Brazilian experience with rapid monitoring of vaccination coverage during a national rubella elimination campaign

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ABSTRACT

Objective. *To describe an adapted version of the Pan American Health Organization (PAHO) methodology for rapid monitoring of vaccination coverage and its use as a supervisory tool to guide decision-making and strategies for end-stage vaccination activities ("mop-up" operations) following a six-week national rubella elimination campaign in Brazil.*

Methods. *Vaccination coverage assessments modeled on a variation of PAHO's rapid house-to-house coverage monitoring methodology were conducted by Brazilian municipalities following mass immunization of adults and adolescents from August to December 2008. Results of monitoring assessments conducted in 3 658 (65.7%) of 5 564 municipalities were reported to Brazil's National Immunization Program.*

Results. *Information on vaccination against rubella was obtained from more than 1.5 million Brazilians (2.1% of the 70.1 million people targeted for immunization) during vaccination coverage monitoring. According to the assessment data, vaccination targets of 95% coverage were reached in 2 175 (59.5%) of the 3 658 municipalities that reported results. The percentage of municipalities that reached coverage targets was lower than administrative coverage estimates (number of vaccine doses administered divided by the immunization target population). These results informed targeted "mop-up" campaigns to reach unvaccinated populations.*

Conclusions. *Rapid coverage monitoring implemented at the local level proved useful for deciding when to conclude vaccination activities and where to focus additional efforts to achieve desired coverage.*

Key words Program evaluation; immunization programs; immunization coverage; rubella vaccine; measles-mumps-rubella vaccine; disease prevention; Brazil.

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In 2003, member states of the Pan American Health Organization (PAHO), including Brazil, set a goal of eliminating rubella and congenital rubella syndrome by 2010 (1). To achieve this goal, all 38 PAHO countries introduced routine childhood immunization against rubella, and 32 countries conducted supplementary immunization activities in which more than 250 million adults and adolescents were vaccinated between 1998 and 2008 (2). Successful experience with measles elimination in the region demonstrated the importance of achieving

high and homogeneous vaccination coverage to interrupt measles transmission (3). To achieve rubella elimination and prevent reestablishment of measles transmission, PAHO recommended that routine and supplementary immunization activities achieve 95% coverage with measles-and-rubella-containing vaccines in every municipality (3–5).

Rapid monitoring of vaccination coverage is one approach recommended by PAHO to assess completeness of vaccination activities, especially when coverage is estimated using the administrative method (number of vaccine doses administered divided by the immunization target population) (3, 6), and the target population includes highly mobile age groups such as adults 20–39 years, who may be vaccinated outside their area of residence, making municipal or district-level coverage estimates less reliable. Rapid monitoring may be performed during immunization campaigns to direct end-stage vaccination activities ("mop-up" operations) or as a final evaluation tool to assess the quality of vaccination activities in a given area (6, 7). House-to-house monitoring is recommended to reduce the risk of missing difficult-to-reach populations (3).

To achieve the goal of rubella elimination, Brazil conducted a national rubella immunization campaign in August–September of 2008, targeting 70.1 million men and women or 36.9% of the Brazilian population (8). PAHO's rapid house-to-house vaccination coverage monitoring methodology was adapted for use as a supervisory tool following the campaign. This report describes the methodology applied in Brazil and its use in informing vaccination strategies and decision-making.

MATERIALS AND METHODS

Brazil is the largest and most populous country in South America, with an estimated population in 2008 of 189 million (9). The territory is divided into 26 states plus a Federal District, and 5 564 municipalities. The target population for the national rubella campaign was based on analyses of rubella epidemiology and the country's history of rubella vaccination (10), and included adult men and women aged 20 to 39 years, regardless of prior vaccination, in all 26 states and the Federal District. Adolescents of both sexes 12 to 19 years old were included in five states (Maranhão, Minas Gerais, Mato Grosso, Rio de Janeiro, and Rio Grande do Norte) that had not achieved 90% coverage in campaigns to vaccinate children 1–11 years old with the measles-mumps-rubella (MMR) vaccine (10). The total number of persons in the targeted age groups for vaccination was 70 149 025. The national immunization campaign was conducted from 9 August through 12 September 2008, during which time vaccines were provided at more than 30 000 vaccination posts throughout Brazil, as well as at mobile vaccination booths. Targeted vaccination activities, including house-to-house vaccination in rural areas, continued until 31 December 2008 to reach coverage goals (8). The measles-rubella (MR) vaccine was provided for adults 20–39 years. Adolescents 12–19 years in five states received the MMR vaccine. Pregnant women were instructed to defer vaccination until after giving birth.

During the campaign, vaccinated individuals received a paper vaccination record stamped with the date of vaccination. Health workers recorded the vaccination on immunization cards for individuals who presented cards (i.e., permanent immunization cards were not distributed specifically for this campaign). To facilitate monitoring of vaccinated individuals, health workers placed vaccination stickers on personal documents such as identification cards.

Vaccination coverage at the national, state, and municipal level was estimated during the campaign using the administrative method defined above for each vaccine (MR and MMR). The number of vaccine doses administered was tabulated at the municipal level using summary sheets from all vaccination posts. During the vaccination campaign, municipal health departments reported the number of doses administered using an online system, for real-time monitoring of progress toward coverage goals, and totals from each vaccination post were entered into Brazil's National Immunization Program Information System (SI-API) for consolidation and calculation of official coverage estimates for the campaign.

Rapid coverage monitoring

The methodology recommended by PAHO for rapid house-to-house vaccination coverage monitoring was adapted for use during the rubella elimination campaign in Brazil to achieve the following objectives: to evaluate whether coverage targets (at least 95% vaccination) had been reached at the municipal level; to provide simplified guidelines for data collection by local staff; to conduct a predetermined number of rapid monitoring activities in a short period of time; to provide a method for random selection of areas or blocks for monitoring; to assess coverage among subgroups of the target population (i.e., males and females, adolescents, and adults); to provide information about reasons for not being vaccinated; and to provide data for decision-making.

The National Immunization Program recommended that each municipality conduct at least one rapid monitoring assessment as a final evaluation tool when administrative coverage estimates reached 95% or at the completion of planned vaccination activities in the municipality. For decision-making purposes, a target was set of monitoring coverage in 1%–2% of the population of each municipality, which was equivalent to one rapid monitoring assessment per each municipal vaccination post. The number of persons to be interviewed in each rapid assessment was thus proportional to the size of the immunization target population: in municipalities with fewer than 1 000, 1 000 to 4 999, 5 000 to 9 999, or 10 000 or more residents in the targeted age groups, each rapid assessment would include 25, 50, 75, or 100 persons, respectively.

Immunization coordinators divided each municipality into sectors, each of which was assigned a number. Sectors were delineated according to various criteria, including census tracts, health districts, and maps used by Brazil's national Family Health Program (*Programa Saúde da Família*, PSF) or dengue control program, among others. Each sector was then divided into smaller survey areas or "blocks." Sectors were chosen for rapid monitoring by picking numbers randomly to reach the number of sectors needed to obtain the recommended number of persons in the targeted age groups. External or crossed monitoring, in which teams from different vaccination post areas perform the assessment, was recommended when administrative data indicated that municipal coverage targets (95%) had been reached. Internal monitoring (monitoring by local staff)

was encouraged for identifying unvaccinated populations. The methodology was designed so that rapid monitoring per vaccination post could be completed within an eight-hour work shift, including training of interviewers.

Within the selected sectors, a random point on a map was chosen as the starting point (the initial block to undergo monitoring). A team consisting of an interviewer and vaccinator then moved from door to door in a clockwise direction. The team recorded the number of household residents in the targeted age range, by age group, and asked to see proof of vaccination (campaign stickers or dated vaccination cards). In most states (with the exception of Espiríto Santo, Santa Catarina, and Maranhão), a verbal report of immunization during the campaign was also accepted if the person identified the location and approximate date of vaccination. Persons with medical contraindications and women who were pregnant during the mass immunization were excluded from the assessment, along with individuals who were not present at the time of the interview (unless acceptable proof of vaccination, described above, was presented by a member of the household). The interviewer–vaccinator teams recorded the number of persons with documented vaccination (including proof of MR vaccination prior to the campaign) and asked unvaccinated persons the reason for non-vaccination. Reasons given for non-vaccination were categorized as: a) "vaccinators did not come to my house or place of work"; b) "vaccinators came when I was not in"; c) "no time to get vaccinated"; d) "did not hear about the campaign"; e) "refused vaccination"; f) "medical contraindication"; or g) "other reasons." After tallying the number of unvaccinated persons, vaccination was offered.

The team continued house-to-house monitoring until a sufficient number of individuals had been interviewed. If the required number of persons was not found in a specific block, the team continued to the next-nearest block until the target sample size was reached. In rural municipalities or dispersed populations, immunization coordinators were instructed to conduct monitoring in areas with the highest population density, at first, and to extend it to less densely populated zones if necessary to reach the target number of interviewees.

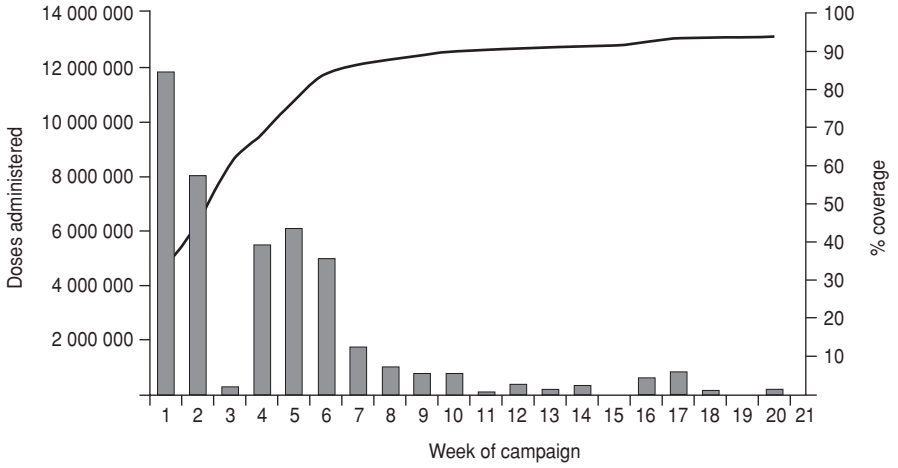
Results of monitoring were tallied for each vaccination post area and at the municipal level. Summary data were then sent to the state health departments, which forwarded the information to the National Immunization Program. Results indicating < 95% vaccination within a specific municipality were considered unacceptable and additional vaccination activities were planned, followed by additional coverage monitoring in randomly selected sectors. Statistical tests were not used to compare administrative coverage estimates to percentages of persons vaccinated according to rapid monitoring assessments due to the non-probabilistic selection of sectors for rapid monitoring.

RESULTS

The rapid monitoring assessments took place over a 14-week period between 13 September and 31 December 2008, following the six-week vaccination campaign. At the end of the six-week period, the administrative coverage estimate was 84.1% (59.0 million doses of MR and MMR vaccines administered) (Figure 1). Targeted outreach and end-stage ("mop-up") vaccination activities, including those conducted as part of the rapid assessments, continued until national administrative estimates surpassed 95% coverage (67.2 million doses administered). In six states, the administrative coverage estimate was > 100% (i.e., the final number of doses administered was larger than the immunization target population due to underestimation of the number of persons in the targeted age groups, or vaccination of persons outside the target population). The majority of persons vaccinated during the extended period of the campaign (seven through 20 weeks after its 9 August 2008 launch) received the vaccine during targeted activities at mobile vaccination booths (versus as-needed vaccination offered during rapid monitoring assessments).

All 26 state health departments and the Federal District reported data for rapid coverage monitoring. Results were available for 3 658 (65.7%) of Brazil's 5 564 municipalities. Table 1 presents the number of persons in the immunization target population, number of doses administered (registered through February 2009), administrative coverage estimates, and results of rapid coverage monitoring, by state. In eight of the 26 states, rapid monitoring results were available for 90% or more of municipalities. In three of those eight states (Minas Gerais, Tocantins, and Roraima), results were available for 100% of municipalities. More than 1.5 million Brazilians were surveyed in rapid monitoring activities, representing 2.1% of the total

FIGURE 1. Number of doses of vaccine (measles-rubella or measles-mumps-rubella)[a] administered in national rubella elimination campaign, and estimated coverage[b] of immunization target population,[c] by week of campaign, Brazil, 2008



[a] Doses registered through 18 February 2009.
[b] Number of doses administered divided by immunization target population.
[c] Number of residents 20–39 years of age (in 21 states and the Federal District) and 12–39 years (in Maranhão, Minas Gerais, Mato Grosso, Rio de Janeiro, and Rio Grande do Norte) according to Brazilian Institute of Geography and Statistics projections published in August 2008.

TABLE 1. Results of rapid monitoring of vaccination coverage versus administrative coverage estimates, by state, for national rubella elimination campaign, Brazil, 2008

State	Immunization target population[a]	No. doses administered[b]	Administrative coverage estimates[c] (%)	No. of municipalities	No. municipalities that "passed" rapid monitoring assessment[d]/ No. municipalities reporting rapid monitoring results (%)	No. persons included in rapid monitoring	% immunization target population included in rapid monitoring
São Paulo (SP)	14 229 325	13 264 224	93.2	645	385/622 (61.9)	225 513	1.6
Minas Gerais (MG)	9 309 954	8 940 668	96.0	853	703/853 (82.4)	152 924	1.6
Rio de Janeiro (RJ)	7 010 456	6 485 971	92.5	92	16/23 (69.6)	73 088	1.0
Bahia (BA)	4 817 915	4 840 642	100.5[e]	417	109/413 (26.4)	96 557	2.0
Paraná (PR)	3 481 027	3 231 359	92.8	399	13/15 (86.7)	73 012	2.1
Rio Grande do Sul (RS)	3 479 660	3 149 112	90.5	496	148/257 (57.6)	285 741	8.2
Maranhão (MA)	3 131 292	3 143 492	100.4[e]	217	4/30 (13.3)	17 940	0.6
Pernambuco (PE)	2 895 223	2 847 007	98.3	185	52/98 (53.1)	66 518	2.3
Ceará (CE)	2 722 181	2 729 469	100.3[e]	184	37/84 (44.0)	176 187	6.5
Pará (PA)	2 447 833	2 374 685	97.0	143	56/122 (45.9)	71 289	2.9
Goiás (GO)	2 072 876	2 056 015	99.2	246	54/94 (57.4)	29 538	1.4
Santa Catarina (SC)	2 019 055	1 965 263	97.3	293	190/267 (71.2)	46 485	2.3
Rio Grande do Norte (RN)	1 514 919	1 448 799	95.6	167	42/76 (55.3)	11 125	0.7
Mato Grosso (MT)	1 472 681	1 452 814	98.7	141	39/81 (48.1)	27 151	1.8
Paraíba (PB)	1 204 565	1 152 010	95.6	223	101/136 (74.3)	38 741	3.2
Espiríto Santo (ES)	1 201 294	1 154 258	96.1	78	36/74 (48.6)	33 908	2.8
Amazonas (AM)	1 152 399	1 111 258	96.4	52	1/13 (7.7)	3 247	0.3
Piauí (PI)	1 015 991	951 825	93.7	223	22/58 (37.9)	44 028	4.3
Alagoas (AL)	1 000 240	1 011 808	101.2[e]	102	10/44 (22.7)	9 062	0.9
Federal District (DF)	910 853	890 866	97.8	1	0/1 (0.0)	6 537	0.7
Mato Grosso do Sul (MS)	778 359	771 566	99.1	78	23/61 (37.7)	27 518	3.5
Sergipe (SE)	687 598	671 223	97.6	75	14/31 (45.2)	2 000	0.3
Rondônia (RO)	550 005	540 392	98.3	62	6/22 (27.3)	6 022	1.1
Tocantins (TO)	461 405	428 744	92.9	139	109/139 (78.4)	15 725	3.4
Acre (AC)	230 826	232 149	100.6[e]	22	5/20 (25.0)	3 108	1.3
Amapá (AP)	211 158	209 414	99.2	16	0/9 (0.0)	747	0.4
Roraima (RR)	139 935	142 616	101.9[e]	15	0/15 (40.0)	11 654	8.3
Brazil	70 149 025	67 197 649	95.8	5 564	2 175/3 658 (59.4)	1 555 365	2.2

[a] Number of residents 20–39 years of age (in 21 states and DF) and 12–39 years (in MA, MG, MT, RJ, and RN) according to Brazilian Institute of Geography and Statistics projections published in August 2008.
[b] Doses registered through 18 February 2009.
[c] Number of vaccine doses administered divided by immunization target population.
[d] Those with rapid monitoring results indicating ≥ 95% of individuals surveyed in the assessment were vaccinated.
[e] Number of doses administered in state exceeded number of persons in immunization target population.

(national) immunization target population of 70.1 million adults and adolescents. In states that accepted verbal reports of vaccination, municipalities reported that persons who presented proof of vaccination (vaccination stickers or dated vaccination cards) far outnumbered those who did not (data not shown). In 2 175 (59.5%) of the 3 658 municipalities reporting rapid monitoring data, assessment results indicated that vaccination targets of 95% coverage had been reached.

In multiple states (Rio Grande do Sul, Ceará, Santa Catarina, Paraíba, Espiríto Santo, Piauí, and Mato Grosso do Sul), rapid monitoring assessments were repeated following additional vaccination activities in municipalities that did not "pass" the first rapid assessment (i.e., those that did not reach 95% coverage), resulting in larger percentages of the immunization target population being interviewed. In the most populous state of São Paulo, with over 14 million adults 20 to 39 years old (i.e., within the target population), nearly 250 000 persons participated in rapid monitoring assessments in 622 (96.4%) of the state's 645 municipalities. The results suggested that local coverage targets had been met in only 385 (61.9%) of the 622 municipalities. Vaccination activities were continued in the municipalities that did not pass the rapid assessment. In Minas Gerais, the state with the second-largest target population and the largest number of municipalities, rapid monitoring continued throughout 2009 until all 853 municipalities had conducted assessments. In the state of Roraima in the Amazon region, rapid monitoring was conducted repeatedly to identify and vaccinate persons who had not been vaccinated during the campaign, but no final monitoring was conducted after these "mop-up" activities to determine if sufficient levels of coverage (95%) had been achieved.

Rapid monitoring results were reported from nearly equal percentages of municipalities across four strata stratified by number of residents in the immunization target population (< 1 000, 1 000–4 999, 5 000–9 999, and 10 000–99 999) (Table 2). The percentage of municipalities in which rapid monitoring

TABLE 2. Results of rapid monitoring of vaccination coverage versus administrative coverage estimates, by number of persons in municipality immunization target population, for national rubella elimination campaign, Brazil, 2008

			Administrative coverage estimates[b]			
			< 95%		≥ 95%	
No. of persons in municipality immunization target population[a]	Total no. of municipalities in Brazil	No. municipalities reporting rapid monitoring results (%)	No. of municipalities	No. municipalities that "passed"[c] rapid monitoring assessment/ No. municipalities reporting rapid monitoring results (%)	No. of municipalities	No municipalities that passed rapid monitoring assessment/ No. municipalities reporting rapid monitoring results (%)
< 1 000	506	324 (64.0)	234	98/129 (76.0)	272	159/195 (81.5)
1 000–4 999	2 789	1 831 (65.7)	1 584	582/973 (59.8)	1 221	604/858 (70.4)
5 000–9 999	1 151	751 (65.2)	621	194/409 (47.4)	560	215/342 (62.9)
10 000–99 999	1 022	691 (67.6)	474	97/309 (31.4)	571	211/383 (55.1)
≥ 100 000	96	61 (63.5)	42	3/28 (10.7)	56	12/33 (36.4)
Total	5 564	3 658 (65.7)	2 955	974/1 848 (52.7)	2 609	1 201/1 810 (66.4)

[a] Number of residents 20–39 years of age (in 21 states and the Federal District) and 12–39 years (in Maranhão, Minas Gerais, Mato Grosso, Rio de Janeiro, and Rio Grande do Norte) according to Brazilian Institute of Geography and Statistics projections published in August 2008, and projections for municipalities from DATASUS / Brazilian Ministry of Health.
[b] Number of vaccine doses administered divided by immunization target population.
[c] Those with rapid monitoring results indicating ≥ 95% of individuals surveyed in the assessment were vaccinated.

showed acceptable levels of coverage was inversely proportional to the size of the target population. Among municipalities where less than 1 000 persons were targeted for vaccination, the percentage that passed their rapid monitoring assessments was similar for those with administrative coverage estimates above 95% and those with estimates below 95%, whereas among larger municipalities, a higher percentage with administrative coverage estimates above 95% passed their rapid monitoring assessments.

Of the 96 municipalities with more than 100 000 inhabitants, 61 (63.5%) reported results of rapid monitoring, including all four cities with more than 1 million inhabitants (Rio de Janeiro, São Paulo, Belo Horizonte, and Salvador). Of the 61 large municipalities that reported monitoring results, only 4 out of 12 capital cities (33.3%) and 15 (24.6%) overall had acceptable levels of coverage (≥ 95%). Coverage levels in targeted age groups for 12 out of all 26 state capital cities are shown in Table 3. These results alerted authorities to the existence of large numbers of unvaccinated individuals in the target age groups (20–39 years in 21 states and the Federal District and 12–39 years in Maranhão, Minas Gerais, Mato Grosso, Rio de Janeiro, and Rio Grande do Norte). Monitoring teams reported high rates of acceptance of vaccination offered to unvaccinated individuals, suggesting that refusal was not a hindrance to achieving coverage targets. Coordinators from municipalities throughout Brazil reported that "not having time" was the most common reason given for non-vaccination during the campaign (data not shown). These findings led to renewed effort to provide additional opportunities for the "hard-to-reach" population, especially young adult men.

In Palmas, the capital of Tocantins, rapid monitoring results were used as justification for concluding vaccination activities. Repeated assessments in Palmas found that 95% or more of persons interviewed had been vaccinated, while administrative estimates were below 80% (Table 3). Following the conclusion of the campaign, the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE) revised its estimate of the immunization target population of Palmas to 76 658 persons, increasing the administrative coverage estimate for the municipality to 97.2%. Several smaller municipalities (e.g., Marcelino Ramos, Rio Grande do Sul [target population 1 416]; Campo Novo, Rio Grande do Sul [target population 1 741]; and Jitaúna, Bahia [target population 7 324]) conducted a complete census of the immunization target population to demonstrate that administrative coverage estimates were based on inflated population estimates and that the 95% coverage targets had been reached. One municipality (Ferraz de Vasconcelos, São Paulo) that did not meet targets according to administrative coverage estimates but passed the 95% target according to rapid monitoring reported that 8.0% of those interviewed had been vaccinated in a different municipality.

DISCUSSION

Use of rapid coverage monitoring at the municipal level in Brazil played a critical role in meeting national coverage targets in the rubella vaccination campaign. Rapid monitoring provided local information about unvaccinated individuals to direct ongoing "mop-up" vaccination. To reach the unvaccinated, municipalities used innovative outreach activities, such as vaccination at football stadiums and concerts of popular music. Rapid monitoring helped reach the national target of 95% coverage for the rubella elimination campaign by raising coverage in specific groups, especially adult males 20 to 39 years of age.

The adapted rapid monitoring approach used in Brazil had several strengths, including the high level of local participation it required, which helped build capacity and ownership, and the immediate feedback of results it provided, which helped maintain political commitment for the rubella elimination strategy. In addition, rapid monitoring allowed for an assessment of the completeness of local immunization activities that did not depend upon the accuracy of pop-

TABLE 3. Results of rapid monitoring of vaccination coverage versus administrative coverage estimates for 12 state capital cities in national rubella elimination campaign, Brazil, 2008

State capital city	Immunization target population[a]	No. doses administered[b]	Administrative coverage estimates[c] (%)	No. persons included in rapid monitoring	No. persons vaccinated	% persons vaccinated	Results of rapid monitoring ("pass"/ "fail"[d])	% immunization target population included in rapid monitoring
Porto Alegre, RS	468 592	454 347	97.0	2 237	1 899	84.9	Fail	0.5
Rio de Janeiro, RJ	2 679 235	2 416 938	90.2	12 284	10 762	87.6	Fail	0.5
São Paulo, SP	3 874 681	3 772 002	97.4	44 655	40 287	90.2	Fail	1.2
Boa Vista, RR	92 809	87 844	94.7	6 099	5 572	91.4	Fail	6.6
Salvador, BA	1 061 746	1 046 138	98.5	5 712	5 251	91.9	Fail	0.5
Maceió, AL	333 133	326 937	98.1	4 349	4 005	92.1	Fail	1.3
Belo Horizonte, BH	1 158 316	1 127 852	97.4	11 185	10 364	92.7	Fail	1.0
Manaus, AM	643 650	662 960	103.0[e]	1 574	1 493	94.9	Fail	0.2
Palmas, TO	96 921	74 493	76.9	2 180	2 077	95.3	Pass	2.2
Vitória, ES	110 476	116 862	105.8[e]	1 327	1 293	97.4	Pass	1.2
Belém, PA	525 824	516 060	98.1	4 616	4 494	97.4	Pass	0.9
João Pessoa, PB	247 603	245 573	99.2	5 776	5 688	98.5	Pass	2.3

[a] Number of residents 20–39 years of age (in RS, SP, RR, AL, BH, AM, TO, ES, PA, PB) and 12–39 years (in RJ) according to Brazilian Institute of Geography and Statistics projections published in August 2008 and projections for municipalities from DATASUS/Brazilian Ministry of Health.
[b] Doses registered through 18 February 2009.
[c] Number of vaccine doses administered divided by immunization target population.
[d] Those reporting rapid monitoring results indicating ≥ 95% of individuals included in the assessment were vaccinated.
[e] Number of doses administered in municipality exceeded number of persons in immunization target population.

ulation estimates. It also identified lack of time as a principal reason given for nonvaccination, leading municipal immunization programs to expand outreach and vaccination posts in convenient locations to create additional opportunities for working adults during the extended period of the campaign. Rapid monitoring has since been used in several states as a follow-up to other immunization activities, including the influenza vaccination of the elderly population and the national polio immunization day for children younger than 5, and has been proposed for use in identifying pockets of unvaccinated children for routine immunizations, and for estimating vaccination coverage against tetanus among women of reproductive age.

In Brazil's major cities, rapid monitoring results helped to alert authorities that there were still large numbers of unvaccinated persons in the targeted age groups despite administrative estimates of nearly 100% coverage. Achieving high and homogeneous vaccination coverage in large urban areas is a priority for rubella elimination goals (5, 11), so this information was critical for campaign success. According to the results of the current study, administrative coverage estimates were unreliable indicators of whether local coverage targets had been met, especially in large cities, where population-based coverage estimates are often problematic due to the large number of people who reside in one area but work in another. Population estimates may also be underestimated in urban areas and overestimated in rural areas due to rural-to-urban migration. Rural-to-urban migrants who missed vaccination opportunities were at increased risk for measles during disease outbreaks in the 1990s (12). It should be noted, however, that Brazil's immunization strategy includes providing vaccination opportunities at all vaccination posts for all persons in the targeted age groups regardless of their municipality of residence to avoid leaving pockets of susceptible individuals.

The method adapted for use in Brazil differed in several ways from that recommended by PAHO for rapid monitoring. First, PAHO recommends choosing suspected "problem" areas—those that are underserved or difficult to access and those with a high proportion of recent migrants or recent cases of vaccine-preventable diseases (3). In Brazil, underserved or difficult-to-access areas were not selected *a priori* as recommended in the PAHO methodology (3) due to the high mobility of the adult immunization target population. Second, PAHO recommends dividing selected areas into blocks or districts and randomly selecting four clusters of five individuals in the target age groups. With an immunization coverage target of 95%, using the PAHO standard method, areas would thus "fail" the rapid monitoring assessment if two or more of the 20 individuals surveyed are unvaccinated, and vaccination activities would be resumed. A systematic, two-step approach to rapid house-to-house monitoring has also been described in which 20 individuals are surveyed, and if one is unvaccinated, an additional 10 individuals are included; finding one additional unvaccinated child leads to "failure" and resumed vaccination (7). The approach adopted in Brazil was a simplified version of the standard approach that did not require extensive training or time. In the Brazilian assessments, a two-person vaccinator-interviewer team surveyed a predetermined number of persons (based on the number of municipal residents in targeted age groups) within each vaccination post catchment area so that 1%–2% of the municipality's immunization target population would be included in monitoring assessments.

As a methodology, rapid monitoring has several limitations. For example, because rapid house-to-house monitoring is a supervisory tool rather than an immunization coverage survey, the assessment results cannot be generalized to the community (13). There were also limita-

tions related to the specific type of rapid monitoring used in the current study, including the fact that priority was given to more populous areas where larger numbers of unvaccinated persons might be found. The exclusion of sparsely populated areas (such as rural areas, which may have lower vaccination coverage) might have inflated the estimated proportion of municipalities nationwide with ≥ 95% vaccination coverage. In addition, rapid monitoring methods were not uniform throughout the country, and there may have been errors in the random selection of the survey areas or blocks, the data recording, or the calculation and summary of results. For example, one state capital city reported 140% vaccination based on its rapid monitoring assessments, presumably by using the number of registered doses (including previous vaccinations) as the numerator, rather than the number of persons vaccinated. Also, data were only available for those municipalities that reported results, and may not include all rapid monitoring that took place, such as follow-up assessments in municipalities that failed the first round of monitoring. Moreover, not all data collected were reported to the national level—many important data, including number of documented versus verbal reports of vaccination, and reasons for not being vaccinated during the campaign, were collected at the municipal level but were not summarized in municipal reports. Finally, there was no independent verification of either the results or the quality of the rapid monitoring (the data presented for analysis were those compiled and reported by state health departments).

Nonetheless, the use of rapid coverage monitoring clearly contributed to the success of the national vaccination campaign to eliminate rubella and congenital rubella syndrome in Brazil. Despite concerns about local capacity to conduct monitoring with limited instruction, local monitoring helped identify pockets of unvaccinated individuals and, by helping to guide "mop-up" activities, contributed to higher vaccination coverage overall. As other countries implement mass vaccination strategies for accelerated control and elimination of rubella and congenital rubella syndrome, consideration should be given to monitoring progress toward vaccination targets at the local level.

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RESUMEN

Monitoreo rápido de la cobertura de vacunación durante una campaña nacional de eliminación de la rubéola en el Brasil

Objetivo. Describir una versión adaptada de la metodología de la Organización Panamericana de la Salud (OPS) para el monitoreo rápido de la cobertura de vacunación. Exponer su uso como herramienta de supervisión para guiar la toma de decisiones y las estrategias para las actividades de vacunación finales (campañas "de barrido") después de una campaña nacional de eliminación de la rubéola de 6 semanas de duración en el Brasil.

Métodos. Los municipios brasileños llevaron a cabo una evaluación de la cobertura de vacunación basada en una variante de la metodología de monitoreo rápido "casa por casa" de la OPS, después de una campaña masiva de vacunación de adultos y adolescentes efectuada entre agosto y diciembre del 2008. Los resultados de las evaluaciones de seguimiento realizadas en 3 658 (65,7%) de 5 564 municipios se comunicaron al Programa Nacional de Vacunación del Brasil.

Resultados. Mediante el monitoreo de la cobertura de vacunación se obtuvo información sobre la vacunación antirrubeólica de más de 1,5 millones de brasileños (2,1% de los 70,1 millones de destinatarios de la inmunización). Según estos datos, se alcanzó la meta de vacunación (cobertura del 95%) en 2 175 (59,5%) de los 3 658 municipios que presentaron resultados. El porcentaje de municipios que alcanzaron la meta de cobertura fue menor que las estimaciones de cobertura administrativa (cantidad de dosis de vacuna administradas dividida por la población destinataria de la inmunización). Estos resultados se usaron para las campañas de vacunación "de barrido" a fin de alcanzar a las poblaciones no vacunadas.

Conclusiones. El monitoreo rápido de la cobertura de vacunación en el nivel local resultó útil para decidir cuándo concluir las actividades de vacunación y en qué aspectos se debían concentrar los esfuerzos posteriores para lograr la cobertura deseada.

Palabras clave Evaluación de programas y proyectos de salud; programas de inmunización; cobertura vacunal; vacuna contra la rubéola; vacuna contra el sarampión-parotiditis-rubéola; prevención de enfermedades; Brasil.