Inequities in Coverage of Preventive Child Health Interventions: The Rural Drinking Water Supply Program and the Universal Immunization Program in Rajasthan, India

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Objectives. I assessed whether the Rural Drinking Water Supply Program (RDWSP) and the Universal Immunization Program (UIP) have achieved equitable coverage in Rajasthan, India, and explored program characteristics that affect equitable coverage of preventive health interventions.

Methods. A total of 2460 children presenting at 12 primary health facilities in one district of Rajasthan were enrolled and classified into economic quartiles based on possession of assets. Immunization coverage and prime source of drinking water were compared across quartiles.

Results. A higher access to piped water by wealthier families ($P<.001$) was compensated by higher access to hand pumps by poorer families ($P<.001$), resulting in equal access to a safe source ($P=.9$). Immunization coverage was inequitable, favoring the wealthier children ($P<.001$).

Conclusions. The RDWSP has achieved equitable coverage, while UIP coverage remains highly inequitable. Programs can make coverage more equitable by formulating explicit objectives to ensure physical access to all, promoting the intervention's demand by the poor, and enhancing the support and monitoring of frontline workers who deliver these interventions. (*Am J Public Health.* 2005;95: 241–244. doi: 10.2105/AJPH.2003.036848)

Rural populations in developing countries access curative care from a range of private and public providers. For preventive care, however, they are largely dependent on public systems. There is a reasonable consensus that the government should continue to play a major role in financing those interventions that are for the public good and those with large positive externalities (as when immunization also benefits the nonimmunized by preventing the spread of a disease)[1]; most preventive interventions fall into this category.

Interventions to prevent illnesses among children are well established; they include immunization, micronutrient supplementation, nutrition counseling, safe water and sanitation, and insecticide-treated bed nets. While children of the poorest families are most likely to need these interventions, the existing (albeit limited) evidence from developing countries suggests that they are less likely to receive them, especially for several years after their introduction.[2] Failure to receive these interventions not only adversely affects the health and survival of the poorer children, but also pushes their families into indebtedness and poverty owing to the high cost of seeking care for their illnesses.

In view of the high potential impact of these services on child health and survival, inequitable coverage is likely to translate into disparities in health outcomes. Describing inequities in the coverage of preventive health services would therefore be useful for guiding child health programs that wish to achieve equity. In this article, I examine 2 public health programs in Rajasthan—the Rural Drinking Water Supply Program and the Universal Immunization Program—that have huge potential for promoting child health. I assess whether these programs have achieved equitable coverage and then discuss the possible reasons why they have or have not.

Rajasthan, located in northwestern India, is the largest state in the country in terms of geographical area. Its population of about 56 million lives in a nonnucleated, dispersed pattern of settlement. The physiography ranges from desert and semi-arid regions to hilly tribal tracts. Literacy levels among women (44%) are among the lowest in the country.[3] The infant mortality rate was estimated to be 80 per 1000 live births in the period 1998 to 1999.[4]

THE RURAL DRINKING WATER SUPPLY PROGRAM

Because of the importance of drinking water in India, the federal government initiated a national drinking water mission in 1985 to "ensure coverage of all rural habitations, especially to reach the unreached with access to safe drinking water."[5(p)] Main components of the strategy formulated by the mission were to provide improvised hand pumps and to establish piped water systems. One of the norms for providing safe water was that a "water source should exist within the habitation or within 1.6 km of the habitation in the plains and within 100 meters elevation in the hilly area."[5(p2)] While the policies and strategies are formulated by the mission, the state government departments (especially the public health engineering department in the state of Rajasthan) are responsible for implementing the drinking water projects. The federal government provides financial assistance to the state governments for implementation on the basis of their need.

By the year 2000, 3.5 million hand pumps and over 100 000 piped water supply schemes had been installed all over the country, providing complete coverage for 83% of rural habitations.[5] By the same year, in Rajasthan, 61% of habitations had been provided complete coverage while another 30% had partial coverage. Of 37 998 villages and hamlets in the state, 23 143 (61%) had at least 1 hand pump, indicating the primacy of this method as a source of safe drinking water in the state.[6]

THE UNIVERSAL IMMUNIZATION PROGRAM

India started the Universal Immunization Program in 1985 with the objectives of rapidly increasing immunization levels by districts, improving the quality of services, and achieving self-sufficiency in vaccine production. It aimed to train all health personnel in the delivery of quality service and supply, as well as in maintenance of the cold chain equipment to keep vaccines safe and effective. To stimulate the program, the government of India converted it into a technology mission in 1987. A large network of procuring, storing, supplying, and delivering vaccines was created within the primary health care system. India also initiated manufacture of the Expanded Program on Immunization vaccines and has largely become self-sufficient in manufacturing some of them, such as BCG vaccine.[7] The coverage levels, however, remained far short of the objectives: in 1998, only 40% of all children throughout the country were fully immunized.[8]

The program was started in Rajasthan the same year as in the rest of the country, with the following objectives:

- To protect all children younger than 1 year by vaccinating them against the 5 vaccine-preventable diseases (measles, diphtheria, tetanus, poliomyelitis, and tuberculosis) and vaccinating all pregnant women against tetanus
- To eradicate polio by the year 2000
- To decrease the incidence of measles by 90% and to decrease deaths owing to measles by 95%
- To eliminate neonatal tetanus

To achieve these objectives, immunization days were organized in all primary health centers on a fixed day throughout the state, and outreach immunization sessions were conducted in the villages on fixed days. Auxiliary nurse midwives (frontline, multipurpose women health workers) conducted these immunization sessions. The government of India provided the supplies and equipment for the program. In view of the program's poor performance in Rajasthan (in 1998, only 18% of children aged between 12 and 23 months were fully immunized),[4] the government of India, through a grant from the World Bank, revised the program. The revised program aims to strengthen monitoring and supervision systems, as well as immunization services for remote populations.[9]

METHODS

Udaipur district, an area of large hills, is located in southern Rajasthan. Thirty percent of its families live below the poverty line of Rs 20000 annually, making it the third poorest district in the state. Forty-four percent of women in the district are literate, and 64% of households have access to a safe source of water (defined as access to piped water or a hand pump).[3]

This article is based on an analysis of data collected as part of an intervention trial that aimed to assess the impact of counseling by trained physicians on the care-seeking behavior of mothers.[10] The pair-matched, community-randomized trial was conducted in 12 primary health centers (PHCs) (6 pairs) of Udaipur district. Over a period of 2 to 6 months after the intervention (in which physicians were trained in counseling skills), children younger than 5 years presenting to these PHCs for curative care, along with their mothers, were prospectively enrolled in the study (average enrollment per PHC=205, range=107–282). A first follow-up home visit by a trained health worker was made within 1 month after enrollment. At this visit, social, economic, and demographic information on the child's family was collected. Mothers were asked about the prime source of drinking water for their family. Mothers who reported that the prime source was either piped water or hand pumps were assumed to use a safe source. Immunization coverage was estimated by examining the immunization cards, or by asking a standard set of questions if the cards were not available.

Of 2460 enrolled children, complete baseline information could be collected for 2365 (average enrollment per PHC=197, range=95–270). I used a score to classify all these families into socioeconomic quartiles (groups 1–4, in order of ascending socioeconomic status) based on possession of assets and amenities, not on household expenditure.[11] I assigned weights to different assets similar to those used by the National Family Health Survey in Rajasthan.[4] I compared the literacy levels of mothers, use of safe drinking water, immunization coverage, and distance from the nearest functional PHC across the socioeconomic quartiles.

Data was analyzed with Stata version 7 (Stata Corp, College Station, Tex). For estimating the significance of differences in access to safe water and immunization coverage across the quartiles, logistic regression analysis was performed, with adjustment for clustering around the PHCs. The nonparametric K-test was performed for estimating significance of differences in median distance of households from PHCs.

RESULTS

The mothers of 1320 of the 2365 children enrolled (56%) were literate. Women of higher socioeconomic status were significantly more likely to be literate than their poorer counterparts (18%, 42%, 72%, and 92% for groups 1–4, respectively; $P<.001$).

Piped water was the most common water source among the enrolled families (41%), followed by hand pumps (37%). The economically better-off families were significantly more likely to have access to piped water than their poorer counterparts (10%, 33%, 54%, and 69% for groups 1–4, respectively; $P<.001$) (Table 1). In contrast, a much larger proportion of the poorer families drew their drinking water primarily from hand pumps (67%, 47%, 28%, and 8%; $P<.001$). However, there were no differences in the use of safe water across the economic groups (77%, 81%, 80%, and 77%; $P<.9$) when the definition of safe water given in the Methods section was applied (piped water or water from a hand pump).

Forty percent of all children aged between 12 and 23 months had received all 5 Expanded Program on Immunization vaccines. Children of the better-off families were significantly more likely than the poorer families to have received all the vaccines (complete immunization coverage=19%, 29%, 46%, and 68% for groups 1–4, respectively; $P=.001$) (Table 2). The higher economic groups had significantly higher immunization rates for all the vaccines except for the oral polio vaccine.

There was strong evidence that poorer families lived at a greater distance from functional primary health facilities than better-off families (median distance=5, 4, 2, and 1 km for groups 1–4, respectively; $P<.001$). There was also clear evidence that complete immunization coverage fell with distance (30%, 32%, 47%, and 55% for groups 1–4, respectively;

TABLE 1—Primary Source of Drinking Water, by Socioeconomic Group[a]: Rajasthan, India

	No. of Families (%) With Indicated Water Source				
	Group 1 (n = 593)	Group 2 (n = 593)	Group 3 (n = 570)	Group 4 (n = 609)	P[b]
Piped water	57 (10)	196 (33)	305 (54)	422 (69)	< .0001
Hand pump	399 (67)	278 (47)	157 (28)	49 (8)	< .0001
Any safe water (piped or hand pumps)	456 (77)	474 (80)	462 (81)	471 (77)	.9
Dug wells/tube wells	135 (23)	116 (20)	105 (18)	136 (22)	. . .
Others	2 (0)	3 (0)	3 (0)	2 (0)	. . .

[a]Groups are numbered in order of ascending socioeconomic status.
[b]Adjusted for clustering.

TABLE 2—Immunization Coverage of Expanded Program on Immunization Vaccines Among Children Aged 12 to 23 Months, by Socioeconomic Group[a]: Rajasthan, India

	No. of Vaccinated Children (%)				
Vaccine	Group 1 (n = 151)	Group 2 (n = 166)	Group 3 (n = 145)	Group 4 (n = 149)	P[b]
BCG	98 (65)	124 (75)	124 (86)	138 (93)	<.001
DPT-3	50 (33)	70 (42)	83 (57)	120 (81)	<.001
Oral polio 3	114 (76)	121 (73)	128 (88)	137 (92)	.5
Measles	40 (26)	65 (40)	81 (56)	108 (72)	<.001
Complete	28 (19)	48 (29)	67 (46)	101 (68)	<.001

Note. DPT-3 = 3 doses (complete primary schedule) of diphtheria-pertussis-tetanus vaccine.
[a]Groups are numbered in order of ascending socioeconomic status.
[b]Adjusted for clustering around the primary health center.

TABLE 3—Complete Immunization Coverage Among Children Aged 12 to 23 Months, by Mother's Education and Distance From Nearest Functional Primary Health Center (PHC): Rajasthan, India

Characteristic	No. of Children Completely Immunized (%)	P
Mother's education, y		
None (illiterate)	56 (20)	<.001[a]
<5	9 (27)	
5–7	46 (42)	
≥8	133 (70)	
Distance of household from nearest functional PHC		
<1 km (nearest quartile)	72 (55)	<.01[b]
1–2 km	70 (47)	
2–7 km	53 (32)	
>7 km (farthest quartile)	49 (30)	

[a]Estimated by logistic regression, adjusted for clustering around PHCs.
[b]Estimated by logistic regression, using the actual distance in kilometers. Adjusted for maternal education and clustering around PHCs.

$P<.001$) (Table 3). The immunization coverage was also independently associated with maternal education ($P<.001$). After adjustment for maternal education, the immunization coverage was still significantly associated with distance, although less so ($P<.01$).

DISCUSSION

The results presented here suggest that the piped water schemes have benefited the wealthier people more than the poorer. However, this drawback has been largely compensated by the poorer people's improved access to the hand pumps. The rural water supply program seems to have succeeded in ensuring equitable access of rural children to safe drinking water through investing heavily in hand pump installation.

There were marked differences in immunization coverage across the economic groups; the poorest quartile had very low levels of complete coverage. An analysis of Demographic Health Survey data conducted by the World Bank also shows large disparities in immunization coverage at the national level.[12] A notable exception to disparity in vaccine coverage was oral polio vaccine, coverage of which was widespread and equitable. The Pulse Polio Campaigns that are currently being conducted 5 times per year in Rajasthan were probably responsible for this high coverage of oral polio vaccine. In the current study, I could not differentiate between the oral polio vaccine given during these campaigns and those delivered through routine immunization.

In this section, I explore some of the factors that explain the findings on coverage of the 2 programs from an equity perspective. The purpose is not to identify a comprehensive list of program characteristics that might affect equitable coverage of preventive interventions, but to generate hypotheses for further work.

It has been suggested that piped water systems disproportionately benefit the better-off people of a village, as they can afford private connections and thus have easier access to water. They can also store piped water in private storage tanks and therefore cope better with erratic piped water supplies. A piped water system is also more expensive per family served; therefore, for a given government expenditure, larger numbers of families can be served by hand pumps than by piped water.[13] The Rural Drinking Water Supply Program, by preferring to invest in a technology that benefits the poorer households, seems to have promoted equitable coverage.

The Rural Drinking Water Supply Program also clearly aimed at ensuring a safe water source within 1.6 km of each habitation. It thus reached all households, including the poorer ones in remote locations. Since the Universal Immunization Program did not specify criteria for ensuring physical access, only those families with easy access to PHCs are likely to be covered. My study, as well as an evaluation of the immunization program in the whole of India, revealed that immunization coverage drops significantly with distance from a PHC.[14]

The greater economic disparities in immunization coverage than in safe water coverage could also reflect poorer households' greater

demand for safe water than for immunization. Whereas drinking water is an elementary perceived need of all, poorer families may not observe the need to get their children immunized. Analysis of Reproductive and Child Health surveys in India has revealed that a large proportion of households with unimmunized children were not aware of the need for immunization.[15] Therefore, whereas programs that address a strong perceived need are likely to be used by all once they are made available, other programs will probably be used preferentially by those who appreciate their benefits.

Compared with drilling hand pumps, which is largely a one-time event (with periodic maintenance), immunization requires the continued efforts of large numbers of functionaries at the ground level who are often overworked and undersupported.[16] In the absence of strong monitoring and support mechanisms, these frontline workers (auxiliary nurse midwives) are likely to focus their limited time and energy on those who are most easily reachable and have a louder voice.

Higher equity in the coverage of the Rural Drinking Water Supply Program, compared with the Universal Immunization Program, could also reflect its significantly higher overall coverage. It has been argued that when an intervention is first introduced, it is used preferentially by the richer, thus widening disparities, but that with increasing coverage, the gaps are reduced.[17,18] While the immunization program has failed to improve coverage, and inequitable coverage therefore continues, high overall coverage of the water supply program could explain its more equitable use.

Limitations of the Study

When interpreting the results of the study, one should keep in mind that the poorest families might have been underrepresented in the study sample, since it consisted of only those families that used a health facility during the study period. This fact, however, probably does not negate the inference, derived from this analysis, that coverage of immunization was much more inequitable than that of safe drinking water supply.

Implications for Policies and Programs

On the basis of the results and discussion presented here, it can be hypothesized that health programs can promote equitable coverage of preventive interventions by the following measures:

- Laying down of explicit objectives in terms of availability of services/products within a reasonable distance from every household/village. In the absence of such objectives, only those living closer to the service point (who are often wealthier) are likely to preferentially use the services.
- Adequate support of frontline workers. In the absence of such support, these workers are likely to preferentially serve the richer and more powerful, thus widening the disparities.
- Efforts to promote appreciation of benefits of preventive services among the poor. In the absence of such efforts, only those who appreciate the benefits of services (the more educated and exposed to the outside world, the wealthier) are likely to preferentially seek these services. An exception is services valued by everybody, not necessarily for health benefits.

Appropriate choice of technology and high overall effectiveness of the program are other program factors that affect equitable coverage. Finally, equity in coverage of preventive health services, as in the current study, can be monitored at the health facility. Such monitoring has greater feasibility (and potentially lower cost) than conducting community-based surveys. ■

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Human Participant Protection

The data presented in this report were collected for a study approved by the ethics committee of Action Research and Training for Health and by the Secretariat Committee for Research on Human Subjects of the World Health Organization, Geneva, Switzerland.

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