Center for Demography and Ecology

University of Wisconsin-Madison

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Michael J. McQuestion

CDE Working Paper No. 94-09

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Michael J. McQuestion
Center for Demography and Ecology
Department of Sociology
University of Wisconsin-Madison

August 1994

This study was supported by core and training grants for Population Research from the National Institute for Child Health and Human Development (P30 HD05876, T32-HD07014) to the Center for Demography and Ecology. The Rotary Foundation of Rotary International provided additional funding and support for the field work.

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ABSTRACT

Mass immunization campaigns comprised one of the strategies leading to the recent successful interruption of wild poliovirus transmission in the Americas Region. A second strategy, active surveillance, permitted health authorities to deploy additional inputs, including purposive volunteers, in high-risk communities where vaccine coverage lagged or where polio cases continued to occur despite the mass campaigns.

This study examines how mass campaigns over the period 1987-1991 affected the probabilities of full immunization among Guatemalan and Filipino children and to what extent volunteer inputs affected those probabilities. A total of 1091 mothers were interviewed in 14 volunteer-assisted and 11 similar high-risk communities where volunteers did not work. Household characteristics, communication sources, immunization knowledge and the immunization status of the youngest children between 12-35 months of age were recorded. Bivariate analyses showed that the volunteers did contribute to campaign awareness in both countries but not necessarily to full immunization status. The probability of both campaign awareness and full immunization were highest when mothers identified local health workers as their immunization informants. Mass media had little effect on either dependent variable. Multivariate logit models showed that maternal education and a mother's stock of immunization knowledge both contributed to the likelihood of full immunization and that the effect of the former outweighed the latter. Children whose mothers worked or who had two or more siblings below age five remained less likely to be fully immunized regardless of volunteer inputs or community-level factors, implying that such families still faced unmet opportunity costs. Controlling for household characteristics and immunization knowledge, the volunteer inputs increased the likelihood of full immunization but only in communities where vaccine coverage and socioeconomic heterogeneity were relatively high. The findings suggest that volunteers can enhance targeted primary health care interventions in communities with characteristics conducive to collective action.

INTRODUCTION AND PROBLEM STATEMENT

Immunizations are credited with averting 15% or more of all expected deaths under age five in the developing world (UNICEF, 1991). By 1992 an estimated 80% of all children in the developing world were being immunized against the six vaccine - preventible childhood diseases targeted by WHO's Expanded Programme on Immunization (EPI) (Kim-Farley, 1992). One of those target diseases is poliomyelitis. Recalling its success against smallpox in the 1970s, WHO initiated a polio eradication effort in the Americas Region in 1985 (De Quadros et al., 1991). Through improvements in EPI program management, aggressive epidemiological surveillance and, most notably, annual mass immunization campaigns, poliovirus transmission was successfully interrupted (Robbins, 1993). As of this writing, no wild poliovirus cases have been confirmed in the Region for well over two years. There is a strong epidemiologic rationale for the mass campaigns. Simultaneously immunizing entire populations served to displace wild polioviruses with attenuated live vaccine viruses which induce immunity but do not cause disease. On policy levels, however, the use of campaigns remains controversial. Critics see them as a diversion of scarce resources away from the routine immunization services and from PHC services generally (Turshen, 1989; Kunitz, 1987; Creese et al., 1987). Advocates counter that campaigns and a disease-specific approach will in the long run strengthen "horizontal" PHC services (Williams, 1988; Foege and Henderson, 1986). What is missing from the debate is a sense of how campaigns actually work.

Modern day immunization campaigns engender large-scale social mobilization, a dimension not formally considered in most studies on primary health care utilization (for an exception see Scheer et al., 1985). In these interventions, conventional health education and mass media communication are complemented by intense interpersonal communication via local networks, volunteers performing house-to-house visits, parades, drama troupes, and other unconventional activities (Abed et al., 1991; Balraj and John, 1986; UNICEF, 1985. To meet the strong test of polio eradication, active surveillance networks in each ministry of health have, since 1986, reported weekly the presence and absence of cases of acute paralysis in over 10,000 *municipios* in the Region. These highly reliable epidemiological data, gathered, analyzed and fed back under WHO auspices, guarantee the efficacy of the eradication effort. Following each round of campaigns, mass media, health workers and volunteers receive and disseminate feedback on whether or not the local targets were met. The monitoring thus makes progress toward universal immunization more noticeable. Though they interrupted poliovirus transmission on national and regional levels, the campaigns were not successful in every community. Vaccine coverage was still low in about 5% of the Region's *municipios* despite successive campaigns through 1988. For whatever reason, mobilization failed in these collectivities and they had to be covered by house-to-house vaccinators (De Quadros et al., 1991).

The failure of families to seek immunizations has been attributed to inefficiencies in the services provided (Cutts et al., 1991); to lack of information and poor health worker-client interaction (Razum, 1993; Liengjindathaworn et al., 1987); to competing demands on working mothers (Basu and Basu, 1991; DaVanzo and Gertler, 1990); to non-allopathic cultural beliefs (Heggenhougen and Clements, 1987; Were, 1985); to the high social and psychological costs of public scrutiny mothers must face (Coreil et al., 1994). There is some evidence that campaigns ameliorate these and other constraints. In the Americas Region immunizations were accessible to the vast majority of the population, yet vaccine coverage never exceeded 50% until the advent of the polio eradication initiative in 1985. Since 1988 the percent of children under age five in the region fully immunized has consistently exceeded 70% (WHO, 1990a; 1990b). Clearly, changes in household-level immunization predictors during this short period cannot explain the rapid coverage gains. In their multivariate analysis of the Guatemalan DHS data, which covered births from 1982 to 1987, Goldman and Pebley (1993) found that an estimated one-half of all immunizations in 1986 were given through mass immunization campaigns; that distance from the nearest health center was not related to immunization status; and that there was little variation across communities with respect to immunizations. The campaigns, they concluded, had a much stronger effect on immunization utilization than did household socioeconomic characteristics.

From a new household economics view campaigns might reduce opportunity costs by making immunizations more easily available to families. Without campaigns, opportunity costs to working mothers would be greater than to those not employed because the value of their time is greater (DaVanzo and Gertler, 1990; Popkin and Doan, 1990; Becker, 1965). Recent ethnographic work suggests however that maternal employment may have contradictory effects on child welfare within a given collectivity, depending on a woman's status. Children whose mothers are better paid and enjoy relative autonomy may fare better than those of poorly paid women who can neither afford suitable childcare nor control the allocation of their incomes (Howard, 1994; Millard, 1994). Large family size has also been shown to reduce a young child's odds of full immunization (Boerma et al., 1990; Elo, 1990; Hanlon et al., 1988), presumably by limiting the attention a mother can give to any one child, thereby reducing the probability of full immunization at higher birth orders (Blake, 1981). By making utilization easier, campaigns would reduce opportunity costs for multiparous and at least some working mothers.

Campaigns also reduce opportunity costs by widely disseminating information. To the extent parents act on that information the campaigns could operate via cognitive mechanisms. If so, two known positive household-level immunization predictors — maternal education (Becker et al., 1993; Boerma et al., 1990; Das Gupta, 1990; Streatfield et al., 1990; Nandan et al., 1985) and a mother's stock of immunization knowledge (Hanlon et al., 1988; Streatfield et al., 1988) — would be less decisive in collectivities where campaign efforts were strong. The "all-or-none" pattern suggests however that community-level factors intermediate between campaign inputs and household-level effects.

It has been shown that explicitly engaging a community in any targeted PHC project stimulates utilization of other PHC services (Chowdhury, 1990; Eng, 1988; Kumar, 1986). In a review of seven South Asian family planning projects, Askew (1988) identified three patterns of community participation strategies: (1) the use of community volunteers to disseminate information; (2) collective action by whole communities on specific program activities, and; (3) representative committees meant to involve the community in decision-making. The conventional public health approaches, (1) and (3), were found to be generally ineffective. Collective action strategies, however, were successful but only in the context of specific short-term activities. Researchers have theorized that cultural traditions such as *shramadanas* in South Asia and *mingas* in Latin America favor such collective action (de Silva, 1988; Ugalde, 1985). Within households, argue Berman et al. (1994), health behaviors are private but are nevertheless socially constructed. With community involvement health problems and choices become "public," exposing the parents to sanctions, positive and negative, for the health-seeking behaviors they choose. Such engagement may not be attainable in collectivities where shared beliefs and preferences are absent or where relations among actors are unstable, unidimensional or mediated by the state (Taylor and Singleton, 1993; Zaman, 1984). Alternatively, rapid modernization may accelerate economic differentiation, eroding patriarchical controls and opening up new opportunities for women and others to lead collective action (Howard, 1984, p.248).

While models exist to explain reduced opportunity costs and cognitive change, modelling the community-level effects is more elusive. One possibility is to conceive of the campaigns as collective action to procure a public good or, alternatively, to eliminate a collective "bad." Protection from polio and the other vaccine-preventible childhood diseases meets the key criteria which define a public good: (1) it is non-excludable in that all actors benefit regardless of whether or not they helped attain it; (2) it has jointness of supply, meaning the consumption of the good by one person does not diminish the supply available to others; and (3) no one actor can attain it by acting alone (Samuelson, 1954). The intense monitoring up to and during campaigns makes actors' behavior contingent on what others in the community are doing. As the proportion of parents (or *municipios*) who complete their children's immunizations increases, the expectation that all will do so likewise increases. Actors may choose to cooperate (fully immunize their children), not due to sanctions necessarily but to a shared ethic of fairness to which all desire to conform. Absent an ethic of fairness and effective monitoring, cooperation would be doubtful because each actor would calculate that others would not do their part (Hardin, 1982).

Granovetter (1978) offers a dynamic collective action model which utilizes contingency but does not impute individual motives from aggregate behavior. Over time, actors of varying "threshholds" for joining a collective action choose to act in relation to the proportion of others around them whom they perceive acting. The first to have their children immunized would have the lowest threshholds, the last the highest. Equilibria are eventually reached. There may be considerable threshhold heterogeneity within a community, reflecting variations in preferences across subgroups. The effects of social structure, states Granovetter, may overwhelm the typically homogenous preferences within interacting groups. Between-group heterogeneity is bridged by "weak ties" between clusters, permitting "chain reactions" to proceed (Granovetter, 1973). Paradoxically, the weak ties make collective action more likely than do the "strong ties" within local reference groups. A mother who has lived all or most of her life in the same community would most likely be linked to others by strong ties. Interpersonal communication from sources other than those in a mother's usual friendship network might therefore set a chain reaction in motion.

In another formulation by Oliver, Marwell and Teixeira (1985), the probability of successful collective action increases to the extent members of the collectivity are heterogenous versus homogenous in both socioeconomic level and in their interest in solving the collective action problem. This is true even when the mean resource and interest levels are rather low for the group as a whole. Secondly, collective action is more likely to occur if there is a "critical mass" of especially interested and/or well endowed actors who help by meeting start-up, informaticnal, and other organizational costs. In larger groups the likelihood of collective action is further enhanced when the individuals comprising the critical mass are socially connected to one another. Connectedness favors their acting in concert (Marwell and Ames, 1979; Marwell and Oliver, 1988). A collective action model for immunization campaigns would therefore incorporate some or all of the following: evidence of an existing immunization norm or convention; high awareness of the coordination outcome — polio eradication; weak ties bridging primary reference groups; socioeconomic heterogeneity but cultural homogeneity; high prevailing vaccine coverage reflecting a relatively high equilibrium; and presence of a critical mass of campaign organizers.

HYPOTHESES AND STUDY DESIGN

In this paper I estimate household-level, cognitive and community-level campaign effects in a set of case communities where "critical masses" of purposive volunteers worked during the campaigns, thereby maximizing campaign intensity, and in a set of control communities where they did not. The purposive volunteers were Rotary club members in Guatemala and the Philippines and those they recruited and supported as campaign workers. A previous study, using ANOVA, had shown that Rotary Club efforts explained about 25% of the variance in a model of full immunization in the Filipino sample (Findley and McQuestion, 1991). If the mass campaigns produced independent community-level effects and if the purposive volunteers were instrumental in the process, then proportionately more children ought to be fully immunized in case versus control communities controlling for household and cognitive factors. To the extent campaigns reduced opportunity costs, the negative effects of maternal employment and high parity on immunization probability should be attenuated in case versus control communities. If the campaigns produced cognitive impacts then case community parents should be both more knowledgeable about immunizations and more likely to have fully immunized children. Further, if collective action constituted a mechanism through which the community-level effects occurred, then the odds of a child being fully immunized ought to be highest in the case communities where the purposive volunteers worked, controlling for other factors.

The above hypotheses are contingent on showing that campaign effects were indeed stronger in case versus control communities. The proportion of mothers in a given community identifying the volunteers and other non-traditional informants can be seen as an indicator of campaign intensity. Demonstrating a link between campaign intensity and immunization uptake would be sufficient grounds to conclude that the campaigns affected families individually. To infer an independent community effect, on the other hand, requires demonstrating that immunization uptake was more likely in communities with both high campaign intensity and characteristics conducive to collective action (socioeconomic heterogeneity, high campaign awareness, relatively high vaccine coverage).

There are several limitations in the study design. First is the inability to distinguish between immunizations given through the routine services and those administered on campaign days. Chronically low coverage levels cannot therefore be ascribed either to poor routine immunization program performance or to lackluster campaigns. Second, the models contain no direct indicators of campaign inputs for a given community. Third, cross-sectional data are being used to model what is an essentially dynamic process: The campaigns inform mothers about immunizations and the mothers act upon that information by ensuring that their children are fully immunized. The former theoretically precedes the latter. To show definitively that collective action occurred would require extensive participatory research beyond the scope of the present study, for instance, to carefully map friendship networks and multiplex relationships and to demonstrate the existence of norms and sanctions in each study community. Given these constraints it will not be possible to conclusively show causal links between collective action processes and the immunization campaigns, or between high immunization levels and the campaigns generally. To show that factors compatible with a collective action process occur jointly with better immunization uptake would merely provide evidence suggestive of such an underlying mechanism.

On the positive side, I compare campaign experiences in two very different countries. Doing so implicitly controls for unmeasured household, cultural, health services and other factors. External validity will be strengthened if the directionality of the explicit household, cognitive and community-level predictors in the model agrees, controlling for country. Any differences in the magnitude of their effects will give some sense of the relative importance of the predictors in each country.

Considering the binomial nature of the outcomes to be modelled and the potentially non-normal error distributions in the data, logistic regression models seemed most appropriate. The logistic model is expressed as:

$$\log[P(z)/(1-P(z))] = a + B X$$

where P(z) is the probability of a binomial independent Bernoulli event occurring, a is the intercept, X is a vector of independent variables, and B is a vector of coefficients for these variables. The dependent variable is the log-odds of a child having been fully immunized. The independent variables are listed in Table 1. I use goodness-of-fit comparisons to gauge the relative importance of household characteristics, immunization knowledge and community characteristics in predicting the odds of full immunization status.

METHODS

In August 1990 and February 1991, respectively, we interviewed 695 Filipino mothers and 396 Guatemalan mothers with living children ages 12-35 months. Both countries had begun aggressive polio eradication initiatives. The study communities, 18 in the Philippines, 7 in Guatemala, had all been classified by local health authorities as high-risk for polio (i.e., polio vaccine coverage levels among children below one were less than 50% and/or there had been a confirmed polio case in the past three years). All were within one hour distance of Rotary clubs active in Rotary International's PolioPlus Program. In 14 of the 25 study communities, adjacent Rotary clubs had mounted significant social mobilization activities in support of polio eradication during the period 1986 to 1991. The remaining 11 study communities were ethnically, geographically, and socioeconomically comparable but Rotarians had not been active in them. The Rotarians' social mobilization activities were episodic in nature and of varying intensity. Examples included organizing workshops to train community volunteers for the campaigns; meetings with local businesses and public authorities to garner their support; placement of radio spots and newspaper ads; and house-to-house distribution of leaflets and census-taking. On actual immunization days Rotarians provided extra transport, delivered supplies, worked in immunization posts, and supervised volunteers (Skolnick, 1993). In all cases members of international evaluation teams fielded by The Rotary Foundation documented local club activities prior to undertaking the community surveys.

The local Rotarians recruited an estimated 120 volunteer interviewers, among them university students, local health workers, Rotaract and Interact club members, and Rotarians themselves. The interviewers were given a brief orientation and role plays were used to simulate the actual interviews. The survey instrument had been extensively pre-tested in several countries beforehand. To select the sample of households in each community the interviewers proceeded in different directions, generally in pairs, from the nearest health facility offering immunizations. If no permanent facility was present the departure point was a place where a temporary immunization post had been sited during the campaigns. Each team interviewed all parents they found of children ages 12-35 months in serial fashion until filling their quotas (usually 8 interviews per pair). Households where no one was home were skipped and were not revisited. It took about 2-4 hours for the interviewers to complete a 64-household cluster. Immunization status was determined by reviewing the child's immunization card or by maternal recall in the absence of a card.

The question of whether the mother was born in the reference community was asked in Guatemala but not the Philippines. To improvise, a dummy variable for long-term residence (15 years or more) was used in the Philippines. The two variables agreed in direction (though not significance) and are used synonomously in the logit models. Several independent variables were combined to produce indices for mass media exposure, immunization knowledge, and communication sources. The mass media score for each household ranged from 0 to 3 points (presence of a television, a radio, or recent newspaper or magazine in the home), as did the immunization knowledge index (mother knew vaccinations begin at birth; that side reactions are normal; and that vaccines prevent diseases). Responses to two questions ("How did you learn about immunizations?" and "How did you learn about the immunization campaigns?") were allocated to one of four categories: purposive volunteers; other non-traditional interpersonal sources; health workers; and mass media. Responses to the two questions were evaluated separately, then summed in each category. Three indicator variables were constructed to estimate community-level effects. One indicator variable identified Rotary case (versus control) communities. A second dummy distinguished communities where the proportion of children assessed as fully immunized exceeded the pooled sample mean for that country. A third indicator variable, to denote socioeconomic heterogeneity, was coded 1 for communities where the standard deviation of maternal education exceeded the overall standard deviation for that country. A four-category variable was constructed to test regional variations among the 18 study communities in the Philippines (Luzon, Metro Manila, Visayas, Mindanao). Likewise, Guatemala's seven communities were classified among three regions (metropolitan Guatemala City, coastal/ Mazatenango, Western highlands/Quetzaltenango). Numerous significant regional variations were found with respect to socioeconomic and demographic variables, knowledge of Rotary, immunization knowledge and polio awareness. They did not significantly affect immunization likelihood in multivariate models, however, and were dropped from further analysis.

Models were constructed deductively. Independent variables for each domain were introduced sequentially and those exerting main effects statistically significant at the ($p<=.10$) level were retained. The surviving variables were then tested for interactions. The best-fitting multivariate models were estimated for each country separately. The files were then merged, an indicator variable for country was added, and a combined immunization status model was run. Significant interactions of the country variable with any of the covariates would indicate that the effect of those covariates differed significantly from one country to the other.

In cleaning the data 74 seriously incomplete interview forms were rejected, yielding a total of 676 Filipino and 341 Guatemalan records. The maximum number of missing values for any discrete variable included in any of the candidate models was 24/341 for the Guatemalan dataset (variable: type of toilet). Among continuous variables, there were three cases of missing values for years residence in the Philippines and four for mother's education in Guatemala. Mean values were assigned to these seven cases. Interviewers reported finding very few households with vaccine-eligible children where no one was home.

In the Philippines, 82% of mothers produced cards for the interviewers compared to 69% of Guatemalan mothers. Eliminating children with lost cards who had reportedly been vaccinated yielded sub-samples of 259 families in Guatemala (a loss of 24% of data) and 582 in the Philippines (a 14% loss). Using cards only improved model fit but weakened the strength of associations between some of the covariates and full immunization status. The directionality of relationships, however, agreed under both criteria. I decided nonetheless that it would be more advantageous to utilize all the data collected even though incorporating the recall method yielded a slightly larger error component in the models.

RESULTS

Bivariate results

Table 2 displays the immunization status of children in both countries. Correlations of selected variables with full immunization status are given by country in Table 3. In both, full immunization status was positively correlated with a mother having heard about the campaigns and with knowing about Rotary, but was negatively correlated with having identified the purposive volunteers as informants. In contrast, in both countries the correlations between having identified health worker informants and full immunization status were positive, though it was only statistically significant in the Philippines.

There was a significant negative correlation between family size and full immunization status in Guatemala. The correlation was also negative in the Philippines but fell short of statistical significance. Maternal employment was negatively correlated with full immunization status in the Philippines, negative but insignificant in Guatemala. The effects of these covariates agree with findings reported elsewhere.

In the Philippines, immunization knowledge did correlate positively with full immunization status, more so than did maternal education. In Guatemala, the maternal education correlation was stronger than it was in the Philippines, while immunization knowledge was insignificant. The maternal education and immunization knowledge results also agree with previous studies but their importance remains indeterminant.

Living in a case community correlated positively with full immunization status in the Philippines but not in Guatemala. In Guatemala, case community mothers more often cited purposive volunteers as their informants whereas control community mothers were more likely to cite local health workers (Figures 1, 2). In the Philippines the same categories differed significantly but in the opposite direction.

These initial findings suggest that the efforts of the purposive volunteers were noticed in both countries and were evidently more intensive in case versus control communities. Knowledge about the purposive volunteers was linked to higher campaign awareness which in turn was positively correlated with full immunization status. The volunteers' efforts, however, were far from decisive in determining a child's immunization status. Campaign intensity mattered but parents must have been convinced to act through mechanisms other than direct volunteer contact. The multivariate models provide more insight on this crucial question.

Multivariate Results

The relative importance of household characteristics, immunization knowledge, and community factors in each country become apparent in the logit model results shown in Tables 4 and 5. In these tables Column 1 corresponds to a model with only household characteristics, Column 2 to only immunization knowledge and Column 3 to community characteristics. The last column shows the full model for each country. The models for each country are nested and so can be compared statistically. Household factors account for over half of the explained variance in the Guatemala model but less than a third in the Philippines. Immunization knowledge is insignificant in Guatemala and only modestly contributes to model fit in the Philippines. Community-level factors account for about one half of explained variance in both countries. They are the most important component of the full Philippines model but are less important than household factors in Guatemala. Neither model fits the data particularly well: The full models explain less than 15% of total variance.

With one exception — long-term residence — the significant household and knowledge covariates agree in direction in the two countries. In the Philippines, long-term residence might denote mothers well embedded in local networks who were more likely to have their children immunized. In Guatemala long-term residence may be picking up other effects. Indigenous Mayan families could be more sedentary, more likely to be living at subsistence level, less aware of the benefits of immunization, and less exposed to the campaigns generally (Goldman and Pebley, 1994).

There is greater variation in the community-level predictors across the two countries. In the full Guatemalan model heterogeneity is positive and borderline significant, while it is insignificant in the Philippines. Case community residence exerts a strongly negative effect on the log-odds of full immmunization in the Philippines but has no apparent effect in Guatemala. The latter discrepancy could reflect a selection bias, for example, if the Filipino case communities were "tougher" for the volunteers to work in than those in Guatemala.

When the two datasets are joined the models become more informative (Table 6). In the additive model, long-term community residence and socioeconomic heterogeneity remain net negative predictors of full immunization while immunization knowledge has an independent positive effect, controlling for country. Living in the Philippines confers a higher immunization probability net of the other predictors.

Four variables interacted significantly with the variable country. Including them significantly improves model fit (chi square = [1206.8-1127.3]/(1010-1003) = 79.5 with 7 df; p<.001). The multiplicative model shows that immunization knowledge had a stronger positive effect on immunization probabilities in the Philippines. This would be logical in a setting where primary health care utilization is relatively intense and where health workers are the main immunization informants. The community-level interactions are best interpreted by converting the empirical logits to probabilities and comparing their effects across the countries (Table 7). The bottom line of Table 7 shows the empirical logits and conditional probabilities of full immunization among control children. The rows above show how a given combination of community-level variables affected immunization probabilities in each country when the household and knowledge variables are controlled. It is now evident that it was the Guatemalan Rotarians who chose the tougher case communities. The table also shows that a Guatemalan child living in an above-average coverage, socioeconomically heterogenous case community would have an 84% probability of being fully immunized compared to 62% for an analogous Filipino child. Take away the effects of case community residence and the probability of full immunization falls to 75% for the Guatemalan child and 48% for the Filipino child. Alternatively, one might say that high coverage and heterogeneity exert much stronger effects on full immunization likelihood in Guatemala than in the Philippines, controlling for the effects of the unmeasured variables represented in the variable country. Despite the strong community-level effects, the negative effects of long-term residence, high parity, and maternal employment remain significant in the multiplicative model, as does the net positive effect of maternal education.

There were significant interactions among the community-level factors as well (Table 8). The two interactive community effects models provide more evidence on how the campaigns work. All four household-level predictors remain significant and are in the expected directions in both models. As shown in Table 9, including the community-level interactions had little effect on the household and knowledge predictors. A mother with three or more children, and/or who works, remains significantly less likely to have a fully immunized child. These findings agree conceptually with the notion of opportunity costs, costs that the campaigns evidently failed to overcome for many of the mothers. Both maternal education and immunization knowledge continue to exert independent positive effects. With the case-community interactions included, however, high-coverage status confers an even stronger positive effect on immunization probabilities while heterogeneity switches from a negative to a positive predictor.

Table 10 shows how various combinations of community-level attributes affected the predicted probabilities for full immunization in each country. As in the earlier multiplicative model, case community residence continues to exert a stronger negative effect in Guatemala than in the Philippines. In this model, living in a heterogeneous, high-coverage control community does not increase immunization probabilities in either country nor does the coincidence of case-community residence and heterogeneity. Living in a high-coverage case community does, however, confer a net increase in immunization probability. In both countries immunization probabilities are maximized when all three community-level factors occur simultaneously. The community-level collective action predictors, in other words, increased immunization likelihood only in the presence of the volunteers. Without high coverage and heterogeneity the volunteer inputs were ineffectual.

DISCUSSION AND CONCLUSIONS

Unexpectedly, communication with the purposive volunteers on the household level was not instrumental to full immunization, although greater campaign intensity on the community level was. The results point to a more intensive involvement by the Filipino health workers in the campaigns. The fact that Guatemalan control mothers more often cited health workers as informants than did their case community peers suggests that health workers may have been less active wherever the purposive volunteers worked. In the Philippines, in contrast, health workers and volunteers may have worked together in the case communities. If so, health workers were evidently more convincing to the mothers.

In Guatemala and in the Philippines a mother who completed at least primary school was significantly more likely to have a fully immunized child. High immunization knowledge did not matter in Guatemala but it added a comparable positive and independent effect among Filipina mothers. There is thus partial support for an independent cognitive effect in one country but not both. The universally positive effect of maternal education agrees with Cleland's (1990) assertion that education affects health behaviors more strongly than does a mother's stock of health knowledge.

A mother working outside the home strongly reduced immunization probabilities in the Philippines net of the other variables. In Guatemala, maternal employment was equally prevalent but had no such effect. It may be that the labor market for women is less developed in the Guatemalan than in the Philippines sample communities. Alternatively, there may have been two classes of working mothers in Guatemala on whom employment exerts opposite effects. Clearly, the campaigns did not eliminate the constraints faced by working mothers.

Controlling for inter-country variation, community-level factors were more influential to the mother's immunization decision than were household constraints or immunization knowledge. The combined multiplicative models suggest that factors conducive to collective action dramatically increased immunization probabilities in Guatemala but not in the Philippines. It may be that ethnicity — an unmeasured variable in the present study — mediated the potential for collective action in Guatemala. Controlling for distance, ethnicity, and maternal education, Goldman and Pebley found that the odds of full immunization remained significantly lower in *municipios* where at least half the families were indigenous *vis-a-vis* ladino or more heterogenous *municipios* (1994, p.37).

By design the volunteers were assigned to work in relatively more difficult communities. Controlling for those difficulties and for household and immunization knowledge effects, the volunteer efforts did increase the probability of full immunization wherever the community-level factors were favorable. In communities where campaign inputs were more intense, parents had added incentives to have their children immunized. There would thus seem to be a niche for critical masses of volunteers like Rotary clubs to fill in many developing countries. Deploying them randomly or to the most uniformly disadvantaged communities, however, may be ineffective. The results suggest that collective action can be induced in communities where contingency, shared coordination goals, and heterogenous interest in achieving those goals co-exist. In such communities the stimuli that exogenous volunteers bring can act as a catalyst. Close coordination with local health workers may be another important determinant of success.

Presently, ministries of health are extending their active surveillance networks to include measles, tetanus neonatorum, cholera, and other preventable diseases (Cutts et al., 1993), often spotlighting the salutory epidemiological impacts of a range of targeted PHC interventions. Formative evaluations promise to reveal other effects the polio eradication effort has had on PHC services management and utilization. Further studies are needed, however, to assess household and community-level impacts. A strategic dividend of the Regional polio eradication effort contribution was the demonstration of a discrete category of high-risk communities. Like high-risk families, such comunities are refractory to standard PHC approaches. This study shows that innovative strategies can reach them.

BIBLIOGRAPHY

Abed FH, McKee N, Chowdhury A, Chowdhury M, and Rahman R (1991). Social mobilization for EPI in Bangladesh. Pp. 9-34 in Huq M (ed.), Near Miracle in Bangladesh, Dhaka, Bangladesh: University Press Ltd.

Askew I (1988). A comparative analysis of community participation projects in South Asia with policy and programme recommendations for family planning associations. London: International Planned Parenthood Federation, Occasional Series on Community Participation, 47 pages.

Balraj V, John TJ (1986). Evaluation of a polio immunization campaign in Madras City. *Bulletin of the World Health Organization* 64(6):861-5.

Basu AM, Basu K (1991). Women's economic roles and child survival: The case of India. *Health Transition Review* 1(1):83-103.

Becker GS (1965). A theory of the allocation of time. *Economic Journal* 75:493-517.

Becker S, Peters DH, Gray RH, Gultiano C, Black RE (1993). The determinants of use of maternal and child health services in Metro Cebu, the Philippines. *Health Transition Review* 3(1):77-89.

Berman P, Kendall C, Bhattacharyya (1994) The household production of health: Integrating social science perspectives on micro-level health determinants. *Social Science and Medicine* 38(2):205-14.

Blake J (1981). Family size and the quality of children. *Demography* 18(4):440.

Boerma JT, Sommerfelt AE, Rutstein SO, Rojas G (1990). Immunization: Levels, trends and differentials. Columbia, Maryland: Institute for Resource Development/Macro Systems, Inc., Demographic and Health Surveys, Comparative Studies, No. 1.

Chowdhury AM (1990). Empowerment through health education: The approach of an NGO in Bangladesh. Pp. 113-120 in Streefland P, Chabut J (eds), Implementing Primary Health Care: Experiences Since Alma-Ata, Amsterdam, Netherlands: Royal Tropical Institute.

Cleland JG (1990). Maternal education and child survival: Further evidence and explanations. Pp. 400-19 in Caldwell JC, Findley S, Caldwell P, Santow MG, Cosford WH, Braid J, Broers-Freeman D (eds), What We Know About Health Transition: The Cultural, Social and Behavioral Determinants of Health, The Proceedings of an International Workshop, Canberra, May 1989, Health Transition Series No. 2,, Canberra: Australian National University.

Creese AL, Dominguez-Uga MA (1987). Cost-effectiveness of immunization in Colombia. *World Health Forum* 8(2):221-6.

Cutts FT, Waldman RJ, Zoffman HM (1993) Surveillance for the Expanded Programme on Immunization *Bulletin of the World Health Organization* 71(5):633-39.

Cutts FT, Zell ER, Soares AC and Diallo S (1991) Obstacles to achieving immunization for all 2000: Missed opportunities and inappropriately timed immunizations. *Journal of Tropical Pediatrics* 37(4):153-58.

Das Gupta M (1990). Death clustering, mother's education and the determinants of child mortality in rural Punjab, India. *Population Studies* 34:489-505.

DaVanzo J, Gertler P (1990). Household production of health: A microeconomic perspective on health transitions. Santa Monica, CA: Rand Corporation, Rand Note No. n-3014-RC. 27 pp.

De Quadros CA, Andrus JK, Olive JM, Da Silveira CM, Eikof RM, Carrasco P, Fitzsimmons JW, Pinheiro FP (1991). Eradication of poliomyelitis: Progress in the Americas *Journal of Pediatric Infectious Diseases* Mar 10(3):222-9.

de Silva V (1988). An analysis of community participation in the Community Managed Rural Family Health Project. Sri Lanka, London, England: International Planned Parenthood Federation, Occasional Series on Community Participation, 62 pages.

Elo IT (1990). Female education and the use of maternal and child health care services in Peru. Princeton: Princeton University, unpublished PhD dissertation, Woodrow Wilson School of Public and International Affairs.

Eng E (1988). The role of community participation in child health: Water supply, ORT and EPI. Pp. 15-19 in Hefferman M (ed), International Health in the 1990s: Directions in Research and Development, Washington, DC: National Council for International Health, Southern Regional Conference, Chapel Hill, NC, October 29-31, 1987.

Findley S, McQuestion M (1991). Does social mobilization work? An assessment of Rotary PolioPlus activities in the Philippines. Evanston, IL: The Rotary Foundation, 29 pages.

Foege WH, Henderson DA (1986). Selective primary health care: XXV. Management priorities. *Reviews of Infectious Diseases* May-Jun; 8(3):467-75.

Goldman N, Pebley A (1993). Family, community, ethnic identity and the use of formal health care services in Guatemala. unpublished paper presented at the Annual Meeting of the Population Association of America, Cincinnati, OH, 1-4 April 1993.

Granovetter M (1978) Threshold models of collective behavior. *American Journal of Sociology* 83(6):1420-43.

Granovetter M (1974) The strength of weak ties. *American Journal of Sociology* 78(6):1360-80.

Hanlon P, Byass P, Yamuah M, Hayes R, Bennett S, M'Boge BH (1988). Factors influencing vaccination compliance in peri-urban Gambian children *Journal of Tropical Medicine and Hygiene* 1988; 91, 29-33.

Hardin R (1982) Collective Action. Baltimore: Johns Hopkins University Press.

Heggenhougen K, Clements J (1987). Acceptability of childhood immunization. Social science perspectives, a review and annotated bibliography, London: London School of Tropical Medicine and Hygiene, Evaluation and Planning Centre, EPC Publication No. 14, 97 pages.

Kim-Farley RJ (1992). EPI for the 1990s. The Expanded Programme on Immunization Team. *Vaccine* 10(13):940-8.

Kumar A (1986). Effective coverage for child immunization through the camp approach. *Journal of Family Welfare* 33(2):44-52.

Kunitz SJ, (1987). Explanations and ideologies of mortality patterns. *Population and Development Review* 13(3):395-397.

Lingdindathaworn P, Panichacheewakul P, Charoenchai A, Stoeckel J (1987). Factors affecting immunization coverage in northeast Thailand, Bangkok, Thailand: Population Council Regional Office for South and East Asia, Regional Research Paper, 35 pages.

Marwell G, Ames RE (1979) Experiments on the provision of public goods. I. Resources, interest, group size and the free rider problem. *American Journal of Sociology* 84(6):1335-60.

Marwell G, Oliver P (1988) Social networks and collective action: A theory of the critical mass II. *American Journal of Sociology* 94(3):502-34.

Millard AV (1994) A causal model of high rates of child mortality. *Social Science and Medicine* 38(2):253-68.

Nandan D, Pandey DN, Agnihotri SP, Qureshi GU, Mehrota AK (1985) Some bio-social factors for drop out of children undergoing oral polio vaccination. *Indian Journal of Public Health* Jul-Sep;29(3):201-5.

Oliver P, Marwell G (1988) The paradox of group size in collective action: A theory of the critical mass II. *American Sociological Review* 53:1-8.

Oliver P, Marwell GG, Teixeira R (1985) A theory of the critical mass I: Interdependence, group heterogeneity and the production of collective action. *American Journal of Sociology* 91(3):522-56.

Popkin B, Doan RM (1990). Women's roles, time allocation and health. Pp. 683-706 in Caldwell JC, Findley S, Caldwell P, Santow MG, Cosford WH, Braid J, Broers-Freeman D (eds), What We Know About Health Transition: The Cultural, Social and Behavioral Determinants of Health, The Proceedings of an International Workshop, Canberra, May 1989, Health Transition Series No. 2,. Canberra: Australian National University.

Razum O (1993) Mothers voice their opinion on immunization services. *World Health Forum* 14(3):282-86.

Robbins FG (1993) Eradication of polio in the Americas. *Journal of the American Medical Association* 270(15):1857-59.

Scheer P, Pinto A, Tuga S, Ebrahim GJ, Abel R, Mukharjee D (1985). Does health intervention ameliorate the effects of poverty-related diseases? Experience in rural South India. *Journal of Tropical Pediatrics* Aug, 31(4):219-22.

Skolnick AA (1993) Rotary clubs offer help in preschool immunization [letter] *JAMA* 270(24):2908, 2910.

Streatfield K, Singarimbun M, Diamond I (1990). Maternal education and child immunization *Demography* 27(3):447-55.

Streatfield K, Singarimbun M (1988). Social factors affecting use of immunization in Indonesia. *Social Science and Medicine* 27(11):1237-45.

Taylor M and Singleton S (1993) The communal resource: Transaction costs and the solution of collective action problems. *Politics and Society* 21(2):195-214

Turshen M (1989) The Politics of Public Health. New Brunswick NJ, Rutgers University Press, pp. 150-163.

Ugalde A (1985). Ideological dimensions of community participation in Latin American health programs. *Social Science and Medicine* 21(1):41-53.

UNICEF (1985). Tetanus toxoid immunization campaign in West Nusa Tenggara, Indonesia. *Assignment Children* 195, (69/72):369-80.

UNICEF (1991). State of the World's Children. Oxford: Oxford University Press, p5.

Were MK (1985). Communicating on immunization to mothers and community groups. *Assignment Children* (69/72):429-42.

WHO (1990a). Expanded Programme on Immunization, *WHO Weekly Epidemiological Record, Part 1* 1990;2:5-11.

WHO (1990b). Expanded Programme on Immunization, *WHO Weekly Epidemiological Record, Part 2,* 1990;3:15-16.

Williams G (1988). The days of the mass campaigns. *World Health Forum* 9(1):7-23.

Zaman WA (1984). Public Participation in Development and Health Programs: Lessons From Rural Bangladesh. Lanham, Maryland: University Press of America, 291 pages.

Table 1. Variables, indicators and criteria included in the household survey, PolioPlus rapid assessments, Philippines (8/90) and Guatemala (2/91)

Variables	Indicators/Criteria
child's immunization status	fully immunized = card or recall + BCG (1 dose) DPT (3 doses) polio (3) measles(1) partially immunized = card or recall + some of the above doses indicated no immunizations = no card + mother states child was never vaccinated
demographic characteristics	maternal age total live births years resident in study community
socioeconomic level	flush toilet in home no/primary/more maternal education mother employed outside the home: yes/no radio, TV in home; read newspaper or magazine in the past month
mass campaign knowledge	1) recalls hearing of mass campaigns 2) identifies campaign immunization post as nearest source
immunization knowledge	1) knows child's correct immunization status 2) knows to begin immunization at birth 3) knows side reactions are normal 4) knows what immunizations do 5) knows all 6 EPI target diseases
polio awareness	1) knows of a lame child in community 2) attributes the lameness to polio
knowledge of Rotary	acceptable definition of Rotary
health behaviors	1) time since last family consult 2) reason for last consult (well baby/preventive vs. other) 3) last provider consulted (public/private)
sources of immunization/ campaign information	1) local health workers 2) purposive volunteer contacts (church, Rotary, schools, etc.) 3) radio 4) TV 5) newspaper, pamphlet, poster 6) other face-to-face contacts

Table 2. Immunization status: card verification versus card and recall methods, Guatemala and Philippines PolioPlus Rapid Assessments

	Guatemala (n=341)		Philippines (n=676)	
Method/ Indicator	**No.**	**Proportion**	**No.**	**Proportion**
A. Card only				
child has card	235	.69	557	.82
card + fully immunized	166	.71	456	.82
card + partially immunized	69	.29	101	.18
no card	106	.31	119	.18
total	341	1.0	676	1.0
B. Card + recall				
fully immunized	204	.60	484	.72
partially immunized	113	.33	167	.25
never immunized	24	.07	25	.04
total	341	1.0	676	1.0

(Column proportion totals may not sum to 1.00 due to rounding.)

Table 3. Correlations[1] of selected variables with full immunization status, card-verified and recall methods, Guatemala and the Philippines

Variable	Guatemala				Philippines			
	mean	st dev	r^2	p	mean	st dev	r^2	p
Maternal characteristics								
mother's age	27.9	6.2	-.09	-	29.1	6.0	-.05	-
children ever born	2.9	1.5	-.28	<.01	3.0	1.6	-.07	-
lived less than one year in the community	.19	.40	.02	-	.12	.32	-.06	-
lived more than five years in the community	.54	.50	.04	-	.59	.49	.11	<.01
born in community/long-term resident[2]	.27	.45	-.14	<.05.	.26	.44	-.02	-
completed at least primary school	.58	.49	.18	<.01	.93	.25	.11	<.01
works away from home	.26	.44	-.02	-	.23	.42	-.12	<.01
knows about Rotary	.43	.50	.23	<.01	.70	.46	.09	<.05
last consult to a private MD	.40	.49	.17	<.01	.24	.43	-.14	<.01
Immunization, campaign knowledge								
immunization knowledge index score[3]	.62	.70	.07	-	.62	.83	.19	<.01
heard about campaigns	.85	.35	.24	<.01	.91	.29	.15	<.01
attributes lameness to polio	.20	.40	.09	-	.23	.42	.03	-
Source of immunization, campaign information								
radio and/or tv	.22	.41	.05	-	.07	.26	-.07	-
purposive volunteers	.14	.35	-.13	<.05	.13	.33	-.14	<.01
neighbors, friends	.16	.37	<.01	-	.05	.21	<.06	-
local health workers	.23	.42	.10	-	.45	.50	.09	<.05
Community characteristics								
high vaccine coverage	.55	.50	.26	<.01	.44	.50	.20	<.01
Rotary case community	.44	.50	-.10	-	.74	.44	.22	<.01

[1] Pearson correlations; two-tailed significance.

[2] Guatemala: birthplace yes/no; Philippines: 15+ years = long-term residence.

[3] three-point index: knows immunizations prevent diseases
+ knows immunization produce side reactions
+ knows immunizations begin at birth

Table 4. Stepwise analysis of best-fitting logit model for the log-odds of full immunization: Guatemala PolioPlus Rapid Assessment (2/91)

Model	1[1]	2	3	1+2	1+3	1+2+3
constant	.85[2] (.26)	.38 (.12)	-1.14 (.49)	.83 (.48)	-.66 (.57)	-.65 (.57)
Maternal characteristics						
born in community	-.69[a] (.26)	-	-	-.68[a] (.26)	-.81[a] (.27)	-.81[a] (.27)
primary education	.57[b] (.24)	-	-	.56[b] (.24)	.61[a] (.25)	.62[a] (.25)
3 or more children	-.90[a] (.24)	-	-	-.91[a] (.24)	-.84[a] (.25)	-.83[a] (.25)
works outside home	-.25 (.27)	-	-	-.26 (.27)	-.25 (.28)	-.25 (.28)
Immunization knowledge						
3/3 on index score	-	.23 (.32)	-	.20 (.33)	-	-.04 (.17)
Community characteristics						
high SE heterogeneity	-	-	1.20[b] (.53)	-	1.04 (.56)	1.03 (.56)
high vaccine coverage	-	-	1.69[a] (.37)	-	1.65[a] (.39)	1.65[a] (.39)
vol case community	-	-	.49 (.37)	-	.49 (.39)	.49 (.40)
model scaled deviance (df)	427.6 (336)	458.1 (339)	430.9 (337)	427.2 (335)	401.2 (333)	401.2 (332)
null model scaled deviance	458.7 (340)					
reduction in scaled deviance[3]	31.1 (4)	0.6 (1)	27.8 (3)	31.5 (5)	57.5 (7)	57.5 (8)

[a] = significant at the .01 level; two-tailed test $|z|>=2.58$

[b] = significant at the .05 level; two-tailed test $|z|>=1.96$)

[1] 1=maternal characteristics 2=immunization knowledge 3=community characteristics

[2] (Standard error in parentheses)

[3] difference between deviance of fitted and null models; distributed as chi square; difference in degrees of freedom in parentheses

Table 5. Stepwise analysis of best-fitting logit model for the log-odds of full immunization: Philippines, PolioPlus Rapid Assessment (8/90)

Model	1[1]	2	3	1+2	1+3	1+2+3
constant	-.40[2] (.62)	.75 (.09)	.89 (.14)	-1.36 (.70)	-1.11 (.72)	-1.13 (.74)
Household characteristics						
long-term resident	.55[a] (.18)	-	-	.47[a] (.18)	.47[b] (.19)	.38[b] (.19)
primary education	.90[a] (.31)	-	-	.92[a] (.32)	.93[a] (.33)	.95[a] (.33)
3 or more children	-.33 (.18)	-	-	-.34 (.19)	-.48[b] (.19)	-.47[b] (.20)
works outside home	-.63[a] (.19)	-	-	-.64[a] (.20)	-.67[a] (.20)	-.69[a] (.21)
Immunization knowledge						
3/3 index score	-	1.01[a] (.25)	-	.97[a] (.26)	-	1.04[a] (.27)
Community characteristics						
high- coverage community	-	-	.81[a] (.23)	-	.76[a] (.24)	.63[a] (.24)
high SE heterogenity	-		-.20 (.21)	-	-.16 (.22)	-.10 (.22)
vol case community	-		-.71[a] (.21)	-	-.82[a] (.22)	-.96[a] (.23)
model scaled deviance (df)	778.6 (671)	788.2 (674)	762.3 (672)	762.5 (670)	733.5 (668)	716.7 (667)
null model scaled deviance (df)	806.8 (675)					
reduction in scaled deviance[3]	28.2 (4)	18.6 (1)	44.5 (3)	44.3 (5)	73.3 (7)	90.1 (8)

[a] = significant at the .01 level; two-tailed test, $|z| >= 2.58$
[b] = significant at the .05 level; two-tailed test, $|z| >= 1.96$

[1] 1=maternal characteristics 2=immunization knowledge 3=community characteristics

[2] standard error in parentheses

[3] difference between deviance of fitted and null models; distributed as chi square; difference in degrees of freedom in parentheses

Table 6. Combined logit model for full immunization status, differences by country, Guatemala and the Philippines

Variable	Additive Model			Multiplicative Model		
	B	S.E.	t-value	B	S.E.	t-value
intercept	.60	.32	-	-.88	.55	-
Maternal characteristics						
born in community	-.43[a]	.15	2.87	-.43[a]	.15	2.87
3 or more children	-.64[a]	.15	4.27	-.62[a]	.15	4.13
completed at least primary school	.88[a]	.26	3.39	.76[a]	.20	3.80
works outside home	-.53[a]	.17	3.12	-.53[a]	.16	3.31
Immunization knowledge						
immunization knowledge index score 3/3 (HIKN)	.60[a]	.21	2.86	<.01	.35	-
Community characteristics						
above overall mean vaccine coverage (HCOV)	1.06[a]	.39	2.72	1.69[a]	.38	4.45
case community (CASE)	.36	.20	1.80	.56	.39	1.44
SE heterogeneity[1] (HETR)	-.52[b]	.21	2.48	1.13[a]	.55	3.47
Country[2]	.41	.21	1.95	1.72[a]	.54	3.19
Interactions						
Country*HIKN	-	-	-	1.03[b]	.44	2.34
Country*HCOV	-	-	-	-1.06[b]	.44	2.41
Country*CASE	-	-	-	-1.54[a]	.44	3.50
Country*HETR	-	-	-	-1.34[b]	.59	2.27
model scaled deviance (df)	1206.8 (1010)			1127.3 (1003)		
null model scaled deviance (df)	1278.9 (1016)					
reduction in scaled deviance[3]	72.1 (6)			151.6 (13)		

[a] = significant at the .01 level; two-tailed test, |z| >= 2.58
[b] = significant at the .05 level; two-tailed test, |z| >= 1.96

[1] std deviation for maternal education in that community exceeds the overall std deviation for that country

[2] omitted category: Guatemala

[3] difference between deviance of fitted model and null model; distributed as chi square; difference in degrees of freedom in parentheses

Table 7. Predicted probabilities of full immunization as a result of community-level predictors[1], controlling for country interactions, Guatemala and the Philippines

	Guatemala		Philippines	
Predictors	**Empirical logit**	**Conditional probability**	**Empirical logit**	**Conditional probability**
case + heterogeneity + high coverage	1.68	.84	.49	.62
heterogeneity + high coverage	1.12	.75	-.07	.48
case community	-1.70	.16	.58	.64
control community	-1.14	.24	1.56	.83

[1] household characteristics and immunization knowledge controlled

Table 8. Best-fitting combined logit model for full immunization status, Guatemala and the Philippines

Variable	Additive Model		Multiplicative Models					
	B (SE)	t	B (SE)	t	B (SE)	t	B (SE)	t
intercept	.55 (.27)	-	.74 (.27)	-	.83 (.27)	-	.71 (.30)	-
Maternal characteristics								
born in community	-.43[a] (.15)	2.87	-.44[a] (.15)	2.93	-.42[a] (.15)	2.80	-.43[a] (.15)	2.87
3 or more children	-.63[a] (.15)	4.20	-.64[a] (.15)	4.27	-.64[a] (.15)	4.27	-.64[a] (.15)	4.27
at least primary school	.71[a] (.19)	3.74	.74[a] (.20)	3.70	.71[a] (.20)	3.55	.74[a] (.20)	3.70
mother works	-.50[a] (.16)	3.13	-.53[a] (.17)	3.12	-.49[a] (.16)	3.06	-.53[a] (.17)	3.12
Immunization knowledge								
index score 3/3 (HIKN)	.60[a] (.20)	3.0	.59[a] (.21)	2.81	.59[a] (.21)	2.81	.59[a] (.21)	2.81
Community characteristics								
above mean coverage (HCOV)	.95[a] (.15)	6.33	.38[b] (.19)	2.47	.90[a] (.15)	6.0	.36 (.19)	1.90
case community (CASE)	-.58[a] (.16)	3.63	-1.14[a] (.21)	5.43	-.83[a] (.19)	4.61	-1.34[a] (.23)	5.83
heterogeneity[1] (HETR)	-.29 (.18)	1.61	-.29 (.18)	1.61	-.58[a] (.21)	2.76	-.53[b] (.21)	2.52
Country	.19 (.17)	1.12	.56[a] (.19)	2.95	<.01 (.19)	-	.42[b] (.21)	2.0
Interactions								
CASE*HCOV	-	-	1.59[a] (.55)	2.89	-	-	1.57[a] (.36)	4.36
CASE*HETR	-	-	-	-	1.15[b] (.46)	2.67	1.03[b] (.47)	2.19
model scaled deviance (df)	1146.7 (1007)		1125.3 (1006)		1140.3 (1006)		1120.4 (1005)	
null model scaled deviance	1278.9 (1016)							
reduction in sc deviance[2]	132.2 (9)		153.6 (10)		138.6 (10)		158.5 (11)	

[a] significant at the p < .01 level; two-tailed test, |z| >= 2.58
[b] significant at the p < .05 level; two-tailed test, |z| >= 1.96

[1] std deviation for maternal education in that community exceeds the overall std. deviation for that country
[2] difference between deviance of fitted model and null model; distributed as chi square; difference in degrees of freedom in parentheses

Table 9. Predicted probabilities of full immunization by covariate, combined additive and multiplicative models, Guatemala and the Philippines

Variable	Additive Model		Multiplicative Model	
	Empirical logit	Predicted probability	Empirical logit	Predicted probability
constant (omitted categories)[1]	.55	.63	.71	.67
Maternal characteristics				
born in community	0.12	.53	.28	.57
3 or more children	-.08	.52	.07	.52
completed at least primary school	1.26	.78	1.45	.81
works outside home	.05	.51	.18	.55
Immunization knowledge				
3/3 index score (HIKN)	1.15	.76	1.30	.79
Community characteristics				
above mean vaccine coverage (HCOV)	1.50	.82	2.64	.93
case community (CASE)	.05	.51	-.63	.35
SE heterogeneity[2] (HETR)	.26	.57	1.21	.77
Country	.74	.68	1.13	.76

[1] omitted categories: mother not long-term resident; less than 3 children; less than primary education; doesn't work outside home; less than 3/3 on imm knowledge index; community has less than national sample coverage; less than sample std deviation for maternal education; Guatemala

[2] std deviation for maternal education in that community exceeds the overall std. deviation for that country

Table 10. Predicted probabilities of full immunization as a result of community-level predictors[1], controlling for community-level interactions, Guatemala and the Philippines

	Guatemala		Philippines	
Predictors	Empirical logit	Conditional probability	Empirical logit	Conditional probability
case + heterogeneity + high coverage	1.53	.82	1.95	.88
case + high coverage	1.03	.74	1.45	.81
case + heterogeneity	-.40	.40	.02	.51
high coverage + heterogeneity	.27	.57	.69	.67
case community	-.90	.29	-.48	.38
control community	.44	.61	.86	.70

[1] household characteristics and immunization knowledge controlled

Figure 1: Communication Sources

Guatemala

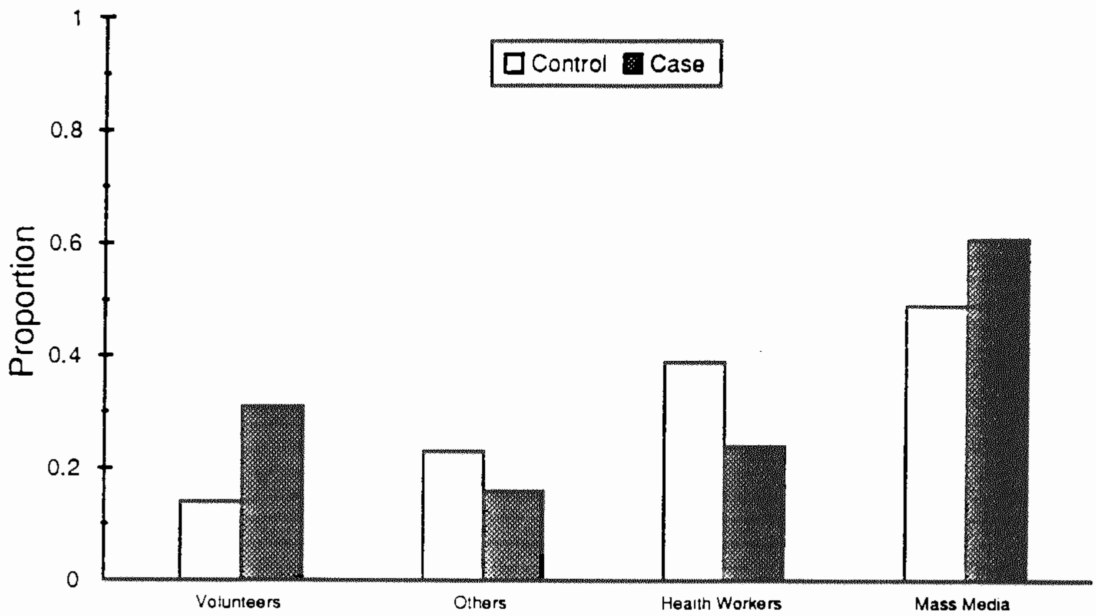
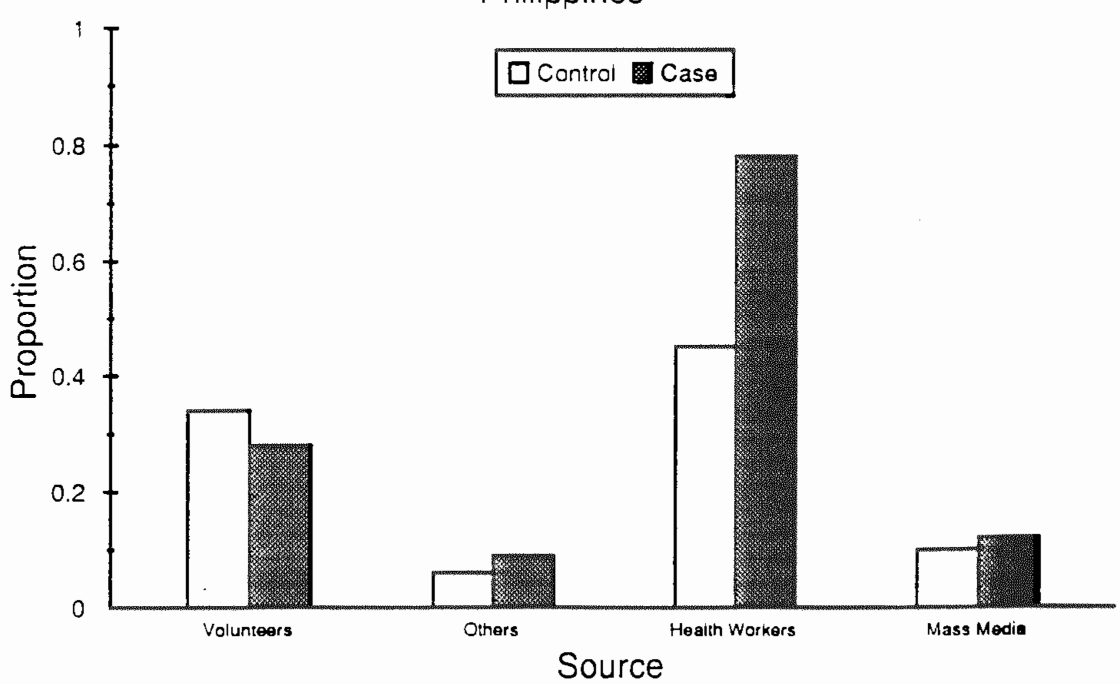


Figure 2: Communication Sources

Philippines



Center for Demography & Ecology
University of Wisconsin
1180 Observatory Drive, Rm. 4412
Madison WI 53706-1393
U.S.A.
608/262-2182
FAX 608/262-8400