Intra-Household Spillover Impact of a Maternal and Child Health Program: Evidence from Rural Bangladesh*

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Abstract

This paper investigates intra-household health externalities generated by a maternal and child health program in rural Bangladesh. This program, administered in a treatment area with an equally impoverished area retained as a control, allows us to estimate treatment effects without endogenous program placement and selection problems. A theoretical model is developed to describe the spillover mechanism. Reduced-form demand approach and data from the Matlab Health and Socio-Economic Survey of 1996 are used for the empirical analysis. Results find a significant spillover on the health of the non-targeted elderly women. Evidence points towards a within-household externality and not a community awareness effect.

1. Introduction

Evaluations of public health programs have been a source of continued interest to social scientists. They are important because policies recommending allocation of funds for continuation or introduction of specific health programs are made depending on the outcome of these evaluations. Evaluation mainly involves a cost-benefit or cost-effectiveness analysis that estimates the direct benefits derived (in monetary terms or through achieving targets) from the programs and compares them to the costs incurred[1]. These studies however are limited in their ability to capture the external benefits generated by these programs.

Externalities or spillovers occur when one individual or group's behavior imposes costs or benefits on other people. Positive spillovers on health may occur through dissemination of knowledge, cash or in-kind transfers made by public programs, through vaccination programs that reduce the spread of infectious diseases, etc[2]. If certain eligible households receive program benefits, it might generate positive spillovers on households in the neighborhood resulting in a community or inter-household effect. Also, if certain groups of people within a household like mothers and children receive benefits, positive spillovers might occur on other members of the household generating what may be called an intra-household spillover. To my knowledge, little attempt has been made to measure these intra-household spillovers while evaluating the impact of public health programs, mainly due to data and methodological limitations. A simple cost-benefit or cost-effectiveness analysis can understate the true benefits derived from these programs. This

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[1] See van de Walle and Nead edited 'Public Spending and the Poor: Theory and Evidence' [1995] for a compilation of such studies.

[2] Negative externalities may occur when a person is sick, has a cold or an infectious diseases, through vaccinations, tobacco use, drunk driving, blood donations, etc.

is a serious limitation since understating the benefits might lead to the rejection of a perfectly legitimate and potentially successful program.

Prior studies have discussed the importance of accounting for externalities (van de Walle, 1995; Beaton and Ghassemi, 1982), recognizing the cross-effects of policy while evaluating policy interventions (Rosenzweig, 1986). Studies like Miguel and Kremer (2001) have measured health externalities of a worm treatment program in schools in Kenya. They measure externalities generated by the program on untreated students in the same school as well as on students of neighboring untreated schools. However, they have not measured the externalities that might occur amongst untreated household members. While a study by Basu and Foster (1998) looks at an intra-household externality, it measures whether literacy within households have external effects on literacy achievements of other household members. A recent study by Alderman et al (2002) has looked at the externalities of education of women on neighboring household's nutrition levels, essentially measuring an inter-household externality. Thomas and Frankenberg (2000) looked at the impact of placing midwives on the health of targeted as well as non-targeted individuals and concluded that the non-targeted individuals in a community were not impacted by the improved health services.

This paper is an important contribution to this growing literature on measurement of externalities generated by public programs. It fills a gap by looking at and providing evidence towards intra-household health externalities generated by a health program. While Miguel and Kremer looks at similar age groups of children ignoring the fact that older or smaller children within households could also be impacted by a worm treatment program indirectly, this paper goes a step forward and evaluates a Maternal and Child Health program in rural Bangladesh by not only measuring the direct benefits on health of targeted mothers and children but also by estimating the intra-household health externalities generated by this program on all other non-targeted household members. A model is developed to explain the various pathways in which spillovers are generated on the health of the non-targeted individuals living in targeted households. The various pathways could include *income effects*, *public good effects* and *contagion effects*. The program in the form of an in-kind transfer frees up resources for other members creating an *income effect*, produces public goods such as health information that creates the *household public good effect* and generates a positive *contagion* as a result of healthier and more hygienic surroundings. All three effects are expected to be positive and mutually reinforcing, resulting in a positive spillover effect.

Using data from the Matlab Health and Socioeconomic Survey (MHSS) of 1996, estimates are obtained, of the effect of the MCH program on health outcomes of various age and gender groups residing within the households. The direct impact on mothers and children are estimated while the spillover impact is estimated for elderly women and adult men in the households. The results obtained from this empirical analysis strongly support a positive intra-household spillover hypothesis. The spillover impact of the program improves the health of elderly women in the targeted areas of 1982 by about 7%, while the combined improvement for both areas targeted in 1982 and 1986 is about 3%. Results of spillover impact on men's health are however, inconclusive. The spillover impact is greater when younger cohorts of women are targeted. The direct impact of the program on the health of the targeted women and children is positive and significant. This study also examines whether the spillover is due to an inter-household spillover effect or a result of a community effect. In contrast to the Alderman study, community effect in this study turns out to be non-existent.

In most program evaluation studies, estimates of treatment effects are biased as a result of endogenous program placements or program-selection issues. Rosenzweig and Wolpin (1986) pointed out that most health programs are placed in relatively impoverished areas resulting in underestimated treatment effects. This study, however, is unique because of the universal allocation of the program to all eligible households in the treatment area thus avoiding program selection. The treatment and control areas were chosen out of an area that was uniformly impoverished and underdeveloped. The fact that the program was not administered in the control area provides a reasonable amount of relevant counterfactual, which enables this study to compare between treatment and control areas and estimate treatment effects on health outcomes. Foster (1994) calls it an “imperfect but a reasonable approximation” to a true experimental program. Selective migration can also potentially bias the true estimates of program effectiveness. However, Phillips et al (1982), Foster and Roy (1997) and Kuhn (2002) assume insignificant diffusion of information into the comparison areas in their studies. Further, the detailed information on the elderly members of the households provided by MHSS adds a new dimension to this study. Increasing attention is being given to issues related to the elderly. However, research on elderly in the developing countries is nipped at the bud as a result of lack of data. New datasets such as the MHSS makes it possible to carry out an analysis of this nature. The added benefit of a “natural experiment” carried out in this area of Bangladesh offers a unique opportunity for this study.

The results in this paper provide important lessons. First, it sheds light on spillovers, an important angle omitted by standard cost-benefit and cost-effectiveness analyses. Second, it provides evidence towards yet another mechanism of intra-household sharing of resources. Third, from the empirical evidence obtained, that targeted benefits create spillovers becomes crystal clear and this lesson is of utmost importance for policy-makers.

This chapter is divided into six sections including the introduction. Section 2 is an overview of the program; Section 3 discusses the theoretical framework, section 4 is a discussion of the empirical framework. Section 5 is a description of the data used. Section 6 discusses the results and Section 7 concludes.

2. Description of the Maternal and Child Health Program in Matlab

Matlab, situated at the confluence of Dhonogoda and Gumti rivers in the flood plain of the Meghna river system, is a regularly flooded area of Bangladesh and is well-known for its frequent cholera epidemics in the 1960s and 1970s. An independent, international, non-profit-making research organization called Cholera Research Laboratory, hosted and supported by the government of Bangladesh was set up in Matlab, Bangladesh in 1963 which later, in 1978 became known as the International Center for Diarrhoeal Disease Research (ICDDR, B). Matlab is the principal field station of the ICDDR, B where several studies and experiments have been carried out over the last several decades.

The climate is subtropical with 6 major seasons and three main agricultural seasons. Most of the households depend on underwater cultivation of rice in the monsoon season (June to September) when almost all land outside of homestead land on high ground is flooded. The landless households and small landholders in this season incur huge debts to pay off during post-harvest season which results in huge fluctuations in prices, nutritional levels, labor outcomes as well as high incidences of default, foreclosures and landlessness. According to the ICDDR, B census of 1993, 88% of the population is Muslim and the rest are Hindus. In 1974, 38.2% of males and 17.2% of females were found to be literate. Agriculture and fishing are the main occupations. The villages in this area have an average population of 1,100 persons with an average population density of about 1500 persons per square miles. In the months of July to September, water level rises by more than 4 meters, population density increases manifold. Apart from the single motorable road between the Matlab *bazaar*[3] and the district capital of Chandpur, all other transport and communication are either by boat or by foot. Thus by all indices, this is a very poor, underdeveloped and densely populated rural community.

Between 1975 and 1977, a 'Contraceptive Distribution project (CDP)' was carried out in 150 villages in Matlab, retaining 84 villages as a control group. Although, contraceptive usage increased from a baseline of 1% to 18% in the first three months, the long-term impact was limited because of insufficient planning and a lack of sustained implementation. Notwithstanding these flaws, the CDP generated a substantial desire for contraceptive use in the community. This led to a need for the 'Family Planning- Health Services Project', set up in 1977. The study area covering 150 villages was divided into treatment and control areas. The treatment area consisted of 70 villages, where the ICDDR, B administered its family planning services along with limited health services. The neighboring control area continued to receive government family planning and health services in the normal course. The treatment area was further split into 4 operational blocks, (A, B, C, D) each organized around a small Maternal and Child Health-Family Planning (MCH-FP) clinic staffed by paramedical personnel (Figure A.1). Bhatia et al (1980) provides a comprehensive description of this project.

The community health workers (CHWs) of the Matlab Family Planning-Health Services Project delivered a range of contraceptive methods and also referred interested women to the local MCH-FP clinic to treat common illnesses and family-planning related problems. They dispensed nutritional advice to pregnant and lactating women, administered tetanus toxoid shots to pregnant women and distributed iron and folic acid tablets. The CHWs also rendered basic childcare, nutrition and breastfeeding advice to interested mothers as well as distributed and promoted the use of oral re-hydration solutions amongst young mothers through a door-to-door

[3] market

delivery method. Bhatia et al (1980) pointed out that unlike most other rural societies, women in this area did not work outside their *bari.* [4] Hence it was necessary to have intensive antenatal, delivery and postnatal care component to a family planning program in order to decrease tremendously high maternal and neonatal mortality rates.

In 1982, the MCH-FP extension project introduced the intensive MCH program in two of the four blocks of the treatment area, focusing on the health component of the MCH-FP program. Blocks A and C were randomly chosen as the “intensive MCH” blocks, wherein CHWs provided tetanus toxoid immunization to all married women of reproductive ages (as opposed to only pregnant women), measles vaccination to all children between nine months and 5 years of age, and antenatal care and safe delivery kits to pregnant women. In the areas B and D, known as the “limited MCH” blocks, the CHWs continued to deliver the same services as in the preceding phase. In 1986, the intensive health services were introduced in blocks B and D as well.

The intensive MCH services also introduced in various phases, components such as: Complete immunization against the six EPI[5] diseases (in 1986), Vitamin A supplementation (in 1986), nutrition rehabilitation (started in 1986), community based maternity care program involving midwives posted in the field (in 1987), control of acute respiratory infections (started in 1988) and control of dysenteric diarrhea (started in 1989) (Fauveau, 1994).

The Matlab Health and Socioeconomic Survey was collected in 1996, by which time the intensive MCH interventions were present in the treatment blocks for 14 years in blocks A and C and for 10 years in blocks B and D. Some of the baseline characteristics comparing the treatment and control areas is given in Table 1.

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[4] Several related households around a clearing makes up a *bari.*

[5] Expanded Program on Immunization (1991).

3. Theoretical Framework

In this section, a theoretical model has been developed to explain the mechanism by which a spillover effect of the MCH program is generated on the health of non-targeted individuals living in the targeted households in the program area. This model is consistent with the standard economic framework involving a constrained maximization of a unified preference function and is based on the farm household framework as discussed in Behrman and Deolalikar (1988). Consider a household with n members. The household's preference over the health of individual members (H) and a composite consumption good (X) that includes leisure can be expressed by a well-behaved utility function with all its standard properties. All such households maximize their utility function given by equation (1).

$$U_j = U_j(\overline{H_{ij}}, \overline{X}_{ij}, \overline{Z}_{ij}) \qquad (1)$$

where U_j is the utility of the jth household, $\overline{H_{ij}}$ represents the vector of the health of individuals i=1,2….,n in household j and $\overline{Z}_{ij}$ represents the vector of health inputs and $\overline{X}_{ij}$ represents the vector of all other consumption goods of household members.

Utility maximization is subject to the household budget constraint and the health production functions of all the individuals in the household. The additional features in a farm household model like time constraints, time inputs and other farm production functions are not introduced explicitly for the lack of data and to maintain the simplicity of the model. The health production function of the household members (given by equation 2) depends on the use of health inputs (Z_{ij}), consumption of all other goods (X_{ij}), household public goods (W_j), health of all other members in the household excluding oneself and all the observed and unobserved endowments of the household (μ). The household members have been grouped into the targeted group (T) and the non-targeted (O) group for the purpose of this analysis. The targeted group consists of the mothers in their childbearing ages (TM) and children between the ages of nine months to 5 years (TC) and the non-targeted group includes the adult men and elderly women.

$$H_{ij} = h(X_{ij}, Z_{ij}, W_j(A), H_{-ij}; \mu) \qquad (2)$$

where $H_{-ij}=\{H_{1j},\ldots\ldots, H_{i-1j}, H_{i+1j},\ldots\ldots, H_{nj}\}$ and $H_{ij} \in [H_j^{TM}, H_j^{TC}, H_j^{O}]$

$$Z_{ij} = f[z_{ij}^1(A), z_{ij}^2] \qquad (3)$$

Z_{ij} is a function of the health input provided by the MCH program z^1 and the private health inputs z^2. z^1 may be in the form of health information, health inputs such as vitamins and vaccines as well as problem-specific and sex-specific health inputs for targeted individuals which are provided free to the targeted members, only in the treatment areas. Hence, z^1 can be looked upon as a function of the health program, denoted by A (Equation 4). Similarly the household public good (W) is also a function of A (Equation 5), generated when the program is present in the household. Let A=1 when the program is available for targeted mothers and children in the treatment areas and A=0 when the program is not available either for individuals in the control area or for the non-targeted individuals in the treatment area. Then,

$$z_{ij}^1(A) = 0 \quad if\ A_{ij} = 0 \qquad (4)$$

$$\rangle 0 \quad if\ A_{ij} = 1$$

$$W_j(A) = 0 \quad if\ A_j = 0 \qquad (5)$$

$$\rangle 0 \quad if\ A_j = 1$$

Equations (4) and (5) are additional constraints on the households' utility maximization.

$$\sum_i p_x X_{ij} + \sum_i p_{z^2} z_{ij}^2 = Y + z_{ij}^1(A) \qquad (6)$$

Equation (6) is the household budget constraint where Y is the pooled household income, $p_{(Z^2)}$ and p_X are prices of the private health inputs and consumption goods respectively. The price of the program input has been normalized to one; hence it enters the budget constraint as an in-kind transfer (Cornes, 1995).

Maximizing utility subject to the production constraints and the budget constraint, the reduced form demand functions for health inputs, consumption and outcome variables that can be derived are given by equation (7).

$$H_{ij}^T, H_{ij}^O, Z_{ij}, W_j, X_{ij} = f\,(p_x, p_z, Y_j; A, \mu_j) \qquad (7)$$

Program intervention that changes any of the right-hand side variables will change the allocation of resources and outcomes within the households to conform to the optimizing allocation. The impact of the program on the health of women and children can be explained with equation (8). The second term on the right hand side in equation 8 denotes the direct effect of the publicly provided health inputs on the health of the targeted individuals. The other terms constitute the indirect effects of the program on the health of women and children.

$$\frac{\partial H_{ij}^T}{\partial A} = \left(\frac{\partial h^T}{\partial X_{ij}}\right)\left(\frac{\partial X_{ij}}{\partial A}\right) + \left(\frac{\partial h^T}{\partial z_{ij}^1}\right)\left(\frac{\partial z_{ij}^1}{\partial A}\right) + \left(\frac{\partial h^T}{\partial z_{ij}^2}\right)\left(\frac{\partial z_{ij}^2}{\partial A}\right) + \left(\frac{\partial h^T}{\partial W_j}\right)\left(\frac{\partial W_j}{\partial A}\right) + \left(\frac{\partial h^T}{\partial H_{-ij}}\right)\left(\frac{\partial H_{-ij}}{\partial A}\right) \quad \ldots\ldots\ldots(8)$$

Impact of the program on women and children's health is estimated when the women and children are directly exposed to the program and also for cumulative exposure by other members in the household. This paper does not isolate the magnitudes of the direct and indirect effects of the program. However, it is possible to estimate the external benefit or spillover impact of the program by looking at the program impacts on the health of the non-targeted individuals. The direct effect for these people is absent because z^1 does not enter the health production functions of the non-targeted individuals directly.

$$\frac{\partial H_{ij}^{o}}{\partial A}=\left(\frac{\partial h^{o}}{\partial X_{ij}}\right)\left(\frac{\partial X_{ij}}{\partial A}\right)+\left(\frac{\partial h^{o}}{\partial z_{ij}^{2}}\right)\left(\frac{\partial z_{ij}^{2}}{\partial A}\right)+\left(\frac{\partial h^{o}}{\partial W_{j}}\right)\left(\frac{\partial W_{j}}{\partial A}\right)+\left(\frac{\partial h^{o}}{\partial H_{-ij}}\right)\left(\frac{\partial H_{-ij}}{\partial A}\right)$$

i=1, 2…., n (9)

Equation (9) therefore, represents the spillover impact and its components. The first two terms denote the income effect, the third term denotes the household public good effect and the last term denotes contagion effect.

Health inputs are assumed to be normal goods. We also assume that the private and publicly provided health inputs are perfect substitutes. By providing some of the necessary health inputs to the targeted members for free, the targeted members would increase consumption of the public health inputs. This would make some household resources and income available for the non-targeted members to increase consumption of their private heath inputs. Moreover, expanded household resources can also be used to purchase or produce more of the composite goods for all household members. If the targeted members of the households hoard tangible health inputs such as vitamins and medicines provided by the MCH program, it would add to the resources available for the non-targeted individuals as well. All of these lead to a positive income effect on the health of the non-targeted individuals.

If the MCH program provides information about health and hygiene practices in the household, it would enhance the basket of household public goods. The availability of this type of public good will generate a positive household public goods effect as a result of the program. Another important component of the spillover effect is the positive biological contagion, which is generated by healthier women and children in the household. This positive contagion has a multiplier effect for all household members since better health of an individual would affect the health of other members, which in turn would affect the individual and so on.

Although this reduced form framework does not permit separate measurement of each component of the transmission mechanism, it can clearly predict the overall spillover effect of the program on the non-targeted individuals. Since all the components are positive and mutually reinforcing, the total spillover effect is expected to be positive. With the help of data, it is possible not only to test this hypothesis but also to empirically estimate the magnitudes of the spillover effect. Although computationally separating out the components of the spillover effect is beyond the scope of this paper, it is possible to conjecture about which component in the transmission mechanism might be relatively stronger in creating the positive externality.

4. Empirical Specification, Estimation and Econometric Issues

4.1. Specification of Estimating Equation

Following from the theoretical framework, the estimating equation for the health outcome of individuals in linear form is the following:

$$H_{ij}= \beta_1 A_j + \beta_2 {P_Z}^2{}_j + \beta_3 Y_j + \beta_4 I_{ij} + \beta_5 J_j + \varepsilon_{ij} \tag{10}$$

where,

i : indexes the individual

j : indexes the household

H: vector of health outcomes

A: Program presence in the household

P_Z^2: Price of private health goods

Y: Log of household per capita monthly expenditure (proxy for income and prices of all other goods)

i: Observed individual characteristics

j: Observed household characteristics

ε: Disturbance term

The parameters that are to be estimated are the vector of coefficients given by β. The standard errors are corrected for within-cluster correlation of error terms as well as for arbitrary heteroscedasticity. The coefficient of "A" is the parameter of interest in this study. It indicates the effect of the MCH program on the health outcomes of various age and gender groups within the households. The hypothesis that we test here is $\beta_1>0$. Squared terms of regressors as well as interaction terms between the covariates are introduced in the empirical specifications to account and control for any non-linearity.

In order to test for intra-household spillovers, this paper looks at the impact of the program on the health outcomes of the non-targeted individuals. These individuals are adult men (above the age of 20 years) and elderly women (above 60 years). Since these adult men have never been directly targeted by the MCH program at any part of their lifetime (not even during childhood), a significant program impact would validate the nature of spillover discussed in this paper. Similarly, the elderly women were past their reproductive ages when the MCH programs were first introduced—if there is any effect, it would most likely be due to a spillover effect. Several variants of the estimating equation are used for these non-targeted individuals.

First, adult men above 20 years of age have been pooled to test whether the MCH program has had any impact or not. Second, categorical variables to indicate different age categories have been used to determine whether the effects are larger for certain cohorts of men. Third, the sample of elderly men (above 60 years of age) and sample of other adult men (20-60 years) have been examined separately to determine the impact of the program.

In addition, all the above set of equations is also estimated for adult men living in households that had either a younger or an older cohort of targeted women or both. This is done in order to see whether the spillover impact varies with the cohorts targeted by the program. A dummy variable indicating the presence of the program has been used to determine the impact of the health program. Number of years of household exposure to the program is used to determine the non-linear effect of the program. Since price information at the village level is not very accurate and the income variable has to be constructed using various assumptions, it is likely that these could introduce measurement biases. Hence, price proxies in the form of 'time taken to go to the drinking water source' and 'average distance to different kinds of health providers from the headman's house' are used as shadow price of private health inputs. Log of household expenditure per capita is used to proxy for permanent income and other prices faced by the households. Individual characteristics such as age, square of age, education, whether head of the household and whether married are used as controls. Household characteristics such as whether house is owned by the family, head's age and head's education are used as additional controls.

Fourth, the sample of elderly women is examined to determine the program impact. Fifth, the program impact on elderly women is further examined to see if the magnitude varies if these elderly women reside in households with targeted women who were targeted as young women, older or both. The control variable 'whether head' is replaced by 'whether head's spouse' for this sample. The estimations have been done separately for men and women as demographic and biological outcomes vary according to gender and pooling the genders will not yield sensible results.

In addition to intra-household spillovers, this paper also evaluates the impact of the program on the targeted women and children's health outcomes. Targeted women are pooled as well as categorized according to age cohorts for these estimations. In addition to the dummy variable approach, own-years of exposure and cumulative exposure by all other targeted members have been used to estimate the direct and indirect effect of the program respectively. For the women, a dummy variable indicating whether currently pregnant is used as an additional control.

Health status of children aged zero to fourteen years is estimated using a similar estimating equation. A dummy variable to indicate exposure to the program is used to capture the impact of the program. Age and gender-standardized height and weights and weight for height measures have been used as continuous measures of child health outcome. Discrete measures such as whether stunted, underweight or wasted[6] are used to estimate health outcomes for children aged 1-10 years. Mother's and father's education have been used as controls. The program effect on children's health is also estimated for mothers who had been targeted by the program as young or older mothers.[7]

It must be noted here that health status is an outcome of cumulative exposure to health care, levels of food intake and use of other goods. We need to therefore implicitly assume that all the right hand side variables used denote a long term living standard of the households. Further, although the public health program provides an in-kind transfer of health goods, this only constitutes preventive care and therefore the income effect on these rural households, (who

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[6] These measures are explained in detail in the data section.

[7] In a separate working paper (Chaudhuri, 2002) "Impact of a public program on investment in children", I construct several other variables to indicate the program. One such is a variable that represents the proportion of lifetime of these children that is exposed to the program. In that paper, whether exposed at birth, own-years of exposure and cumulative years of exposure by all other targeted members of the household are also used to assess program impacts on children. Other socioeconomic variables and their interaction terms with the program are used to capture socioeconomic determinants of children's health.

approximately spend less than 5% of their annual budget on preventive health care) is expected to be quite minimal.

4.2. Estimation Technique

This sub-section explains the sampling technique used in this analysis to identify the targeted households in the treatment area and the eligible households in the comparison area. It also explains the estimation method used to compare the health status of individuals residing in targeted households in the treatment area with the health status of individuals living in the eligible households in the comparison area. This will enable us to determine the MCH program's impact on individual health status.

Table A.1 describes the MCH program coverage. The intensive MCH program was initiated into Blocks A and C in 1982 and extended into Blocks B and D in 1986. Areas A, B, C and D cover 70 villages while the comparison area comprises 79 villages. The program targeted women in their childbearing ages (15-44 years) and children between the ages of nine months and 5 years. This study categorizes the targeted women into various groups. Table A.2 describes the scheme used to detect the targeted women in 1996 depending on the year they were first targeted and their residence block.

Row 1 in Table A.2 shows that the women targeted in 1982 and living in blocks A and C were between the ages of 15 and 44 years. These women would be in the age group of 29 to 58 years in 1996. The women targeted in 1986 (shown in Row 3) and living in blocks B and D would be in the age group of 25 and 54 years in 1996. Further, since the project was an ongoing one, women residing in Blocks A and C would age into the program between 1982 and 1996 and this would be the age group of 15 to 58 years in 1996. Similarly, women aging into the program in Blocks B and D would be between 15 and 54 years in 1996.

The women targeted in 1982 and living in Blocks A and C have been compared to the women of the same age group living in the comparison area. The impact of the program, which these women have been exposed to for 14 years, has been estimated using data collected in 1996. Since the program was extended to include the blocks B and D in 1986, the targeted women of blocks B and D have been compared to the same age group living in the comparison area. In addition, comparisons have been made between all ever-targeted women in blocks A and C with the women in the comparison area, as well as, between all ever-targeted women in blocks B and D with those in the comparison area. Another important comparison has been made between women in the age group of 20 and 54 years living in all the four blocks and the same age-group in the comparison area. The reason for this will be elaborated shortly.

Two sets of schemes have then been used to identify the targeted households. First, the women who were targeted in 1982 in blocks A and C would be in the age group of 29-58 years in 1996. The households in blocks A and C, which have women in this age group, would be the targeted households. We compare individuals in these targeted households to the individuals in the eligible households (which have women in the age group of 29-58 years) of the comparison region. A dummy variable is used to indicate the presence of the MCH program and estimate its impact.

Second, the women in their childbearing ages living in blocks B and D were additionally targeted in 1986. These women would be in the age group of 25-54 years in 1996. Bringing the blocks B and D into the treatment area, the targeted households would be the ones in the treatment area with women aged 25-54 years. This would incorrectly exclude the women aged 54-58 years and living in blocks A and C (women living in A and C aged 40-44 years in 1982 would be 54-58 years in 1996). Further, we need to take into account the ongoing nature of the project where women aged 15-25 years would have aged into the program between 1986 and

1996. However, including women in the age group 15-20 years might result in 'double-counting' since the women in this age group will have been affected as child targets at younger ages. Alternatively, these women could include young brides married into the treatment area households. These reasons could result in spurious estimates for this group, which is why the women below 20 years of age have been left out. Further, we can assume that the women in the age group of 54 and 58 years might not have been affected since they were at the end of their fecundity with most of them having had completed their child bearing [8]. Hence, to determine the effect of the program introduced in the entire treatment area, targeted (and eligible) households are determined as those that had women between the ages of 20 and 54 years residing in them in 1996[9].

It should be noted at this point that target households are indicated in this analysis according to presence of targeted women only, since we can assume that if a household has children who were targeted, the likelihood of that household having a woman in her childbearing age is very high, but the converse is not true[10]. Table A.3 presents the different cohorts of targeted women. The fourth column in the table explains the various age cohorts of women taken from the

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[8] Preliminary estimation results show that the program does not have a significant impact on the women between the ages of 54 and 58 years and between 15 and 20 years in the blocks A and C compared to the control area. The women in the ages 15 and 20 residing in blocks B and D are also compared to the women living in the control area but no significant impact of the program is evident in the estimation results. These results are available from the author.

[9] See last row of Table A.2.

[10] It is possible that high rates of maternal mortality might render a few households with new born children and no women but several marriages or immediate remarriage by men in this society makes such households constitute a very small percentage of the whole sample.

first treated date and the fifth column explains the corresponding age groups of these women in 1996. This paper estimates the impact of the MCH program on these groups of women and also uses these groups of women to indicate the targeted households in order to estimate the spillover impact of the program on the non-treated members of these target households.

4.3. Econometric Issues

Studies such as Rosenzweig and Wolpin (1986) discuss several biases that might arise in the econometric analyses of program impacts. The coefficient of the variable of interest might be biased if there is endogenous program placement. For example, if an area is of inherently poor health and hence receives a public health program, then the coefficient of the program variable will be downwardly biased. This will not enable the study to determine the true program impact. This paper however looks at an intensive MCH program that was randomly placed in a few blocks designated as the treatment area while not administered in other blocks that remained the control area. All these blocks were in an area of similar demographic characteristics and health status[11]. Using data from 1996, Table 1 shows that there are no significant differences in most key

[11] Baseline characteristics of a survey sample of those living in treatment area in 1977 is available in Bhatia (1982). Unfortunately, we do not have any data from the comparison area. Phillips et al (1982) and Foster and Roy (1997) document that both areas had similar demographic characteristics when the family planning program was started in 1978. It led to an increase in contraceptive prevalence and a decline in age-specific fertility rates in the treatment area compared to the control area. Fertility selection could potentially result in overestimates of the MCH program. However, I believe that even if the number of children born in the treatment area has decreased, the number of children born per mothers and per households is still high enough and birthing practices still lacking in hygienic practices (Bhatia, 1981) to pose a serious health risk to mothers and children.

socio-economic and biological variables across the two areas except for some variables where the difference could be as a result of the program (for eg. Household size and distance to health providers). Hence, this random control experiment provides a unique opportunity to determine the true impact of the program. A source of bias could be a selection bias if women and children had a choice to be or not to be a part of this intensive MCH program. However, all eligible women and children in the treatment area receive the benefits of the program; hence there is no case for selection in this study.

Rosenzweig and Wolpin (1988) discuss another potential source of bias in program evaluation studies and this is 'selective migration'. If less healthy people migrate to areas that receive a public health program then the impact of the program will be biased. However, studies like Phillips et el (1982) suggest that the socio-geographic setting of Matlab is such that mobility of families between blocks is limited, the villages are fairly isolated, connected by waterways or by foot and relatively free from potentially contaminating factors such as migration and trade. This tends to insulate treatments from one another and the outside world allowing us to assume insignificant diffusion of benefits of treatment into the control areas. Kuhn (2002) explains the nature of migration that takes place in Matlab. The majority of migration is of a rural-to-urban nature. Any male rural-to-rural migration takes place mostly seasonally or for labor market opportunities and female rural-to-rural migration for marital reasons only. Hence, selection into the treatment areas can be assumed to be negligible in this area.

Another potential source of bias could be mortality selection. This area is prone to natural disasters such as floods that have economic fallout especially on landless households. As a result of poverty and hardship, the weak and frail are likely to succumb more. It is even more possible that there will be less unhealthy survivors in the control area compared to the treatment area (where the frail and weak might survive longer) which will result in underestimation of the treatment effects (Rose, 1999). This will only make the treatment effect results in this study stronger and will provide a lower bound for the treatment effects in the absence of a correction for selection of this nature[12].

5. Data

This analysis is carried out using the Matlab Health and Socioeconomic Survey (MHSS) of 1996. This dataset was collected primarily to address socioeconomic and health issues of rural adults and the elderly in Matlab, Bangladesh. The main sample consists of household-level and individual-level information on 4,364 households (after eliminating the incorrectly sampled households). The households are clustered in 2,687 *baris*, which are approximately one-third of the total number of *baris* in the surveillance area. The Survey also collected community level information, which has been incorporated in the analysis. This paper carries out individual level analysis using individual, household and village level information from the Household and Community/Provider surveys. All individuals were recorded and detailed information was collected on the adults and the elderly. Detailed records of only a random selection of two children per household were collected, and not of all the children in the sample. However, this analysis uses limited information but of all the children from the main household roster.

The key variable of interest is whether the household is in the treatment or the comparison area. The identifying question for the maternal and child health treatment area in the questionnaire was whether or not the household was under any of the following six categories of treatment and control areas: Treatment area, block A; Treatment area, Block B; Treatment area, Block C; Treatment area, Block D; Comparison area, Non-CDP; Comparison area, Old CDP

[12] It is not possible to attempt to correct for mortality selection since we need information on all the individuals including those who died. This information is not available in this dataset.

Pgm[13]. All women in the childbearing ages and children between nine months and 5 years residing in the treatment area were given intensive MCH services, whereas the comparison area got no such intensive health programs except for the prevailing government family planning and health services. Price proxies used in the analysis are the time (in minutes) taken by each household to go to a drinking water source and the average distance (in kilometers) (in the child sample, we use average time in hours) from the headman's house to all the health providers of a village. A measurement problem could arise here from the fact that some villagers in Bangladesh still report distance in 'miles' rather than in 'kilometers', which is more commonly used and the surveys have not been able to completely correct for mistakes of this nature.

Means and standard deviations of selected variables are presented in tables 2 and 3. Table 2 presents the summary statistics for the entire sample and Table 3 presents information on the sample of children below the age of 14 years. The tables show that the mean level of education measured in years is very low. The sample population is a fairly young population although the dataset was tilted towards collecting information on the elderly.

Health of adults is measured in terms of Body Mass Index (BMI) [14]. Measuring health status is not an easy task, especially since it is multi-dimensional and context sensitive (Ware, 1987). Clinical measurements are prohibitively expensive while self-reported perceptions of health are neither always clear nor easy to interpret (Gertler et al, 1999). Anthropometric outcomes, however, are measured objectively and they indicate the nutritional status of individuals. These anthropometric outcomes are not unrelated to health status in a poor developing country context and are more reliable as indicators of individual health status than

[13] Part of the comparison area includes villages that had participated in the Contraceptive Distribution Program (CDP) of the 1960s. The treatment area villages did not have CDP in the 1960s.

[14] Body Mass Index is calculated as height in meters divided by square of weight in kilograms.

self-reported measures. In the analysis of adult health, Strauss and Thomas (1993) treated physical functioning as a stock measure of health and BMI as a measure that is more susceptible to short run fluctuations. The average BMI for women and men in the age group of twenty to sixty years is about 18.9. BMI for men and women above the age of sixty is 17.5 and 17.9 respectively which are below the lower-most bound of the scale that indicates healthy levels of body mass indices.

There appears to be a general consensus in literature regarding the long-term measures of child health measured by sex- and age-standardized height and short-term measures such as sex- and age standardized weight or weight-for-height. For children older than ten years, a short-term measure could also be BMI. Height is considered to be a long run measure of health status and is not subject to transitory shocks while weight for age and weight for height are measures that capture short term fluctuations. However, health outcomes may differ depending on the reference population used in standardizing heights and weights.

Heights and weights are standardized using the NCHS reference population and the Center for Disease Control ‘anthro’ software. The mean height-for-age Z score for the child sample is –2.13, which means that the average child below 14 years in this sample is 2.13 standard deviations below the median for a child of the same age and gender in the reference population. Similarly, average standardized weights are 2.24 standard deviations below the median of the reference child.

Discrete measures of child health denoting extreme health outcomes are also used as dependent variables. Stunted children are those with height-for-age that is two standard deviations below the median of the NCHS reference population. Children are deemed as underweight if their weight-for-age Z score is less than 2 standard deviations and wasted if the weight-for-height Z scores are less than 2 standard deviations from the median of the reference population. Fifty eight percent of this sample of children is stunted, sixty six percent are underweight and twenty three percent are wasted by the NCHS/WHO/CDC standards. These numbers are much below the accepted norm and indicate a chronic public health problem.

6. Results

This section presents the treatment and spillover effects on various groups of individuals, the targeted and non-targeted. Sections 6.1 and 6.2 briefly discuss the direct impact of the program on the health of targeted women and children. Sections 6.3 and 6.4 discuss the intra-household spillover effects on the non-targeted individuals. Section 6.5 summarizes the results and discusses some additional hypotheses.

6.1. Impact of the Program on the Targeted Women

Table 4 reports only the program impact on women's health status. The first column reports the coefficient of the program variable for the women targeted in 1982, comparing them to women in the control area. The second column reports the coefficient of the variable of interest for the women targeted in 1986 and the third column reports the coefficient for all targeted women in the treatment area. The first row reports the coefficient of the program dummy, the second row reports marginal impacts for each extra year of exposure while the third row reports marginal program impact for own years of exposure and for exposure by others (other targeted individuals in the household including children). Both the dummy variable and the exposure coefficients are positive and significant, which means that the women in the treatment area are of significantly better health than women in the control area. The targeted women seem to be impacted significantly by being exposed to the program directly whereas the indirect effect is positive but not significant.

These results hold for women in their childbearing ages even after controlling for pregnancy during data collection for some of these women. Unfortunately, there is no data on whether some of these women were nursing during the survey. All other controls are included in the regressions. Health improves with age for these targeted women but at a diminishing rate. The price proxies show a negative coefficient while income has a positive and significant coefficient. Being head's spouse makes women worse off. Marriage, on the other hand, improves their health. Education has a positive and significant impact on the health of these women, everything else remaining constant. Head's education has a positive and significant impact on the health of the women. The fourth row in Table 4 shows that the magnitude of impact of the program in improving women's body mass index is statistically significant and larger for the younger cohorts.

6.2. Impact of the Program on Targeted Children

Table 5 summarizes the impact of the MCH intervention on children living in the treatment areas, tabulating only the coefficient of the program dummy variable. Columns indicate the various specifications using different dependent variables to determine the program impact. The rows indicate the different samples used, i.e., all children, children of targeted mothers and children of different cohorts of targeted mothers, separately for the area that was targeted in 1982 and the entire treatment area.

The results show that the MCH program improves children's health and nutritional status both in the long run and the short run. Children of mothers who were targeted in their young ages seem to better off compared to their comparison cohorts. There is no such difference when mothers are of other age groups. Results are similar and consistent for all measures that are used. The treatment effects on short-term measures of health seem to be more robust.[15]

6.3 Impact of the Program on the Elderly Non-Targeted Women

In Table 6, the first two rows show the program effect on elderly women above the age of sixty years. Columns indicate different targeted cohorts with whom the non-targeted elderly women live. The first three columns are to compare the blocks A and C with the comparison area while the last three compare the whole treatment area with the comparison area. Coefficients of program dummy as well as total years of exposure are reposted in rows 1 and 2 respectively. The treatment improves the body mass index of elderly women living in the targeted households of the treatment area confirming the hypothesis that the MCH program has a positive spillover effect on the health of elderly non-targeted women. Apart from a dummy variable, a variable indicating cumulative years of program exposure of the household yields similar results.

Elderly women living in households exposed to the MCH program since 1982 have a seven percent higher BMI whereas all elderly women exposed to the program have three percent higher BMI than those in the comparison area. This estimated effect of the program is shown in Figures 1 and 2 which graph the cumulative distribution of BMI of elderly women. In the presence of the program, there would be almost 20% more elderly women with BMI more than

[15] In another paper (Chaudhuri, 2002), I look more closely at the impact of the MCH program on children's health and nutritional status and draw a few interesting conclusions. Mother's education impacts children's health status positively, affecting girls more than boys while the less educated mothers seem to be able to improve their child's health significantly in the presence of the program. The program improves the girl children's short term health more significantly while boys do better in the treatment area in terms of long term health status. Several different indicators of program presence are used to check the sensitivity of these results.

18 (healthy range of BMI is between 18 and 25) in the control areas had they been exposed to the program of 1982 (Figure 1). Figure 2 shows that the estimated program effect on elderly women in the treatment area would have resulted in 15% more women with BMI more than 18 had the elderly women in the control areas been exposed to the MCH program. Although a formal test has not been performed, graphically the cumulative distributions do not cross each other indicating that the new distribution (with the estimated program effect) strictly first order dominates the old one in the accepted range of BMI and hence is a better distribution in terms of the welfare variable (BMI in this case).

Controlling for individual and household characteristics and assuming that health of individuals is a normal good, the coefficient of the price proxy, "average distance to the health provider from the headman's house", is positive and significant. This could imply that the presence of the public health inputs lead to greater use of private health inputs by the non-targeted members. Income of the household generates a positive effect on the demand for health, being significant in case of elderly women residing in households targeted throughout the fourteen-year period. Own education seems to be a significant determinant for elderly women's health when the whole treatment area is taken into account. The evidence in literature is largely ambiguous in this regard. Thomas, Lavy and Strauss in their 1992 study show similar results for urban women. However, impact of education on BMI disappears for rural women when household resources are controlled for in their study.

In households where the younger cohorts of targeted women reside, elderly women are positively and significantly affected by the MCH program. This result does not hold for elderly women sampled from households where older cohorts were targeted in 1982. This indicates that when younger women are targeted with the program, the spillover effect on the elderly women is stronger than when older women are targeted. However, the number of elderly women sampled on the basis of presence of older targeted cohorts are also very few in number. The sample size, being as small as 27 and 30 could also result in not having enough degrees of freedom for a precise estimate.

6.4. Impact of the Program on Adult Men

The summary results in Table 6 do not conclusively indicate any program effect on the health of the adult men. The samples of adult men, pooled and disaggregated according to age as well as living with different cohorts of women in areas targeted in different years are examined. Both dummy indicator and years of exposure are used to find the program effect. The coefficient of interest is not statistically significant except in one case. For the sample of elderly men living with older cohort of women in the households targeted for the entire fourteen year period, the program effect is negative and significant. Elderly men have a declining health with age and the decline aggravates with age. Controlling for the debilitating effect of age, the negative effect of the program on the elderly men could mean that if a health program exemplifies health consciousness or generates resources and impacts household members positively, these households might have weaker and older men surviving longer and hence program effect remains understated in their cases. Hence, the program effect that we are seeing could be a lower bound.

Alternatively, it is also possible that households would allocate resources to the children, youth and the more productive members of the household as a result of the health consciousness fostered by the program. The result might be robust in the sample where the program targeted the women when they were older. These women are more likely to be in control of the resources in the households and more likely to be the decision-makers than the younger women. However, as the negative effect of the program is not statistically significant for other groups of elderly men, we do not have enough evidence to conclude that the program has an adverse effect on the elderly men or that the spillover effect is underestimated.

Results indicate (from other control variables) a strong income effect for adult males. Even after controlling for income, own education has a positive and robust effect on the health of all adult men. Further, in accordance with findings in literature, being the head of the household adversely affects health whereas education and marriage significantly improves health of adult males.

6.5. Summarizing the Results

Results in section 6.3 provide substantial evidence towards a spillover effect on elderly women. Younger cohorts of women who are targeted seem to transfer the positive impact of the program onto the elderly women more efficiently. The elderly men are affected negatively by the presence of the program when the older cohort of women is targeted but this result holds only if we compare the treatment area targeted in 1982 with the control area. There is no strong evidence to consolidate these results universally across all the samples. Program impact results using the 'exposure' variable are very similar to those using the dummy variable approach though not as robust.

There are reasons to be cautious about interpreting the above results. There are several issues that emerge from these results, each of which can be statistically tested. The next three sub-sections investigate these interpretations.

6.5.1. Is there an inter-household effect? Our model suggests that the program impact on individuals could be through a community effect or inter-households effect. As defined earlier, if a public program such as the discussed MCH program is present in a village or community, it might promote an overall health consciousness which might result in improved health status for those not targeted as well. It might also result in resource sharing amongst neighboring households in the community. I use a sample of all the non-targeted elderly women living in the non-eligible households of the treatment and control areas to test the null hypothesis that the coefficient of the program dummy is not significant. The first row in Table 7 reports the coefficient of the program variable and the results indicate that we cannot reject the hypothesis that the program dummy is not significant. The program effect that we see on the non-targeted elderly women in Section 6.3 is therefore through the intra-household spillover effect as discussed in the theoretical model and not through an inter-household effect.

6.5.2. Is the intra-household spillover through an income effect or through household public goods and contagion? The theoretical model indicates that the spillover effect could be through a combination of the following effects: a resource effect, a household public goods effect or a contagion effect. Although it is computationally not possible to disentangle all the components, it may be possible to speculate whether the spillover is through a stronger income effect or through a household public good and contagion effect. To test this, I compare between two samples, A and B. Sample A consists of all elderly women living in households that have numerically more non-targeted individuals than targeted individuals. Sample B consists of elderly women living in households that have more number of targeted occupants. I test the hypothesis that the coefficient of the program for Sample A will be less than the coefficient of the program for Sample B.

If the spillover was through contagion and public goods (non-rival and non-excludable) for elderly women, the impact should not be different in magnitude whether number of non-targeted members in a household was greater or lesser than the number of targeted members. The relative number of non-targeted and targeted members will matter if it were an income effect because then non targeted members in a household living with relatively more targeted members would be better off because per capita share of health resources (if they were rival goods) would be higher. Non-targeted members in households with relatively less targeted members would be worse off because per capita health resource share would be lower making the program impact smaller in magnitude.

Although results in Table 8 show that the magnitude of the program coefficient for Sample A is less than that in Sample B suggesting an income effect, a Chow test fails to reject the hypothesis that the program impact for sample A and sample B are not significantly different from each other. This indicates that the spillover effect is not different across the two samples and that may permit us to conclude that the spillover impact is more a result of household public good and contagion effects.

6.5.3. Is there a healthy threshold effect? Since program effect is inconclusive for men, it is possible that men have already reached a healthy threshold which women have not which is why the marginal effect of the MCH program is significant for elderly women but not for men. To test this threshold effect, the sample I use is two groups of elderly women in households that own more and less than one acre of land. Households that own more land should be economically better off compared to those who own less or more. Hence additional resources through in-kind transfers may not significantly impact the health status of these households. The results in Table 9 report that the coefficient of the program variable is positive and significant for the sample of women living in poorer households (that own less than once acre of land) while positive and not significant for the elderly women in richer households. This means that treatment makes the elderly women in poorer households better off than their counterparts in the control area while those in the richer households are not affected differentially by the program spillover. However, chow test fails to reject the hypothesis that the set of elderly women living in households that own more than one acre of land is significantly different from the pooled sample, not enabling us to draw definite conclusions regarding the threshold hypothesis.

7. Conclusion

This paper evaluates an MCH program documenting the nature of spillovers that might occur as a result of this public program. It takes advantage of a relatively new, unexplored and publicly available dataset and its unique control experiment setting to test for and measure the extent of spillovers generated by the public health program. van de Walle in Nead and van de Walle (1995) wrote that the drawback in most program evaluation studies is the inability to account for and measure the extent of externalities. This paper, by modeling a possible pathway in which health externalities of the MCH program are generated within households and by empirically measuring the size of it, has significantly contributed to the empirical literature on program evaluation.

The results in this paper indicate that the maternal and child health program intended for mothers and children generates a spillover effect on the health of the elderly women living with the targeted individuals. This spillover effect is positive and significant for the elderly women and would have resulted in bringing almost 15% more such individuals in the healthy range of BMI had the women in the control area been exposed to the program.

There is no evidence of spillovers for men. It is possible that the weak men do not survive until old age in the absence of the program and mortality selection of this nature makes the program impact to be underestimated. However, the most important finding is that elderly women who are present in the vicinity of women and children get impacted by spillovers through contagion and public goods. Also, the benefit from the program is possibly gender-specific and even if the spillover was through an income effect, it impacts the elderly women and not the men in these households. For example, if information on healthy cooking practices were incorporated into daily routines of women, it would most likely affect elderly women and not the elderly or other adult men.

It is possible as results indicate that the health program benefits the poorer households while the relatively well to do households show no significant marginal impact of the program on the health of their elderly female occupants. There is a suggested threshold effect by which the men might have already attained a healthy threshold and therefore the program provided no additional benefit for them although the paper could not provide a strong support for this. The program thus not only benefits its targeted population, it also benefits elderly women living in poor households.

These results have important implications. First, when the impact on non-targeted members of the households is not taken into account, the true distributional impact of the health program is understated. The marginal benefit of the MCH services would be much higher if the positive externality is also taken into account. Second, this adds another angle to achievements from the program shown by standard cost-effectiveness analyses. Third, it throws light on possibilities of developing policies such as gender targeting, specific in-kind transfers and targeting of public programs by economic status to achieve maximum benefits. Duraiswamy and Malathy (1991) stressed on the importance of looking at the manner in which public policy alters the environment in which families make decisions, thereby influencing resource allocation and the importance of this aspect in correctly evaluating the impact of a public program. In that respect, this paper brings attention to yet another mechanism of resource sharing within households.

On the aspect of policy recommendation, although it is a common perception that the MCH-FP services in Matlab, Bangladesh are too expensive to replicate for the whole country, a detailed cost effectiveness analysis showed that the output generated more than offsets the extra cost of the intensive delivery system of the Matlab project (Simmons, Balk and Faiz, 1991). The present study makes a stronger case for fund allocation in health programs that are designed as door-to-door delivery programs in underdeveloped regions.

However, the task of evaluating public programs is complex and many questions remain unanswered. First, although the mechanism through which spillovers happen could be identified, their relative magnitudes could not be measured. Second, this analysis can be extended to a bargaining model where the MCH program can provide data on inputs that improve bargaining power for the targeted population. This would help in determining program impacts and resource allocation within the households in a bargaining framework. Future research may try to address similar questions using a larger unit of observation like an extended family compound rather than a single household and also try to account for higher order age effects. Finally, the mechanism or hierarchy through which households share resources, needs to be better understood. This study reveals that public programs targeted towards certain individuals in fact affect the entire family and this is important to bear in mind while designing targeted social policy programs in developing countries.

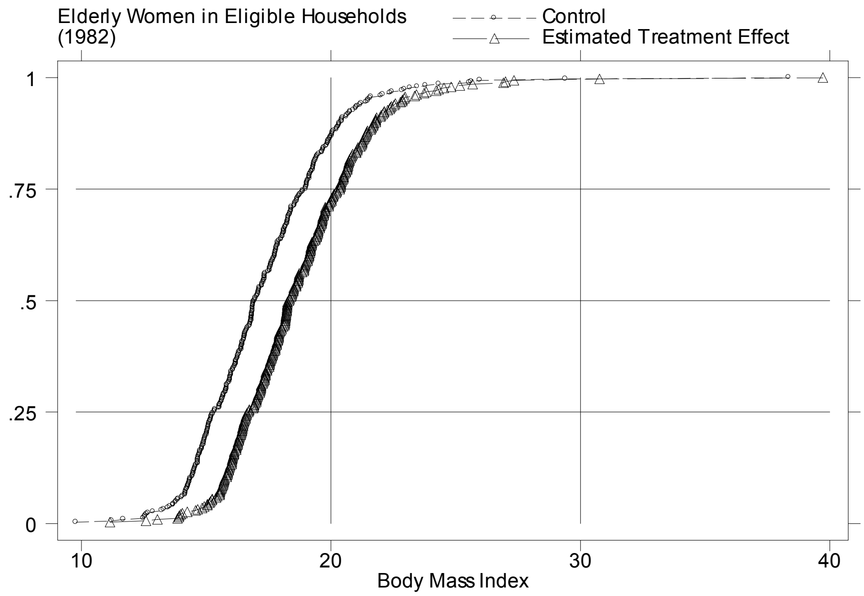

Fig. 1. Estimated effect of exposure to the program on the Cumulative Distribution of Body Mass Index of all Elderly women comparing the blocks A and C with the control area

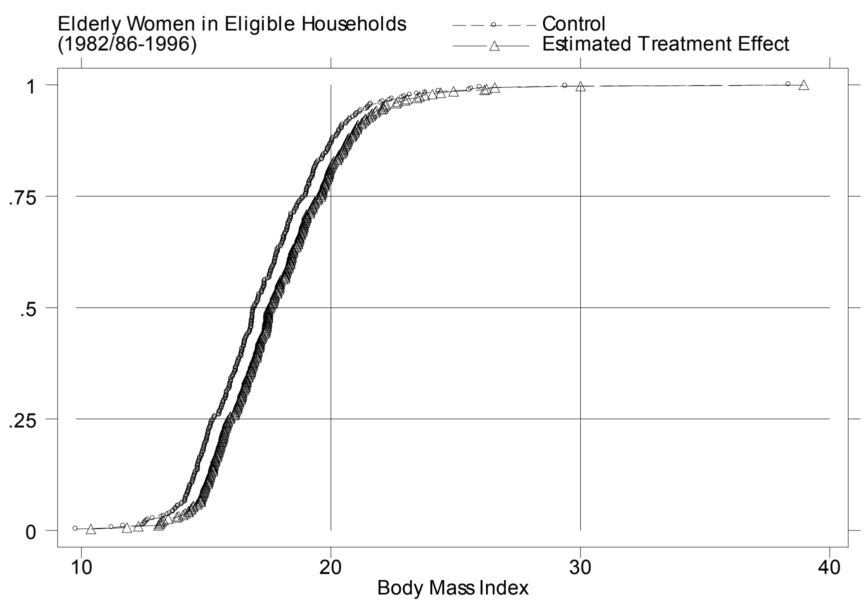

Fig. 2. Estimated effect of exposure to the program on the Cumulative Distribution of Body Mass Index of all Elderly women, comparing the entire treatment area with the control area

Table 1. Baseline Characteristics*

Indicator	Control Mean (std dev)	Treatment mean (std dev)	Ho: mean(C) -mean(T) = 0
Health Indicator: height (in meters)			
Female >60 yrs	1.417966	1.428692	t = -0.6009
	(.0139302)	(.0111618)	(P>|t|=0.5481)
Male >60 yrs	1.578881	1.546492	**t = 2.3081**
	(.0075984)	(.0117974)	**P > |t| = 0.0212**
Male>20 & <60yrs	1.583752	1.569498	t = 1.6392
	(.0054114)	(.0068067)	P > |t| = 0.1013
Female >54yrs &<60yrs	1.460005	1.462805	t = -0.1850
	(.0128685)	(.0079696)	P > |t| = 0.8533
Mother's characteristics			
Heights in cm	149.1336	149.0703	t = 0.2046
If age>40	(.1913815)	(.2432122)	P > |t| = 0.8379
Education for	.7557666	.8346667	t = -1.0545
women>40 yrs	(.0480078)	(.0573933)	P > |t| = 0.2918
Household Indicators			
Land owned	1.444965	1.409989	t = 0.1268
	(.175562)	(.2128901)	P > |t| = 0.8991
Education if age>60	1.686441	1.868233	t = -1.3397
	(.0927213)	(.0990734)	P > |t| = 0.1805
Household Size	5.713096	5.410803	**t = 4.3206**
	(.0513585)	(.0475133)	**P > |t| = 0.0000**
Average distance to	8.144217	8.48704	**t = -5.7984**
health providers	(.0430628)	(.0405123)	**P > |t| = 0.0000**
Behavioral Indicators			
Yard Clean	.6098239	.6395084	**t = -2.0231**
	(.0105029)	(.010246)	**P > |t| = 0.0431**
House surrounded by	.4396113	.4236364	t = 1.0648
waste	(.0106795)	(.0105374)	P > |t| = 0.2870
House surrounded by	.4197131	.4029104	t = 1.1272
trash	(.0106187)	(.0104619)	P > |t| = 0.2597

*These are computed for 1996. However, height and education for people above 40 years of age will not change between 1982 and 1996.

Table 2: Summary Statistics (Entire sample)

Variable	N	Mean	Std. Dev.
Dependent Variable			
BMI (according to age and gender)			
20-60 years and female	4141	18.91	2.85
20-60 years and male	3048	18.85	2.38
>60years and female	669	17.48	2.84
>60years and male	908	17.89	2.36
Program Variables			
1982 program =1	24266	0.2735	0.4458
1982/86 program =1	24266	0.4912	0.4999
Control area =1	24266	0.5088	0.4999
Household Characteristics			
Time to drinking water (in minutes)	20667	2.2514	2.2578
Average distance to health provider from headman's house(in kilometers)	24139	8.3173	1.9695
Log of total expenditure per capita	24258	6.3165	0.9665
Own house =1	24250	0.9481	0.2219
Head's age in years	4364	49.1549	13.7150
Head's Education in years	4301	3.0135	3.7222
Individual Characteristics			
Years of education	23679	2.7908	3.4658
Whether household head=1	24266	0.1798	0.3841
Whether head's spouse=1	24266	0.1498	0.3568
Whether Married=1	24266	0.3996	0.4898
Whether Female=1	24266	0.4997	0.5000
Age in years	24266	26.1994	19.7329
Age squared	24266	107782	1413.096
Distribution			
Female aged 20-29=1	24266	0.0714	0.2575
Female aged 29-44=1	24266	0.0935	0.2911
Female aged 44-54=1	24266	0.0429	0.2025
Female aged 60 & above=1	24266	0.0371	0.1889
Men aged 20-40=1	24266	0.1332	0.3397
Men aged 40-60=1	24266	0.0722	0.2589
Men aged 60 & above=1	24266	0.0446	0.2063

Table 3: Summary Statistics (Child Sample (0-14 years))

Variable	N	Mean	Std. Dev.
Dependent Variable			
Height-for-age Z-score	4347	-2.1344	1.2838
Weight-for-age Z score	4946	-2.2419	0.9721
Weight-for-height Z score	3529	-1.2280	1.0843
Stunted	4347	0.5896	0.4919
Underweight	4946	0.6684	0.4708
Wasted	3529	0.2355	0.4244
Program Variables			
1982 program =1	8423	0.2545	0.4356
1982/86 program =1	8423	0.4574	0.4982
Control area =1	8423	0.5426	0.4982
Percent Exposed at birth	8423	0.3964	0.4891
Exposure as a proportion of life	8423	0.3310	0.4189
Years of exposure	7737	1.4866	2.0666
Mother's years of exposure	7909	4.8256	8909
Other targeted members' years of exposure	7292	1148	8.9273
Household Characteristics			
Time to drinking water (minutes)	8410	1.9870	2.2056
Average time to health provider from headman's house (hours)	8423	0.4806	0.3914
Log (total expenditure per capita)	8423	7.3915	1.1234
Head's Education	8423	3.0215	3.6874
Head's Age in yrs	8423	46.1042	12.3640
Household Land ownership (acres)	7598	1.6284	10.4869
Individual Characteristics			
Age in years	8423	7.3206	3.9621
Age squared	8423	69.2878	58.1064
Whether Female=1	8423	0.4950	0.5000
Mother's height (centimeters)	6584	150.1529	7441
Mother's age in years	7381	34.6857	7.1092
Father's age in years	6558	42.8284	9.2050
Mother's education in years	8423	1.8549	2.7739
Father's education	8423	2.5121	3.6305
Head's age in years	8423	46.1042	12.3640
Head's education in years	8423	3.0215	3.6874

Table 4: A summary of the Impact of the MCH program on Targeted Women

	Program Variable	(1) Targeted in 1982 Dependent Variable Log(BMI)	(2) Targeted in 1986 Dependent Variable Log(BMI)	(3) Targeted between 1982/86-1996 Dependent Variable Log(BMI)
1	Treatment Dummy	**0.0340***** **(4.95)**	**0.0190***** **(3.06)**	**0.0236***** **(4.84)**
2	Cumulative years of exposure	**0.0024***** **(4.95)**	**0.0019***** **(3.06)**	**0.0021***** **(00)**
3	Own years of Exposure	**0.0020***** **(2.59)**	0.0013 (1.27)	**0.0017***** **(2.89)**
	Other targeted exposure	0.0004 (0.75)	.0005 (0.85)	0.0003 (0.86
4	Treatment dummy for younger cohort	**0.0407***** **(4.93)**	**0.0176**** **(2.5)**	**0.0306***** **(4.62)**
	Treatment dummy for older cohort	**0.0221*** **(1.84)**	0.0198 (1.51)	**0.0195*** **(1.76)**
	Treatment dummy for newer cohort	-	-	0.0102 (1.12)
	H_0:Program impact is the same for older and younger targets~	**F=3.65***** **P value=0.00**	**F=1.51*** **P value=0.10**	**F=1.73***** **P value=0.01**

Robust t-ratios have been reported in the parenthesis; Only the coefficient of the program variable is reported. Other controls are price proxies, log per capita expenditure, age, age square, years of education, household head's spouse, whether married, whether own house, head's age, head's education.
* denotes 10% and ** denotes 5% and *** denotes 1% level of significance

Table 5: Impact of the MCH program on Children's health status

		Continuous dependent Variables			Discrete Dependent variables		
		Aged<14 yrs		Aged<10 yrs	Aged 1-10yrs		
		HAZ	WAZ	WHZ	Stunting	Wasting	Underweight
1982	All Children	**0.1036****	**0.1018*****	0.0536	-0.0302	-0.0292	**-0.0475****
		(2.00)	**(2.70)**	(1.03)	(1.43)	(1.31)	**(2.46)**
	Children with targeted mothers	**0.0994***	**0.0885****	0.0455	-0.0219	-0.0311	-0.0334
		(1.83)	**(2.26)**	(0.73)	(0.91)	(1.16)	(1.54)
	Children with mothers targeted when young	0.0856	**0.0785***	0.0549	-0.0021	-0.0376	-0.0411
		(1.31)	**(1.67)**	(0.75)	(0.07)	(1.20)	(1.61)
	Children with mothers targeted when older	0.0747	0.1212	0.1229	0.0112	**-0.1485***	-0.0109
		(0.62)	(1.41)	(0.58)	(0.17)	**(1.71)**	(0.18)
1982-96	All Children	**0.1050****	**0.1051*****	**0.0980****	**-0.0330***	**-0.0443****	**-0.0499*****
		(2.50)	**(3.54)**	**(2.23)**	**(1.85)**	**(2.47)**	**(3.16)**
	Children with targeted mothers	**0.1094*****	**0.1066*****	**0.0953****	**-0.0337***	**-0.0442****	**-0.0504*****
		(2.59)	**(3.56)**	**(2.16)**	**(1.88)**	**(2.45)**	**(3.16)**
	Children with mothers aging into the program	0.1113	0.1176	0.0288	-0.0397	-0.0032	**-0.0726****
		(1.07)	(1.45)	(0.36))	(1.01)	(0.10)	**(2.03)**
	Children with mothers targeted when young	**0.1055****	**0.0990*****	**0.1091****	-0.0312	**-0.0488****	**-0.0469****
		(2.08)	**(2.84)**	**(1.97)**	(1.42)	**(2.17)**	**(2.42)**
	Children with mothers targeted when older	0.1367	**0.1313***	0.2472	-0.0232	**-0.1427***	-0.0322
		(1.36)	**(1.79)**	(1.36)	(0.43)	**(1.93)**	(0.69)

Robust t statistics in parentheses, For discrete dependent variables, marginal effects are reported. Coefficient of the program dummy is reported
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: A summary of the impact of the program on the health of non-targeted members

Samples of people living with the targeted cohorts	Blocks A and C			Entire treatment area			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Pooled	Cohort of women targeted was young	Cohort of women targeted was older	Pooled	Cohort of women targeted have aged into the program	Cohort of women targeted was young	Cohort of women targeted was older
	Log(BMI)	Log(BMI)	Log(BMI)	Log(BMI)	Log(BMI)	Log(BMI)	Log(BMI)
Elderly Women (>60yrs)[a]	**0.0722*** (3.12)**	**0.0873*** (3.51)**	-0.0306 (0.47)	**0.0304* (1.96)**	0.0174 (0.77)	**0.0478** (2.39)**	-0.0563 (1.15)
-[b]	**0.0014* (1.96)**	**0.0016** (2.03)**	-0.0006 (0.43)	0.0008 (1.61)	0.0008 (1.29)	0.0010 (1.52)	-0.0008 (0.75)
Elderly men (>60 years)[a]	-0.0182 (1.48)	-0.0114 (0.54)	**-0.0295** (2.09)**	-0.0028 (0.27)	-0.0054 (0.40)	-0.0044 (0.26)	-0.0168 (1.05)
-[b]	-0.0003 (0.92)	-0.0002 (0.52)	-0.0006 (1.43)	-0.00004 (0.14)	0.00003 (0.08)	-0.0002 (0.59)	-0.0003 (0.49)
Non-elderly Men (20-60yrs)[a]	0.0063 (1.03)	0.0063 (1.03)	-0.0015 (0.31)	-0.0015 (0.31)	-0.0112 (1.45)	0.0006 (0.10)	0.0007 (0.08)
-[b]	0.0002 (1.25)	0.0002 (1.25)	0.0001 (0.49)	0.0001 (0.49)	-0.0002 (0.60)	0.0001 (0.67)	0.0002 (0.50)
Adult Men (>20yrs)[a]	0.0009 (0.16)	0.0018 (0.26)	-0.0046 (0.55)	-0.0021 (0.48)	-0.0103 (1.50)	0.0001 (0.01)	-0.0051 (0.63)
-[b]	0.0001 (0.66)	0.0001 (0.65)	-0.00001 (0.03)	0.0001 (0.39)	-0.0001 (0.54)	0.0001 (0.40)	-0.00001 (0.06)

a: coefficient of the dummy program variable
b: coefficient of 'years of exposure to the program'
Robust t-ratios have been reported in the parenthesis;
* denotes 10% and ** denotes 5% and *** denotes 1% level of significance

Table 7: Is there a Community Effect on the health of pooled elderly women?

	(1) Targeted in 1982	(2) Targeted between 1982/86-1996
	Dependent Variable Log(BMI)	Dependent Variable Log(BMI)
Treatment Dummy	0.0012	-0.0238
	(0.05)	(0.73)
Time taken to go to the drinking water source	-0.0051	-0.0020
	(1.28)	(0.41)
Average distance in kilometers to health providers from the headman's home	0.0019	0.0113
	(0.29)	(1.23)
Log of per capita total expenditure	-0.0029	**-0.0232***
	(0.30)	**(1.77)**
Own house=1	-0.0085	-0.0281
	(0.23)	(0.67)
Age in yrs	-0.0089	-0.0699
	(0.18)	(1.36)
Age Squared	0.0000	0.0005
	(0.06)	(1.28)
Years of education	0.0124	**0.0240****
	(1.63)	**(2.25)**
Household head's spouse=1	-0.0235	**0.1627***
	(0.50)	**(1.91)**
Married==1	-0.0178	**-0.1583*****
	(0.52)	**(3.03)**
Head's education	**0.0093*****	0.0069
	(2.79)	(1.19)
Head's age	0.0013	0.0004
	(1.52)	(0.33)
Constant	**3.2712***	**4361*****
	(1.95)	**(3.02)**
Observations	217	139
R-squared	0.09	0.11

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8: Income effect on the health of Pooled elderly women

	Sample where Non-targeted >Targeted	Sample where Non-targeted <=Targeted	Pooled Samples
	(1)	(2)	(3)
	Dependent Variable Log(BMI)	Dependent Variable Log(BMI)	Dependent Variable Log(BMI)
Treatment dummy	**0.0286**	**0.0668**	**0.0668***
	(1.65)	**(1.66)**	**(1.77)**
Time taken to go to the drinking water source	-0.0010	0.0026	0.0026
	(0.20)	(0.20)	(0.22)
Average distance in kms to health providers from the headman's home	**0.0102****	-0.0091	-0.0091
	(1.98)	(0.75)	(0.80)
Log of per capita total expenditure	**0.0280****	0.0177	0.0177
	(2.39)	(1.32)	(1.42)
Own house=1	0.0052	0.0714	0.0714
	(0.14)	(0.72)	(0.77)
Age in yrs	0.0007	-0.0909	-0.0909
	(0.03)	(1.53)	(1.64)
Square of age of the household members	-0.0000	0.0007	**0.0007***
	(0.07)	(1.57)	**(1.69)**
Years of education	0.0104	0.0098	0.0098
	(1.46)	(0.93)	(1.00)
Household head's spouse=1	-0.0021	-0.0544	-0.0544
	(0.04)	(0.69)	(0.74)
Married==1	0.0080	0.0613	0.0613
	(0.25)	(1.08)	(1.16)
Head's Education	0.0015	-0.0074	-0.0074
	(0.55)	(1.34)	(1.44)
Head's Age	-0.0000	-0.0002	-0.0002
	(0.01)	(0.14)	(0.15)
^Dummy indicating more non-targeted members			-3.2500
			(1.52)
Dummy^ X Treatment Dummy			-0.0382
			(0.92)
Dummy^ X Time taken to go to the drinking water source			-0.0036
			(0.28)
Dummy^ X Distance^			0.0193
			(1.54)
Dummy^ X Log of per capita total expenditure			0.0102
			(0.59)
Dummy^ X Own house=1			-0.0662
			(0.66)
Dummy^ X Age in yrs			0.0916
			(1.52)
Dummy^ X Age squared			-0.0007
			(1.59)
Dummy^ X Years of Education			0.0006
			(0.05)
Dummy^ X Dummy for Hh head's spouse			0.0523
			(0.56)

Dummy^ X Dummy for married			-0.0533
			(0.86)
Dummy^ X Head's Education			0.0089
			(1.52)
Dummy^ X Head's Age			0.0002
			(0.11)
Constant	**2.5584*** **	**8084*** **	**8084*** **
	(3.01)	**(2.77)**	**(2.96)**
Observations	326	70	396
R-squared	0.08	0.11	0.09
F test			1.21
Prob > F			0.27

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9: Program effect on elderly women according to household ownership of land

	Comparing Blocks A and C with Comparison area	
	(Households own>=1 acre))	(Households own<1acre)
	Dependent Variable Log(BMI)	Dependent Variable Log(BMI)
Treatment Dummy	0.0370	**0.0912*** **
	(1.10)	**(2.73)**
Time taken to go to the drinking water source	0.0082	-0.0006
	(0.92)	(0.05)
Average distance in kms to health providers from the headman's home	**0.0202** **	0.0020
	(2.33)	(0.16)
Log of per capita total expenditure	0.0118	0.0376
	(0.65)	(1.50)
Own house=1	0.0288	-0.0624
	(0.74)	(1.37)
Age in yrs	0.0053	0.0509
	(0.16)	(1.15)
Age squared	-0.0000	-0.0003
	(0.18)	(1.13)
Years of education	-0.0023	0.0082
	(0.15)	(0.75)
Household head's spouse=1	**0.1586***	-0.0974
	(1.99)	(0.84)
Married==1	-0.0259	0.0395
	(0.57)	(0.49)
Head’s Education	-0.0033	-0.0036
	(0.92)	(0.59)
Head’s Age	-0.0022	-0.0016
	(1.34)	(1.03)
Constant	**2.4928** **	0.8539
	(2.01)	(0.52)
Observations	95	94
R-squared	0.21	0.19

Robust t statistics in parentheses
*significant at 10%; ** significant at 5%; *** significant at 1%
Chow test for 1 & 2: F=1.17 (p value= 0.30)

Comparing between the entire treatment area and control area, there is no differential treatment effects on elderly women according to household land ownership.

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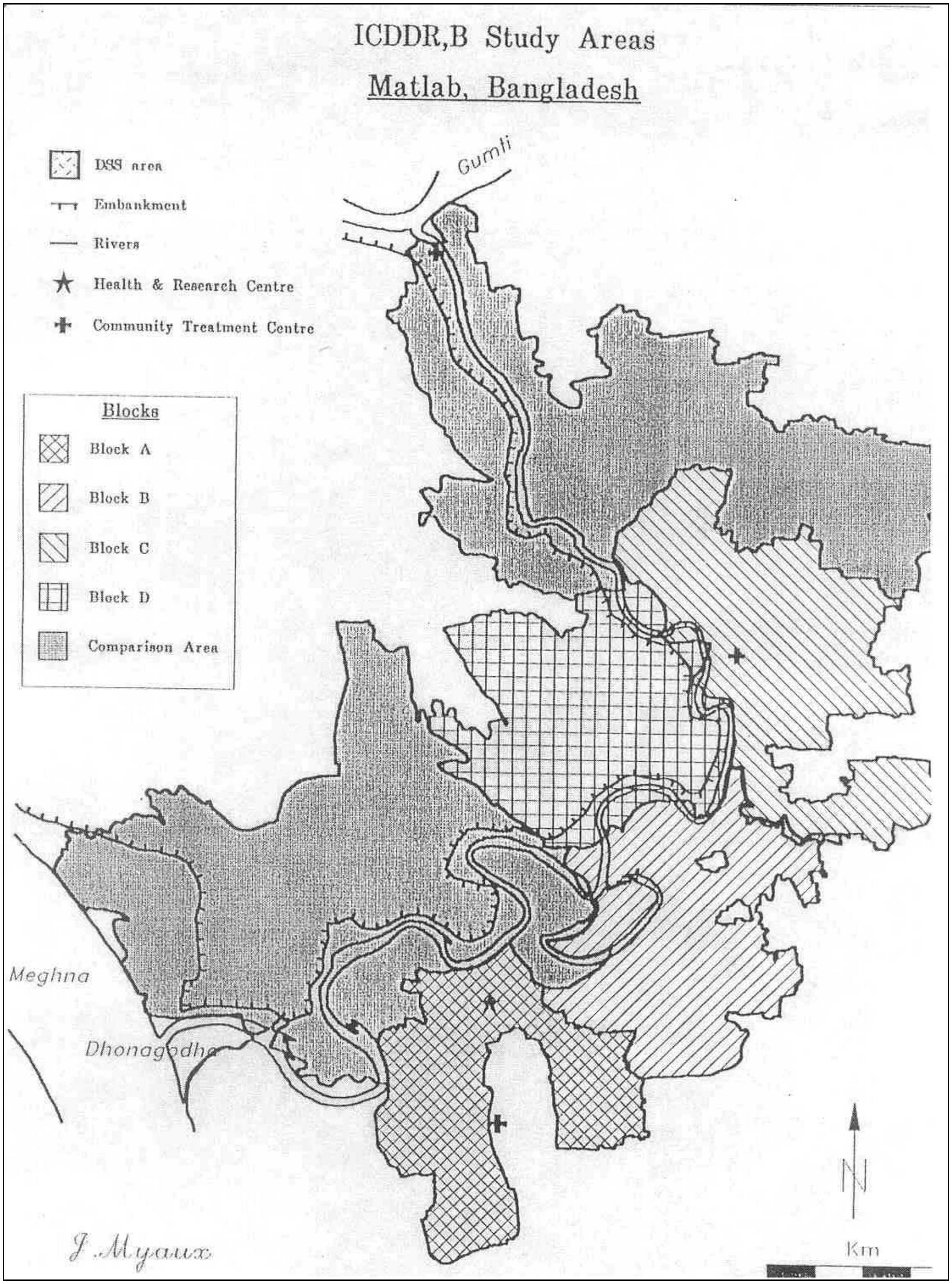

FigA.1. Map showing the ICDDR, B Surveillance Area in Matlab, Bangladesh.
Source: Demographic Surveillance System-Matlab Scientific Report No. 83, March 1998, ICDDR, B: Centre for Health and Population Research, Dhaka, Bangladesh.

Table A.1: MCH program coverage by area and targeting date

<table>
<tr><th>Program initiation date</th><th colspan="4">Treatment Area</th><th colspan="3">Control Area</th></tr>
<tr><td>1982</td><td colspan="2">A</td><td colspan="2">C</td><td>B</td><td>D</td><td>Comparison</td></tr>
<tr><td>1986</td><td>A</td><td>C</td><td>B</td><td>D</td><td colspan="3">Comparison</td></tr>
</table>

Table A.2: Sampling scheme used to detect the targeted women in 1996

Target year/s	***Targeted*** members	Residence Blocks	Age(yrs) in the Target year	Age(yrs) in 1996
1982^	Women	A and C	15-44	29-58
1982-96	***Women***	A and C	15-44	15-58
1986	***Women***	B and D	15-44	25-54
1986-96	***Women***	B and D	15-44	15-54
1982/86-96^	***Women***	A,B,C,D	20-44	20-54

^Sampling scheme used to detect the targeted households.

Table A.3: Sampling scheme used to detect the different cohorts of women in 1996

Target year/s	***Targeted*** members	Residence Blocks	Age(yrs) in the Target year	Age(yrs) in 1996
1982	Women	A and C	15-30 30-44 15-44	29-44(TY)* 44-58(TO)* 29-58(TA)*
1982/86-96	***Women***	A,B,C,D	NT+15-19 19-34 34-44 15-44	20-29(TN)* 29-44(TY)* 44-54(TO)* 20-54(TA)*

* TY: younger cohort of targeted women; TO: older cohort of targeted women; TA: all age groups of targeted women; TN: newer cohort of women who have aged into the program; NT: not-targeted