SUPPLEMENT ARTICLE

Measles Incidence Before and After Mass Vaccination Campaigns in Burkina Faso

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Burkina Faso conducted mass measles vaccination campaigns among children aged 9 months to 4 years during December 1998 and December 1999. The 1998 campaign was limited to six cities and towns, while the 1999 campaign was nationwide. The last year of explosive measles activity in Burkina Faso was 1996. Measles surveillance data suggest that the 1998 urban campaigns did not significantly impact measles incidence. After the 1999 national campaign, the total case count decreased during 2000 and 2001. However, 68% of measles cases occurred among children aged 5 years or older who were not included in the mass vaccination strategy. During 2000 and 2001, areas with high measles incidence were characterized by low population density and presence of mobile and poor populations. Measles control strategies in Sahelian Africa must balance incomplete impact on virus circulation with cost of more aggressive strategies that include older age groups.

Burkina Faso is a landlocked Sahelian country with one of the least developed economies in the world [1]. From 1995 to 2000, routine measles vaccination coverage of children during their first year of life ranged from 29% to 68%. A survey among children aged 12–23 months in 1998 found that 45% had received 1 dose of measles vaccine at or after age 9 months [2]. In 1998, following rapid success with the polio eradication initiative, Burkina Faso was among the first West African countries to develop a measles control plan. That year a supplemental measles vaccination campaign for children aged 9 months to 4 years was added to the second round of poliomyelitis national immunization days (NIDs) in 6 cities and towns. Because this campaign permitted vaccination of a large proportion of children who had not been previously vaccinated [3], the Ministry of Health (MOH) and its partners subsequently expanded this strategy to a nationwide measles vaccination campaign, which was added to the second round of NIDs in December 1999.

In Burkina Faso, measles is a seasonal disease, with most cases occurring between January and June. Following the 1999 campaign, the MOH with support from the World Health Organization (WHO) implemented a national review of measles surveillance data. In addition, case-based surveillance was implemented, starting in areas that reported the most cases and was progressively expanded to all health districts. Laboratory capacity that allowed serologic confirmation of a subset of reported cases was also developed.

Here we present an analysis of the most consistent trends observed from all sources of data collected for 1995–2001. We describe patterns of measles occurrence a year after intense measles transmission nationwide in 1996 and after the urban campaign of 1998 and the national campaign of 1999. We also attempt to identify risk factors associated with measles occurrence at the district level following the 1999 campaign.

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METHODS

Mass vaccination campaigns. In December 1998, during the second round of poliomyelitis NIDs, measles vaccination was offered to all children aged 9–59 months who resided in 2 cities (Ouagadougou and Bobo Dioulasso) and 4 towns (Kaya, Koudougou, Ouahigouya, and Tenkodogo). Because this campaign was limited to urban areas, children who resided in rural parts of the health districts were not offered measles vaccination. Ouagadougou and Bobo Dioulasso are spread over 6 health districts, with an estimated 78% urban population. Each of the other 4 towns is the urban center of a health district. The combined population of the 4 towns is estimated to be 17% of the population of all 4 districts. Overall, the urban population that was included in the 1998 measles vaccination campaign was estimated to represent 13% of the country's population. In the cities of Ouagadougou and Bobo Dioulasso, a survey determined that 79% of children aged 9–59 months had received measles vaccine during the campaign and that 91% had received ⩾1 dose of the vaccine either through routine services or in the campaign [3].

In December 1999, a national measles vaccination campaign was added to the second round of NIDs. All children aged 9–59 months were offered measles vaccination except those living in 1998 campaign areas. In these areas, measles vaccination was offered only to children aged 9–23 months. Measles vaccine coverage measured through a survey was found to be 89% for the campaign. Taking into account measles vaccination previously received through routine services, 91% of the country's children eligible for vaccination during the campaign had received ⩾1 dose of the vaccine at the end of 1999 [4].

Measles surveillance data. We reviewed three sources of measles surveillance data for this analysis: weekly aggregate district-level reporting of diseases with epidemic potential from 1996 to 2001, also called TLOH (télégramme lettre officiel hebdomadaire); case-based information on a subset of measles cases reported during 2001; and quarterly aggregate district reporting through the national health information system from 1995 to 2001, termed DEP (Direction des Etudes et de la Planification). Each source provides complementary information on both measles cases and measles-related deaths:

TLOH is based on a well-established network of district and regional surveillance officers who transmit weekly information on aggregate cases and deaths identified in all health facilities. This information should be transmitted no later than the following Tuesday for each weekly report. Data include information on the number of reporting facilities and timeliness of the reports. The requirement for rapid transmission of data is necessary to allow for prompt disease control interventions.

Case-based information was obtained from March to June 2000 on a subset of cases reported through the TLOH system by using a generic integrated diseases surveillance form. Unlike the aggregated TLOH data, case-based data permit analysis of the age distribution of cases. For a subset of cases, usually when more than 5 cases occurred during the same week in a district, serologic verification was conducted at the national reference laboratory by using Enzygnost anti-measles virus/IgM ELISA test kits (Behring) [5]. Among a subset of cases that tested negative for measles, rubella IgM test kit serology was also assessed. Data on vaccination status of cases could not be collected systematically because information on most cases was obtained from registries only.

DEP data that included quarterly total cases and deaths by age group were reviewed retrospectively. These data likely are more complete than data from the TLOH system because the DEP system permits a longer interval to elapse between disease onset and case reporting. However, because the DEP system collects a wide range of administrative and disease-specific health data, DEP data may not be as accurate as TLOH data.

Population data. District-level population estimates from the 1996 national census (Institut National de la Statistique et de la Démographie [INSD]) were used as the basis for calculating population denominators. For every consecutive year since 1996, these figures were increased by 2.3% in accordance with the INSD-estimated national growth rate. Age group-specific population estimates were obtained by applying national average population proportions to the adjusted annual population totals.

Rate calculations. We calculated district level cumulative reported measles incidence for all years between 1996 and 2001 by using TLOH data. We defined high incidence of measles as corresponding to ⩾100 reported measles cases per 100,000 persons, moderate incidence as 25–99 reported cases per 100,000, and low incidence as ⩽25 per 100,000 persons. To compare trends in measles incidence within areas included in the 1998 urban campaign, we grouped the 6 districts that comprise the

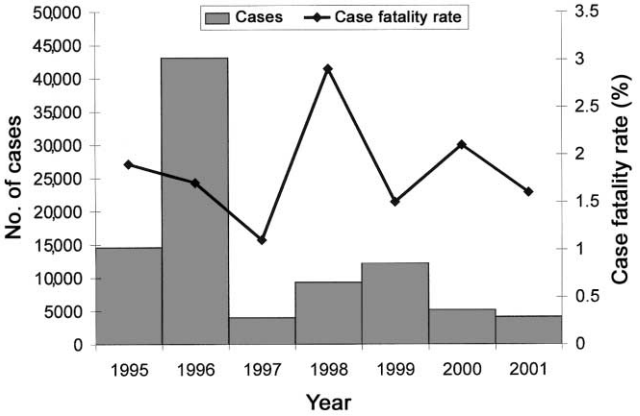

Figure 1. Reported measles cases and case-fatality ratio from quarterly aggregate district data, 1995–2001, Burkina Faso.

Figure 2. Annual reported measles incidence at the health district level from weekly aggregate district-level reports of diseases with epidemic potential, Burkina Faso, 1996–2001.

2 large cities, the 4 districts that comprise the 4 towns, and the remaining 43 districts. To estimate age-specific attack rates for the year 2000, we calculated the proportion of cases reported through the TLOH system in 2000 that belonged to each respective age group by using the age group–specific proportions determined through case-based surveillance. Case-fatality ratios were estimated by dividing the number of reported deaths by the number of cases in the corresponding surveillance system.

Table 1. Reported measles incidence (cases/100,000 persons) determined from weekly aggregate district-level reporting of diseases with epidemic potential by health districts, Burkina Faso, 1996–2001.

Health districts	1996	1997	1998	1999	2000	2001
Ouagadougou, Bobo Dioulasso	438	6	13	38	50	18
Kaya, Koudougou, Ouahigouya, Tenkodogo	301	45	64	111	32	28
Other 43 health districts	265	22	58	81	57	36
Whole country	301	23	53	80	53	32

RESULTS

From 1995 to 2001, 92,645 measles cases were reported from health care facilities through the national (DEP) health information system. The highest annual count was in 1996, with 43,123 cases (figure 1). This is three times higher than in any other year during the period studied. Following intense measles activity in 1996, case counts dropped dramatically to 4040 cases in 1997 and then increased progressively until 1999. In 1999, after the 1998 urban campaign, national case counts were higher than in the previous year. After the 1999 national mass campaign, case counts decreased during 2000 and were even lower in 2001. During this 6-year period, the case-fatality ratio ranged from 0.9% to 2.9% (average, 1.8%), similar to the 1.7% measured in 1996.

Figure 2 shows the annual measles incidence by health district, based on TLOH data, from 1996 to 2001. The 1996 epidemic was associated with a high incidence of measles in 52 of the 53 districts. Only the district of Djibo in the region of Ouahigouya appeared to have a lower incidence, although underreporting cannot be excluded. After the year of intense measles transmission nationwide, it appears that measles outbreaks became more focal. In 1997, only 3 districts experienced measles incidences of >100 per 100,000 persons. In 1998, 9 districts had a high incidence of measles and in 1999, 13 did. During 2000, after the 1999 national campaign, 8 health districts had a high incidence of reported measles cases; 4 districts had a high incidence during 2001.

By using TLOH data, the rate of reported measles was 301 cases per 100,000 persons in 1996 (table 1). This rate was higher in the 6 health districts that encompass the cities of Ouagadougou and Bobo Dioulasso than in the other 2 groups of districts analyzed in 1996. In the same 6 districts, the 1998 mass vaccination campaign permitted vaccination of 79% of children residing in urban areas (78% of the population of the 6 health districts of Ouagadougou and Bobo Dioulasso) [3]. Despite this campaign, measles incidence was higher in these health districts in 1999 than in 1998 (38 vs. 13 cases/100,000 persons, respectively). In the other 4 health districts (Kaya, Koudougou,

Table 2. Reported measles cases, case-based investigations, and laboratory results by health region, Burkina Faso, 2000.

Health region	Measles vaccine coverage[a]	Reported cases (TLOH)	Cases investigated (% of all reported cases)	Measles serology performed (% of all cases)	Measles IgM positive (% of cases with measles serology)	Rubella serology done (% of all cases)	Rubella IgM positive (% of cases with rubella serology)
Banfora	89%	134	21 (16)	10 (4)	9 (90)	10	0
Bobo Dioulasso	91%	330	68 (21)	18 (6)	13 (72)	5	2 (40)
Dedougou	92%	200	45 (23)	15 (5)	12 (80)	3	0
Dori	87%	1558	1205 (77)	20 (7)	17 (85)	3	0
Fada N'Gourma	91%	366	229 (63)	15 (5)	11 (73)	7	0
Gaoua	91%	735	393 (53)	59 (21)	54 (92)	26	1 (4)
Kaya	96%	952	365 (38)	54 (19)	45 (83)	9	0
Koudougou	93%	396	185 (47)	9 (3)	5 (56)	4	0
Ouagadougou	92%	862	289 (34)	42 (15)	30 (71)	16	11 (69)
Ouahigouya	91%	385	85 (22)	38 (14)	22 (58)	17	0
Tenkodogo	86%	156	90 (58)	0	0	0	0

NOTE. Data are no. (%) unless indicated. TLOH (télégramme lettre officiel hebdomadaire), weekly aggregate district-level reporting of diseases with epidemic potential by health districts.

[a] Children aged 9–59 months who had ⩾1 dose of measles vaccine as of December 1999.

Table 3. Age distribution of measles cases with case-based information by area, Burkina Faso, 2000.

Health region	No. (%) by age group			
	<1 year	1–4 years	5–14 years	⩾15 years
Dori	105 (9)	210 (17)	448 (37)	447 (37)
Fada N'Gourma	25 (11)	54 (24)	51 (22)	99 (43)
Gaoua	34 (9)	91 (23)	208 (53)	60 (15)
Kaya	54 (15)	57 (16)	123 (34)	131 (36)
Ouagadougou	47 (16)	55 (19)	148 (51)	39 (13)
Other 6 health regions	85 (17)	123 (25)	190 (38)	96 (19)
Country totals	350 (12)	590 (20)	1168 (39)	867 (29)

Ouahigouya, and Tenkodogo) that conducted an urban campaign in 1998 (urban population accounts for 17% of the total in these 4 districts) measles incidence was higher that year than elsewhere in the country. During 2000, after the 1999 national campaign, measles incidence was higher than in 1999 in the 6 districts of Ouagadougou and Bobo Dioulasso but was lower than during 1999 elsewhere in the country. In 2001, measles incidence was lower than in 2000 in all 3 groups of health districts analyzed.

Health districts that experienced high measles incidence during 2000 or 2001 were predominantly in the northeast (Dori, Kaya, and Fada N'Gourma) or southwest (Gaoua) of the country. During 2000, of 6074 cases reported through the TLOH system, 2975 (49%) were documented by case-based reports. Serologic verification was obtained for 280 (5%) of all cases (table 2). In the regions with the highest reported incidence during 2000 (Dori, Kaya, and Gaoua), more than 80% of cases tested were confirmed by positive measles IgM serology. In the health region of Ouagadougou, where case counts were high but incidence was lower because of high population density, 71% of tested cases had positive measles IgM tests. Among 44 cases that tested negative for measles, 14 (32%) tested positive for rubella. In other areas with moderate incidence (e.g., the health regions of Bobo Dioulasso and Dedougou), more than 70% of cases tested positive for measles, confirming the existence of moderate measles transmission.

After the 1999 nationwide campaign, 68% of reported measles cases during 2000 were ⩾5 years old (table 3). In addition, 29% of all cases were ⩾15 years old. Of cases in the Sahelian regions of Dori, Fada N'Gourma, and Kaya, 38% were ⩾15 years old. The Dori and Fada N'Gourma regions comprise large population groups with nomadic lifestyles, and Kaya has numerous gold prospectors with high mobility, low socioeconomic status, and poor access to primary health care services. All regions also have population densities below the national average of 48 persons per square kilometer (INSD data). In the health region of Gaoua, the proportion of cases >15 years old was lower (15%). In this region, large groups of displaced persons resettled during 2000 after civil unrest in neighboring Côte d'Ivoire.

Despite a large proportion of cases in 2000 being older than the age group that had been offered measles vaccine during the 1999 national campaign, attack rates of reported measles remained slightly higher among children aged 1–4 years than among those aged 5–14 years (table 4). Of the 45 deaths among cases with case-based information, 16 (35%) occurred among patients aged ⩾5 years. Although the case-fatality ratio was clearly higher among children aged 0–4 years, 36% of deaths were documented among the age group that was not offered vaccination during the national campaign.

DISCUSSION

The last year of extensive nationwide measles transmission in Burkina Faso was 1996. From 1997 to 1999, national measles case counts increased progressively as did the number of districts with high measles incidence. In subsequent years an explosive large-scale outbreak, usually observed every 2 to 4 years in countries with less than 50% measles vaccine coverage [6], was averted, most likely as a result of the 1999 national mass vaccination campaign. During 2000, intense measles transmission was restricted to 3 main areas with special high-risk population groups. In addition, during 2001, total reported measles cases and the number of districts with high measles incidence were even lower than in the previous year.

From the surveillance data reviewed, it does not appear that in 1998 there was a significant population-based impact on measles occurrence. During 1999, measles incidence was higher in Burkina Faso than during the previous year, even in health districts that were included in the 1998 campaign. This finding suggests that a campaign reaching only 79% coverage and limited to children aged 9 months to 4 years and living in urban areas was insufficient to prevent measles virus circulation, even within the districts that encompassed these urban areas. In contrast, after the 1999 national campaign that reached 89% of children of similar ages, a reduction of measles transmission was clearly apparent.

During 2000 and 2001, moderate measles transmission was

Table 4. Cases, attack rate, deaths, and case-fatality ratio (CFR) by age group, Burkina Faso, 2000.

Age group	No. (%)	Attack rate (case × 10^{-5})	No. of deaths (%)	CFR
<1 year	350 (12)	148	8 (18)	2.3%
1–4 years	590 (20)	72	21 (47)	3.6%
5–14 years	1168 (39)	67	10 (22)	0.9%
⩾15 years	867 (29)	28	6 (13)	0.7%
All	2975 (100)	53	45 (100)	1.5%

documented in more than half of the country's health districts. This indicates that limitation of the 1999 mass vaccination campaign to children <5 years old was not sufficient to completely interrupt the circulation of measles viruses. Indeed, following the national campaign, 68% of measles cases occurred among persons ⩾5 years old who were not included in the mass campaign. Of interest, this proportion was even higher (75%) in the Dori region, which has one of the lowest population densities and includes the largest numbers of nomadic populations. Previous studies have demonstrated that large proportions of nomadic people who have not been vaccinated against measles remain susceptible to measles until adulthood [7].

In addition to health districts in the Dori region, 2 other groups of health districts experienced high measles incidence during 2000. In 3 districts overlapping the Kaya and Fada N'Gourma regions, population density is low and settlers include numerous gold prospectors. In the southwestern districts from the Gaoua region that also have lower population densities, an estimated 15,000 persons (70% women and children) came from Côte d'Ivoire at the end of 1999 [8]. This migration resulted in disruption of community life in the region. These examples suggest that the 3 groups of health districts that experienced high measles incidence after the 1999 vaccination campaign were all characterized by low population density and the presence of mobile and poor population groups.

Of note, after the campaign, 36% of recorded deaths were among persons ⩾5 years old. However, case-fatality ratios were clearly higher among children <5 years of age. Aggregate case-fatality ratios obtained for 2000 from DEP, TLOH, and case-based surveillance were <2%, which is in the lower range of WHO estimates [9]. These lower figures may in part be due to the broader age distribution of measles cases and the lower mortality after age 5 years. It may also reflect the impact of vitamin A supplements administered by the MOH during NIDs since 1998 [10].

Mass measles vaccination of children <5 years of age resulted in substantial reduction of measles morbidity and mortality in Burkina Faso because it prevented a large-scale outbreak. Because routine delivery of vaccination services remains low [4], the impact of the national campaign likely will not be sustained more than 2 to 4 years. Additional supplementary vaccination activities will be required in order to sustain the benefit from the 1999 campaign until routine vaccination services reach most of the population. Data from this report also illustrate that a mass vaccination campaign limited to children <5 years of age was not sufficient to interrupt circulation of measles virus and provided minimal protection in areas with low population densities and mobile populations. During December 2001, Burkina Faso conducted another vaccination campaign, including children aged 9 months to 14 years. Surveillance data were not available for analysis at the time this article was being prepared. The development of future measles control strategies in Burkina Faso and other West African countries must balance the limited impact of supplementary vaccination among children <5 years of age with logistical, economical, and practical constraints of more ambitious approaches encompassing a wider age range.

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