3ª DOSE				DPT/Hep.B 3ª DOSE						
Province	Population	Target group: 3,9% of popula-tion	Vaccina-tions	Rate	Rate	Population	0 years old	Vaccina-tions	Rate	Target group as % of tot. popula-tion	Diff estimated popula-tion and census 2007	Per-centage point diff btw MoH register and survey rate.
NIASSA	1 084 670	42 302	33 833	80 %	75 %	1 169 348	47 150	33 833	72 %	4,0 %	7,8 %	5,1 %
CABO DELGADO	1 717 427	66 979	68 554	102 %	88 %	1 605 649	53 368	68 554	128 %	3,3 %	-6,5 %	14,2 %
NAMPULA	3 958 890	154 396	128 003	83 %	64 %	4 076 642	158 989	128 003	81 %	3,9 %	3,0 %	19,4 %
ZAMBEZIA	3 967 135	154 718	118 480	77 %	62 %	3 848 276	146 777	118 480	81 %	3,8 %	-3,0 %	14,9 %
TETE	1 635 769	63 794	54 476	85 %	56 %	1 832 339	71 461	54 476	76 %	3,9 %	12,0 %	29,9 %
MANICA	1 441 658	56 224	62 858	112 %	75 %	1 412 029	58 184	62 858	108 %	4,1 %	-2,1 %	36,4 %
SOFALA	1 755 829	68 477	59 277	87 %	81 %	1 642 636	59 568	59 277	100 %	3,6 %	-6,4 %	5,4 %
INHAMBANE	1 476 759	57 593	47 016	82 %	91 %	1 252 479	41 850	47 016	112 %	3,3 %	-15,2 %	-8,9 %
GAZA	1 391 935	54 285	46 726	86 %	89 %	1 226 272	42 835	46 726	109 %	3,5 %	-11,9 %	-3,3 %
MAPUTO PROVINCIA	1 125 174	43 881	25 443	58 %	87 %	1 205 553	36 621	25 443	69 %	3,0 %	7,1 %	-29,4 %
MAPUTO CIDADE	1 298 807	50 653	33 395	66 %	90 %	1 094 315	27 774	33 395	120 %	2,5 %	-15,7 %	-23,6 %
Total	20 854 053	813 302	678 061	83 %	74 %	20 365 538	744 577	678 061	91 %	3,7 %	-2,3 %	9,3 %

NB! Census was undertaken in 2007 while the registry data and MICS is from 2008. MICS used the old census data, as Census 2007 was only published in 2009. Detailed census results were not ready from Nampula and Tete provinces when this was written. The population numbers for those provinces are therefore preliminary and the share of 0-year-olds is estimated using the share used by MoH of 3.9 % of the population.

Explanations to the table
The first columns presents the 2008 data for vaccinations as received from Ministry of Health in July 2009. This is more or less the same as WHO/Unicef uses in their joint report for 2008. It contains the population in each province as estimated based on the 1996 census, a target group set to be 3,9 per cent of the population and the registered number of vaccinations in each province with the rate.

The following column presents the percentage coverage according to the last survey, which is the 2008 MICS.

The next section uses the Census data from 2007 as published on the INE web page. An exception is that there are only preliminary results available for the provinces Nampula and Tete and no age distribution. The numbers are therefore the preliminary result and the target group is estimated using the Ministry of Health method of 3,9 per cent of the population. For those provinces where data is available, the rate of children under 1 year to the total population is calculated. The number of children vaccinated is the absolute number officially reported from Ministry of Health.

The final section compares the numbers: Firstly the percentage difference between the estimated population and the population according to Census 2007. Note that there is one year's difference between the two sources of population data. The last column shows the percentage difference between the survey (MICS) rate and the official register data rate.

Implications
The table above illustrates two important issues: One is the importance of updated census data and the second is the differences between provinces.

The new system of collecting vaccination data in Mozambique has resulted in the official register data based coverage rate moving significantly closer to the survey rate found in MICS 2008. However, when disaggregated to provincial level, there are huge differences.

One problem is that while the total population is only 1,6 per cent lower than the estimated population, there are larger differences between the provinces. The population in Inhambane is for instance 15 per cent lower than the estimate, and as the target group is based on the estimate, it will be estimated to be too high as well. The result is that the coverage rate in Inhambane based on these numbers will be too low. Looking at the extremes, the situation in Maputo Cidade and Inhambane looks worse than it is, while Tete and Niassa looks better than they should. For the whole country, the coverage rate increases from 83 per cent to 91 per cent using the actual number of 0-11 months old children in the new Census data.

Secondly, Ministry of Health is using the same rate of children (0-11 months) to the total population in all provinces to work out the target group. According to the census data, there are large differences. Maputo Cidade is again coming out negatively with this practice. While MoH has estimated the target group to be more than fifty thousand children, the census says it is 27,774. The result is that the coverage rate changes from 66 per cent to 120 per cent.

These distortions of the coverage rates makes it difficult to identify where the problems are as well as where the successes can be found.

6.4. Zambia

Objectives

Zambia was included as a case for two reasons:
a) According to Lim et al. the number of additional children immunised here following the ISS investments was overestimated by more than four times (Lim et al.: Table 2) b) Institutions could be contacted in advance.

Objectives:
1 - Look into official statistics and national surveys, and find out how data on vaccination is collected, if there has been a vaccination card, how the data is published, what are the results.

2 – Look into relevant aspects of the country's health management information system:
Distribution of vaccines to local health facilities, reports back on use of vaccines, information on vaccination coverage. Of particular interest is the data flow back to the Ministry of Health: Cleaning and evaluation of data, aggregation and treatment of data at the various administrative levels, and presentation of results.

National survey data

An important source for information on immunisation of children are the Demographic and Health Surveys in Zambia (ZDHS). Restricting our focus to the last two decades, there have been carried out four surveys in 1992, 1996, 2001/2002 and the latest one in 2007, hence the surveys have been carried out quite regularly, about every five yeas. The surveys are extensive projects implemented by the Central Statistical Office (CSO) in partnership with the Ministry of Health (MoH). Technical support and funding is provided by Macro International Inc. through the Measure DHS programme. Several other national and international institutions contribute to the funding.

Methodology
ZDHS are sample surveys. The sample is selected through a multi-stage design. At the first stage(s) a set of standard enumeration areas are selected by pps-sampling, whereas at the last stage a final sample of about 8000 (96,07 check others) households are selected at random. All women aged 15-49 in the selected households are eligible for interview. Previously only a subsample of men were selected, however in 2007 ZDHS all men 15-59 years of age were eligible. Allocation among provinces is non-proportional to ensure sufficient number of interviews in the least populated provinces.

Instrument
A standard international DHS questionnaire is applied, where basic modules are retained across years. This means the survey instrument is well tested and a robust and reliable tool. Immunisation is registered for all children under 5 years of age. Data on vaccinations are copied from the child's vaccination card whenever a card is presented. If the child has no card or the card for some reason is not presented, detailed questioning and probing is applied. Vaccination cards are presented for a great majority of children: 82 per cent in 1996, 78 per cent in 2007 among children 12-23 months. Card data are assumed to be reliable. For the remaining 20 per cent one will expect more errors, be it whether immunisation has been done or the timing. Random errors will not affect the rates, but contribute to increased variance. Non-random errors will lead to bias. It is a risk that the quite extensive probing may lead to some over-reporting, as intentions may be memorized as actions.

Another source of error is censoring: It is a sad fact that a number of mothers die from their children. Children with no female caretaker will not be included in the survey.

Trends
The ZDHS figures show that the vaccination rates increased during the first part of the period, whereupon they dropped to a significantly lower level in the next decade. The trends point downward, most pronounced for the full vaccination, where the estimate is only slightly higher than 15 years ago.

Table 1. Percentage of children age 12-23 months who received DPT3 /all basic vaccinations at any time before the survey Zambia Demographic and Health Surveys

	1992		1996		2001/02		2007	
	%	C.I	%	C.I	%	C.I	%	C.I
DPT3	76.8	73.7 – 79.9	85.7	83.1 – 88.2	80.0	*76.9 – 83.1*	79.7	76.5 - 82.9
All	66.6	63.3 – 69.9	78.3	75.6 – 81.0	70.0	*66.9 – 73.1*	67.6	64.1 -71.1
Number of children		1123		1347		1299		1272

Administrative data – Zambia Health Management Information System (HMIS)

HMIS is the current information system for the health sector in Zambia. The country embarked on the design, development and implementation of the system in 1996. The system was introduced to hospitals and other units throughout the years 1998 to 2001. A brief presentation of the system is given in a paper by Mr Chipalo Kaliki, Acting Director Monitoring and Evaluation in Ministry of Health. Mr. Kaliki was contacted prior to the mission and asked to present a writeup on the distribution of vaccines to the local health institutions and the flow of data on use of vaccines, reporting, data quality checking, presentation and feedback. It gives a detailed presentation of the flow of vaccination data, the aggregation, cleaning and evaluation of data, the dissemination of results and feedback to ach level of health care delivery.

The mission was furthermore kindly provided with softcopies of the various sheets and aggregation forms applied for data collection and reporting. The two tools with relevance for child immunisation are

‘Child health activity sheet_20 Feb 2009_ A3 landscape final.xls’
‘Service Delivery Aggregation Form(HIA2) March 2009 final.doc’

(8 pages)
The Excel sheet comprises 80 lines and scaled down to A3 format the cells will be very tiny. It will demand concentration and precision from the health worker to fill in. The potential for errors is surely present.

HMIS comprises four levels:

Health centres and facilities
District Health Offices
Province Health Offices
Ministry of Health headquarters

Data on service provision is collected at health facility level. For vaccinations, tally sheets and aggregation forms are applied. Each level is supposed to perform a self assessment and analysis of own performance. Data are reported in an aggregated form. The higher level shall validate the data and provide feedback to the lower level.

Quality checks
An example of quality checks is assessment of the vaccination coverage rate. When coverage rates of more than 100 per cent occur, the lower level is consulted for explanations. No official population figures exist at the facility level. Here local information on ‘catchment area’ population is applied as denominator. At district and higher levels, projected population figures from census are applied as target

population. One explanation is refugees from neighbour countries. Refugees have been and still are numerous in border provinces Northwestern (Angola) and Luapula (DR Congo). Refugees are entitled to health services, but are not captured in the population figures.

A basic principle in the HMIS is focus on decentralisation of decision-making and accountability. Analysis and self-assessment should be carried out at the level where data is collected and data be used for decision-making at that level, hence there is an incentive to provide high quality data else it will "strike back" on the provider.

This is a sound principle, but it is not clear to what extent the intended 'educational' effect is obtained.

Challenges
The information system is quite ambitious and for the system to work smoothly and efficiently skilled and trained personnel is required at all levels. From the Ministry's point of view, the weakest point in the chain is the number of unskilled personnel at the health facility level.
Key challenges are pointed out as follows:

Lack of trained staff in data management. Health workers' primary task is provision of health services. Their focus is not on data compiling and analysis. Shortage of time and resources in general, and insufficient skills in data interpretation and analysis is the common picture.

Weak involvement of program managers in data management. The system produces enormous quantities of data, but the required time, software and outlook to extract essential and relevant information is scarce.

Weak timely reporting and feedback. Even if information is of high quality, if it is outdated, it is of low value for planning.

Vaccination figures from HMIS
The following table shows the full immunisation coverage of children under 1 year of age by province for the period 2002-2008, taken from Annual Health Statistics Bulletin 2004, 2006 and 2008.

	2002	2003	2004	2005	2006	2007	2008
Zambia	76	74	80	82	87	85	90
Central	86	81	96	93	99	103	109
Copperbelt	84	82	81	78	76	86	89
Eastern	65	53	70	77	85	77	85
Luapula	52	49	54	70	73	68	84
Lusaka	98	85	93	101	98	106	110
Northern	78	68	81	74	86	78	86
NorthWestern	55	73	68	66	87	65	72
Southern	84	94	90	93	99	87	78
Western	70	61	71	76	78	78	85

The 2008 bulletin was at the time for the mission still under preparation, hence the 2008 figures was not yet officially released.

Some observations:
1) The overall full vaccination coverage for Zambia has, with small fluctuations, increased during the period. This trend is not consistent with the ZDHS figures, according to which the coverage rate not increased, on the contrary a small drop, though not significant, has been estimated. The overall rate from HMIS is also higher in 2002 as compared to ZDHS 2001/02, as the HMIS value is outside the confidence interval.

2) Some coverage rates exceed 100 per cent. This may at first glance seem illogical, however, a number of factors could explain such figures:

- refugees are entitled to health services, as mentioned before
- domestic migration, people move to other areas to search for jobs or to make living
- non-residents go to urbanized areas to have their children vaccinated
- outdated or imperfect population figures
- System-related problems, cf challenges mentioned above

Most likely there is a combination of factors. The mission considers outdated population figures to be a severe problem. The 'denominator problem' is well known and described from other countries, not least in Africa.

The need for population data

Zambia carried out its last Population census in 2000. The total population was 9.9 million, having grown from 7.8 million in 1990 and 5.7 million in 1980. The fertility rate has decreased somewhat over the period, but is still very high. In 2000 the total fertility rate (TFR) was 6.0 per woman. ZDHS 2007 indicates a TFR of 6.2. Now Zambia is also suffering from a high HIV prevalence rate, severely affecting the population structure. Nevertheless the population growth continues.

According to Population Reference Bureau (www.prb.org) the Zambian population mid-2007 was 11.5 million.
From Census 2000 17.1 per cent of the population belonged to the age group 0-4 years.
If we assume these group to be evenly distributed, each year-class counted about 340 000 children. With an equal population structure, that number would be 393 000 in 2007. This is probably a conservative percentage, most like likely the relative size of the group has increased, say to 18 per cent. Consequently a survey coverage rate to be inflated with this number to find the number of children vaccinated will give a number that is to low. If you use the number as the denominator when calculating an administrative vaccination rate, you will get a rate that is too high.

If we interpolate from ZDHS, full vaccination rate in 2000 can be estimated to 72 per cent.
To illustrate the impact of the population size, assume that vaccination coverage estimates from ZDHS are valid and consider estimated number of fully vaccinated children.

Year	Year class	Vaccination rate	Fully vaccinated
2000	340 000	72	245 000
2007 low	393 000	67.6	266 000
2007 high	414 000	67.6	280 000

If the denominator in 2007 is taken from Census 2000, the calculated vaccination coverage rates would be 78 and 82 for the 'low' and 'high' scenario respectively. This is not dramatically different from the official HMIS rate of 85 per cent in 2007.
This exercise is primarily for illustration, but it demonstrates the importance of updated population figures or high quality, generally approved projections.

Population and housing censuses are very demanding, both in human resources and funding, and to have them more frequent than the present 10-year cycle is unrealistic.
A feasible option, however, is to launch a program of annual 'light' household surveys in-between censuses and expensive traditional household surveys. Light surveys are favourable for monitoring purposes, poverty monitoring being particularly emphasised. A spin-off would be frequent input for population models.

6.5. Summary of case studies

Uganda: Inconsistencies was observed between different sources of data, including government estimates, surveys, Unicef/WHO estimates and reports to GAVI. A general lack of survey estimates due to problems with financing makes comparisons with administrative data and surveys difficult. It is assumed that difficulties related to the collection of administrative data are the main source of the discrepancies. The inquiries suggested that reporting routines are largely in place, that a significant potential for improvements exist, and that actors at different levels are motivated to improve the accuracy of the reports. Difficulties to achieve adequate administrative reports have different sources, including vacancies, the work-load and working conditions of the staff, the skills of the staff, and insufficient supplies and storage of supplies. Administrative reforms like decentralisation in the health sector also cause difficulties in the performance of administrative routines.

Problems with the denominator were observed in Uganda, with underestimation of population data and consequently overestimation of coverage. Cross border movements also undermined the accuracy of demographic data.

The report from Uganda concluded that it is highly unlikely that staff at the local level inflate figures, because the have no incentive to do so, or are unaware of performance based funding. A recent validation from Uganda did not report deliberate over-reporting at the local level. The investigations from Uganda could not confirm or reject that deliberate over-reporting is an issue at higher level in the collection of data. However, mechanisms exist to control or limit deliberate over-reporting.

Malawi: Mothers able to report vaccines received, even when vaccination cards are missing. Surveys are often not comparable with administrative data, regarding age groups and timing.
An infrastructure of recording vaccination exists, but the potential is not always met due to lack of skilled personnel and the availability of required resources in general. No evidence of intentional inflating was observed in Malawi.

Denominators based on old inaccurate census data were regarded as a probable (but not the only) source of relatively high immunisation measures of coverage. Cross border vaccination visits from Mozambique have resulted in vaccinations given to children not included in the denominator.

Mozambique: A significant regional variation in coverage was observed for Mozambique, implying a major uncertainty in the aggregate measures. Investigations also found that representatives within the health care organisation relied on other measures of vaccination coverage than the estimates used in the analysis of Lim et al. (2008). These estimates tended to be closer to the rates observed in surveys. Impressions from Mozambique suggested a number of explanations for the uncertainties involved in establishing reliable measures of vaccination, including lack of training (not knowing how to fill in forms properly, lack of control mechanisms and feedback), and lack of capacity and understanding of the importance of accuracy of vaccination records. Other sources of error included vaccinations given to children up to 4 years of age, but 1 year olds used as denominator.

Other sources of error included that vaccinations given to children up to 4 years of age could be included in the data, while 1 year olds were used as denominator. In 2008 a new system for collection of register data was introduced, resulting in a dramatic fall in reported vaccinations.

Zambia: There are two main sources of vaccination coverage in Zambia: Demographic and Health Surveys (ZDHS) carried out by the Central Statistical Office, and the Health Management Information System (HMIS). The figures are not consistent, as regards coverage levels as well as coverage trends. According to ZHDS the vaccination coverage rate for 1-year olds has dropped after the turn of the century to about 70 per cent. The ZHDS instrument is well tested and robust and the results are considered reliable.

Annual HMIS-figures show immunisation rates increasing during the last decade reaching 90 per cent full vaccination coverage in 2008. A number of factors may, however, affect the HMIS data quality:

1) HMIS facility tools are very detailed and suboptimal in use and require attention and meticulousness from the health workers who keep the records
2) Weak Human Resources situation: There is a shortfall of staff at all levels from medical doctors to nurses ranging from 45 to 60 per cent of the recommended establishment, hence the workload for the staff is severe
3) Lack of trained staff in data management
4) Data is reported, evaluated and aggregated at district, province and finally at national level. There is no suspicion of fraudulent reporting; however, an expected bias would be towards over-reporting.
5) Last, but not least there is the 'denominator problem'. According to the MoH population projections are applied for target population estimates. However, as the last census was carried out in 2000, projections are now likely to be inaccurate. Several provinces with immunisation coverage rates well above 100 per cent in the 2008 Health Statistical Bulletin illustrate this problem. Refugees from neighbouring countries and domestic migration may to some extent cause such odd figures, but this is only part of the explanation.

Taking into consideration the serious problems with poor population data, the overall impression is that the administrative data are subject to considerable uncertainty. According to ZDHS 2007 the total fertility rate in Zambia is stable and high, meaning the population growth is still extensive, despite the HIV/AIDS pandemic. Hence the gap between survey data and administrative data could be partly spurious.

Literature

Anand, S., and Bärnighausen, T. (2007) Health workers and vaccination coverage in developing countries: an econometric analysis. *Lancet* 369:1277-1285

Benson, T. D. (2002). *Malawi: an Atlas of Social Statistics.* International Food Policy Research Institute: Wshington, DC

Burton, A., Monasch, R., Lautenbach, B., Gacic-Dobo, M., Neill, M., Karimov, R. Wolfson, L., Jones, G. and Birmingham, M. (2009). *WHO and UNICEF estimates of national infant immunization coverage: methods and processes.* http://www.who.int/bulletin/volumes/87/7/08-053819/en/ (accessed 11.08.2009)

Central Statistical Office (Zambia) and Ministry of Health and Macro International Inc (1993): *Zambia Demographic and Health Survey 1992*

Central Statistical Office (Zambia) and Ministry of Health and Macro International Inc (1997): *Zambia Demographic and Health Survey 1996*

Central Statistical Office (Zambia) and Ministry of Health and Macro International Inc (2003): *Zambia Demographic and Health Survey 2001/2002*

Central Statistical Office (CSO), Ministry of Health (MOH), Tropical Diseases Research

Centre (TDRC), University of Zambia, and Macro International Inc. (2009). *Zambia*
Demographic and Health Survey 2007

Central Statistical Office (CSO) (200x): *Zambia Population and Housing Census 2000*

Chee, G., His, N., Carlson, K., Chankova, S. and Taylor, P. (2007). *Evaluation of the First Five Years of GAVI Immunization Services Support Funding.* Prepared for the GAVI Alliance.

DHS Analytical Reports (1997). *An Analysis of Sample Designs and Sampling Errors of the Demographic and Health Surveys.*

GAVI annual progress reports for Mozambique 2003 to 2007

GAVI Data Task Team Report (2009). *Recommendations from the data task team to the GAVI Alliance (final version Feb 25th)*

GAVI DQA (2003) *Report on the 2003 Data Quality Audit (DQA) of the year 2002, Pakistan*.

GAVI Country Information (2009). http://www.gavialliance.org/performance/country_results/index.php (accessed 19.08.2009)

GAVI Madagascar Information (2009). http://www.gavialliance.org/resources/Madagscar_GAVI_Alliance_country_fact_sheet_June_2008_ENG.pdf (accessed 19.08.2009)

GAVI Progress Report – India (2005). *Progress Report to the Global Alliance for Vaccines and Immunization (GAVI) and The Vaccine Fund by the Government of India. Reporting period: 2004*.

GAVI/Government of Uganda (2008): Annual Progress Report 2007

GAVI (2008): Minutes from GAVI Alliance and Fund Board Meeting 25-26 June 2008

Government of Uganda (2008): Annual Health Sector Performance Report – Financial year 2007/08

Honaker, J., Joseph, A., King, G., Scheve, K. and Singh, N. (1999). *Amelia. A program for missing data*. Harvard University, Cambridge, MA.

INE and Ministério da Saúde Moçambique (2005): Mocambique Inquérito Demográfico e de Saúde 2003 (The final DHS report for 2003)

The LATH Consortium (2002): Immunisation Data Quality Audit Uganda, 2002

Lim, S. S., Stein, D. B., Charrow, A. and Murray, C. J. L. (2008). Tracking progress towards universal childhood immunisation and the impact of global initiatives: a systematic analysis of three-dose diphtheria, tetanus, and pertussis immunisation coverage. *Lancet*, 372: 2031-2046.

Mavimbe, J. C., Braa, J. and Bjune, G. (2005). Assessing immunization data quality from routine reports in Mozambique. *BMC Public Health* 5:108.

Ministry of Health, Republic of Zambia: *Annual Health Statistics Bulletin 2004*

Ministry of Health, Republic of Zambia: *Annual Health Statistics Bulletin 2006*

Ministry of Health, Republic of Zambia: *Annual Health Statistics Bulletin 2008 (Draft)*

Ministry of Health (2008): Report of the Data Validation Exercise in Uganda

Ministry of Health and Population, Malawi: Health Information System: National Policy and Strategy (MoH, 2003)

Ministry of Health and Unicef (2006): Uganda EPI Plus Coverage Survey 2005: National Summary Report

Ministry of Health and Population, Malawi (MoH 2008): Health Management Information Bulletin

Murray, C. J. L., Shengelia, B., Grupta, N., Moussavi, S., Tandon, A. and Thieren, M. (2003). Validity of reported vaccination coverage in 45 countries. *Lancet* 362:1022-1027

National Statistical Office, Malawi and ORC Macro, USA: Malawi Demographic and Health Survey 2004

National Statistical Office, Malawi and United Nations Children's Fund: Malawi Multiple Indicator Cluster Survey 2006

Republic of Zambia: *National Health Strategic Plan 2001-2005*

Population Reference Bureau (2009): *Zambia Statistics, Demographic and Health Highlights* (http://www.prb.org/Countries/zambia.aspx?p=1)

Rutstein, S. O. and Rojas, G. (2006). *Guide to DHS Statistics*. Demographic Health Surveys, ORC Macro, Calverton, Maryland.

Suarez, L., Simpson, D. M. and Smith, D. R. (1997). Errors and Correlates in Parental Recall of Child Immunizations: Effects on Vaccination Coverage Estimates. *Pediatrics.* 99(5)

Uganda Bureau of Statistics (2006): Report of Uganda Demographic and Health Survey 2005

United Nations Statistics Division (2003) Handbook of Statistical Organization, Third Edition: The Operation and Organization of a Statistical Agency; http://unstats.un.org/unsd/publication/SeriesF/SeriesF_88E.pdf

United Nations Children's Fund (1995). *Monitoring Progress Towards The Goals of the World Summit for Children. A Practical Handbook for Multiple-Indication Surveys.* New York.

WHO Reported Coverage (2009). http://www.who.int/immunization_monitoring/en/globalsummary/timeseries/tscoveragedtp3.htm (accessed 12.08.2009)

WHO/UNICEF Estimates Methods (2009). www.who.int/entity/immunization_monitoring/routine/WHO_UNICEF_best_estimates.pdf (accessed 20.08.2009)

WHO/Unicef (2009): Review of National Immunisation Coverage 1980-2008 – Uganda

World Health Organization: List of official immunization coverage in the world's countries (http://www.who.int/immunization_monitoring/en/globalsummary/countryprofileresult.cfm)

World Population Prospects: the 2002 revision (2003). Department of Economic and Social Affairs, Population Division. New York: United Nations

World Population Prospects: the 2006 revision (2007). New York: United Nations.

The base of our informants

Our informants on the situation in Uganda is based in:
Ministry of Health
UBOS
Department for Health, Wakiso District Head Office
Health facilities
Health Centre
Home Care (for HIV/Aids treatment and prevention)
WHO country office
Unicef country office

Our informants on the Malawian situation is based in:
Ministry of Health
WHO Malawi
Centre for Social Research, Zomba
University of Oslo in particular Section of International Health
National Statistical Office, Zomba
Health facilities
Norwegian Church Aid Malawi.

Our informants on the situation in Mozambique is based in:
Instituto Nacional de Estatística (INE)
Ministry of Health
Unicef
WHO

Our informants on the situation in Zambia is based in:
Ministry of Health, Zambia

Figures and table

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