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Measles supplemental immunization activities improve measles vaccine coverage and equity: Evidence from Kenya, 2002☆

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Abstract

Objectives: To compare the measles vaccine coverage achieved through the routine vaccination program with that achieved during the 2002 supplemental immunization activity (SIA) at the national and provincial level, the percentage of previously unvaccinated children (zero-dose children) reached during the SIA, and the equity of measles vaccine coverage among children aged 9–23 months in Kenya.
Methods: Using data from a post-SIA coverage survey conducted in Kenya, we compute routine and SIA measles vaccine coverage and the percent of zero-dose children vaccinated during the SIA at the national and provincial level. Nationwide and for each province, we use the concentration index (CI) to measure equity of measles vaccine coverage.
Results: The SIA improved both coverage and equity, achieving significantly higher coverage in all provinces with routine measles vaccination coverage less than 80%, reached a large percentage of zero-dose children in these provinces, and reached more children belonging to the poorest households.
Conclusion: Overall, by improving both measles vaccine coverage and equity in Kenya, the 2002 SIA reduced the gap in immunity between rich and poor households. Measles SIAs provide an ideal platform for delivering other life-saving child health interventions.

Keywords: Measles; Supplemental immunization activities; Equity; Kenya

☆ Disclaimer: The findings and conclusions in the paper are those of the authors and do not necessarily represent the views of the funding agency.

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1. Background

1.1. Strategies to reduce the burden of measles

Worldwide, an estimated 873,000 children died of measles in 1999 [1]. To reduce the burden of measles, in 2001, the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) established a joint strategic plan (2001–2005) to halve global measles mortality by the end of 2005, compared with 1999 estimates. In 2002, this measles mortality reduction goal was adopted by the United Nations General Assembly Special Session on children (UNGASS). The strategic plan includes providing a second opportunity for measles vaccination to all children either through a routine two-dose vaccination schedule in countries with good access to health services, or through supplemental immunization activities (SIAs) in countries with limited access to health services [2].

Measles vaccine coverage through routine health services in the African region was 55% in 1999 [1] failing to reach nearly 45% of the target population. In this setting of low coverage through routine health services, the second opportunity for measles vaccination is provided through SIAs. These SIAs target large geographic areas and a wide age range, and use intense, short-term social mobilization, careful planning and outreach services to achieve high coverage in a short period. In synergy with increasing routine vaccination coverage, SIAs can interrupt transmission of measles in the population [3].

1.2. Wealth, health and equity

In countries or sub-populations where it is difficult to accurately measure household income or consumption, a wealth index [4], computed from information on socioeconomic characteristics of a household can be used to reflect a household's economic status. Using the wealth index, households are divided into five subgroups or wealth quintiles. Children born in households whose asset ownership places them in the top quintile of the distribution of economic status have a high probability of access to health services. Conversely, children from households in the lower wealth quintiles are more likely to lack access to basic health care [5]. This may result in lower measles vaccine coverage (and therefore lower vaccine-derived immunity) through routine health services. To obtain high vaccination coverage during SIAs, all targeted children regardless of wealth must be reached.

The word equity means different things to different people [6]; however, the common denominator is that equity relates to fairness. The International Society for Equity in Health defines equity as "the absence of systematic and potentially remediable differences in one or more aspects of health across population sub-groups defined socially, economically, demographically or geographically" [7,8]. Using wealth as a measure of socioeconomic group (SEG), equity in measles vaccination coverage implies that measles vaccine coverage is similar across the wealth quintiles from poor to rich. In addition to addressing issues of social justice, ensuring equity in measles vaccine coverage is important for disease control. Despite high overall measles vaccine coverage in the population, measles outbreaks are likely to occur in places where there is geographical clustering of measles-susceptible sub-populations, often attributable to low vaccine coverage [9]. In addition, children from lower wealth quintiles may have higher measles case fatality rates (CFRs) because they live in overcrowded conditions, which may result in greater intensity of exposure to the virus, and have poorer nutritional status and poorer access to health care, making their susceptibility to measles a great concern.

In countries with sub-populations that have low access to routine health services, SIAs aim to address these inequities by aiming to achieve high (>90%) measles vaccine coverage in the targeted children, thus narrowing the gap in immunity between the rich and poor in the population. National measles vaccine coverage figures for the total population mask potentially remediable differences in coverage between population sub-groups, providing the rationale for measurement at a more disaggregated level.

2. Introduction

Kenya recommends one dose of measles vaccine at 9 months of age through the routine vaccination program. The country's 5-year (2001–2005) plan of action for accelerated measles control included nationwide measles SIAs, with an initial catch-up SIA in 2002 targeting children aged 9 months to 14 years, regardless of

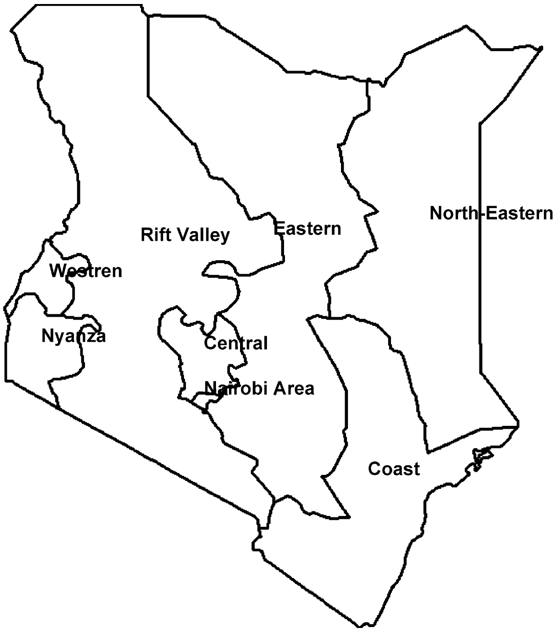

Fig. 1. Map of Kenya with provinces.

previous vaccination status, and follow-up SIAs every 3–4 years targeting children aged 9 months to 5 years. In June 2002, Kenya conducted a nationwide measles catch-up SIA, with Vitamin A supplementation, targeting 13.5 million children in all eight provinces (Fig. 1).

In this paper, we compare the measles vaccine coverage achieved through the routine vaccination program with that achieved during the SIAs at the national and provincial levels, by wealth quintile, the percentage of previously unvaccinated children (zero-dose children) reached during the SIAs, and the equity of measles vaccine coverage among children aged 9–23 months in Kenya.

3. Data and methods

3.1. Design

In July 2002, after the measles catch-up SIA, a national household coverage survey was conducted by the Kenya Ministry of Health to assess vaccination coverage. Measles vaccine coverage was evaluated in the target population, children aged 9 months through 14 years, as well as the immunization status for all antigens for children aged 9–23 months. The design and methods of this survey are described in detail in the Kenyan evaluation report [10]. Using a cluster survey design, a total of 7637 households were surveyed covering 18,922 children aged 9 months to 14 years, yielding a sufficient sample size to estimate provincial-level routine and SIA vaccine coverage. Data were collected on characteristics of households, mothers and all children aged 9 months through 14 years in each household included in the sample. Measles vaccination status was assessed through both routine vaccination services for all children aged 9–23 months and the catch-up SIA for all children aged 9 months through 14 years. Routine and SIA measles vaccination was assessed by reviewing child health cards on which routine immunizations were recorded, and the cards that were distributed in the SIAs as proof of vaccination, as well as respondents' recall of both routine and SIA vaccination. In this paper, we restricted our analysis to the sample of 1455 children aged 9–23 months, to enable comparison of measles vaccine coverage through pre-SIA routine health services with coverage attained through the SIA.

3.2. Data analysis

In order to generalize the survey results to the total population, data were weighted. Percentages and proportions for characteristics of surveyed households and children in the households aged 9–23 months were computed. Using principal components analysis [11], a wealth index was constructed in SPSS^{TM} [12] from responses to question groups listed in Box 1 . Based on

Box 1
Question groups for derivation of the household wealth index

ID	Question group
1	Number of people in the household
2	Main dwelling unit: main flooring material, main material for wall, main material for roof, number of separate rooms
3	Main source of cooking fuel
4	Main source of lighting
5	Main source of water
6	Type of toilet facility
7	Household has: radio, television or telephone
8	Member of household owns: bicycle, motorcycle or car
9	Household employs domestic worker

this index, households were divided into five equal size groups, or quintiles: poorest, second, middle, fourth and richest, in ascending order of wealth.

Point estimates of measles vaccine coverage and their 95% confidence intervals by province and wealth quintile were computed as well as the percentage of zero-dose children reached through the SIA. In order to compare the percentage of zero-dose children vaccinated during the SIA and routine measles vaccine coverage overall and by wealth quintile children, the Pearson's correlation coefficient (r) was calculated. Data analysis was conducted using Stata™ Version 8.0 [13].

3.3. Concentration index

To measure the extent of disparity in measles vaccine coverage across the wealth quintiles, we used the concentration index (CI), a summary statistic used to measure socioeconomic inequities in the health sector [14,15]. In this study, the CI was used to measure the extent of inequity in measles vaccine coverage across the five wealth quintiles. The CI ranges in value from −1 to +1. A positive value of the CI represents inequity favoring higher wealth groups (pro-rich), a negative value represents inequity favoring lower wealth groups (pro-poor), and a value of 0 indicates there are no inequities in measles vaccine coverage. Nationwide and for each of the eight provinces, the CI was computed as described in the literature [14]. To evaluate the equity of measles vaccine coverage, the CI was plotted on the vertical axis, and the nationwide and provincial vaccine coverage on the horizontal axis of a scatter plot. This permits one to view both the overall coverage and equity of measles vaccine coverage in the entire country and in each of the provinces for the routine vaccination program and the 2002 SIA. The Pearson correlation coefficient between measles vaccine coverage and the CI was calculated to determine the association between vaccine coverage and equity.

4. Results

Mothers were respondents in the majority (86%) of households (Table 1), and most (82%) had at least a primary school education. Fixed-temporary sites (e.g. schools and churches or mosques) accounted for the largest percentage (69%) of vaccination sites nationwide, with schools comprising the majority of sites nationwide. However, in the remote and largely rural North-Eastern province, 78% of mothers had no formal education, and churches and mosques were the main places of vaccination: 69% of all sites. Among children aged 9–23 months included in the household survey, 59% had child health cards, 83% had cards distributed during the SIA for proof of vaccination and 53% were male. Nationally, 75% of children aged 12–23 months were fully vaccinated; however, there were great differences by province.

Nationwide, more than three-quarters (77%; 95% CI: 75%, 80%) of children aged 9–23 months received the measles vaccine through routine health services before the SIA (Fig. 2). The nationwide coverage of the 2002 SIA in these children was 90% (95% CI: 88%, 91%), a statistically significant increase over routine coverage. Among children aged 9–23 months, compared to the routine measles vaccine coverage, the SIA resulted in statistically significant increases in coverage in five provinces: Eastern 79% (95% CI: 72%, 84%) to 91% (95% CI: 87%, 95%), North-Eastern 64% (95% CI: 52%, 74%) to 88% (95% CI: 87%, 95%), Nyanza 74% (95% CI: 68%, 80%) to 93% (85% CI: 88%, 96%), Rift Valley 78% (95% CI: 73%, 82%) to 92% (95% CI: 88%, 95%) and Western 67% (95% CI: 75%, 80%) to 94% (95% CI: 88%, 91%). In Nairobi, Central and Coast Provinces, the measles vaccine coverage achieved through the SIA was not statistically different from that achieved through routine health services.

Nationwide measles vaccine coverage among the poorest, second and fourth wealth quintiles increased significantly as a result of the SIA (Fig. 3): coverage in the poorest wealth quintile increased from 65% (95% CI: 59%, 70%) routine coverage to 86% (95% CI: 82%, 90%) as a result of the SIA, from 71% (95% CI: 66%, 77%) to 92% (95% CI: 88%, 95%) in the second poorest quintile, and from 80% (95% CI: 75%, 84%) to 92% (95% CI: 89%, 95%) in the fourth poorest quintile. In the middle and richest wealth quintiles, the measles vaccine coverage was similar for routine and SIA.

Nearly 10% of children aged 9–23 months vaccinated during the SIAs had not previously received measles vaccine through routine services (zero-dose children). The highest percentage of these children vaccinated during the SIA was in North-Eastern Province

Table 1
Characteristics of households and children aged 9–23 months by province surveyed in Kenya, 2002

	Nairobi	Central	Coast	Eastern	North-Eastern	Nyanza	Rift Valley	Western	Nationwide
No. of children in sample	**149**	**133**	**175**	**206**	**74**	**208**	**305**	**205**	**1455**
Male children (%)	53	52	54	56	46	51	53	51	**53**
Rural residence (%)	0	75	64	79	65	75	67	62	**62**
Respondent (%)									
Mother	86	88	84	90	92	86	87	80	**86**
Guardian	3	6	7	3	1	7	3	1	**4**
Father	10	4	6	5	3	6	8	13	**7**
Other	1	2	3	2	4	1	2	6	**3**
Place of vaccination during SIA (%)									
School setting	20	42	33	30	5	54	47	48	**39**
Health facility	38	26	29	43	14	24	30	24	**30**
Church/mosque	13	7	4	5	69	4	6	6	**6**
Other	29	25	34	22	12	18	17	22	**25**
SIA card present (%)	71	80	84	88	92	85	79	85	**83**
Did not receive measles vaccine before the SIA (%)	5	5	10	10	20	14	11	15	**10**
Child health card present (%)	53	67	71	66	35	56	60	50	**59**
Mother's education (%)									
No education	5	5	28	22	78	9	18	8	**18**
Primary	42	55	54	51	15	65	58	66	**55**
Secondary	36	37	17	25	4	23	22	23	**24**
Post secondary	17	3	1	2	3	3	2	3	**3**
Fully immunized children aged 12–23 months (%) ($n = 1302$)	90	87	91	72	53	63	76	61	**75**

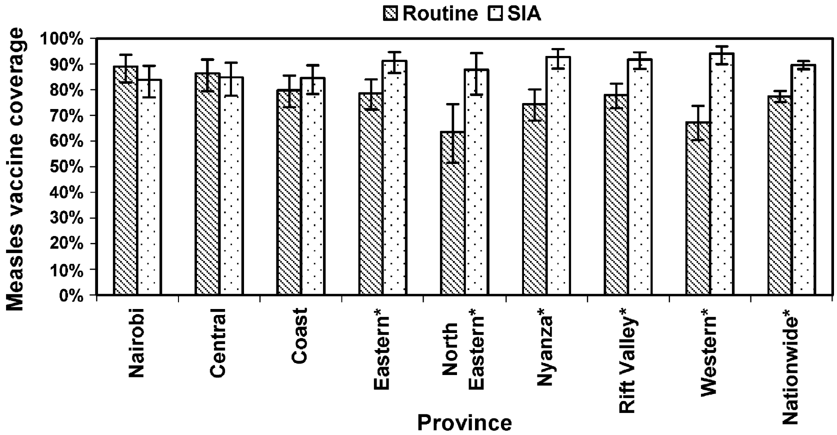

Fig. 2. Nationwide and provincial routine and SIA measles vaccine coverage among children aged 9–23 months, Kenya, 2002. (a) Lines above and below the point estimates of coverage represent 95% confidence intervals, and (*) indicates a statistically significant ($\alpha = 0.05$) difference between routine and SIA measles vaccine coverage.

(15.4%), followed by Western (10.9%) and Nyanza (9.6%) Provinces. Nairobi (4.8%) and Central Province (4.4%) had the lowest percentage of zero-dose children vaccinated during the SIA. In comparing the association between the percent of zero-dose children reached through the SIA and the routine measles vaccination coverage in the provinces, the Pearson correlation coefficient (r) is −0.98 and is statistically significant ($p < 0.001$).

The percentage of zero-dose children vaccinated during the SIA declined with increasing wealth. Among children aged 9–23 months belonging to households in the lowest wealth quintile, nearly 17% of those vaccinated during the SIAs had not been vaccinated before through routine services. Only 9.8% in the second, 8.7% in the third, 8.2% in the fourth and 3.7% in the richest quintile were zero-dose children vaccinated during the SIA. The Pearson correlation coefficient between the percentage of zero-dose children reached during the SIA and the routine measles vaccination coverage by wealth quintile is −0.93 and statistically significant ($p < 0.001$).

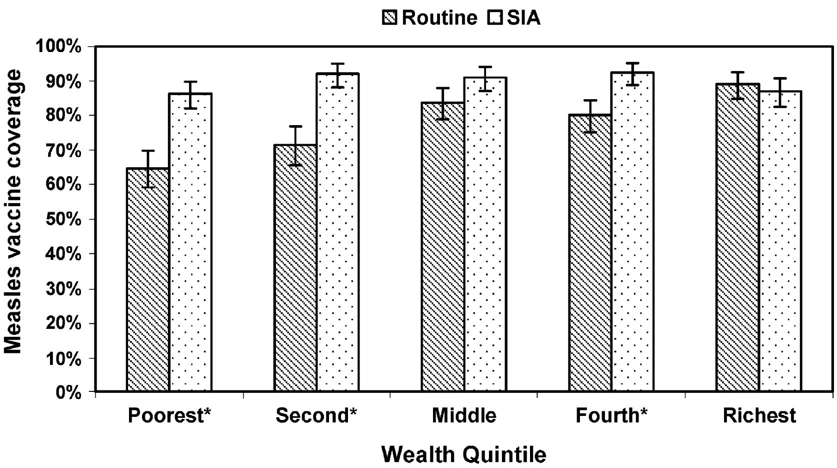

Fig. 3. Nationwide routine and SIA measles vaccine coverage by wealth quintile among children aged 9–23 months, Kenya, 2002. (a) Lines above and below the point estimates of coverage represent 95% confidence intervals, and (*) indicates a statistically significant ($\alpha = 0.05$) difference between routine and SIA measles vaccine coverage.

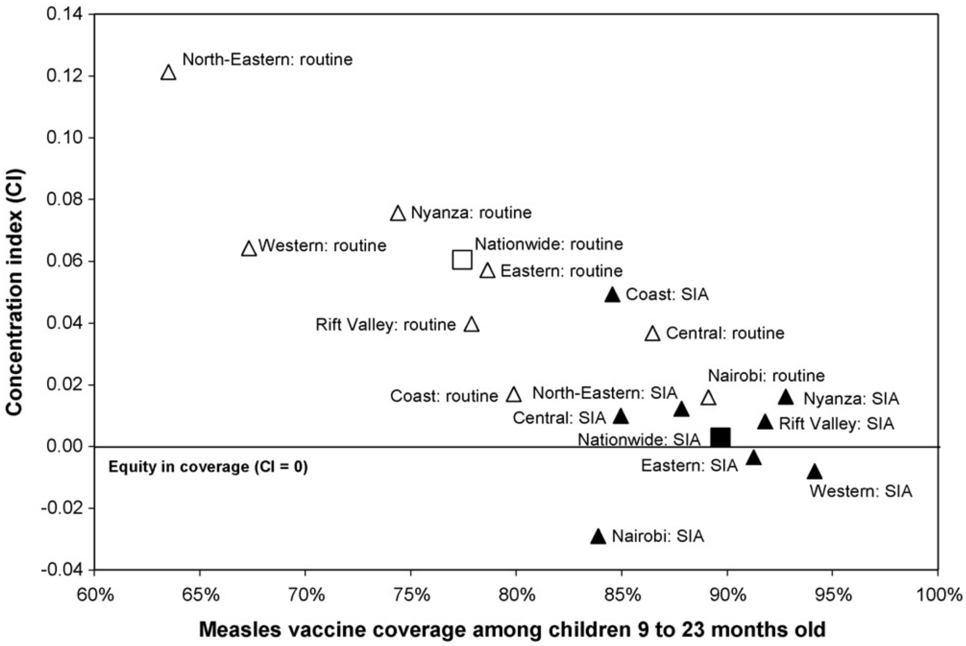

Fig. 4. Nationwide and provincial measles vaccine coverage and equity of measles vaccine coverage among children aged 9–23 months, through the routine immunization program and the SIA, Kenya, 2002.

In Fig. 4, the nationwide and provincial SIA and routine measles vaccine coverage and the concentration index are plotted in two-dimensional space: measles vaccine coverage on the horizontal axis and equity of measles vaccine coverage on the vertical axis, with unshaded symbols representing routine coverage and equity and shaded symbols representing the SIA coverage and equity. Even though the SIA's provincial coverage was not statistically significantly different from routine in three of the provinces, the SIA resulted in an improvement in equity in Kenya nationwide, and in all provinces but Coast Province. Nationwide, there was a demonstrated reduction in the CI from 0.06 to 0.003, corresponding to an increase in overall measles vaccine coverage from 77 to 90%. In Coast Province, the SIA resulted in an increase in measles vaccine coverage from 80% (95%CI: 73%, 86%) to 85% (95%CI: 78%, 90%), but the CI also increased from 0.02 to 0.05.

North-Eastern Province with the lowest routine coverage of 64%, showed an increase in coverage to 88% as a result of the SIA, and also had the largest improvement in equity, with the CI declining from the routine level of 0.12 to 0.01 as a result of the SIA. Eastern, Nyanza, Rift Valley and Western Provinces also had large gains in equity of measles vaccine coverage. In Eastern, Western and Nairobi Provinces the SIA CI were negative. Overall, higher SIA and routine coverage was associated with lower values of the concentration index ($r = -0.82$; $p < 0.05$).

5. Discussion

The analysis of measles vaccine coverage data at the provincial level revealed trends previously masked by nationwide coverage data. In all five provinces with routine coverage less than 80%, coverage with the SIA was higher than that achieved through routine health services, while Nairobi, Central and Coast Provinces with routine coverage greater than 80% did not see a statistically significant change in coverage as a result of the SIA. These results highlight the difficulty of reaching the small percentage of previously unreached sections of the population in high-coverage provinces.

Gwatkin argues that health policy goals, currently expressed as societal averages (e.g. nationwide measles vaccine coverage), be reformulated so that they point specifically to conditions among the poor and to poor–rich differences (e.g. sub-national measles vaccine coverage by wealth quintiles), and yield more useful indicators to better formulate appropriate interventions to address these inequities [16]. SIAs play an important role in reaching children in the lower wealth strata not vaccinated through routine services. Children born in families belonging to the two poorest wealth quintiles were the biggest beneficiaries of the SIA, with significant increases in measles vaccine coverage compared to the routine vaccination program. In a study of social demand for routine vaccination services in Africa and Asia, there was a general impression among respondents that the mothers with unimmunized children lived the furthest from vaccination sites and had the lowest social status [17]. Studies, which reviewed the routine vaccination program in Bangladesh found that increased coverage among all children was significantly associated with proximity to outreach clinics [18,19]. A study in Bangladesh found that universal distribution of measles vaccine largely nullified socioeconomic status (SES) related mortality differentials within a high mortality population of children [20]. Thus, ensuring equity of measles vaccine coverage across all wealth quintiles can reduce child mortality, especially in high mortality populations. Since the SIA aimed to reduce or eliminate barriers to access by increasing the number of vaccination sites thereby bringing services closer to the target population, the increase in measles vaccine coverage and equity achieved by the SIA in Kenya is consistent with findings from these studies. The measles SIA in Kenya reached a larger proportion of zero-dose children in the provinces with the lowest routine coverage. In addition, a larger percentage of previously unvaccinated children belonging to households in the lowest wealth quintiles benefited from the SIA. This resulted in fewer susceptible children among the vulnerable poor, making the population more resilient to the spread of infection.

To the best of our knowledge, ours is the first study to use the concentration index as a summary measure to evaluate the impact of measles SIAs on the equity of measles vaccine coverage. As the routine and SIA CIs in Fig. 4 indicate, the largest improvements in equity as a result of the SIA occurred in the Eastern, North-Eastern, Nyanza, Rift Valley and Western Provinces, which had statistically significant increases in provincial measles vaccine coverage. While in Nairobi and Central Province the SIA did not result in a statistically significant increase in measles vaccine coverage, equity was improved favoring the poorer wealth quintiles. Provinces with limited access to routine immunization services were the biggest beneficiaries of the SIA, with improvements in both overall coverage and equity. Even in provinces with good access, measles SIAs conferred benefits to the poorer sections of society by improving their access to these services.

Overall, higher measles vaccine coverage was associated with greater equity. However, in Coast Province, measles vaccine coverage during the SIA increased, as well as the CI, indicating that a higher percentage of children in the wealthier quintiles were vaccinated during the SIAs. Possible reasons for this include the initial lack of comprehensive political support for the SIA, and suspicion of mass campaigns linked to concerns that contraceptives were included with tetanus toxoid (TT) earlier in the May 2002 TT campaign targeting women aged 14–49 years. With the delay in political support for the measles SIA, there was inadequate time for appropriate social mobilization activities. Thus, the poor in the Coast Province may have had limited access to accurate public health information about the measles SIA.

Although this study demonstrated the equity-enhancing properties of measles SIAs, the cost per child vaccinated is likely to play a role in the health planner's choice to deploy this method. A study reported the health sector cost per fully immunized child in the African region using a fixed facility was \$8.51 compared to \$23.08 using campaigns [21]. However, the Kenya evaluation reported a cost of \$0.90 to the health care system for a dose of measles vaccine delivered by the routine vaccination program (including vaccine wastage cost of \$0.30), and a marginally lower cost of \$0.89 for the 2002 SIA (with a significantly lower vaccine wastage cost of \$0.001) [10]. These figures do not include cost of overhead and replacement capital [10]. In addition, for the routine vaccination program, costs of social mobilization, monitoring and evaluation, training, cold chain and transport were considered shared costs, and were not distributed per dose [10]. Capital costs, costs of vehicles and cold chain equipment were excluded from the campaign costs, and the value of donated resources such as volunteer time, vehicles and goods was not estimated while measuring the indirect costs of the SIA [10]. The household cost of obtaining measles vaccination in Kenya through the routine program was significantly higher ($0.86) than that obtained through the 2002 SIA ($0.11), resulting in a higher societal cost of the routine program ($1.76), compared to the SIA ($1.00) [10]. A previous study found that in systems where parents have to expend time and energy to vaccinate their children, socioeconomic status will be an important factor, and public health programs utilizing outreach can reduce prevailing gender and socioeconomic differentials in vaccine receipt [22]. By increasing the number of vaccination sites and bringing services closer to the target population, the measles SIA in Kenya decreased the household transport costs, travel and waiting time, providing part of the explanation for the success of the SIA in reaching more children belonging to poorer households.

This study does have some limitations. Given that all children aged 9 months to 14 years were selected, the vaccination status of each child in the household is not independent of others, but is correlated. Furthermore, clusters of households in this national survey were sampled by urban and rural locality within a province. However, the district level may be a more appropriate level of analysis for feasible interventions, but the costs were prohibitive to obtain precise estimates for all 78 health districts. Therefore, we cannot comment on the equity for any specific district.

Routine vaccination information was collected from all participating households with children aged 9–23 months. While all respondents were asked to present vaccination cards for age-eligible children, recall of vaccination history from memory was also recorded. However, in most instances, the coverage from immunization cards and memory were comparable and the trends by wealth quintile were the same. In most provinces, over 50% of children had child health cards, and over 80% had cards distributed during the SIA as proof of vaccination. In addition, information on knowledge, attitudes and practice was not collected in a standardized format to explain differences in measles vaccine coverage and equity within provinces.

The measles catch-up SIA in Kenya improved nationwide coverage and the equity of measles vaccine coverage for children aged 9–23 months. The SIA reached a large proportion of zero-dose children in provinces with the lowest routine coverage and children belonging to the lowest wealth quintiles, thus narrowing the gap in immunity between the rich and poor. While measles SIAs increase coverage and equity, the gains cannot be sustained without improving routine measles vaccine coverage. Further studies are needed to operationalize how to provide routine immunization services more equitably across all wealth quintiles, for example, by increasing outreach services and by tracking the immunization status of children for follow-up. If most zero-dose children reached through the SIA could be reached by improving access to routine services, countries could begin to consider providing the second opportunity for measles vaccine through routine services.

6. Conclusions

The 2002 SIA improved both measles vaccine coverage and equity, reducing the gap in immunity between children belonging to rich and poor households. As this study demonstrates, coverage survey data analyzed at the sub-national level reveal trends in measles vaccine coverage and equity masked by national-level data. When available, coverage survey data should be used to track changes in vaccine coverage and equity at the sub-national level to enable appropriate targeting of interventions.

Results from this study support continued implementation of measles SIAs in countries with low routine coverage and high measles burden to ensure high overall coverage and equity in measles vaccine coverage for all children, regardless of household wealth. In addition, as was done in Togo [23] and Zambia [24], the gains in equity using the measles SIAs platform could be built upon to deliver other health interventions that address the leading causes of childhood mortality.

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