An Assessment of the Quality of National Child Immunization Coverage Estimates in Population-based Surveys

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An Assessment of the Quality of

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Population-based Surveys

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Abstract

Background

This study aims to assess of the quality of child immunization coverage estimates obtained in 101 national population-based surveys in mostly developing countries.

Methods

The Demographic and Health Surveys (DHS) and UNICEF's Multiple Indicator Cluster Sample (MICS) surveys provide national immunization coverage estimates for children aged 12-23 months once every three to five years in many developing countries. The data are collected by interview from a nationally representative sample of households. 83 DHS and 18 MICS surveys were included.

Findings

85% of mothers reported that they had ever received a health card for their child. 81% still had the card at the time of the interview, and nearly two-thirds of these presented the card to the interviewer. Cards were therefore observed for 55% of children overall. Rural and less educated mothers were less likely to report receiving health cards. Recall of additional immunizations by mothers that presented a card ranged from 1 to 3%. Recall of immunizations by mothers who reported never receiving a card ranged from 9 to 32%. Coverage among those who did not show a card rarely exceeded coverage among those who did, and there was good correlation between DPT and OPV doses received according to health card and recall data.

Conclusion

Though maternal recall data are known to be less accurate than health card data, we found no major systematic weaknesses in recall and believe that inclusion of recall data yields more accurate coverage estimates.

Keywords

Immunization coverage survey, child immunization, health cards, national coverage estimates, developing countries

Estimation of child immunization coverage is essential for monitoring of immunization programs, for identification of underserved populations and is a general measure of the utilization of health services. Immunization coverage is also one of the best general measures of the utilization of child health services. Common sources of data used to derive coverage estimates in developing countries are routine health service statistics and population-based surveys. In surveys, coverage estimates are obtained from information copied from observed child health cards and from maternal recall of specific immunizations. Child health cards are not subject to recall bias, but are not always accurate (Ramakrishnan 1999). Health cards may not be shown to the survey interviewer, or immunizations may not have been recorded on the card. In these cases, maternal recall may provide additional information. Maternal recall, however, can either over- or underestimate the true level of coverage (Bolton 1998, Hawe 1991, Ramakrishnan 1999, Suarez 1997).

Some suggest that maternal recall should not be used to determine coverage estimates, since it introduces recall bias (Bolton 1998, McKinney 1991, Valadez 1992). Others maintain that inclusion of recall data in survey-based estimates yields a more accurate coverage estimate (Boerma 1990, Goldman 1994, Suarez 1997, Langsten and Hill, 1998). Immunization campaigns present an additional challenge, as health cards are rarely used to record such vaccinations. This paper presents an assessment of the quality of immunization coverage estimates obtained in 101 national population-based surveys which collected both health card and recall data.

Data and Methods

The Demographic and Health Survey programme (DHS), predominantly sponsored by the United States Agency for International Development, and the United Nations Children's Fund Multiple Indicator Cluster Sample (MICS) surveys are national population-based surveys that provide national immunization coverage estimates once every 3-5 years in many developing countries. DHS surveys collect data on a wide range of topics related to population and health programs; the child health questions occur in the middle of the interview. MICS surveys focus mainly on maternal and child health, and interviews are of shorter duration. Both surveys select nationally representative samples, using a two-stage design. In the first stage, sampling clusters (usually census enumeration areas) are selected proportional to size. In the second stage, a sample of households is selected from a complete household listing in the cluster. All women aged 15 to 49 in each household are interviewed. The child health questions are addressed to those with living children under five years old. In this paper, the focus is on immunization coverage estimates for children aged 12 to 23 months at the time of the interview. Most developing countries recommend completion of the immunization schedule before age 12 months.

Mothers are asked if they ever received health cards for each of their living children under five years (under three years in some surveys). If a mother reports that she received a card, she is asked to present it to the interviewer. If the card is presented, the interviewer copies the child's immunization history, including dates, from the card. The mother is then asked whether her child received additional immunizations that are not recorded on the card. If that is the case, or if the card is not presented, the interviewer asks the mother to recall specific vaccinations, including measles, BCG, diphtheria-pertussis-tetanus (DPT), and oral polio vaccine (OPV). If DPT or OPV are reported, she is asked to recall how many doses were given. If a card is not shown, DHS survey interviewers ask whether the mother ever received a health card or whether the card was lost. MICS survey interviewers simply record whether or not a card was shown.

Immunization coverage tends to be higher in children with health cards than in those without cards (Bolton 1998, Goldman 1994, Suarez 1997). If having and showing a health card is evidence of good immunization practices, then four criteria can be used to evaluate the internal consistency of maternal recall data. First, we examined recall of additional immunizations by mothers who presented a card. This figure is expected to be low. Second, recall of immunizations by mothers who reported never receiving a card is also expected to be low. Third, we examined coverage ratios between those who reported receiving a card but did not present it and those who presented a card. Coverage among those who reported receiving a card but did not present it is not expected to exceed coverage in those who presented a card. Hence, the ratio of these two proportions is expected to be less than or (at most) equal to one. Fourth, we examined correspondence between recall and card data for DPT and OPV. Since multiple doses of both DPT and OPV are recommended, and since both are usually administered at the same time, a highly positive correlation between DPT coverage and OPV coverage is expected for each dose. The correlation based on health card data is expected to be similar to the correlation based on maternal recall data. However, if polio vaccination campaigns have been conducted and vaccinations are not recorded on cards, recall but not card DPT/OPV coverage ratios are expected to be different.

Only surveys conducted during the period 1990-2000 were considered, since DHS surveys prior to 1990 did not ask mothers to recall specific immunizations, including 83 DHS and 18 MICS surveys. Five geographic groupings were used: sub-Saharan Africa, Latin America and the Caribbean, North Africa and the Middle East, Central Asia Republics and Eastern Europe, and the rest of Asia (Table 1). The smallest survey was in Kazakhstan in 1999 (N=269 children 12-23 months) and the largest was in India in 1993 (N=11,845). Excluding the exceptionally large surveys in India, on average a survey included 1,173 children 12-23 months, with 90% of the surveys having between 369 and 2,888 children.

In all cases, the overall mean statistics reported are unweighted averages of the means reported by each country, as the primary purpose is to assess the quality of survey-specific coverage estimates rather than global estimates.

Results

Card observation rates

Table 2 presents the country mean of the proportion of mothers reporting that they had ever received a health card, the card presentation rate (of those who reported ever receiving a card, the proportion who presented it to the interviewer), and the card observation rate (of all those in the survey, the proportion who presented a card to the interviewer) by place of residence and level of education. Overall, 85% of children ever had a card and the rates for rural children were lower in sub-Saharan Africa and South/Southeast Asia. In all regions, it was less likely that rural and less educated mothers ever received a card for their child.

Overall, just under two-thirds of the cards were presented. Card presentation rates were highest in sub-Saharan Africa and lowest in Middle East and North Africa and especially South/Southeast Asian countries. There were no major differences in card presentation rates according to place of residence or level of education. Of those who reported receiving a card, the mean proportion that said they had lost the card was just under 4%. Card loss exceeded 10% in a few surveys in Asia, including three in Bangladesh and one in India. Reported card loss was extremely high in the Yemen 1991 and Nepal 1999 surveys (both 55%).

Cards were observed for an average of 55% of children 12-23 months in the 101 national surveys. Card observation rates were similar in the surveys in sub-Saharan Africa, Latin America and the Caribbean, and Central Asia and Eastern Europe but lower in North Africa and the Middle East and in South/Southeast Asia. Card observation rates were higher in urban residents compared to rural residents in sub-Saharan Africa, Asia, North Africa and the Middle East and South/Southeast Asia. In all regions, card observation rates increased with increasing levels of education.

Contribution of maternal recall to coverage estimates

There is a positive correlation between card observation and estimated measles coverage in sub-Saharan Africa (β=0.838, r^2=0.675). There was a weak correlation between card observation and measles coverage in the combined countries in Asia, Eastern Europe, North Africa, and the Middle East (β=0.365, r^2=0.346) and no correlation in Latin America and the Caribbean (β=0.251, r^2=0.039).

Table 3 presents the proportional contribution of maternal recall to the total coverage estimate for each immunization by region. The contribution of recall to overall estimates was consistently lowest in sub-Saharan Africa and highest in South/Southeast Asia and North Africa, and the Middle East, where about half of the vaccinations were derived from recall. The contribution of recall was lower for the third doses of OPV and DPT (OPV3 and DPT3) than for the other immunizations.

Quality of maternal recall data

Information on recall of additional immunizations by mothers who presented a card or who lost a card is available for the 83 DHS surveys (Table 4). The mean percent of mothers presenting cards who recalled additional immunizations not recorded on the card was less than 5% in almost all surveys. A slightly greater proportion of mothers recalled OPV3 when compared with DPT3.

Table 4 also shows the percent who recalled a specific immunization among women who reported never receiving cards. Only countries with at least 25 children in this category were included. The mean percent recall for all immunizations was much higher in countries in South/Southeast Asia than in the other regions. Recall of the first doses of OPV and DPT was greater than recall of the third doses for both immunizations. Recall of OPV was greater than recall of DPT for the first and third doses of each.

OPV1 was the most commonly recalled immunization among those who reported never receiving a card. In 23 countries that conducted a survey in the early nineties and one in the late nineties, recall of OPV1 by mothers who reported never receiving a card increased during the years 1990-2000 in almost every country studied in sub-Saharan Africa (Figure 1).

Table 5 presents the mean coverage ratios (defined as coverage among those who reported receiving a card but did not present it compared with those who presented a card) by region for measles, DPT1, and DPT3. For all three immunizations, the mean coverage ratio in sub-Saharan Africa was much lower than elsewhere in the world. There were only 12 surveys with ratios greater than 1 for one or more immunizations. The coverage ratios were consistently higher in DPT1 when compared with DPT3.

Table 6 shows the correlation between OPV and DPT immunization by dose and source of information. The correlation based on health card data is strong. For example, 97% of children who received OPV3 also received DPT3, according to health card data. The correlation based on maternal recall is weaker, but still impressive. Overall, 77% of the mothers who recalled that OPV3 was given also recalled that DPT3 was given. The correlation between OPV and DPT doses is consistently lowest in sub-Saharan Africa.

Discussion

Surveys in which a large proportion of health cards are seen and maternal recall data are internally consistent yield good immunization coverage estimates. Data from well over 100,000 children 12-23 months in 101 national surveys during the nineties show that 85% of children ever had a card, 81% still had one at the time of the interview and nearly two-thirds of those presented the card to the interviewer. As a result, cards were observed for, on average, 55% of the children. Card observation rates were about 60% in sub-Saharan Africa and Latin America and the Caribbean, but considerably lower in Asia, Eastern Europe, North Africa, and the Middle East. This may be because in some countries in this region health cards are kept at health service facilities. For example, in Kazakhstan in 1995, the card observation rate based on household interviews was 8%. In the1999 survey, child health cards were located at local clinics following the household survey, improving the observation rate to 91%.

Goldman et al. (1994) and Suarez et al. (1997) found that the probability of observing a health card varies according to demographic or socioeconomic characteristics. We found that card observation rates were indeed higher in urban residents compared to rural residents in sub-Saharan Africa and Asia, Eastern Europe, North Africa, and the Middle East, and that rates increased with increasing levels of education in all three regions. However, the probability that a mother who reported receiving a card would present it during the interview generally did not differ according to place of residence and education level. Thus, card observation rates were lower in rural and less educated mothers because such mothers were less likely to have received health cards in the first place.

If rural and less educated mothers are less likely to receive cards, then their children are probably less likely to be immunized. Our finding of a positive correlation between card observation and immunization coverage is consistent with other studies. Immunization coverage is higher in children with health cards than in those without cards (Bolton 1998, Goldman 1994, Suarez 1997), simply because health cards are typically issued at the time that immunizations are given. Receipt of a health card may also reflect parental organization or commitment to obtaining child immunizations.

Though coverage is higher in children with cards, this does not mean that coverage in children without cards is zero. It is even more difficult to assess the level of coverage in children whose mothers report that they received a health card but do not present it during the interview. Coverage estimates that are calculated based on the assumption that children for whom no cards are seen are not immunized tend to underestimate true coverage (Boerma 1990, Goldman 1994). Likewise, estimates calculated based on the assumption that children for whom no cards are seen have coverage levels equal to those with cards tend to overestimate coverage. Since both of these assumptions are implausible, one cannot hope to get an accurate estimate using card data alone (Bolton 1998). Furthermore, maintenance of health cards may be poor in developing countries (Ramakrishnan 1999) and a study showed that cards can underestimate coverage when compared with medical records (Bolton 1998).

In the 101 national surveys about one-third of the recalled immunizations are dervied from recall. In surveys in South and South East Asia, and in North Africa and the Middle East more than half of the immunizations are derived from recall. These regions also have the highest rates on other indicators of possibly poorer quality of coverage estimates: highest proportion with card lost, lowest proportion of cards presented to the interviewer, and highest proportion recalling immunizations among those who never had a card. However, other indicators of quality did not appear to indicate particularly poor quality of the recall data themselves.

The relative contribution of maternal recall to the overall coverage estimate increases as card observation rates decrease, indicating that low card observation rates are not necessarily an indicator of poor coverage. Card observation rates are a reasonable predictor of coverage in countries in sub-Saharan Africa, but less so in other parts of the world. The contribution of recall was lower for the third doses of OPV and DPT than for the other immunizations. This may be because parents are less likely to recall immunizations that occur late in a series (Valadez 1992, Suarez 1997).

Recall data are expected to be less accurate than health card data, since they are subject to recall bias. Some studies have reported that maternal recall tends to overestimate coverage for all immunizations (Ramakrishnan 1999, Bolton 1998, Hawe 1991) or that the direction of bias varies for different immunizations (Suarez 1997). Maternal recall may overestimate true coverage if the respondent feels that reporting immunizations is a socially desirable response (Bolton 1998) or if other medical treatments are erroneously reported as immunizations. Recall may underestimate true coverage in immunizations that require multiple doses (Valadez 1992, Suarez 1997). Poor maternal memory may result in either over- or underestimation of coverage. Suarez (1997) found that accuracy of maternal recall was not dependent on demographic or economic factors, and Gareaballah (1989) showed that even uneducated mothers provided accurate recall information. In rural Egypt, repeat interviews after one year showed that mother's reports about receiving specific vaccinations were of very high quality (Langsten and Hill, 1998).

Our results indicate that maternal recall data in the surveys were internally consistent. Recall of additional immunizations by mothers who presented a card was low; recall of immunizations by mothers who reported never receiving a card was low; coverage among those who did not show a card did not exceed coverage among those who did; and there was a good correlation between specific doses of DPT and OPV. Inconsistencies in maternal recall data may be due to recall error, mass immunization campaigns, prolonged shortages of health cards, or storage of cards at health care facilities.

During the nineties national immunization days became an important strategy to boost coverage of specific vaccinations, especially polio. During most campaigns vaccinations are not recorded on the health cards and surveys can only obtain such information by recall. The higher levels of polio1 recall in the late nineties compared to the early nineties was evidence of such changes over time in our analysis. There is some experience with evaluating national immunization days using surveys (Reichler et al., 1998), and several DHS and MICS surveys now include questions on participation in specific immunization days. Continued evaluation of the impact of immunization days on coverage estimates based on card and recall is needed.

Both health cards and maternal recall are important sources of data to determine child immunization coverage estimates in national population-based surveys. Health cards are an appealing source of information because they are not subject to recall bias. However, health cards are not always available to interviewers. Using health card data alone to determine immunization coverage estimates requires implausible assumptions and can over- or

underestimate coverage, depending on the method of calculation. Maternal recall of immunizations is a convenient source of information when health cards are unavailable. Though recall data are known to be less accurate than health card data, we found no major systematic weaknesses in maternal recall and believe that inclusion of recall data yields more accurate coverage estimates.

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Table 1. Countries where DHS and MICS population-based surveys were conducted in the 1990s.

Region	Countries
Sub-Saharan Africa (50)	Benin, Burkina Faso (2), Burundi, Cameroon (3), Central African Republic (2), Chad (2), Comoros, Cote d'Ivoire (3), Ethiopia, Gabon, Gambia, Ghana (2), Guinea, Guinea-Bissau, Kenya (2), Madagascar (2), Malawi (2), Mali, Mozambique, Namibia, Niger (3), Nigeria (2), Rwanda, Sao Tome/Principe, Senegal, Sierra Leone, Tanzania (3), Togo (2), Uganda, Zambia (2), Zimbabwe (2)
Latin America and the Caribbean (19)	Bolivia (2), Brazil (2), Colombia (3), Dominican Republic (2), Guatemala (2), Haiti (2), Nicaragua, Paraguay, Peru (3), Suriname
Middle East and North Africa (10)	Azerbaijan, Egypt (3), Jordan, Morocco, Sudan, Turkey (2), Yemen
Central Asian Republics And Eastern Europe (8)	Bosnia/Herzegovina, Kazakhstan (2), Kyrgyz Republic, Moldova, Tajikistan, Uzbekistan (2)
South and Southeast Asia (14)	Bangladesh (3), Cambodia, India (2), Indonesia (3), Nepal, Pakistan, Philippines (2), Vietnam

Table 2. Card ownership rates, observation rates, and presentation rates by region, place of residence, and level of education for children 12-23 months at the time of the survey.

		Sub-Saharan Africa	Latin America, Caribbean	Mid. East, N. Africa	Cent. Asia, E. Europe	South, Southeast Asia	Total
Ever had a card							
Overall		82.4	92.8	88.3	91.8	77.2	85.0
Residence	Rural	78.2	89.5	74.9	89.4	73.7	80.3
	Urban	93.3	96.4	92.6	94.7	89.8	93.4
Education	None	76.7	82.2	85.9	*	61.4	76.7
	Primary	87.8	92.2	96.0	*	79.9	88.4
	Secondary	94.7	97.7	93.2	91.2	91.1	94.5
Card presented†							
Overall		73.5	63.3	56.6	70.1	44.8	64.6
Residence	Rural	73.1	64.8	53.0	71.3	44.5	64.5
	Urban	72.9	61.7	60.0	68.0	47.1	64.7
Education	None	73.1	63.3	52.4	*	42.3	62.6
	Primary	74.3	64.2	60.5	*	45.0	65.1
	Secondary	74.7	61.6	57.6	70.3	46.7	65.4
Card observed							
Overall		61.0	60.1	44.4	57.1	34.9	55.3
Residence	Rural	58.3	59.3	40.8	57.1	33.2	53.2
	Urban	68.3	60.9	54.4	58.1	42.1	61.1
Education	None	56.6	51.9	43.7	*	26.4	49.2
	Primary	66.1	59.4	53.6	*	36.8	58.8
	Secondary	70.6	61.6	49.3	58.0	42.5	62.0
Card lost†		2.3	3.7	7.0	2.1	7.1	3.8

*Insufficient data (N < 25 children)
†DHS data only

Table 3. Mean proportional recall contribution to overall coverage estimate by vaccine.

	Sub-Saharan Africa	Latin America, Caribbean	Mid. East, N. Africa	Cent. Asia, E. Europe	South, Southeast Asia	Total
Measles	25.9	35.3	50.2	32.3	56.2	34.8
OPV1	30.3	35.4	52.4	32.1	57.7	37.4
OPV3	19.4	25.3	47.0	28.1	51.7	28.4
DPT1	26.3	34.9	51.1	31.4	56.3	35.0
DPT3	18.2	27.3	45.6	27.5	51.5	28.0

Abbreviations:
OPV1, OPV3: First and third doses of OPV
DPT1, DPT3: First and third doses of DPT

Table 4. Mean percent recall of additional immunizations among those who presented a card and those who never had a card by region.

	Sub-Saharan Africa	Latin America, Caribbean	Mid. East, N. Africa	Cent. Asia, E. Europe	South, Southeast Asia	Total
Recall among those presenting a card						
Measles	1.7	2.9	6.2	*	6.1	3.0
OPV1	1.7	1.2	2.8	*	1.1	1.6
OPV3	2.5	2.0	4.3	*	3.0	2.6
DPT1	0.6	1.1	3.0	*	1.2	1.0
DPT3	1.1	1.4	4.5	*	2.9	1.7
Recall among those who never had a card						
Measles	8.1	12.6	25.1	73.1	20.6	14.9
OPV1	25.4	27.0	36.1	81.1	28.9	31.5
OPV3	7.3	8.4	16.3	47.5	16.5	12.3
DPT1	12.4	22.4	43.3	88.1	36.9	21.6
DPT3	4.0	6.6	18.7	55.1	19.6	9.3

Abbreviations:
OPV1, OPV3: First and third doses of OPV
DPT1, DPT3: First and third doses of DPT

*Insufficient data

Table 5. Mean coverage ratios (percent coverage among those who reported receiving a card but did not present it divided by percent coverage among those who presented a card) by region for selected immunizations.

	Sub-Saharan Africa	Latin America & Caribbean	Mid. East, N. Africa	Cent. Asia, E. Europe	South, Southeast Asia	Total
Measles	0.77	1.01	0.98	0.92	1.00	0.88
DPT1	0.80	0.93	0.93	0.87	0.92	0.86
DPT3	0.52	0.66	0.75	0.64	0.80	0.62

Abbreviations:
DPT1, DPT3: First and third doses of DPT

Table 6. Proportion of children receiving OPV who also received DPT according to health card or recall by dose and source of information.

	Sub-Saharan Africa	Latin America & Caribbean	Mid. East, N. Africa	Cent. Asia, E. Europe	South, Southeast Asia	Total
DPT1: card	97.6	98.0	99.5	99.5	98.6	98.1
DPT1: recall	95.3	96.2	96.6	97.9	98.4	96.2
DPT2: card	97.3	96.2	99.2	99.2	98.9	97.6
DPT2: recall	85.5	88.6	94.6	92.0	95.7	88.9
DPT3: card	96.8	96.4	99.2	97.0	99.0	97.3
DPT3: recall	71.0	75.1	88.1	82.6	90.8	77.1

Abbreviations:
DPT1, DPT2, DPT3: First, second, and third doses of DPT

Figure 1. Trends in recall of OPV1 among those who report never receiving a card in 23 countries with two surveys in the early and late nineties respectively.