RESEARCH

EXPLORATORY STUDY INVESTIGATING FACTORS INFLUENCING MASS DRUG ADMINISTRATION (MDA) COMPLIANCE FOR LYMPHATIC FILARIASIS IN SAMOA

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Abstract

Successful elimination of lymphatic filariasis (LF) requires a multi-faceted approach. In Samoa, persistent transmission in residual areas, despite many years of mass drug administrations (MDAs), may be in part due to systematic MDA non-compliance of infected individuals. These individuals could potentially remain as reservoirs of infection, thus impeding successful elimination of LF in Samoa. Data were available for five villages where epidemiological prevalence studies are currently being conducted. Individuals testing positive for LF and children aged 7 to 10 years were asked to participate in a small questionnaire designed to ascertain: 1) level of knowledge of LF, (2) compliance, and, (3) a small number of select risk factors. For the dataset from infected persons, there was a significant association between MDA compliance and knowledge of LF and, for the children, this association also extended to use of mosquito protection. Of those infected, 33% admitted to being systematically non-compliant. This exploratory study highlights the need for restructuring current educational campaigns and their deliverance to appropriately target children and the systematically non-compliant infected individuals. In order to improve compliance, focus needs to be on motivation by informing the individuals of the benefits of MDA compliance versus the dire effects of disease. These findings are critical for the Samoan LF program and should help initiate updating current educational material to improve compliance. Without securing higher rates of compliance amongst those infected, successful elimination of LF in Samoa will be challenging.

Introduction

Lymphatic filariasis (LF) is a mosquito-transmitted, parasitic disease caused by the filarial nematodes *Wuchereria bancrofti* (commonly referred to as bancroftian filariasis), *Brugia malayi,* and *Brugia timori*[1]. LF continues to be a major cause of morbidity worldwide with currently 128 million people infected and an estimated 1.3 billion people at risk of exposure[2]. Of those infected, 40 million face incapacitation and disfigurement[4]. Consequently, LF is ranked by the World Health Organization (WHO) as the second-leading cause of permanent disability worldwide, after mental illness [2].

In 1997 the 50th World Health Assembly forum acknowledged the morbidity and socioeconomic costs of LF, the general lack of awareness of the disease and the potential for its eradication[3]. Subsequently, in 1999, the Global Program to eliminate LF (GPELF) [4], and the Pacific Program for the Elimination of LF (PacELF)[5] were formed. Both programs have employed mass drug administrations (MDAs) with accompanying vector control, where appropriate, to reduce LF prevalence below a transmission threshold [4, 5]. Importantly for the present paper, successful elimination has been linked to community involvement and MDA compliance [6-8], where untreated cases remain as disease reservoirs[9, 10].

Sixteen of the 22 countries in the Pacific, falling under the jurisdiction of PacELF, were classified as endemic for bancroftian filariasis[11]. Five of these, including Samoa, have completed at least the obligatory five rounds of MDA and were recently assessed for their post-campaign prevalence[12]. The investigation revealed a low level persistence of LF transmission in Samoa[12], consistent with earlier reports of resurgence in Samoa[13], and thought to be the result of residual groups of non-compliant, infected individuals[12]. This reported persistence of transmission in Samoa emphasizes the need for community surveys to ascertain levels of MDA compliance and general awareness of LF.

Due to this need for further information and understanding about MDA compliance, the present paper is an exploratory study that assesses the links between levels of knowledge and awareness of LF and MDA compliance in a group of infected individuals. Additionally, since ongoing educational campaigns may be required to ensure that the younger population remains aware of the im-

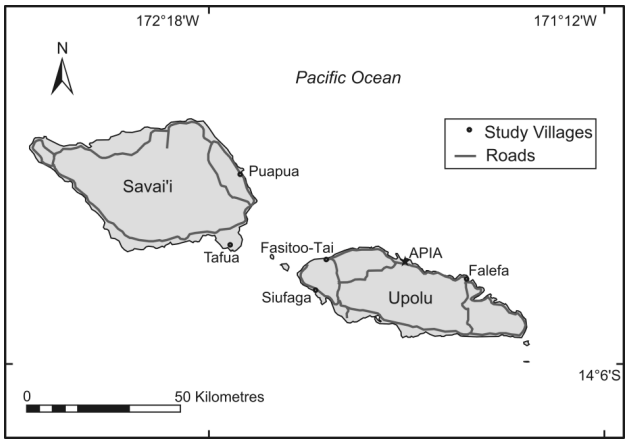
portance of MDAs and disease, a group of children born after the formation of PacELF (7 to 10 years), was also assessed for these characteristics.

Materials and Methods

Study Population

Data was available for five villages where epidemiological prevalence studies are currently being conducted (by HJ) under human ethics approval number H1423, as approved by the James Cook University Research Human Ethics Committee (Figure 1). The current study protocol was also reviewed by the Samoan Ministry of Health for approval prior to commencing the research. In these villages, TV and radio are key media

Figure 1. Location of the 5 study villages in Samoa. On Savai'i, the two villages were Tafua and Puapua. On Upolu the three villages chosen were Fasitoo-Tai, Siufaga and Falefa. The capital city, Apia, is included on the map as a reference.



for the provision of information to the population generally, i.e. the study area is not isolated from information about LF and LF elimination programs, as are more remote parts of the country. Data were available for two groups in the population:

- CFA positive group: Individuals who tested positive for circulating filarial antigen (CFA) during the epidemiological study were asked to participate in a brief survey, regardless of their age (Table 1a).
- Children aged 7 to 10 years: All children aged between 7 and 10 years were also asked, through their parents and carers, to participate in a similar brief survey (Table 1b).

Ongoing transmission in the 5 study villages was defined in two ways:

1. Based on the detection of microfilaraemic (Mf) positives[4]; residents from villages with Mf positive people were classified as "high Mf prevalence" and those from areas where no Mf people were detected were classified as "low Mf prevalence"; and,
2. Based on the presence of CFA positive children[4]; residents from villages where CFA prevalence in children exceeded 1% were classified as "high prevalence" and those where CFA prevalence was below 1% were "low prevalence". The threshold set by the WHO for ongoing transmission is ≥ 0.1% of CFA positive children born after the initiation of effective MDAs[4]. For this study a slightly higher threshold of ≥ 1% was set to be confident that transmission was occurring. The areas are referred to as "high CFA prevalence" or "low CFA prevalence".

Defining MDA Compliance

Individuals who had participated in ≥ 1 MDA were considered compliant, regardless of whether they participated every year. Those who did not participate in any MDA were recorded as "systematically non-compliant". This definition was crucial since only those systematically non-compliant are deemed the true reservoirs of infection and contribute to persistent transmission[10]. This is because those who are sporadically non-compliant would have received treatment at some point in time[14].

Since retrospective studies have limitations concerning recall bias, in order to prompt a participant's memory (especially the children), participants were shown the tablets when asked if they participated in MDAs. Most importantly, participants were asked if they "swallowed" the tablets given to them, since there have been differences noted between the distribution of tablets and their consumption[15, 16].

Questionnaire

Prototype questionnaires underwent rigorous pilot testing prior to their application in the field. Personnel with a long-standing association with public health programs edited the questionnaires based on their experiences and cultural understanding. Trial interviews were conducted with volunteers who were either members of staff or younger members of their respective family. From this, minor changes were made and both questionnaires were translated into Samoan. Samoan staff members from the Ministry of Health generously volunteered to assist the researchers to conduct the interviews. F Maiava translated the answers into English.

Table 1a: Demographics of CFA positive individuals participating in the questionnaire (n=153). Ongoing transmission was defined as village of residence having either detectable Mf positives (high or low) or ≥ 1% CFA prevalence in children aged ≤ 10 years[4].

	Mf* high	Mf* low	CFA** high	CFA** low
Male	73	39	97	15
Female	32	9	37	4
Total participants	**105**	**48**	**134**	**19**
Median age, years	36	37	36	47
Age range, years	5-90	2-79	2-90	4-79

Mf = microfilaraemic
**CFA = circulating filarial antigen

Questions asked of CFA positive individuals were designed to ascertain their level of knowledge of LF and to assess contributing factors for MDA non-compliance. The questions were:

1. Do you swallow the tablets from Mass Drug Administrations?
2. Have you heard of lymphatic filariasis?
3. Do you know how lymphatic filariasis is transmitted? If 'yes', how?
4. Do you use protection against mosquitoes? If 'yes', what type?
5. Have you tested positive for infection previously? If 'yes', when (which year/)?

The questionnaire designed for the children aged 7 to 10 years was a truncated version of the questionnaire for CFA positive adults and older children to predominantly ascertain the level of knowledge and MDA participation. The questionnaire was administered by Samoan staff members of the Ministry of Health. Every child residing in the village was asked to participate. Children were either interviewed in their place of residence or at their respective primary school if they attended. Prior to the interview process verbal consent was obtained from a parent or guardian. In addition, for those children attending school, permission was also sought from the school principal. The questions were:

1. Do you swallow the tablets that are given out? (Health worker shows the child the tablets).
2. Have you heard of lymphatic filariasis?
3. Do you know how you get lymphatic filariasis? If 'yes', How?
4. Do you use protection against mosquitoes? If 'yes', what type?

Statistical Analysis

Data was analysed using Stata (version 9.0). For continuous data (age) means were compared using t-tests.

For categorical data, logistic regression was used in univariable analyses. In the children aged 7 to 10 years, the association between MDA compliance and whether the child had heard of LF (key independent variable) was assessed as well as potential confounding variables including gender, age, use of mosquito protection and number of residents in the household. For the CFA positive group, available data also described socio-economic variables including employment, amount of time spent around the home or away from the home at work, whether their leisure time was spent predominantly indoors or outdoors, and whether they had tested positive for LF in previous years.

Table 1b: Demographics of children aged 7 to 10 years participating in the questionnaire (n=309). Ongoing transmission was defined as village of residence having either detectable Mf positives (high or low) or ≥ 1% CFA prevalence in children aged ≤ 10 years[4].

Characteristic	Mf* high	Mf* low	CFA** high	CFA** low
Male	64	109	111	62
Female	55	81	84	52
Total Participants	**119**	**190**	**195**	**114**

*Mf = microfilaraemic
**CFA = circulating filarial antigen

In multivariable logistic regressions, the effects of potential confounders on the association between MDA compliance and whether the child or adult had heard of LF were assessed by stepwise inclusion of each variable in the model. A potential confounding variable was defined as one that caused a change of +/- 5% in the odds ratio.

Separate analyses were performed to compare areas with high and low Mf prevalence and to compare areas with high and low CFA prevalence.

Table 2: Odds ratios (ORs) and 95% confidence intervals (95%-CI) for factors compared with MDA compliance in 153 CFA positive individuals in five Samoan villages as determined with uni-variable regression modelling. Significant associations (P<0.05) for MDA compliance (key independent variable) are highlighted in bold text.

Factor	Value	MDA compliance	OR	95%-CI	P*	
		No	Yes			
Have you heard of LF?	No	30	37	1.0		
	Yes	20	66	2.7	1.3-5.4	**0.005**
Heard of national programme?	No	26	28	1.0		
	Yes	24	75	2.9	1.4-5.9	**0.003**
Use mosquito protection?	No	11	21	1.0		
	Yes	39	82	1.1	0.5-2.5	0.818
Gender	Male	32	80	1.0		
	Female	18	23	0.5	0.2-1.1	0.076
Age (continuous variable)	Mean	30	39	|t|=2.79		
	SD	19	18			**0.006**
Number of residents in the household	2-5	11	36	1.0		
	6-10	27	48	0.5	0.2-1.2	
	≥ 11	12	19	0.5	0.2-1.3	0.244
Paid employment	Unemployed	26	39	1.0		
	Employed	11	11	0.7	0.3-1.8	
	Farmer/ plantation	13	53	2.7	1.2-6.0	**0.007**
Hours spent at home	< 4 hours	27	60	1.0		
	4 hours or more	23	43	0.8	0.4—1.7	0.619
Hours spent at work	Do not work	29	45	1.0		
	< 4 hours	1	13	8.4	1.0-67.5	
	4 hours or more	20	45	0.2	0.7-2.9	**0.033**
Where leisure time	Indoors	28	52	1.0		
	Outdoors	7	20	1.5	0.6-4.1	0.378
CFA previously	No	45	76	1.0		
	Yes	5	27	3.2	1.1-8.9	**0.026**

* Likelihood-ratio chi^2

Results

CFA positive group

Uni-variable analyses

Of 153 participants in this group, 69% (n=105) were from villages in areas with high Mf prevalence and of these the majority (88%) were from villages in areas with high CFA prevalence (Table 1a). Comparing areas with high prevalence to areas with low prevalence, for both Mf and CFA, there was no statistically significant difference between the proportions of males and females (P=0.129 and P=0.546 respectively). The average age of participants when defining the groups by high or low Mf prevalence was also similar (35 years and 38 years respectively) (t=0.74; P=0.459). However, the average age of participants in the high CFA prevalence group (35 years) was less than the average age in areas with low CFA prevalence (46 years) (t=2.47; P=0.015).

Among the 153 CFA positive participants, 67% (n=103) reported MDA compliance and 56% (n=86) had heard of LF. In uni-variable analyses, those who reported that they had heard of LF were around three times more likely to report MDA compliance than those who had not heard of LF (P=0.005; Table 2). Furthermore, there was a similarly strong association between self-reported MDA compliance and whether the participant had heard of the national LF program (P=0.003; Table 2). However, it is of interest that among those who stated that they had not heard of LF, 37% reported they had heard about the national LF program, while just 14% of those who had heard of LF said they had not heard about the national program (data not shown).

Of the 86 participants who had heard of LF, 57% (n=49) said they knew how it is transmitted with most of these (94%=46/49) reporting they believed mosquitoes transmitted it. Although there was no statistically significant

association between MDA compliance and self-reported use of any mosquito protection (P=0.818; Table 2), the majority of the sample (79%=121/153) reported they used some form of mosquito protection and most of these (84% =102/121) said they used a bed net.

The data show that those who reported MDA compliance tended to be older (39 years compared with 30 years; P=0.006) and more likely to be farmers or plantation workers compared with those who were unemployed (P=0.012; Table 2). There was no significant association between MDA compliance and spending more time outdoors (P=0.378; Table 2). Thirty two participants reported testing positive for CFA in previous years. Of these, 53% (n=17) reported they had heard of LF, 69% (n=22) had heard about the national program and 59% (n=19) reported they initially tested positive during the years from 2005 to 2007. Those previously CFA positive were more likely to report MDA compliance (84% =27/32; P=0.026; Table 2). The data also appear to indicate that women tended to be less likely than men to report MDA compliance (P=0.076; Table 2). Finally, those who were employed tended to be more likely to report MDA compliance (OR=1.8, 0.9-3.5, P=0.099), although the association was not statistically significant (data not shown).

Table 3: Odds ratios (ORs) and 95% confidence intervals (95%-CI) for factors compared with MDA compliance in 153 CFA positive individuals in five Samoan villages as determined with multivariable logistic regression modelling. The effects of potential confounders on the association between MDA compliance and knowledge of LF were assessed in the sample overall, in analyses restricted to areas where Mf prevalence was high and to where it was low and where CFA prevalence was 'high' and where it was 'low'. Significant associations (P<0.05) with MDA compliance are highlighted in bold text.

Factor	Value	N	OR	95%-CI	P*
Sample overall		153	2.4	1.1-5.3	**0.034**
Mf prevalence	High	105	2.9	1.0-7.9	**0.042**
	Low	48	1.6	0.3-7.8	0.560
CFA prevalence	High	134	2.8	1.2-6.6	**0.020**
	Low	19	1.1	0.0-105.7	0.970

* Likelihood-ratio chi^2

Multi-variable analyses

The results of multiple logistic regressions are tabulated (Table 3). To assess the impact on the association between MDA compliance and knowledge of LF, potential confounders were added one at a time sequentially in the regression model. Inclusion of the variables: age, gender, previous CFA positivity, hours spent at home and hours spent at work each caused changes of +/- 5% in the OR. Although the association weakened, those who reported that they had heard of LF remained significantly more likely to report MDA compliance than those who had not heard of LF (P=0.034; Table 3). The association remains strong when data were analysed for areas with high Mf prevalence (P=0.042) or CFA prevalence (P=0.020), but when data for areas of low Mf/CFA prevalence were analysed there was no association (P=0.56 and P=0.97 respectively; Table 3).

Children aged 7-10 years

Uni-variable analyses

Of the 309 children surveyed, 39% (n=119) were from villages in areas with high Mf prevalence (Table 1b). Comparing areas with high Mf prevalence to areas with low Mf prevalence, there was no statistically significant difference between the proportions of males (54% and 57% respectively) and females (46% and 43% respectively) (P=0.537). Almost two-thirds (63%) of the 309 children were from villages in areas with high CFA prevalence (Table 1b). Areas with high CFA prevalence also had similar proportions of males and females in the sample (57% and 43% respectively) as areas with low CFA prevalence (54% males, 46% females; P=0.665).

Among the children, 48% (n=147) reported MDA compliance and 27% (n=84) had heard of LF. In uni-variable analyses, those who reported that they had heard of LF were also around three times more likely to report MDA compliance than those who had not heard of LF (P<0.001; Table 4).

Of the 84 children who had heard of LF, 35% (n=29) said they knew how it is transmitted with the majority (93%=27/29) reporting they believed mosquitoes transmitted it. Unlike the infected group, the association between MDA compliance and self-reported use of any mosquito protection among the children was statistically significant (P<0.001; Table 4). Additionally, the majority of the children (84% =261/309) reported they used some form of mosquito protection and most said they used a

Table 4: Odds ratios (ORs) and 95% confidence intervals (95%-CI) for factors compared with MDA compliance in 309 children (aged 7 to 10 years) in five Samoan villages as determined with uni-variable regression modelling. Significant associations for MDA compliance (key independent variable) are highlighted in bold text.

Factor	Value	MDA compliance	OR	95%-CI	P*	
		No	Yes			
Have you heard of LF?	No	135	90	1.0		
	Yes	27	57	3.2	1.9-5.4	**< 0.001**
Use mosquito protection?	No	39	9	1.0		
	Yes	123	138	4.9	2.3-10.4	**< 0.001**
Gender	Male	92	81	1.0		
	Female	70	66	1.1	0.7-1.7	0.765
Age (continuous variable)	7	36	35	1.0		
	8	39	45	1.2	0.6-2.2	
	9	44	36	0.8	0.4-1.6	
	10	43	31	0.7	0.4-1.4	0.481
Number of residents in household	2-5	26	34	1.0		
	6-10	108	77	0.5	0.3-1.0	
	≥ 11	28	36	1.0	0.5-2.0	**0.038**

* Likelihood-ratio chi^2

bed net (78%=203/261).

The data also indicate that those children living in crowded houses with 6-10 residents tended to be significantly less likely to report MDA compliance (P=0.038; Table 4). For example, those children living in houses with 6-10 residents were around half as likely as those living in houses with 2-5 residents to report MDA compliance. There were no statistically significant differences between those who reported MDA compliance and those who did not in terms of gender and age (Table 4).

Multi-variable analyses

To assess their impact on the association between MDA compliance and knowledge of LF, potential confounders were added one at a time sequentially in multiple logistic regressions (Table 5). Only the variable 'use mosquito protection' caused a change of +/- 5% in the OR. In multi-variable analysis with 'use mosquito protection' included as a confounder, those who reported that they had heard of LF remained significantly more likely to report MDA compliance than those who had not heard of LF (P<0.001; Table 5). Unlike the data from infected persons, the association is stronger where data for areas with low Mf prevalence are considered alone (P=0.003) and is around the same level, and statistically significant, in areas with both high (P=0.003) and low (P=0.016) CFA prevalence (Table 5).

Discussion

This exploratory study underlines the link between knowledge and awareness of LF and compliance with treatment campaigns in Samoa. This observation between knowledge of LF and/or national campaigns and MDA compliance is not a new concept for the global LF program[16-23] and, in fact, health education and information has been identified as a crucial accompaniment to MDA campaigns and other public health programs [7, 24-27]. Initially, for the LF program, population compliance was reliant on the high prevalence of chronic cases, serving as an incentive for community participation, and initial comprehensive educational campaigns[28]. As disease prevalence declines, it becomes challenging to convince asymptomatic individuals to consume tablets because of the misconception that only those with visible signs of disease are infected[29, 30]. As prevalence of LF decreases the need to target these systematically non-compliant individuals

Table 5: Odds ratios (ORs) and 95% confidence intervals (95%-CI) for factors compared with MDA compliance in 309 children (aged 7 to 10 years) in five Samoan villages as determined with multivariable logistic regression modelling. The effects of potential confounders on the association between MDA compliance and knowledge of LF were assessed in the sample overall, in analyses restricted to areas where Mf prevalence was high and to where it was low and where CFA prevalence was 'high' and where it was 'low'.

Factor	Value	N	OR	95%-CI	P*
Sample overall		309	3.0	1.7-5.2	**< 0.001**
Mf prevalence	High	119	1.9	0.8-4.7	0.139
	Low	190	4.1	2.0-8.4	**< 0.001**
CFA prevalence	High	195	3.0	1.5-6.3	**0.003**
	Low	114	2.8	1.2-6.6	**0.016**

* Likelihood-ratio chi^2

escalates. Health education needs to refocus on the effects of disease in those asymptomatic[29].

In 1999, Samoa was the first country to conduct MDAs under the direction of the WHO[4,31]. The reported MDA coverage for the 5 rounds conducted in Samoa from 1999 to 2003 was 90%, 57%, 68%, 60% and 80% respectively[12, 32]. It is believed that sustained MDA coverage > 80% annually for 4 – 6 years is required in order to interrupt transmission of LF[33]. It could be speculated that, since only 2 of the 5 rounds achieved this target, low MDA coverage could be a contributing factor to persistent transmission. Additionally, drug distribution for MDA campaigns in the South Pacific did not generally enforce directly observed therapy (DOT) and thus it is unknown whether drugs were consumed which could further affect MDA coverage percentages[12]. Lack of compliance was attributed to, in the current exploratory study, a lack of knowledge concerning LF. This highlights a critical niche for the Ministry of Health to design innovative educational campaigns to optimize targeting those non-compliant.

Education campaigns prior to the implementation of each MDA were mandatory for Samoa and were based on materials supplied by PacELF. PacELF designed information, education and communication (IEC) materials for all Pacific countries when it was first initiated[32]. IEC materials included pamphlets, posters, and T-shirts which, in 2003, were updated from the dire effects of filariasis morbidity to more positive images of children and adults taking the medication[32]. Interestingly, another means for the community to gain information concerning LF elimination is via the PacELF website and, despite logistical difficulties of internet access, quite a large proportion of those who access the website reside in the Pacific Islands[32]. In Samoa, additional education measures included radio-talk back shows, TV live panels, pamphlets, and calendars demonstrating rugby players swallowing the tablets. Radio-talk back shows allowed individuals to telephone and raise queries concerning the disease and upcoming MDAs. The live TV panel involved discussions between doctors, nurses and health officers with community leaders to raise awareness of the disease and the forthcoming MDA. Since access to technology is limited in areas of Samoa, some isolated residents relied on word of mouth, via relatives or village mayors. The effects of education campaigns on general knowledge within the community were not formally assessed in Samoa using knowledge attitude and practice (KAP) community surveys (WHO Samoa, *personal communication by F. Maiava*), which have been shown to significantly improve MDA compliance in Indonesia[34].

In May 2008, a Communication for Behavioral Impact (COMBI) study was conducted in two villages in Samoa, one with high Mf prevalence and the other with zero Mf prevalence prior to the June MDA. The purpose of the study was to assess the behavior of people in their daily lives and how this impacts on their compliance with MDA. The main findings from this study were:

1. Higher rates of compliance could be achieved if drugs were distributed on the weekend;
2. The maximum impact of awareness of upcoming MDAs was mornings for radio media and evenings for TV media; and
3. Higher rates of compliance could be secured if health professionals/ personnel distributed drugs rather than people elected from the community (WHO, *personal communication by F. Maiava*).

The success of the high MDA coverage that followed was to some part attributed to the findings of the COMBI study, which were implemented for the June MDA. However, since only 2 villages were assessed because of time constraints, much larger COMBI studies should be conducted in the future. In addition, the findings from the current exploratory study argue for this necessity and for the reassessment of current means to disseminate the educational message.

Of concern, in the current study in Samoa, only 67% of infected people and 48% of children were recorded as MDA compliant. Consequently, those 33% systematically non-compliant infected individuals remain as reservoirs of infection contributing to the persistent transmission observed in Samoa and, thus, impeding successful elimination of LF[8]. Furthermore, although those who had tested CFA positive in previous years were significantly more likely to be compliant, even more alarming is that 16% (n=5) still admitted to having never participated in MDAs. Whether these individuals, after initially testing positive, were compliant with their own individual treatment program is unknown.

The data indicate that the lack of MDA compliance could be due to a lack of knowledge concerning the disease, since those who had heard of LF were three times more likely to be MDA compliant, which was also the case for children (Tables 2 and 4). However, further

studies must also focus on beliefs, since this can be a strong driving force for drug adherence[35, 36]. The link between knowledge and compliance is a crucial finding for the Samoan LF program, as it highlights the necessity to either implement further educational campaigns or to reassess the existing ones in terms of reaching the target audience appropriately. This is especially highlighted by the discrepancy between people having heard of the disease, but not the national program to eliminate LF (14%). Furthermore, of those who had tested CFA positive in previous years, only 53% had heard of LF and 69% of the national LF program. This is very disappointing considering these individuals remembered testing positive, but did not understand the significance. These people require immediate attention.

The fact that, for the dataset from infected persons, the link between knowledge of LF and compliance remained strong in areas of high Mf or CFA prevalence in children (Table 3) is encouraging news for the Samoan LF program. It means that if these areas of residual endemnicity are targeted with appropriate education campaigns and health promotion models, then levels of MDA compliance should increase. Ideally this will decrease prevalence. Why, for the dataset from children, this significant relationship was not observed in areas of high Mf prevalence is unknown (Table 5). It could be speculated that in areas of high Mf prevalence there is a reduced number of children attending school because such areas are usually associated with poorer socioeconomic standards[16, 37-39] Consequently, children would be less likely to recognize the association between treatment and disease. However, school attendance figures were not confirmed and, thus, the differences in the strength of association between understanding disease and complying with the MDA in different prevalence areas should be further studied.

Individuals within villages with a lower socio-environmental composite index usually represent areas of higher LF endemnicity[37]. Factors such as overcrowding, poor sanitation, little education, and poor housing construction contribute to a lower composite index[38, 39] This is interesting since, in the current study, children from crowded households with a larger number of residents (6-10 people) were about half as likely to be MDA compliant than those children residing in households with <6 residents (Table 4). This raises some important questions regarding why these children are less likely to be compliant.

Overall, the publicity campaigns preceding the annual MDAs in Samoa appeared quite comprehensive involving a range of media. Therefore, in Samoa, efforts must be concentrated on assessing why the message is not being received and why these individuals are systematically non-compliant. Is it because those non-compliant do not have access to media? Is it because the message itself is not pertinent? Is it because the message is not adequately targeting those non-compliant or young children? Is the compliance status of children related to that of their parents? These questions could be explored using focus group discussions involving the community, trained health workers, and social scientists[24, 25, 29, 40-45] These focus group discussions could also include those individuals identified as systematically non-compliant to discover the reasons behind this. As part of these discussion groups, the beliefs of the participants need to be explored using qualitative research methods, as cultural and religious beliefs can be a driving force for drug adherence (western vs. non-western medicine)[35].

The data emphasizes the necessity for targeting these areas of residual endemic foci with appropriate education campaigns, health promotion models, and qualitative research to understand the reasons behind non-compliance. Specific communication exercises targeted to problem areas has shown improved MDA compliance in Kerala, India[46]. Secondly, successful elimination of LF in Tanzania has been in part attributed to community acceptance of the prevention and control activities via targeted educational campaigns[28]. In Samoa, new educational campaigns need to address: strategies to motivate participation, innovative public health messages, and different ways to disseminate the health messages. Most importantly, qualitative research must be conducted to explore the reasons for non-compliance.

Dissemination of the health message can include the use of church groups, which has had some success in India[20], schoolchildren[40, 47-50] or known members of the community[16, 51]. The latter has been identified as unsuitable for Samoa in the recent COMBI survey and, potentially, use of non-medical staff can result in misunderstandings concerning health messages[20]. Secondly, use of church groups may be inappropriate in areas where there are religious differences, since it has been shown in the OCP that people of differing religious denominations are reluctant to consume tablets distributed by a different church group[51]. In addition, the credibility of the source and the

person's status in the community must also be considered. Interestingly, in Samoa, drug distributors consist of health personnel, assisted by women's committees and, in some areas, church groups. Whether the choice of distributor has a direct effect on compliance in Samoa is yet unknown, but requires further investigation.

Another important finding warranting attention is that the older age group who were employed tended to be compliant (Table 2). Whether this was because of a wider knowledge base, social contact with other co-workers, or a higher level of education is unknown and warrants further investigation. It has been found previously that awareness of protection against mosquito biting was positively associated with better education and employment of the head of the household[38]. Whether this finding is transferable to MDA compliance is unknown, but in Sri Lanka those earning a middle income were found to have higher compliance than the lower income earners[16]. The finding from the current study could be exploited to ascertain why employed personnel are more likely to be MDA compliant. There were no significant associations between compliance and whether an individual spent more time indoors or outdoors (Table 2).

Males tended to be compliant, albeit not at a significant level (Table 2). This finding is interesting since men in Samoa have a three to five-fold higher Mf prevalence than females[31]. Consequently, the higher MDA compliance reported for males is encouraging news for the Samoan LF program. The higher rate of non-compliance in females also correlated with other studies in Haiti, Sri Lanka and India[16, 52, 53]. It has been speculated that the higher rates of non-compliance in women could be due to previous decisions to not treat women of reproductive age or because the drugs are not distributed to pregnant women[52]. However in Samoa, those women who are not excluded due to the aforementioned reasons do have higher compliance rates than men (WHO, *personal communication by F. Maiava*), which is possibly the cause of the higher infection prevalence in the male demographic group[31]. Other possible reasons for the lower compliance in females observed in the current exploratory study could relate to anecdotal evidence. In the Pacific it was believed that the administered drugs caused sterility in females when the health message was intended to be sterility of female worms. This reiterates the importance of accurate health messages reaching the community in order to successfully control this disease and the need to explore cultural and religious beliefs using qualitative research methods.

Studies have highlighted schoolchildren as a potential resource of information on public health campaigns for the rest of the community[25, 28, 34, 40, 49]. Previous innovative studies have demonstrated the success of using comic books to specifically target children, or handing out pamphlets/leaflets to be passed onto parents[28, 47, 54]. Parents are more likely to trust either older children (> 12 years) or propaganda coming directly from the school as credible rather than younger children [47]. However, for this strategy to be feasible in Samoa, the following must be determined: 1) community perceptions on using schoolchildren as a source of information, and, 2) levels of school attendance. Furthermore, current levels of knowledge of LF by the children need to be improved. Especially since, in Samoa, only 27% of interviewed children aged 7 to 10 years had heard of LF, which demonstrates the lack of appropriate educational campaigns targeting this demographic group. Targeting a specific cohort could maximize the educational message without straining resources such as using health workers to visit every household in a community.

Additionally, for children, there was a significant association between MDA compliance, knowledge of LF, and the use of mosquito protection (Table 4). Why is there a strong association between MDA compliance, knowledge, and mosquito protection? Do these young children receive this important message through school education or are their parents/guardians aware of the disease? These important questions need to be answered in order to create an effective community-wide educational campaign. The synergistic relationship observed among these three parameters may be because children who are aware of the disease are more likely to want to protect themselves, either through MDA compliance or mosquito protection. This synergism between mosquito protection and MDA compliance has been identified previously in India[20]. This is encouraging, as it emphasizes the need to continue educating the children concerning the dire effects of the disease in order to secure a higher MDA compliance rate.

Both infected individuals and children were more likely to report bed nets as their method of protection. In Samoa, the predominant vector is the day-biting *Aedes polynesiensis*[13] thus the use of bed nets in these areas is likely to be ineffective[55]. Therefore, the community requires re-education on other ways to

protect themselves against mosquito bites such as the use of mosquito coils, the reduction of potential breeding containers in and around their households, or the use of personal repellents. Unfortunately, implementation of other personal protection measures against mosquitoes results in some personal expense, which might not be feasible for long-term sustainability [56].

Scheduling further MDA rounds in Samoa to reduce the reservoir of infection will not succeed if these issues concerning non-compliance and the need to strengthen education are not addressed. Unfortunately, inferences cannot be made from the current exploratory study as to whether infected individuals are more likely to be non-compliant, since data were available only for those CFA positive. Therefore, it is imperative to conduct future community surveys in these areas of residual endemnicity to ascertain if non-compliance rates are higher in the infected people. This limitation does not detract from the crucial finding that 33% of infected individuals were systematically non-compliant and this was significantly associated with a lack of knowledge concerning LF. Another potential limitation from this exploratory study is, like any retrospective study, there is a degree of reporting and recall bias[20, 52, 57] and, despite reassurance that all responses were valid, there may have been concern from the participants about providing the wrong answers. Secondly, previous studies have demonstrated that the status of the interviewer can potentially affect the respondent's answers[10]. In the current study, an employee of the Ministry of Health volunteered to conduct the interviews. If this impacted upon the answers to the questions, we would have expected most people to have answered "yes" to both MDA compliance and hearing of the disease. Since this was not observed, it was concluded that the status of the interviewer did not significantly impact the answers to the questionnaire or alter data collection.

Globally there is growing recognition of the need for community involvement and effective health education[20]. Although 30 years ago the need for the introduction of qualitative research into the LF program was recognized [58], there appears to be little responsive action. Unfortunately, the move from theory to practice can often be limited because of economic constraints, time, and lack of personnel[47]. However, the investment will benefit the program in the long run by potentially securing higher rates of compliance. Secondly, if educational campaigns are based on current policies it is difficult to change these behaviors from the country level if policies are not changed at the global WHO level. However, intervention is required immediately if LF is to be successfully eliminated[52]. Health messages should be culturally appropriate and emphasize that all individuals living within endemic areas would benefit from MDA compliance, possibly by reintroducing images of filariasis morbidity [15]. In Sri Lanka, individuals who were aware of the personal benefits of MDA and the severity of progression of disease, even in the absence of clinical symptoms, were more likely to be compliant[16]. Consequently, the lessons learnt from the LF program could well aid other public health programs in the future. That is to incorporate social science as a prerequisite from the outset to be proactive and pre-empt possible non-compliance.

In summary, the findings from the study identified crucial gaps that could potentially impede successful LF elimination in Samoa. In order to improve MDA compliance, collaboration with social scientists and community members should be a priority to develop pertinent strategies for the health message to reflect local understandings, interpretations of disease, and behaviors. This can be achieved using qualitative research models to explore beliefs, barriers and solutions in order to expand community involvement in the elimination of LF [36]. In order to maximize MDA compliance, it is also necessary to re-evaluate the current strategies for dissemination of this information, including the types of media, and exploring other avenues such as school-based education. Infected, but non-compliant, individuals and/or schoolchildren represent the prime cohort for targeting these educational messages. How this is achieved and sustained long-term, requires further investigation, but if LF is to be successfully eliminated in Samoa high population compliance needs to be secured[8]. These preliminary exploratory findings are exciting in terms of aiding successful LF elimination in Samoa and their potential impact on other country programs.

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