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Improving community participation to eliminate lymphatic filariasis in American Samoa

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ABSTRACT

In 2000, the American Samoa Department of Health initiated a campaign of annual mass drug administration (MDA) with albendazole and diethylcarbamazine (DEC) to eliminate transmission of filariasis. Drug coverage was well below prescribed targets in the first three campaigns, ranging from 24 to 52% of the total population. Evaluation findings from a variety of formative research methods identified opportunities to improve MDA coverage and ensuing program modifications resulted in increased drug coverage of 65–71% in the following four annual distributions. Partnering with churches for drug distribution and using multiple media channels for health promotion led to sustained program improvements. With the increased emphasis on the use of mass distribution for delivery of drugs for a number of neglected tropical diseases, other programs may benefit from a similar approach.

1. Introduction

Lymphatic filariasis (LF) is a mosquito-transmitted parasitic disease that affects an estimated 120 million persons throughout the tropics and 1.3 billion persons are at risk of infection (Ottesen, 2006). LF caused by *Wuchereria bancrofti* is transmitted in the United States Territory of American Samoa primarily by *Aedes polynesiensis* (Byrd et al., 1945). LF was first documented in American Samoa in 1923 and transmission persisted despite two rounds of mass treatment with diethylcarbamazine (DEC) in the 1960s (O'Connor, 1923; Murray, 1948; Ciferri et al., 1969; Kessel et al., 1970; Reid and Kimura, 1993).

In May 1997, the World Health Assembly passed resolution 50.29 calling for the "global elimination of lymphatic filariasis as a public health problem" (WHA 50.29 1997). Elimination programs in the Pacific commenced in 1999 with the organization of the Pacific Programme to Eliminate Lymphatic Filariasis (PacELF) (Ichimori and Crump, 2005). The PacELF strategy is to treat annually all persons living in LF endemic areas with a single combined dose of DEC and albendazole for at least 5 years. Mass drug administration (MDA) for 5–7 years is thought to be sufficient to interrupt the transmission cycle if all eligible persons (greater than 80% of the total population) are treated each year (Ottesen et al., 1997).

After a baseline survey in 1999 indicated that the prevalence of circulating filarial antigen was 16.5%, the American Samoa Department of Health (DOH) developed a filariasis elimination program and initiated MDA in 2000 (Ichimori et al., 2006a,b). Nurses from the health department, accompanied by health assistants, were responsible for supervising patient registration and drug administration. Teams of nurses circulated through villages going door-to-door to deliver the drugs. In addition, drug distribution booths were set up at major work locations and the central market. Mobilization in communities was carried out by notifying village mayors of distribution times, broadcasting news about the campaign through local television during government news programs, and handing out health education materials during MDA. The proportion of the total population treated with DEC and albendazole during the first three campaigns, from 2000 to 2002, ranged from 24 to 52%, indicating the need for program improvement (Ichimori et al., 2006b). This manuscript describes the formative research methods used, opportunities identified, changes made in the campaign strategies and the impact on community compliance in MDA.

2. Methods

Between the period of November 2002 and March 2005, several approaches were used to evaluate the program to identify opportunities for improvement. Fig. 1 shows the timeline of program events.

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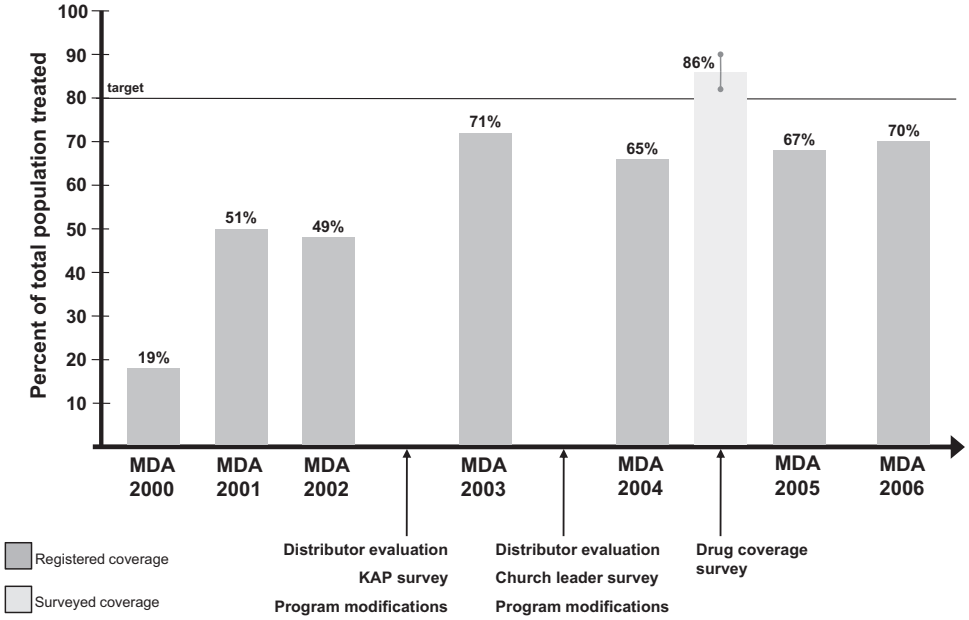

Fig. 1. American Samoa lymphatic filariasis elimination program timeline of events and MDA coverage 2000–2006.

2.1. Registration data analysis

To monitor community compliance, the LF program collected registration and treatment information during each MDA to monitor coverage according to WHO guidelines (WHO, 2005). Drug coverage was calculated after each round of annual treatment. The data for the 2002 MDA were analyzed to determine coverage by age group, gender, and village. The program defined coverage as the proportion of the total population ingesting the drug; in most instances, this was directly observed by the distributor. Total population estimates were taken from the 2000 Territorial Census for the 2001–2004 MDA. The total population was adjusted thereafter with a new census estimate for total population in 2005.

2.2. Distributor discussion groups and individual questionnaires

Following the 2002 and 2003 MDA, focused group discussions were held as part of program evaluation with nurses, program directors, health assistants and volunteers who served as drug distributors. Participants were divided into small groups and asked to respond to questions covering drug distribution strategy, communication strategy, problems experienced in the field, and suggestions for improving the next MDA. The responses for each group and the discussions for the group at large were written down by a recorder.

In addition to the group session, each participant was given a self-administered individual questionnaire with a Likert-type scale to rate different distribution and communication strategies utilized during MDA (Likert, 1932). The questionnaire had a five point rating system with one neutral rating of satisfaction. Participants were also asked to list reasons for their ratings. This individual questionnaire provided the opportunity for participants to give comments anonymously without the risk of publicly offending or disrespecting program leaders and supervisors.

2.3. Community knowledge, attitudes and practices (KAP) survey

Prior to the 2003 MDA, a KAP survey was incorporated into a volunteer field assignment for students enrolled in the American Samoa Community College (ASCC) to identify community perspectives about filariasis and the mass treatment program. A multi-stage, household cluster survey was conducted using the methodology described in Bennett et al., 1991. Twenty clusters, defined as villages, were selected with probability proportionate to size (PPS) and students were instructed to select 12 sequential households from a random starting point within the village. One adult, preferably the household head, was asked to respond to a short questionnaire administered by the students. Prior to the start of the survey all students were trained on techniques for interviewing and sampling methods.

2.4. Key informant interviews

Using a comprehensive list of 179 churches present in the territory in 2002, a simple random sample of 50 churches was selected after the 2003 MDA. Students from ASCC conducted short, structured interviews with the religious leaders of selected churches. The interview consisted of nine questions that explored the leaders' perceptions about partnering with DOH in a disease prevention program, concerns about conducting MDA on the Sabbath, desire to be included in the program, and suggestions about increasing compliance within the community.

2.5. Coverage survey

To validate actual drug coverage, the DOH conducted a multistage, random household survey following the 2004 MDA, as recommended by the World Health Organization (WHO, 2005). Clusters were selected in the first stage by PPS. Households were selected by simple random sampling in the second stage utilizing extensive geographical data available from the American Samoa Department of Commerce. Residential building structures within each selected cluster were given a random number by the random number generation function in Microsoft Excel and sorted in ascending order. The first ten structures became the selected households for the cluster. No alternates were selected for abandoned or unoccupied household structures. Maps and navigational software were used to identify selected households. Interviewers

used Personal Digital Assistants (PDAs) to enumerate all household members present in the territory during the 2004 MDA and record whether each household resident took antifilarial drugs and if not, the reasons for not being treated. All household members who were living in the selected houses during the drug distribution period were included in this survey, regardless of age or current residency status. If residents of the house were not available, an attempt was made to contact them later. If the attempt was unsuccessful, a guardian/parent, spouse or other household member provided a response for absent persons only if knowledgeable about the missing person's treatment status. Additionally, in each household, one resident over 17 years of age was randomly selected by the PDA to respond to a detailed interview regarding awareness of the campaign and reasons for participating or not participating.

2.6. Data analysis

Registration data was entered and analyzed in Microsoft Access 2000. Quantitative and coded responses from the KAP survey and structured interviews were entered and analyzed in Epi Info version 6.04d (Centers for Disease Control and Prevention, 2001). Coverage survey data from PDAs were aggregated in Microsoft Access 2003 from all PDAs and analyzed using the CSAMPLE procedure in Epi Info version 6.04d (Centers for Disease Control and Prevention, 2001).

Qualitative responses from group discussions and structured interviews were analyzed using Grounded Theory analysis, grouping responses according to recurring themes and forming conclusions and hypotheses for improving the campaigns (Glaser and Strauss, 1967).

3. Results

3.1. Registration data

Analysis of the 2002 MDA registration data collected from all drug distributors showed that the program achieved 49.6% coverage. Coverage for males was similar to females at 50.1% and 49.0% respectively. Compliance was highest among school aged children 5- to 14-year old (66.5%), and lowest among young adults aged 20–34 years of age (40.8%). Coverage varied by village, from 16.0% to 96%, but decreased with increasing village size. Residents of small villages (less than 300 people) were more than twice as likely to be treated during the MDA as residents of medium-sized villages (300–1000 residents) (OR 2.37, 95%CI 2.19–2.57) and 3.5 times more likely to be treated as residents of large villages (more than 1000 total population) (OR 3.55, 95%CI 3.29–3.82).

3.2. Distributor discussion groups and individual questionnaires—post-MDA 2002

A summary of group discussions with the teams of nurses and assistants that distributed drugs during the 2002 MDA is presented in Table 1. Nurses preferred house to house distribution as it provided a more personal interaction with families, which they felt was useful, yet found the amount of work and associated logistical issues problematic. They found distribution in public places, like the market, least useful because they felt people did not want to be disturbed from their errands. Nurses agreed that there were opportunities for public distribution but in a different context, where the focus of groups was centered specifically around the distribution; such as scheduled distribution in schools to students or distribution immediately following a church service announced by a church leader. Nurses identified opportunities to improve the social mobilization by utilizing church leaders who, before the 2003 distribution, had not been approached. In the individual evaluations, 64% of respondents indicated they were satisfied with the previous MDAs, although more than half were dissatisfied with what was seen as the extensive work load presented by the campaigns. More than 70% of distributors were satisfied with the mobilization and communication efforts; however, there was less satisfaction with the educational print materials.

3.3. Community knowledge, attitudes and practices survey—pre-MDA 2003

Student volunteers administered and returned 153 KAP questionnaires. Relative to the characteristics of the total population estimated by the 2000 Census, a disproportionate number of young adult females 15–24 years of age were included in the survey; 27.8% of KAP respondents versus 13.2% of territorial census estimates ($p < 0.001$). Of persons surveyed, 126 (82.4%) respondents said that they had heard of 'filariasis' and 68.0% were aware of the DOH filariasis program (Table 2). The most common sources of filariasis information cited by respondents were TV, health care workers and posters, while the least common sources of filariasis information were banners, pamphlets, and churches. A majority (108/153) of survey respondents received prior notification of the distribution. TV (43/108) and radio (37/108) were the most cited sources of hearing about the drug distribution and the least cited sources were the church (2/108) and village mayor (9/108).

Forty-five KAP survey respondents (29%) had never participated in the three rounds of annual MDA prior to 2003. Of the respondents that reported ever participating, 83 had been treated in the 2002 MDA (54.3%). The reason cited most frequently for participating in the MDA was to avoid getting the disease (66/106). The most cited reason for not participating was being unaware of the MDA (16/45). Some respondents perceived no personal risk of becoming

Table 1
Perceptions among drug distributors about strategies used during MDA campaigns 2000–2002.

	Most useful	Least useful	Problems	Opportunities
Drug distribution	House to house School Work place	Central guesthouse within a village Booths in public places	Large geographical area per team Feral dogs Loss of motivation Working overtime with no compensation Distributing after dark Inclement weather Lack of transportation	Target organizations: churches schools businesses/government offices Train more distributors Prioritize use of DOH vehicles
Social mobilization	Visual aids showing disease TV sessions Outreach lectures	Village mayors T-shirts Print materials	Lack of community awareness Rumors of side effects Anxiety of taking many pills for one dose	Share program data with the public All materials should be bilingual Utilize available media outlets Utilize church leaders

Table 2
Distributor satisfaction with aspects of MDA campaigns 2002 and 2003.

Aspect rated	2002		2003		*p*-Value for difference between years[a]
	Number satisfied[b]	Percent satisfied[c]	Number satisfied[b]	Percent satisfied[c]	
Amount of work required	15	48.4	32	80.0	0.005
MDA time period	15	50.0	32	86.5	0.001
Treating at churches	NA	NA	41	100	NA
Treating at schools	11	35.5	37	90.2	<0.001
Treating at workplace	19	59.4	32	86.5	0.011
Treating at clinics	25	78.1	36	94.7	0.069
Overall distribution efforts	20	64.5	36	94.7	0.001
Print materials	19	61.3	39	95.1	<0.001
Registration booklets	NA	NA	38	92.7	NA
Radio announcements	22	75.9	40	95.2	0.027
Live radio broadcasts	NA	NA	40	97.6	NA
TV spots	22	75.9	39	95.1	0.028
Overall mobilization and communication efforts	19	70.4	33	86.8	0.102

[a] Derived from chi-square test; Fisher's exact test was used when an expected value was less than 5.
[b] Number checking "satisfied" or "very satisfied".
[c] Denominator varies because it does not include those checking no opinion.

infected or were not sure whether the disease was a problem in the territory.

Survey respondents (92/153) had additional questions about the disease and the MDA. The most common questions about filariasis concerned etiology; prevention, treatment, or cure; transmission and personal risk. The purpose of the drugs, side effects, and frequency required to prevent the disease were the most common themes of additional questions about the MDA.

3.4. Key informant interviews—post-MDA 2003

Church leaders from 45 of the 50 selected churches were interviewed. Two church leaders declined to be interviewed and three were unavailable during the survey period. Leaders from 46.7% (21/45) of churches estimated their membership to range between 100 and 300 people and an additional third of church leaders led congregations of over 300 members. All of the church leaders interviewed felt that it was a good idea that DOH was seeking assistance from the churches for disease prevention activities. One minister was quoted as saying, "I was very impressed and happy when the nurses asked for my help." Forty-one leaders (91%) had no objections to conducting MDA on the Sabbath, yet only 34 recalled having teams distribute drugs at church during the 2003 campaign. Three ministers felt that MDA on the Sabbath was either a distraction or in conflict with church policy, but that distribution on another day was allowable. All church leaders interviewed stated that they wanted DOH teams to conduct MDA at their church in future campaigns. "I fully support it because all the church members will get a chance to take the pills to eliminate this disease," stated one pastor about the drug distribution at his church. The ministers also suggested that the DOH could encourage people to participate and could use the church to announce the MDA. One church leader suggested that "the best way to catch a Samoan is at church."

3.4.1. Program modifications

Based on the information collected from nurses and other health staff, church leaders and interviewed residents, a number of changes were made to the MDA strategy prior to the 2003 campaign. The specific modifications are listed in Box 1. From 2003 forward, the house-to-house distribution strategy was abandoned. A concerted effort was undertaken to enlist the active support of church leaders both for dissemination of messages about prevention of LF, and for distribution of DEC and albendazole to churchgoers immediately after church services (thereby minimizing disruption to religious ceremonies). Church leaders were engaged to announce the distribution date in advance of the scheduled date and to encourage compliance.

Box 1: Modifications made to the American Samoa Lymphatic Filariasis Elimination Program 2003–2004.

Drug distribution	Condensed campaign time period from 4 to 2 months
	Engaged more distributors
	Distributed DEC and albendazole at churches
	Allowed school principals to direct distribution in schools
	Allowed employers to direct distribution in workplaces
	Conducted MDA at additional crowded public venues such as bingo halls; shopping centers; and the airport
Mobilization	Intensively engaged church leaders/congregations
	Involved island news media
	Held visible events in public venues such as live radio broadcasts
	Engaged schools and workplaces more intensively
Behavior change communication	Focused messages on specific actions, such as pill-taking and specific barriers such as lack of disease recognition
	Advertised village-level participation data of the previous MDA and announced dates of the upcoming MDA in local newspapers
	Broadcasted 30-second radio spots, 2–3 times a day on all local radio stations
	Conducted live radio morning show interviews and television news interviews during the campaign
	Held filariasis—targeted discussions during regular health programming on public television at the start of each campaign
	Broadcasted television spots during high viewing times such as immediately before local news and during high profile sporting events
	Played video testimonial from a Samoan elephantiasis patient in Samoan language with English subtitles on TV and during group presentations

Schools and workplace distributions were used as in earlier MDAs, but greater effort was placed on communicating with school administrators and employers to schedule distribution dates and announce the distribution at their direction. Additional public venues where crowds of residents could be found were also employed for drug distribution, including sites of bingo games, and the airport on the two nights per week that commercial flights arrived from the United States. It was felt that distribution would not be overly intrusive in these venues. Finally, drugs were available from all District Health Centers throughout the MDA time period during normal working hours for all presenting persons. These distribution points provided additional opportunities for non-church goers to participate in the campaign. There was emphasis on directly observed treatment in all distribution venues.

To improve the behavior change communication, radio and television public service announcements were developed to increase awareness of LF and the need for all persons to be treated in MDA. The content of the media spots addressed gaps in knowledge identified by the KAP survey, in particular the lack of knowledge about the infection and disease and the purpose of the MDA. For radio and television spots, we used a variety of techniques, including testimonials, skits, and news announcements providing encouragement of "pill taking" and indicating locations of distribution. Television spots showing cases of elephantiasis and hydrocele were aired on the public TV station prior to the evening news and on a private TV station between widely-viewed major international sporting events such as the Rugby World Cup. Prior to the 2004 MDA, an additional video was developed with a testimonial by an American Samoan woman with elephantiasis, encouraging Samoans to participate in MDA and eliminate the disease that led to her disability.

3.5. Distributor discussion groups and individual questionnaires—post-MDA 2003

Focused group discussions were repeated immediately after the 2003 MDA with nurses and other health staff involved with the distribution to monitor their perceptions regarding changes in the campaign. Compared to the 2002 questionnaire, distributors reported a higher degree of satisfaction with the overall distribution efforts (Table 2). The difference in satisfaction for treating at the clinics between 2002 and 2003 was not statistically significant. All distributors were satisfied with church distribution. While there was no statistically significant difference in reported satisfaction with the overall mobilization and communication efforts, distributors were more satisfied with the print materials, radio and TV spots.

3.6. Coverage survey—post-MDA 2004

Fig. 1 shows annual compliance in MDA and corresponding program events from 2000 to 2006. After the program strategy was modified, coverage increased from 49% in 2002 to 71% in 2003 ($p < 0.001$) and remained consistently higher than the initial years in subsequent MDAs based on registered treatments. To validate coverage after the 2004 MDA, interview teams surveyed a total of 278 of 300 selected households on the main island of Tutuila. A total of 1597 persons were living in the selected households during the time of the MDA from September to November 2004. Surveyed coverage post-MDA 2004 was higher than coverage estimates based on treatment registers. Reported compliance for people living in the surveyed households at the time of the 2004 MDA was 86.4% (95%CI, 83.8–88.9%). Children less than 2 years of age, pregnant women and persons with a serious illness were ineligible for mass treatment. If these ineligible persons are excluded from the analysis, coverage of the eligible population in 2004 was 92.7% (95%CI 90.5–94.8). Assuming that the surveyed coverage of the total population (86.4%) was the true coverage of the population, then based on the actual number of people treated in the 2004 MDA (37,013), we estimate that 42,836 people (lower bound 41,613; upper bound 44,139) were actually living in American Samoa during the MDA.

Teams completed 261 detailed interviews among the 278 households surveyed. 95.4% (249/261) of interview respondents had heard of filariasis, an increase ($\chi^2 = 19.2$; $p < 0.001$) from findings of the 2003 KAP survey (Table 2). These respondents recalled receiving information from TV (62.2%), radio (43.0%), newspaper (39.0%) and the church (27.3%). Among respondents who had heard of filariasis, 91.2% (227/249) said they knew what it was, another increase from the 2003 KAP survey ($\chi^2 = 20.1$; $p < 0.001$). 94.6% of the respondents reported taking tablets at least once since the program inception (247/261); 73.6% reported taking the tablets every MDA (192/261); and 81.6% reported taking the tablets during the 2004 MDA (213/261). Among respondents participating in the most recent MDA, 82.6% received prior notification of the distribution (176/213) which was an improvement from reports from 2003 KAP survey participants ($\chi^2 = 7.4$; $p < 0.01$).

4. Discussion

Achieving and sustaining consistent levels of high coverage is an important, if often overlooked, aspect of programs for the elimination of lymphatic filariasis. Targeting populations living in endemic areas with appropriate health education messages and developing appropriate drug delivery strategies has been a challenge for many programs and coverage has suffered as a result. During the initial rounds of MDA in American Samoa, the coverage level was substantially below the levels thought to be necessary to interrupt LF transmission. Additionally, unsustained treatment campaigns with DEC in the 1960s may have compounded challenges in American Samoa where residents remembered elderly relatives with clinical disease, but currently saw little disease, which may have created the perception identified among KAP survey respondents of no personal risk of infection. Through the careful evaluation of the program, specific opportunities for improving drug delivery, mobilization and communication strategies were identified. Implementation of these changes led to a marked, sustained improvement in drug coverage.

In this setting, the involvement of churches was a key factor in the improved coverage. During the 2004 MDA, over half of the population was treated in conjunction with church attendance. Although these results highlight the value of church-based MDA from the logistic standpoint, it is also important to emphasize the additional benefits to the program of partnering with faith-based institutions, which in American Samoa, was a culturally appropriate way to connect with communities. Because of the prominent role that religion plays in the lives of followers, religious leaders were a valuable and trusted resource for delivery of health and prevention messages and were able to emphasize the altruistic elements of participation in MDA. The lack of connection to the community has been reported to be a major contributor to noncompliance in MDAs for LF and other NTDs (Babu and Kar, 2004; Katabarawa et al., 2000; Talbot et al., 2008). The results in American Samoa suggest that involvement of churches in MDA forges stronger links between community members and health activities and provides a community context for the campaign. The recognition of the special societal role occupied by churches has been a feature of many faith-based health initiatives; however, religious institutions have been underutilized as partners for MDA campaigns. As evident in the initial MDAs, the house-to-house method may have resulted in high coverage in rural villages but overwhelmed the

limited number of distributors in more densely populated villages. Utilizing religious institutions improved compliance in the larger villages.

The proportion of coverage survey respondents ever hearing about filariasis was higher than that reported by KAP respondents, and similarly, the proportion of coverage survey respondents receiving prior notification of the MDA was also higher. This increase in reported awareness was likely due to the number of media outlets used to disseminate information about LF in both Samoan and English language. However, we were not able to dissociate the effects of increased knowledge of the program from the increased compliance due to the involvement of churches in MDA; nonetheless, our results document the value of culturally appropriate health education strategies aimed specifically to address concerns of the target population that were identified by the KAP survey and the utility of targeting specific behavioral outcomes (e.g. pill-taking) in outreach messages. We had a small sample size in the KAP survey due to the students' inability to complete the surveys in the time available, not due to refusal to participate. Additionally, the KAP survey population was biased towards young adult females, who were the persons most likely to be at home during the household visit. Nonetheless, the responses and questions were consistent across age groups and by gender. Therefore, we feel we captured the major gaps in knowledge and the most common concerns of the target population.

Coverage, based on analysis of treatment registers, increased significantly from 2002 to 2003 following the modification of health education and MDA strategies. Because registered coverage may differ from true coverage, we conducted a cluster survey to validate coverage estimates. Treatment coverage in the 2004 MDA based on the survey (86%) was higher than the reported coverage (64%). To our knowledge, this may be the only documented LF coverage survey that showed higher drug coverage than what had been reported based on census estimates. The estimate of the total population living in American Samoa during the 2004 MDA calculated using the survey results (42,836) was less than the 2000 territorial census population estimate of 57,291. Frequent travel and migration of American Samoans to the United States and to neighboring island countries is common and is reflected in the lack of growth in the population based on the 2005 population estimate of 57,881 by the American Samoa Department of Commerce. Territorial census estimates do not account for immigration or off-island migration and may overestimate the actual population living on the islands (and therefore available to participate) during the MDA. Many families in American Samoa have family members living in the mainland United States that may have been included in the territorial census. This could provide an explanation for the difference between surveyed and reported coverage and also suggest the coverage in earlier and subsequent rounds may have been higher than previously estimated.

The coverage survey had several limitations. First, the survey relied on the ability of the individuals to recall whether they had participated in the most recent MDA. Because of resource availability, the survey was conducted 5 months after MDA, so it is possible that some persons did not recall their true treatment status. Additionally, courtesy bias is possible: the respondents could have perceived that interviewers were seeking answers that confirmed compliance and thus said that they had participated when they had not. However, most interviewers (6 of 8) had no role in the drug distribution and were unlikely to prompt a preferred answer. We were unable to confirm whether survey respondents had participated in MDA using registration data, as names of individuals are not collected in registration booklets in order to maintain confidentiality of persons taking treatment and to prevent punitive social actions against persons who decline treatment.

Despite the limitations, the coverage survey (as well as registration data) indicated an improvement in community compliance in 2004; which was sustained in 2005 and 2006 (Fig. 1). In addition, recent sentinel surveillance activities document a significant decline in *W. bancrofti* microfilaremia and antigenemia prevalence following the adaptation of the MDA program (Liang et al., 2008; Mladonicky et al., 2009). In contrast, no decline in filarial infection prevalence was seen over the first 3 years of the program when coverage was low. The temporal association between increased coverage and decreases in filarial infection levels argues that investments in community outreach, social communication and improved MDA delivery pay important dividends in terms of program impact.

In summary, our ability to use different evaluation strategies to monitor the LF program in American Samoa provided important opportunities to modify the program and these changes resulted in increased coverage and greater program impact. With the increased emphasis on the use of MDA for delivery of drugs for a number of neglected tropical diseases, we suggest that other programs would benefit from a similar approach.

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