Working Paper No. 25

Immunization Coverage in Zone 3 of Dhaka City, Bangladesh

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MCH-FP Extension Project (Urban)
Health and Population Extension Division

1997

ICDDR,B
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MCH-FP Extension Project (Urban)

Urban FP/MCH Working Paper No. 25

Immunization Coverage in Zone 3 of Dhaka City, Bangladesh

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Foreword

I am pleased to release these reports on urban Maternal and Child Health and Family Planning issues which are based on the operations research activities of the MCH-FP Extension Project (Urban) of the Centre. Over the years, the Centre has acquired a unique expertise on urban development matters that ranges from operations research on reproductive health, child survival and environmental issues to providing technical assistance for capacity building to service delivery organizations working in urban areas.

This work has produced important findings on the health conditions and needs of city dwellers, particularly the poor and those living in slums. The research has also identified service delivery areas in which improvements need to be made to enhance effectiveness. Together, these research findings have been translated into interventions currently being applied in government and non-government settings.

In order to carry out this innovative work, the Centre has established a partnership effort known as the Urban MCH-FP Initiative, with different ministries and agencies of the Government of Bangladesh and national non-government organizations, notably Concerned Women for Family Planning, a national NGO with wide experience in the delivery of MCH-FP services. The partnership receives financial and technical support from the United States Agency for International Development (USAID).

The overall goal of the partnership is to contribute to the reduction of mortality and fertility in urban areas. In practice, this joint work has already resulted in the development and design of interventions to improve access, coordination and sustainability of quality basic health services to urban dwellers with emphasis on the needs of the poor and those living in slum areas.

The Centre looks forward to continuing this collaboration and to assist in the wider dissemination and application of sustainable service delivery strategies in collaboration with providers in government, the NGOs and the private sector.

Syed Shamim Ahsan
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GLOSSARY

BASICS	Basic Support for Institutionalizing Child Survival
BCG	Bacillus of Calmette Guérin (vaccine against tuberculosis)
DCC	Dhaka City Corporation
DPT	Vaccine against diphtheria, pertussis, and tetanus
EPI	Expanded Programme on Immunization
ICDDR,B	International Centre for Diarrhoeal Disease Research, Bangladesh
MCH	Maternal and child health
NGO	Non-governmental organization
OPV	Oral polio vaccine
TT	Tetanus toxoid
TT2	Two tetanus toxoid immunizations
UPS	Urban Panel Survey
WHO	World Health Organization

Summary

This report analyzes childhood and tetanus toxoid (TT) immunization coverage among 12-23 months old children and women of reproductive age in Zone 3 of Dhaka, based on data obtained in 1995 from the Urban Panel Survey of the MCH-FP Extension Project (Urban) of the International Centre for Diarrhoeal Disease Research, Bangladesh. The Project is working with the Government of Bangladesh and Concerned Women for Family Planning to strengthen basic health services for women and children in urban areas.

Fifty-one percent of the children aged 12-23 months had received the complete series of childhood immunizations by the date of the survey. Among the women with a child aged less than one year, 85% had received at least two TT (TT2) immunizations at some point during their reproductive years.

Only 11% of the women of reproductive age had received the complete series of five TT immunizations, and only 52% of the women of reproductive age had received one or more TT immunizations.

Over half (57%) of children 12-23 months of age in Zone 3 live in slum households as defined by a Household Index score of less than 6 (described further in the text). The lower immunization coverage in Dhaka among children living in slum households compared to children not living in slum households appears to be persisting. In 1990, the coverage for the complete series of childhood immunizations in the slums was 76% of the overall coverage, and in 1995, according to our data for Zone 3, the slum coverage was 75% of the overall coverage. The slum/non-slum gap for maternal TT2 coverage appears to be diminishing, however.

While 53% of the mothers have a childhood immunization card for their 12-23-month-old child, only 24% of the mothers with a child aged

less than one year have a maternal TT immunization card, and only 7% of the women of reproductive age have a maternal TT immunization card.

Aside from residing in slum households, other characteristics that most strongly associated with either childhood or maternal immunization status include educational level of the mother, distance from the nearest immunization centre, and contact with field workers. Additional characteristics associated with immunization status include age of the mother, marital and working status, recency of migration, sex of the child, and the number of children which the mother has.

The children of mothers who reported three or more field worker visits during the previous year were found to have higher coverage levels (55%) compared to children whose mothers reported fewer contacts (47%). Also, 90% of women with a child under one who reported two or more field worker contacts during the previous year had obtained at least two TT immunizations previously compared to 78% of women who reported fewer contacts.

The findings of this study point to the need for improving childhood immunization promotion and service delivery among the slum populations. Innovative approaches which expand demand and which facilitate access to immunization services will help increase the coverage in the urban slum households which, at least in Zone 3, contain 73% of the incompletely immunized children and 84% of the incompletely immunized mothers of young children.

The findings also point to the need for launching a broad-based campaign to promote among all younger women access to TT immunization as well as completion of all five TT doses. TT access and coverage among young women is low in all socioeconomic groups, so promotion of TT access should not be limited to slum populations.

The two most promising strategies for improving coverage for both children and women of reproductive age are:

- reducing the number of missed opportunities for immunization promotion during encounters between health workers and clients, and
- identifying through periodic visits to all homes those who need additional immunizations.

In the long run, increasing the educational level among women will provide a strong stimulus for improving coverage in slum households.

The findings of this study may be relevant for other urban areas in Bangladesh as well.

I. Introduction

Since the mid-1980s, Bangladesh has made a dramatic improvement in its immunization coverage for children and mothers. Nationally, the coverage among children aged 12-23 months for the standard six immunizations (BCG, three doses of polio vaccine, three doses of DPT vaccine, and one dose of measles vaccine) rose from only 2% in 1985 to 76% in 1995 (1,2). A similar dramatic improvement has been achieved in the national coverage of tetanus toxoid (TT) immunizations among women with a child aged less than one year, from 2% in 1985 to 86% in 1995 (1,2).

According to recent surveys, the overall coverage of immunization services in the urban areas in Bangladesh has been just as high or higher than in the rural areas. In 1995, the coverage in all urban areas of Bangladesh for the complete set of immunizations among children aged 12-23 months was 85% compared to 76% for the entire country, and the maternal TT coverage rates were identical for the urban areas and for the country as a whole, 86% (2).

In spite of this "near miracle" achievement (3), vaccine-preventable diseases still account for 17% of the deaths among children aged less than five years in Bangladesh (4). In underserved populations, the percentage of deaths due to the vaccine-preventable diseases is even higher. In the slums of Dhaka for instance, the vaccine-preventable diseases account for 22% of the deaths among children aged less than five years (5).

There are persistent pockets of relatively low childhood immunization coverage in the urban slums of Dhaka (6-8). Between 1990 and 1993, coverage levels among children in Dhaka City Corporation (DCC) slums was only about three-quarters of the coverage rate achieved in the city as a whole (Table 1). Thus, the gap between the overall slum coverage and the overall DCC coverage had not diminished at all.

Approximately one-third of Dhaka City's overall population lives in slum neighbourhoods (9). Therefore, addressing the problem of low immunization coverage in slum neighbourhoods is an important problem.

The slum/non-slum differences in maternal TT immunization coverage, however, have diminished recently (Table 1). Between 1990 and 1993, TT2 coverage levels for Dhaka as a whole improved by 5%, while the coverage levels in the slums improved by 23% (but only 12 actual percentage points).

The lower coverage within the urban slum population is a cause of special concern due to several reasons. First, this is a rapidly growing population. According to one estimate, the Dhaka urban population is growing at a rate of 9% per year (10). If this is, in fact, true, and if the growth rate of the urban slums is at least as great as the growth rate of the overall urban population, the population of the urban slums will be doubling every eight years. Secondly, because of the crowded conditions which exist in the urban slums, communicable vaccine-preventable diseases (and measles in particular) have higher transmission rates than in rural communities and non-slum urban neighbourhoods (11). Thirdly, the levels of malnutrition in Bangladesh's urban slum children are higher than for children in rural and in non-slum urban areas, and even in rural and non-slum urban areas malnutrition levels are quite high by international standards (12). Thus, the capacity of malnourished slum children to combat infections, including those which are vaccine-preventable, is particularly compromised (13). In the case of measles in urban slums of developing countries, greater levels of malnutrition together with earlier age among the cases when the case-fatality is higher lead to higher levels of measles mortality (14).

Table 1. Immunization Coverage for Children and Mothers in Dhaka City Corporation (DCC) Overall and in Dhaka Slums between 1990 and 1993*

	Complete series coverage among children aged 12-23 months (%)†	TT2 coverage among women with a child aged less than one year (%)‡
1990		
DCC slums	50	52
DCC overall	66	78
Slum coverage as percentage of DCC overall coverage	76	67
1993		
DCC slums	54	64
DCC overall	70	82
Slum coverage as percentage of DCC overall coverage	77	78
Percentage improvement in coverage between 1990 and 1993**		
DCC slums	8	23
DCC overall	6	5

* More recent information on Dhaka as a whole and Dhaka slums in general is not currently available;

† Percentage of children 12-23 months of age who were fully immunized by the date of the survey

‡ Percentage of women with a child aged less than one year who had obtained at least two TT immunizations at some point during their reproductive life

** (1993 coverage-1990 coverage)/1990 coverage x 100; sources: 6,7

The next phase in improving overall coverage and reducing the number of deaths in Bangladesh from the vaccine-preventable diseases involves, in part:

- identifying particular subgroups in the population with low-immunization coverage and directing efforts toward raising the coverage within these subgroups;

- improving the quality of immunization services; and,

- establishing a surveillance system to detect and respond to cases and deaths due to vaccine- preventable diseases.

Issues related to the quality of immunization services in Zone 3 of Dhaka City have earlier been addressed (15). Improving the surveillance of vaccine-preventable diseases has become a priority of the Expanded Programme on Immunization (EPI) of the Ministry of Health and Family Welfare and will receive increased attention during the next few years.

This paper describes the immunization coverage for children and women of reproductive age in one urban area of Bangladesh (namely Zone 3 of Dhaka City), and compares the coverage between slum and non-slum populations. Factors influencing immunization status have also been highlighted in the paper.

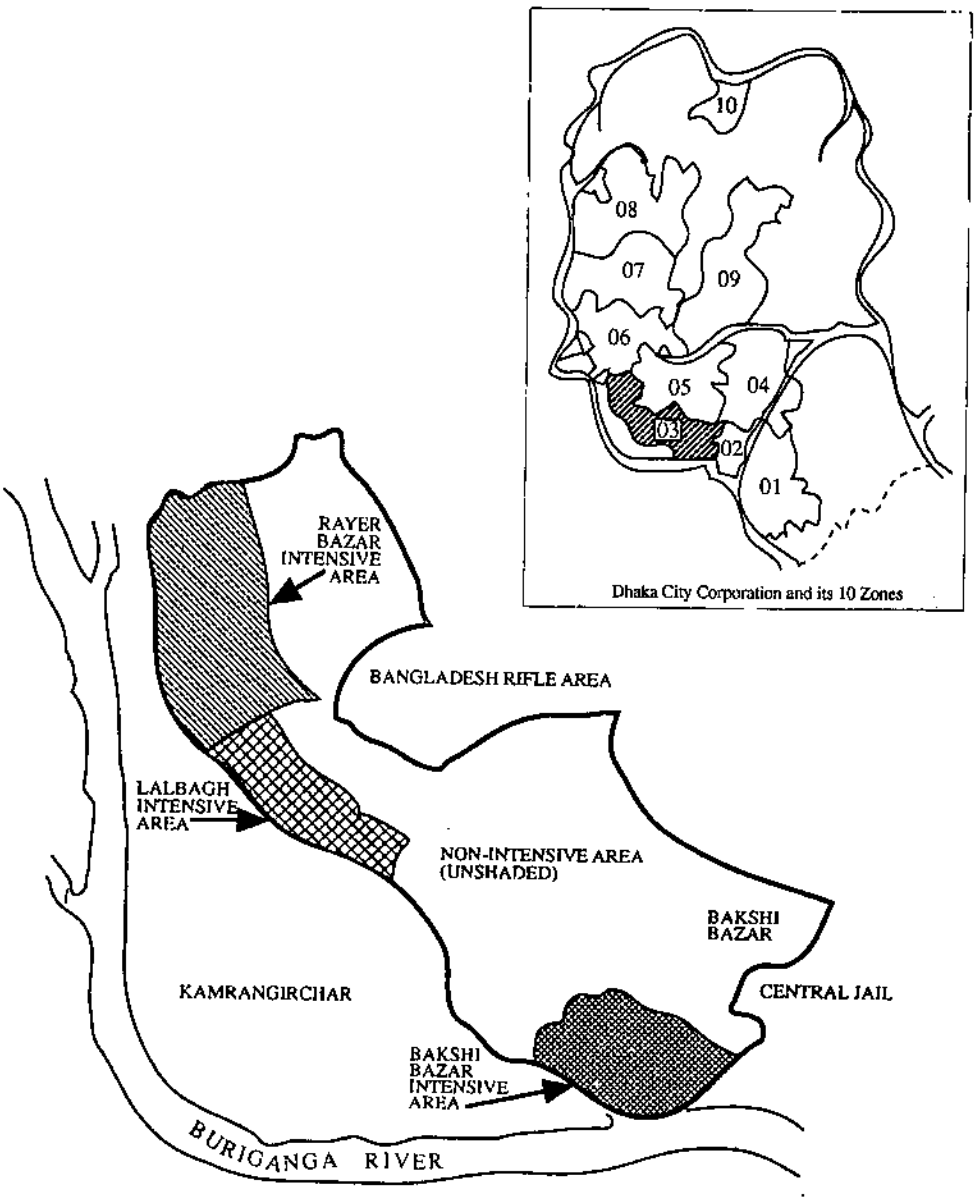
II. Methods

The data used for preparing this report are from the Urban Panel Survey of the MCH-FP Extension Project (Urban) of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). The

Project is collaborating with the Government of Bangladesh and Concerned Women for Family Planning, a leading national NGO providing maternal-child health and family planning services, to strengthen urban MCH-FP services through operations research. Many of these operations research activities are located in Zone 3, an area in the southwestern section of Dhaka City bordering the Buriganga River which contains a population of approximately 450,000 persons (see Fig. 1).

One of the operations research activities of the Project is a panel survey (referred to as the Urban Panel Survey, or UPS) which has been carried out every three months since late 1994 in a representative sample of the households. The UPS covers 5,940 households in 160 randomly selected clusters from throughout Zone 3. One hundred non-slum clusters and 60 slum clusters each with approximately 40 households have been included in the survey. Prior to the initial survey, Zone 3 was mapped and divided into predominantly slum and predominantly non-slum neighbourhoods, and then, using a stratified sampling strategy, clusters were selected for inclusion in the survey. Each cluster was defined as being in one of the four geographic areas of Zone 3 shown in Fig. 1 and also as being located in a predominantly slum or predominantly non-slum neighbourhood. In each of the four geographic areas, 25 "non-slum" clusters and 15 "slum" clusters were selected for inclusion in the UPS. The population sizes of each geographic area within Zone 3 differ substantially as do the population sizes in the slum and non-slum neighborhoods, thereby necessitating weighting of the data in order for the results to be representative of Zone 3. The findings reported here are based on weighted n's which have been rounded to the nearest integer, so occasionally the sums of the n's in certain tables do not add up exactly because of the effects of rounding.

Fig. 1. Map of Dhaka City Showing the 10 Zones and the Sampling Areas of Zone 3



The geographic areas in Zone 3 defined for UPS are as follows: (a) the Rayer Bazar Intensive Area, (b) the Lalbagh Intensive Area, © the Bakshi Bazar Intensive Area, and (d) the remaining area of Zone 3 (Fig. 1). The "Intensive Areas" are the areas where the Urban Initiative has located a number of its field research activities.

During the third quarter of 1995, the UPS collected information about previous immunizations received by women of reproductive age and by their children aged less than two years. The data for this report have been obtained from this particular round of the UPS. The survey respondents included 6,527 women aged 15-45 years. Of these women, 651 had a child aged 12-23 months and 707 had a child aged less than one year. The current study analyzes the childhood immunization information provided by these 651 women and the maternal TT information provided by these 707 women. In addition, the current study analyzes TT information for all 6,527 women participating in the study.

Each respondent was asked if she had a maternal immunization card and, when appropriate, if she had an immunization card for her 0-23-month-old child. If she did and the card was available, the interviewer recorded the dates of the immunizations. If no immunization card was available, the interviewer asked the mother how many TT immunizations she had ever received. Information was collected only for immunizations obtained since adolescence. Since women often had not obtained TT immunizations during the recent past, the actual dates of the TT immunizations were not recorded. Coverage rates are based on the number of TT immunizations reported by the mother.

If the respondent had a 0-23-month-old child but no immunization card, the interviewers (who are well-trained, highly experienced, and closely supervised) probed at length to ascertain which immunizations the child had received and the approximate date of receipt. In fewer than 1% of the cases were the interviewers unable to obtain what they considered to be fairly precise and accurate dates of the immunizations. There is no

notable difference in the percentage of children with inappropriate dates for immunization among those mothers who did have and those who did not have an immunization card for the child. Appendix 4 explores these issues further.

Unless otherwise specified, the childhood immunization coverage rates cited in this report refer to the percentage of children aged 12-23 months who have been fully immunized, meaning that they have received at the appropriate times the following immunizations: one BCG immunization (against tuberculosis), three DPT immunizations (against diphtheria, pertussis, and tetanus), three polio immunizations, and one measles immunization. The childhood immunization coverage rates were calculated based on the World Health Organization (WHO) immunization schedule criteria and the conformity of the dates recorded on the child's immunization card (if a card was available) or the dates given by the mother (if no card was available) with these criteria. The findings for the overall complete coverage were confirmed using COSAS 4.3 software.[1]

Distance from the household to the nearest immunization site was obtained by measuring the distance directly on a detailed map of Zone 3 prepared by the members of the project staff.

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[1] COSAS is the **C**overage **S**urvey **A**nalysis **S**ystem used by the World Health Organization for analyzing the results of EPI coverage surveys. Only those children who have been vaccinated appropriately for their age and at appropriate time intervals (for second and third doses of DPT and polio) are considered to have been appropriately immunized. Thus, if a child received a DPT immunization before six weeks of age, or received a follow-up DPT or OPV immunization at an interval of less than four weeks, or received a measles immunization before 9 months (38 weeks) of age, then these immunizations are not considered valid and therefore not included in the calculation of coverage statistics. The usual procedure using COSAS software is to calculate the percentage of children with cards whose coverage for each specific antigen is invalidated because of inappropriate timing of the doses and to apply this correction factor to the other group of children in the coverage survey who do not have a card but who have, according to the history provided by the mother, received the particular immunization.

A Household Index score was constructed for each household by adding the number of favourable characteristics present for each house. The housing characteristics making up the index and the scores for computing the index are as follows:

roof:	non-pucca[2] roof = 0, pucca roof = 1
wall:	non-pucca wall = 0, pucca wall = 1
number of rooms:	1 room = 0, 2+ rooms = 1
sanitation:	primitive latrine or no sanitation = 0, latrine with no water seal = 1, latrine with water seal = 2
khat[3]:	no khat = 0, khat = 1
almirah[4]:	no almirah = 0, almirah = 1
table/chair:	table or chair not present = 0, table or chair present = 1
radio:	no radio = 0, radio = 1
TV	no TV = 0, TV = 1
fridge	no fridge = 0, fridge = 1.

We considered a household with a Household Index score of less than six to be a slum household. Although the great majority of slum households are located in slum neighbourhoods, this is not entirely the case since there are scattered clusters of slum households standing in non-slum neighbourhoods, and within slums there are occasional households that do not fit our definition of a slum household. The basis for this categorization can be found in Appendix 3, which describes the findings

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[2]*Pucca* refers to cement or brick, while non-*pucca* refers to less permanent materials, such as bamboo, tin, wood, or *jhupri*. *Jhupri* is a dwelling made from pieces of scrap material, such as plastic sheets, pieces of bamboo, or pieces of tin.

[3]A *khat* is a wooden bed which is raised above the floor. Those without a *khat* usually sleep on the floor.

[4] An *almirah* is a bureau.

of an analysis of various definitions of slum households. Virtually all of the households with a Household Index score of less than six have a roof made of non-permanent material, no modern toilet facilities and only one room. About two-thirds of the households with a Household Index score of less than six have no almirah (bureau), three fourths have no table or chair, three-fourths have no radio, and virtually none have a TV or a refrigerator.

Two variables characterizing the level of contact between family planning field workers[5] and their clients have been included in the analysis. While analyzing the childhood immunization coverage, we included whether or not the mother indicated that the field worker had referred her child to for an immunization and also the number of times the mother reported that a family planning field worker had visited her during the past year. Referral for immunization was excluded from the multivariate analysis because of its high (>0.60) correlation with the number of field worker visits. The UPS did not include a similar question for women of reproductive age regarding whether the field worker had referred them for a TT immunization but did include the number of field worker visits during the previous year.

Statistical analyses have been performed with EPI INFO (version 6.0) and SPSS (version 6.0 for Windows) software. When appropriate in the bivariate analyses, the statistical significance of differences between groups is reported. These results are based on the Chi-square tests for differences in distributions between two groups, but the actual Chi-square value and number of degrees of freedom are not shown to make the interpretation of the table more straightforward. For two-by-two tables, the Yates continuity correction was used in calculating the Chi-square value.

[5] Field workers are government and NGO workers who visit the homes of married women of reproductive age mainly to promote family planning, but, to a lesser degree, to promote other MCH services, including immunizations (16).

Confidence intervals for the immunization coverage levels are based on EPI INFO C-Sample software for stratified multi-stage cluster sampling designs.

The logistic regression analyses were performed by entering all variables in the model as a single group. Statistical significance of the logistic regression odds ratios is based on the Wald statistic.

For categorical variables with more than two possible categorizations, some of the categories were collapsed in the logistic regression model if the difference in coverage within the collapsed categories was minimal. Thus, for instance, depending on the nature of the relationships with the coverage level being investigated, maternal age groups were collapsed as were occupational groups of the husband. In the logistic regression analysis, all initial model variables were entered into the analysis in a single stage. The final model from which odds ratios were calculated includes only those significant ($p < .05$) predictors which had been identified on the basis of the Wald statistic.

Because of the high ($> .60$) correlation of the reported monthly income with the Household Index score, income was not included in the multivariate model to avoid problems related to multicollinearity. Similarly, because of the high ($> .60$) correlation between household and neighbourhood slum/non-slum status, the latter was not included in the multivariate model either. Finally, in the analysis of access to TT immunization for women of reproductive age, we deleted number of living children and husband's occupation from the multivariate analysis because of their high ($> .60$) correlation with marital status.

In the interpretation of the logistic regression findings, we will use the terms odds of immunization. While analyzing the coverage of children who received the complete series of immunizations, for instance, the term "odds" refers to the percentage of children fully immunized divided by the

percentage of children incompletely immunized. The odds ratio is the ratio of the odds at one level of an independent dichotomous categorical variable with the odds at the other level of the categorical variable.

All possible two-way interaction effects were assessed by expanding the final logistic regression model of significant predictors to include a new set of variables consisting of all product terms of the variables making up the final model. Those statistically significant interaction effects were analysed further with a stratified analysis, the details which are contained in the Appendices.

III. Findings

A. Childhood Immunization[6]

1. Coverage by Antigen, Slum/Non-slum Household Status, and Timing of First Dose

Figures 2 and 3 describe the coverage for immunizations in Zone 3 among children aged 12-23 months for each antigen and for the complete series. Overall, 51% of the children aged 12-23 months had completed their entire series of immunizations by the day of the household survey, and 46% had completed their entire series of immunizations by their first birthday. The complete series coverage in the slum households is only 56% of the coverage in the non-slum households. For specific antigens, the slum coverage is 65-81% of the non-slum coverage. Ninety per cent of the completely immunized children received all of their immunizations before their first birthday, including 89% of the completely

[6]Appendix 1 contains all of the detailed data on which the findings related to childhood immunization are based.

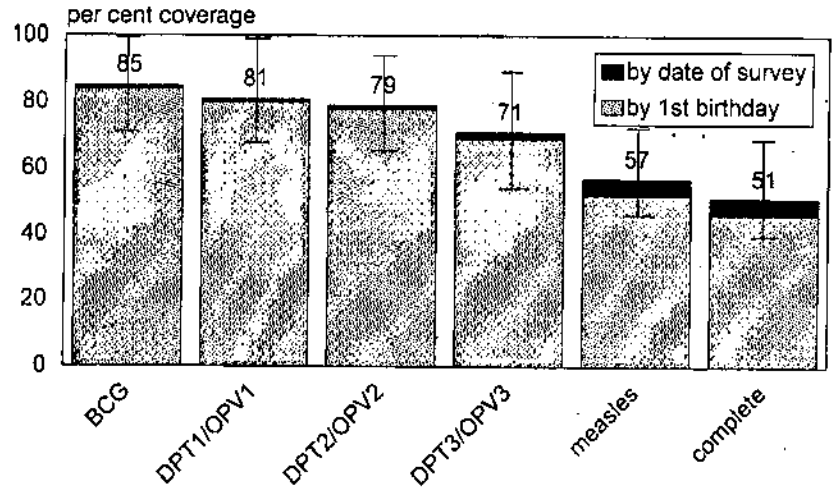
immunized children living in slum the households and 91% of the completely immunized children living in the non-slum households.

Among children 12-23 months of age who received a BCG immunization during the first three months of life, the complete series coverage by the date of survey was 63% compared to only 30% for those children who did not receive a BCG immunization during their first three months of life (Fig. 4).

Approximately 13% of the children who have been fully vaccinated received one or more doses at an inappropriate time. Five per cent of the children who were given OPV1/DPT1 immunizations received them before completing six weeks of age, and 12% of children who were given a measles immunization received it before completing 38 weeks of age. Virtually no DPT2/OPV2 immunizations and no DPT3/OPV3 immunizations were given less than four weeks after the previous dose (see Appendix 3 for further discussion). As mentioned in the Methods section, the coverage data reported here are based on only valid immunizations given at appropriate times. The adjusted coverage rate is 82% of the unadjusted rate (51% versus 62%).

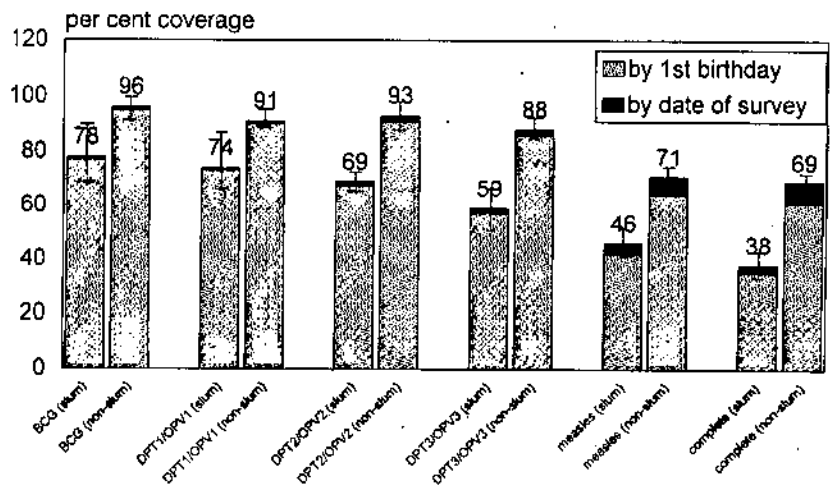
Access to immunization services (as measured by BCG coverage among children aged 12-23 months) is 85%, and access in the slum households is 81% of access in the non-slum households. The overall dropout rate from DPT1 to DPT3 among the 12-23-month-old children is 14%, but the dropout rate for the children in the slum households is almost six times that for children in the non-slum households (Table 2). The overall dropout rate from BCG to measles is 33%, but again the dropout rate for children in the slum households is much higher than for children in the non-slum households. Fifty-three percent of 12-23-month-old children have an immunization card at home, but the difference is substantial between those in slum versus non-slum households: 42% versus 68%.

Fig. 2. Immunization Coverage Among 12-23 Month-Old Children in Zone 3 of Dhaka City, 1995



see Appendix 1, Table 1 for actual data; 95% confidence intervals shown for coverage on date of survey

Fig. 3. Immunization Coverage by Slum/Non-Slum Status Among 12-23-Month-Old Children in Zone 3 of Dhaka City, 1995



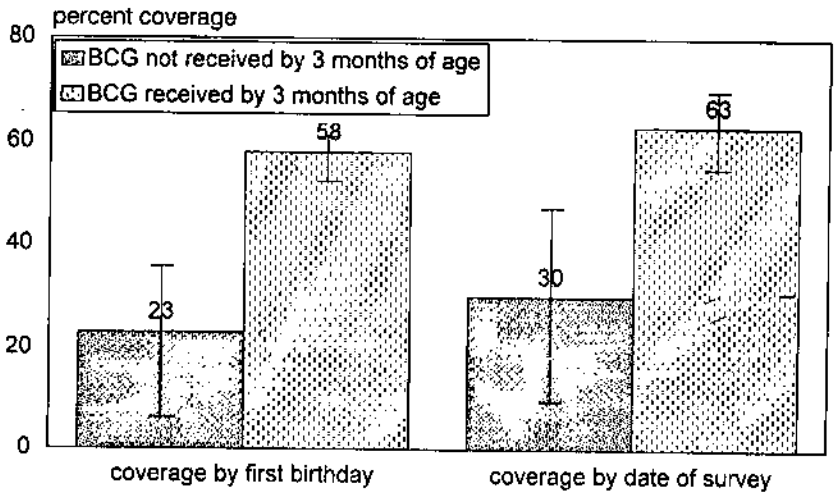
see text for definition of slum household; see Appendix 1, Table 1 for actual data; 95% confidence intervals shown for coverage on data of survey

Table 2. **Immunization Dropout Rates Among 12-23-Month-Old Children in Zone 3 of Dhaka City, 1995**

Type of dropout measure	Slum households (%)	Non-slum households (%)	All households (%)
DPT1 to DPT3*	20	3	14
BCG to measles**	41	25	33

(DPT1-DPT3)/DPT1 x 100; ** (BCG-measles)/BCG x 100; the terms in the equations refer to the percentage of children who received that particular antigen; the data for these calculations were obtained from Appendix 1, Table 1.

Fig. 4. Immunization Coverage Among 12-23-Month-Old-Children According to Timing of BCG Dose



see Appendix 1, Table 2 for actual data

2. Relationship of Family Background, Household, Programme, and Geographic Characteristics With Childhood Immunization Coverage

Table 3 provides a summary of the findings of both the bivariate and multivariate analyses of the childhood immunization coverage. The actual data for these findings can be found in Appendix 1. Two variables have highly significant ($p < .001$) associations with coverage for both the bivariate and the multivariate analyses: mother's education and slum/non-slum status of the household. Coverage is lower among the children whose mothers have fewer than six years of education and among the children living in the slum households.

The number of living children and mother's employment status are both highly significant ($p < .001$) predictors of coverage in the bivariate analysis and significant ($p < .01$) predictors in the multivariate analysis. Children in families with three or more children and children in families in which the mother works for money have lower levels of coverage.

Distance to the nearest EPI centre is significant at the 0.05 level in the bivariate analysis, but becomes even more significant in the multivariate analysis ($p < .01$). Mother's birthplace, age and marital status, father's occupation, sex of the index child, and referral for child immunization by field workers are all significant predictors in the bivariate analyses but not in the multivariate analysis.

Providing a statistical explanation for the differences in the findings between the bivariate and multivariate analyses is beyond the scope of the current report. However, we have explored this topic in detail (data not shown). Mother's birthplace is not a significant predictor in the multivariate analysis because of its correlation with other socioeconomic variables. Mother's born in more impoverished circumstances (i.e., in an urban slum or in a rural location) have more children, are more likely to live in a slum household, and are more likely to work for money. All of

these characteristics are associated with lower childhood immunization coverage in the multivariate analysis.

Older mothers also have more children. After controlling for the effect of the number of children, the effect of maternal age on coverage is no longer significant.

Mothers who are divorced, widowed, or separated are more likely to work for money. After controlling for the negative effect of maternal employment on coverage, the effect of marital status becomes non-significant.

Father's occupation has no independent effect on coverage because of its correlation with slum household status and maternal employment.

The effect of the child's sex on coverage can be explained almost entirely by its interaction with number of living children. In families with only one or two living children, the immunization coverage of the 12-23-month-old child does not differ significantly by sex, but for families with three or more children, the immunization status of the female 12-23 month-old child is far less than that of male children of similar age (28% versus 49%).

The effect of number of field worker contacts on childhood immunization coverage appears to be mediated through maternal education, maternal employment and slum/non-slum household status. Less educated mothers have fewer field worker contacts as do employed mothers and mothers living in slum households.

The average reported family income and slum versus non-slum status of the neighbourhood in which the family lives are significant ($p < .001$) predictors in the bivariate analysis, but were not included in the multivariate analysis because of their high correlation with other

independent variables, as described previously. Finally, there were no significant associations of either length of time mother has been living in Dhaka or area of Zone 3 with coverage in either the bivariate or multivariate analysis.

Mother's education and slum/non-slum status of the household are the two major influences on childhood immunization coverage. Only 42% of the children whose mothers have less than six years of formal education are completely vaccinated compared to 76% of the children whose mothers have more education, and in the logistic regression, the odds of obtaining the complete series of immunizations is 2.1 times greater for children whose mothers have six or more years of education compared to other children.[7]

Among those children living in the slum households, the immunization coverage rate is 38% compared to 69% among the children in the non-slum households. In the logistic regression analysis, the odds of obtaining the complete series of immunizations is 2.2 times greater for those living in the non-slum households compared to the children living in the slum households.

The other two major influences on coverage are the number of children in the family and the distance from the nearest EPI centre. Children in families with three or more children have a coverage of only 36% compared to a coverage of 59% among the children who live in families with only one or two children.[8] The odds of complete coverage

[7]Tables 3-6 in Appendix 1 contain the actual data cited here and in the following four paragraphs.

[8]Since the children for whom the coverage is calculated are all aged 12-23 months, the great majority of them are the most recently born in their families.

for the latter group is 2.7 times the odds of the former group according to the logistic regression analysis.

The coverage among children living 400 or more metres from the nearest EPI centre is 40% compared to a coverage of 54% for those living within 400 metres. The logistic regression odds of complete coverage for the latter group is 1.9 times the odds of the latter group.

Only 13% of the mothers work for money, either in the home or outside of it. But the effects of maternal employment are quite strong. The coverage of children whose mothers work is 29% compared to 55% for the mothers who do not work, and the odds of complete coverage among the children of mothers who do not work is 2.4 times the odds of complete coverage among children whose mothers do work according to the logistic regression analysis.

There were no significant interaction effects identified in the logistic regression model.

Table 3. Relationship of Family Background, Household, Programme, and Geographic Characteristics with Childhood Immunization Coverage

Variable	Nature of relationship with childhood coverage	Level of statistical significance	
		Bivariate analysis	Multivariate analysis
Family background			
Mother's birthplace	Children of mothers born in urban slums or in a rural village have lower coverage	<.001	ns
Mother's age	Children of mothers aged 30 years or over have lower coverage than those whose mothers are aged 30 years or less	<.001	ns
Number of living children in the family	Children in families with 3 or more children have lower coverage than children in families with fewer children	<.001	<.01
Mother's education	Children whose mothers are less educated (particularly those who have no education and those with 1-5 years of education) have lower coverage levels	<.001	<.001
Length of time mother has been living in Dhaka	No association	ns	ns
Mother's marital status	Children of mothers who are divorced, separated, or widowed have lower coverage	<.05	ns

Table 3 (cont.)

Variable	Nature of relationship with childhood coverage	Level of statistical significance: Bivariate analysis	Level of statistical significance: Multivariate analysis
Mother's employment status	Children of mothers who work for income (either in the home or elsewhere) have lower coverage	<.001	<.01
Father's occupation	Children whose fathers are unemployed or who have manual or unskilled jobs have lower coverage	<.001	ns
Sex of the index child	Female children have lower coverage rates than male children	<.05	ns
Household			
Average reported monthly income	Children in households with a monthly income of less than Tk 2,500 have lower coverage	<.001	not included in model
Slum/non-slum household status	Children in slum households have lower coverage	<.001	<.001
Programme			
Distance to nearest EPI centre	Coverage decreases with increasing distance from the nearest EPI centre	<.05	<.01
Home visitation by field workers	Coverage is lower among children whose mothers reported fewer than 3 field worker visits during the past year	<.05	ns

Table 3 (cont.)

Variable	Nature of relationship with childhood coverage	Level of statistical significance: Bivariate analysis	Level of statistical significance: Multivariate analysis
Referral by field workers	Coverage is lower among those whose mothers reported that field workers had never referred them for child immunization	<.05	not included in model
Geographic area			
Area of Zone 3	No association	ns	ns
Type of neighbourhood	Coverage is lower among those who live in predominantly slum neighbourhoods	<.001	not included in model

ns: statistically not significant

B. Maternal Tetanus Toxoid Immunization[9]

1. Coverage by Number of Doses, Target Group, and Slum/Non-slum Household Status

Eighty-five per cent of the women with a child aged less than one year indicated that they had obtained at least two TT immunizations (TT2) during their reproductive years, as did 64% of the married women who had ever been pregnant and 47% of all women of reproductive age (Fig. 5). The slum/non-slum difference is greater among the women with

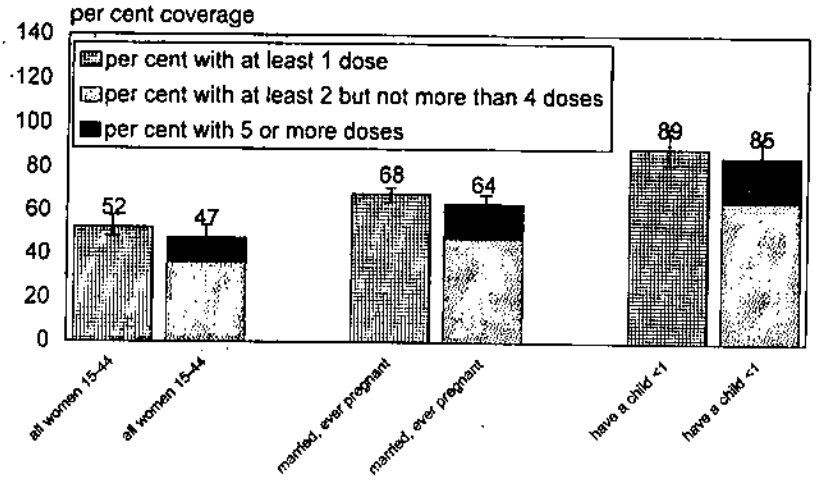
[8]Appendix 2 contains all of the detailed data on which the findings related to TT immunization among women are based.

a child aged less than one year than among the ever-pregnant women or among all women of reproductive age (Fig. 6). In the latter two groups, the differences are 7% or less, while among the women with a child aged less than one year, the difference is 14%. It is interesting to note that the coverage among all of the women living in slum households is slightly higher than the coverage among all of the women living in non-slum households. We will return to this finding.

Access to TT, as defined by receipt of at least one TT immunization, is 89% for the women with a child aged less than one year, but only 52% for all women of reproductive age (Fig. 5). Twenty-one per cent of all women with a child aged less than one year have obtained five TT immunizations, and 24% of women with child aged less than one year have a TT card at home. Only 7% of all women of reproductive age have a TT card at home.

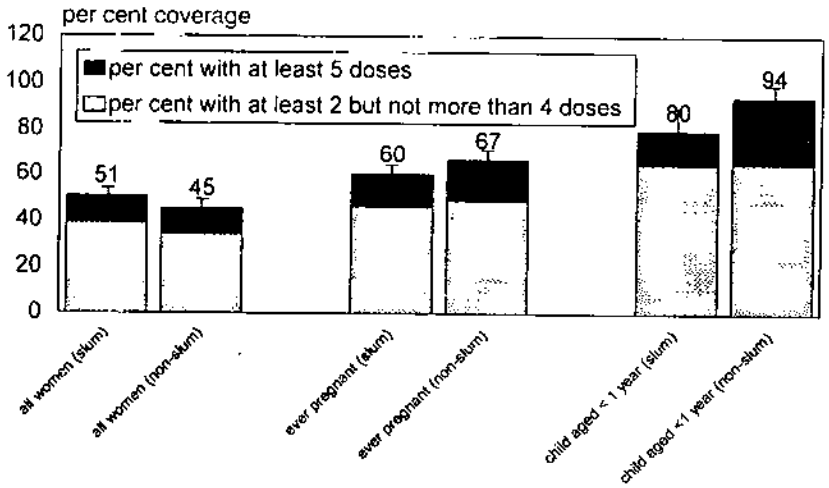
The dropout rates from TT1 to TT2 are only 3-11%, but the dropout rates from TT1 to TT5 are 70-82% depending on which group of women is included in the calculation (Table 4). The dropout rates among slum women are only slightly higher than among non-slum women.

Fig. 5. TT Immunization Coverage Among Women of Reproductive Age in Zone 3 of Dhaka City, 1995



see Appendix 2, Table 1 for actual data;95% confidence intervals shown for TT1 and TT2 coverage

Fig. 6. TT2 and TT5 Immunization Coverage Among Women of Reproductive Age by Slum/Non-slum Status in Zone 3 of Dhaka City, 1995



see text for definition of slum household; see Appendix 2, Table 1 for actual data; 95% confidence interval shown for TT2 coverage

Table 4. TT Immunization Dropout Rates Among Women of Reproductive Age

Type of dropout measure	Slum households (%)	Non-slum Households (%)	All households (%)
TT1 to TT2*			
Among all women of reproductive age	11.2	7.4	9.2
Among married women who have ever been pregnant	10.0	4.6	7.2
Among women with a child aged less than one year	5.6	2.7	4.3
TT1 to TT5**			
Among all women of reproductive age	79.6	77.3	78.4
Among married women who have ever been pregnant	78.8	74.7	76.8
Among women with a child aged less than one year	82.3	69.8	76.9

* (TT1-TT2)/TT1 x 100; ** (TT1-TT5)/TT1 x 100

Note: The terms in the equations refer to the percentage of women who received that particular antigen.
The data for these calculations were obtained from Appendix 2, Table 1.

2. Relationship of Family Background, Household, Programme, and Geographic Characteristics with TT2 Coverage Among Mothers Who Have a Child Aged Less than One Year

As shown in Table 5, two variables have highly significant ($p < .001$) relationships with TT2 coverage in both the bivariate and the multivariate analyses: mother's education and the number of home visits by the field workers. Mothers with no education have a TT2 coverage level of 75% compared to 93% for the women with at least some education. When controlling for the effects of the other independent variables included in the model, the odds of coverage are four times as great among the women with some education compared to women with none.

Mothers who reported 0-1 visits by a field worker during the past year have a TT2 coverage rate of 78% compared to a coverage rate of 90% among mothers reporting two or more visits. The logistic regression indicates that the odds of coverage are 4.6 times as great among those with two or more visits compared to those who reported 0-1 visits.

Distance from the nearest EPI centre is a significant ($p < .05$) predictor of TT2 coverage in the bivariate analysis, but an even more highly significant ($p < .001$) in the multivariate analysis. Those mothers living 400 metres or more from an EPI centre have a coverage rate of 79% compared to a coverage rate of 87% for those living within 400 metres. Controlling for the effects of the other independent variables in the logistic regression model, the odds of TT2 coverage for mothers living within 400 metres are 2.6 times greater than the odds for women living further away.

Mother's birthplace has a significant effect on TT2 coverage both in the bivariate and multivariate analyses. The coverage for mothers born in an urban slum or in a rural area is 82% compared to a coverage of 97% for mothers born in an urban non-slum area, and the odds of coverage for

mothers born in an urban non-slum area is 4.2 times the odds for a woman born in an urban slum or rural area.

Among all the possible two-way interaction effects in the logistic regression analysis, two were found to be statistically significant: the combined effect of mother's educational level and the number of field worker contacts on TT2 coverage, and the combined effect of mother's educational level and distance from the nearest EPI centre.[10] The effects of the number of field worker contacts on TT2 coverage are confined to those mothers with no education. Among the mothers with no education, TT2 coverage is only 57% for those who reported 0-1 field worker visits compared to 87% among those who reported two or more visits. However, for mothers with some education, TT2 coverage does not vary with the number of field worker visits.

The combined effect of mother's educational level and distance from the nearest EPI centre is confined to mothers with some formal education. Mothers with no formal education have a lower coverage level which does not vary with distance from the nearest EPI centre. For mothers who live 400 or more metres away, there is no significant difference in TT2 coverage by educational level. But for mothers with some education, TT2 coverage increases from 81% to 95% as the distance from the nearest EPI centre diminishes.

Several variables are significantly related to TT2 coverage in the bivariate analysis but not in the multivariate analysis: length of time mother has been living in Dhaka, marital status, husband's occupation, and slum/non-slum household status. Providing a statistical explanation for the differences in the findings of the bivariate and the multivariate analyses

[10]Appendix 2, Table 6 contains the actual data for this finding.

is a task too complex for our purposes here. However, we have explored this topic (data not shown) and can make several observations.

First of all, the length of time the mother has been living in Dhaka is correlated with slum/non-slum household status. Women living in Dhaka for five years or less are more likely to be living in slum households. Therefore, after controlling for the effect of slum/non-slum household status, the effect of length of time living in Dhaka on maternal TT2 coverage becomes insignificant.

Mothers with no education are more likely to be divorced, separated, or widowed than mothers with some education. Thus, after controlling for mother's education, the effect of marital status on maternal TT2 coverage becomes insignificant.

Husband's occupation has a significant bivariate association with maternal TT2 coverage, but in the multivariate analysis, the effect becomes insignificant because of its relationships with the wife's birthplace, wife's educational level, and number of field worker contacts. Husbands with higher occupational status are more likely to be married to women born in urban non-slum locations and to women with more education. These same husbands are also more likely to be married to women who reported more field worker contacts as well. Thus, after controlling for all of these effects, the independent effect of the husband's occupational status becomes insignificant.

Slum/non-slum household status is highly correlated with birthplace of the mothers and mothers' level of education. After controlling for the effects of these variables, slum/non-slum household status has no independent effect on maternal TT2 coverage.

Two variables have a significant relationship with maternal TT2 coverage in the bivariate analysis but were not included in the multivariate

analysis. For women living in households with monthly incomes of less than Tk 5,000, maternal TT2 coverage is 80%, compared to 94% among women in households with higher incomes. The maternal TT2 coverage is 81% in slum neighbourhoods compared to 94% in non-slum neighbourhoods.

Finally, several variables have no association with maternal TT2 coverage in either the bivariate or the multivariate analysis: mother's age, number of children living in the family, mother's employment status, and geographic area of Zone 3.

Table 5. Relationship of Family Background, Household, Programme, and Geographic Characteristics with Maternal TT2 Coverage Rates Among Women Who Have a Child Aged Less Than One Year

Variable	Nature of relationship with maternal TT2 coverage	Level of statistical significance	
		Bivariate analysis	Multivariate analysis
Family background			
Mother's birthplace	Mothers born in urban slums or in a rural village have lower coverage	<.001	<.01
Mother's age	No association	ns	ns
Number of living children in the family	No association	ns	ns
Mother's education	Mothers with no education have lower coverage levels than mothers with at least some education	<.001	<.001[1]
Length of time mother has been living in Dhaka	Mothers living in Dhaka for less than 5 years have a lower coverage level than mothers living in Dhaka for a longer period	<.05	ns
Mother's marital status	Children of mothers who are divorced, separated, or widowed have lower coverage	<.05	ns

Table 5 (cont.)

Variable	Nature of relationship with maternal TT2 coverage	Level of statistical significance: Bivariate analysis	Level of statistical significance: Multivariate analysis
Mother's employment status	No association	ns	ns
Father's occupation	Women whose husbands have manual/unskilled occupations have lower coverage than women whose husbands have manual/skilled or non-manual occupations	<.001	ns
Household			
Average reported monthly income	Women in households with a monthly income of less than Tk 5,000 have lower coverage	<.001	not included in model
Slum/non-slum household status	Slum households have lower coverage	<.001	ns
Programme			
Distance to nearest EPI centre	Women who live more than 400 metres from an EPI centre have lower coverage than women living closer	<.05	<.001
Home visitation by field workers	Women who report fewer than two field worker visits during the past year have lower coverage than women reporting two or more visits	<.001	<.001

Table 5 (cont.)

Variable	Nature of relationship with maternal TT2 coverage	Level of statistical significance: Bivariate analysis	Level of statistical significance: Multivariate analysis
Geographic area			
Area of Zone 3	No association	ns	ns
Type of neighbourhood	Coverage is lower among those who live in predominantly slum neighbourhoods	<.001	not included in model

ns: statistically not significant

3. Relationship of Family Background, Household, Programme and Geographic Characteristics with Access to TT Immunization Among All Women of Reproductive Age

Table 6 describes the results of bivariate and multivariate analyses of various predictor variables on access to TT immunizations among all women of reproductive age, where access is defined as the percentage of women reporting at least one TT immunization. Because the number of respondents for this analysis is substantially larger than for the childhood immunization and maternal TT2 analyses, smaller differences here are highly statistically significant. Age, education, marital status, and number of field worker contacts have highly significant ($p < .001$) associations with TT access in both the bivariate and multivariate analyses.

Concerning the effect of age on access, we find that 70% of the women aged 20-29 years have access compared to only 28% of the women aged 15-19 years and 48% of the women aged 30 years or older. The odds of the women who are aged less than 30 years obtaining access

is 1.9-3.8 times than that of the women aged 30 years or older in the logistic regression analysis.

In the bivariate analysis, we find that women with 1-5 years of education have slightly higher access than other women (57% versus 51%), but in the multivariate analysis, the effect is slightly different: women with any education are 1.4-1.6 times more likely than women with no education to have reported at least one TT immunization. The explanation for this difference is complex, but can be simply stated as follows: more highly educated women in our sample are more likely to be unmarried and therefore, as shown below, have a lower TT access rate. Thus, once marital status is controlled for in the multivariate analysis, those with higher levels of education have higher access rates.

Women who have no children have an access rate of only 18% compared to 79% for those with 1-2 children. But those with three or more children have an access rate of only 59%.

Unmarried (and almost certainly never-pregnant) women have a substantially lower access rate (of 12%) compared to the married women (67%) and compared to separated, divorced, or widowed women (39%). The odds of ever-married women obtaining access is 9.5-14.6 times than that for never-married women.

The number of field worker contacts has a strong association with access. Those women reporting two or more contacts have an access rate which is twice as high as that for women with 0-1 visits (75% versus 37%). When the bivariate analysis is limited to the currently married women (since field workers visit only married women of reproductive age), the access rates are still one-third higher among those with more field worker visits (75% versus 56%). In the logistic regression analysis, women with two or more field worker visits have an odds of access which is 2.4 times that for women with 0-1 field worker visits.

Several variables have significant associations in bivariate analysis but not in the multivariate analysis. A determination of the reasons that some of the significant relationships in the bivariate analysis were no longer significant in the multivariate analysis is a complex task. Further exploration of this issue does permit some limited observations to be made (data not shown). First of all, women born in less impoverished environments (i.e., non-slum urban locations) are more likely to be unmarried than are women born in urban slum or rural locations. Thus, after controlling for marital status, the effect of birthplace becomes insignificant.

The effect of length of time living in Dhaka on TT access is mediated in part by the woman's age. Women who have been living in Dhaka for less than five years are younger than women who have been living in Dhaka for 5-14 years. Thus, after controlling for the effect of age, the effect of living in Dhaka for less than five years becomes insignificant. Comparing women living in Dhaka for 15 or more years with those living in Dhaka for 5-14 years, we find that those women living in Dhaka for 15 or more years are more likely to be unmarried. Therefore, after controlling for the effect of marital status, the differences in access between women living in Dhaka for 5-14 years and women living in Dhaka 15 or more years disappear.

The effect of a woman working for money on access seen in the bivariate analysis becomes non-significant in the multivariate analysis because women who work are more likely to be older and less educated.

The reason that non-slum households have a lower TT access rate in the bivariate analysis is that the women of reproductive age living in these households are more likely to have never been married than are women living in slum households. Thirty-one percent of women of reproductive age who live in non-slum households have never been married compared to only 12% of women living in slum households. Since

married women are far more likely to have received at least one TT immunization, controlling for marital status eliminates the relationship between slum/non-slum household status and TT access.

Several variables were significant in the bivariate analysis but were not included in the multivariate analysis. The association of number of children with TT access is dramatic. Women who have no children have an access rate of only 18%-31% (depending on whether they are never married or currently married) compared to 67% for currently married women with at least one child. In the bivariate analysis (limited to only currently married women), 58% of the women whose husbands are unemployed or haye manual/unskilled jobs reported one or more TT immunizations compared to 70% of the women with husbands having manual/skilled jobs or non-manual jobs.

The bivariate analysis shows that women living in households with higher incomes and women living in non-slum neighbourhoods have lower access to TT immunization. Women living in households with a monthly income of greater than Tk 7,500 per month, and women living in the non-slum neighbourhoods have significantly lower access rates. This unexpected relationship can be explained in the same way that we explained the lower access rates among women living in non-slum households: these better off households are more likely than poorer households to have unmarried women residing in them.

The two variables that were not significantly related to TT access in the bivariate analysis (distance to the nearest EPI centre and area of Zone 3) also had an insignificant association with TT access in the multivariate analysis.

Out of all of the possible two-way interactions in the logistic regression analysis, three were found to have a statistically significant influence on access. These interactions involved the following variables:

women's age, woman's education, marital status, and the number of field worker visits.[1]

Access rates show less variation by education among the 20-29 year-old age group (although the difference is still significantly different) than in the other age groups. In addition, among women who are 15-19 years of age, TT access rates are lower than for similar-aged women with less education, most certainly because these better educated younger women are much less likely to married than the less educated women. In contrast, among women who are 30 years of age or older, more highly educated women have higher access than less educated women.

The access rates increase significantly as the woman's educational level increases for the never-married and currently married women. However, among women who are separated, divorced, or widowed, the access rates do not differ significantly by the educational level.

Finally, the association of field worker visits and access is particularly strong among women aged 15-19 years. In this age group, the access rates are almost four times higher among those with more field worker visits compared to those with only 0-1 visits, while in the other age groups, more frequent visits are associated with access rates that are 1.4 to 1.8 times greater. When the analysis is limited to the currently married women, however, the effect of field worker visits on women aged 15-19 years is no greater than on women who are aged 20 years and over. Thus, at least in this case, age seems to be confounded with marital status in its effect on access.

[1]The data on which the discussion of interaction effects is based are shown in Appendix 2, Table 11.

Table 6. The Relationship of Family Background, Household, Programme, and Geographic Characteristics With Access to TT Immunization Among All Women of Reproductive Age

Variable	Nature of relationship with TT1 coverage	Level of statistical significance: Bivariate analysis	Level of statistical significance: Multivariate analysis
Family background			
Woman's birthplace	Women born in urban slums have a lower access rate than women born in urban non-slum areas or rural areas	<.001	ns
Woman's age	Younger women (<20 years of age) have the lowest access in the bivariate analysis; in the multivariate analysis, older women (30+) have lower access	<.001	<.001
Number of living children	Women with no living children have an access rate much lower than women with at least one child; women with three or more children have an access rate which is less than that for women with 1-2 children	<.001	not included in model
Woman's education	In the bivariate analysis, women with 1-5 years of education have slightly higher access rates than women with no education or women with 6 or more years; in the multivariate analysis, however, women with at least some formal education have higher access rates	<.001	<.001

Table 6 (cont.)

Variable	Nature of relationship with TT1 coverage	Level of statistical significance: Bivariate analysis	Level of statistical significance: Multivariate analysis
Length of time woman has been living in Dhaka	Women living in Dhaka for less than 5 years or for more than 15 years have slightly lower access rates than women living in Dhaka for 5-14 years	<.001	ns
Woman's marital status	The access rate is quite low among the never-married women, moderate among those who are separated, widowed, or divorced, and relatively high among the married women	<.001	<.001
Woman's employment status	Those who work for money have a lower access rate	<.001	ns
Husband's occupation	Women whose husbands are unemployed or whose husbands have manual/unskilled occupations have lower access rates than women whose husbands have manual/ skilled or non-manual occupations	<.001	not included in model

Table 6 (cont.)

Variable	Nature of relationship with TT1 coverage	Level of statistical significance: Bivariate analysis	Level of statistical significance: Multivariate analysis
Family background			
Household			
Average reported monthly income	Women in households with a monthly income of more than Tk 7,500 have a lower access rate	<.001	not included in model
Slum/non-slum household status	Women living in non-slum households have a slightly lower access rate	<.001	ns
Programme			
Distance to nearest EPI centre	No association	ns	ns
Home visitation by field workers	Women who report less than 2 field worker visits during the past year have a lower access rate than women reporting 2 or more visits	<.001	<.001
Geographic area			
Area of Zone 3	No association	ns	ns
Type of neighbourhood	Women who live in predominantly non-slum neighbourhoods have a lower access rate	<.001	not included in model

ns: statistically not significant

IV. Discussion

As far as we know, the current study is the first in Bangladesh to assess factors aside from slum/non-slum status which are associated with immunization status in a major urban area, and also the first in Bangladesh to address TT coverage issues among all women of reproductive age. The findings indicate that the unmet need, at least in Zone 3, for additional immunizations is still substantial: half the children aged 12-23 months and almost all (89%) of the women of reproductive age still need additional immunizations. Forty-eight per cent of the women of reproductive age have never received even one TT immunization. The dominant influences on immunization coverage, apart from slum/non-slum household status, are educational level, access to EPI facilities, and contact with field workers.

Characteristics of Those Families With a Woman or Child in Need of Additional Immunizations

Even though three-quarters of children living in slum households obtained access to an immunization, only 38% of such children had received their complete series of immunizations, and 57% of all Zone 3 children live in the slum households as defined in this analysis. Similarly, only 38% of the children whose mothers have no formal education had been completely vaccinated. At present, children living in the slum households are 44% less likely to have completed their series of vaccinations compared to those living in the non-slum households. These findings suggest that the slum/non-slum differences in childhood coverage encountered in earlier surveys in Dhaka are persisting and, perhaps, even widening. The problem is not so much one of obtaining access to the EPI program as it is obtaining prompt access during the child's first three months of life, keeping an immunization card in the home, and continuing with all the necessary immunizations until the series is complete.

TT2 coverage among mothers with a child aged less than one year is quite high in both the slum and non-slum households (80 and 94% respectively), and the gap in slum/non-slum maternal TT2 coverage appears to be narrowing substantially, from approximately 26% in 1990 to 14% in 1995.

The decision of the Bangladesh EPI Programme in 1993 to switch its TT policy from promoting at least two TT immunizations among pregnant women to promoting a lifetime total of five TT immunizations among all women of reproductive age has still not been implemented on a national basis. Women aged 15-19 years, never-married women, and women with no children are those who have the lowest rates of access to TT immunization at present: all of these subgroups have access rates that are 28% or less. Marital status is far and away the strongest predictor of access in the multivariate analysis.

Aside from the major influences on immunization status mentioned above, there are a number of other influences which have been identified. Women who have migrated to the city more recently tend to have lower TT coverage levels; working women and those who have been previously married but are currently separated, divorced, or widowed tend to have lower immunization coverage levels in their children. In addition, older women tend to have both lower TT coverage levels as well as lower immunization coverage levels among their children.

With respect to childhood coverage, two family characteristics merit special attention. In families with three or more children, immunization levels are lower for their 12-23-month-old children than the 12-23-month-old children in families with only one or two children. This finding has been reported in Bangladesh (17) and elsewhere (18-20). The effect observed in our study is not simply one which reflects the obvious fact that women with more children are also older and less educated, since the effect persists after controlling for these variables in the logistic

regression analysis. In addition, female children have a coverage which is about 10 percentage points lower than male children (47% versus 57%). Similar findings for Bangladesh have been reported in other studies as well (21-23).

Further analysis indicates that the sex and birth-order effects are intertwined: the birth order effect is limited to female children, and the sex difference is limited to those children living in families in which there are currently three or more children.

The Significance of EPI Centre Location and Contact With Field Workers

Distance of the household from the nearest EPI centre and contact with field workers are both important predictors of immunization status. The effects depend on the type of analysis (bivariate or multivariate) and on which type of immunization status (childhood, TT for women, or TT for mothers). For childhood coverage, nearness to the EPI centre appears to be particularly important, while for maternal TT2 coverage, both proximity to a centre and level of contact with field workers are important predictors of coverage. For TT access, contact with field workers is an important predictor, but proximity is not.

It is unfortunately the case that slum households are further away from the nearest EPI centre, on an average, than the non-slum households.[2] But even after controlling for slum household status in the logistic regression analysis of both childhood immunization coverage as well as maternal TT2 immunization coverage, distance is still a highly significant predictor of coverage. Since the persons living in the slum households already face barriers to obtaining EPI services due to their lower

[2]Further analysis of the UPS data indicates that the slum households are 15% further away from the nearest EPI centre than the non-slum households. The correlation of the Household Index score with distance from the nearest EPI centre is -0.19 ($p<0.001$).

educational and socioeconomic status as well as their more recent immigration to Dhaka, the additional distance to an EPI centre constitutes a further barrier for those women living in slum households. Although, in fact, all households in Zone 3 are within one kilometre of an EPI centre, the "social" distance may be particularly important for certain groups of women. For instance, women living in slum households may not feel comfortable in travelling very far from their homes for immunizations. In rural Bangladesh, the mother's ability to visit a health centre alone is a strong predictor of access to childhood immunizations (21) and TT immunizations (23).

Other studies have documented the strong negative effect which distance from the nearest EPI centre exerts on coverage in rural Bangladesh (21-23), in rural Senegal (24), as well as in urban areas of South Africa (25, 26). In Zone 3, even though the average distance to an EPI centre is only 0.24 kilometres and the longest distance to an EPI centre is only 0.63 kilometres, childhood immunization coverage increases abruptly when the distance is less than 0.40 kilometres, and maternal TT2 coverage increases gradually with decreasing distance from the EPI centre.

Level of contact with field workers is also a significant predictor for both the childhood and maternal TT immunization coverage in the bivariate as well as the multivariate models. In the case of childhood immunization, a demarcation was observed for those with three or more visits during the previous year compared to those with two or fewer visits during the previous year. In the case of maternal TT immunization, the demarcation was observed for those with two or more visits compared to those with 0-1 visits. An association between immunization coverage and the level of personal contact of community outreach workers with clients through home visitation has been found in other studies in Bangladesh (21, 23), particularly for mothers of lower socioeconomic status, as well as in Thailand (27, 28). The relationship is particularly strong for mothers of lower socioeconomic status.

Our study provides evidence that the association of field worker visits with immunization coverage is particularly strong among young women and those with no formal education.

Does a higher visitation rate from field workers offset the disadvantage of being further away from an EPI centre? Apparently, to a large degree, it does. Further analyses (shown in Appendix 5, Tables 1 and 2) indicate that, for childhood immunization coverage, the effect of distance on coverage is reduced by half among those with 3-4 visits compared to those with 0-2 visits. For maternal TT2 coverage, the effect of distance is nearly eliminated altogether.

In urban areas in general, information and motivation appear to be key factors influencing use of immunization services. The critical role which personal contact, particularly from health workers during home visits, can play in providing information and motivation has been demonstrated in other studies of the urban slums in Dhaka (29) and in other urban settings as well (11). The current study suggests strongly that field worker visits play an important role in the promotion of immunization utilization.

Strengths and Limitations of the Study

EPI coverage surveys generally consist of 30 clusters of seven children each, yielding a sample size of 210 children. This methodology, however, does not permit an analysis of coverage in subgroups of the population. In our study, a considerably larger sample (of 651 children aged 12-23 months, 707 mothers of children less than one year, and 6,527 women of reproductive age), together with the collection of a considerable array of personal and household information, makes it possible to carry out a very detailed analysis of coverage. But, at the same time, this has led to a much more complex task of analysis, interpretation, and communication of the key findings.

The degree to which Zone 3 is representative of Dhaka City as a whole and other urban areas of Bangladesh is beyond the scope of this analysis. A representative sample of all of Dhaka or of all of urban Bangladesh would have been preferable for our study. Nevertheless, Zone 3 is the second largest of the 10 Zones in Dhaka City Corporation and the findings obtained for Zone 3 may be relevant to other urban areas in Bangladesh.

Relying on maternal recall for the dates of childhood immunizations in those households in which there is no immunization card has introduced some error into coverage assessment, but presumably this error is similar in all subgroups analyzed here. Relying on maternal recall for the dates of immunizations has not affected the overall coverage levels that otherwise would have been obtained using the COSAS methodology.

Relying on maternal recall for information about maternal TT immunizations in the distant past may be an even greater source of error, however. One recent study from Matlab, Bangladesh, has shown that women may underreport up to 40% of TT doses that were provided more than one year ago, and recall is worse among older women with more children who have a poor immunization status (30). Thus, the coverage levels reported here may be, to a certain degree, lower than is the case in actual fact.

A second limitation of the measurement process for TT coverage is the determination of the number of doses among those women with a card which is based solely on the number of doses reported on the card. Some of these women may have obtained additional doses that they are aware of which were not reported on the card, and those cards which were replacements of earlier lost cards may not report all the doses which the woman had received during her reproductive years. Thus, this source of error could possibly have led to a somewhat smaller TT coverage rate than

is actually the case. However, the effect is likely to be minor since only 7% of women of reproductive age and only 24% of women with a child under one year of age have a maternal immunization card.

An additional weakness of this study is that it does not include information for the "floating" population, that is those persons who live on sidewalks and other non-residential spots who move about from place to place in the city. The inclusion of this group, estimated to be about 1% of the population, would not affect the findings in any substantial way, however.

V. Recommendations

In spite of the dramatic progress made during the past decade, there is still a strong need to continue the efforts to improve the immunization coverage levels, particularly among slum children and among young women. Two promising strategies for improving coverage are reducing the number of missed opportunities for immunization promotion and conducting home visits to identify and refer those in need of immunization (15, 31).

In a previous report on the quality of EPI services in Zone 3 (15), we analyzed the missed opportunities for immunization promotion and found that 89% of children and 99% of women coming to an MCH-FP clinic in Zone 3 did not have their immunization status checked by the provider. At the time of home visits by field workers, 45% of children less than one year of age and 97% of non-pregnant women did not have their immunization status checked. Therefore, extensive promotion of immunization services is needed. In all interactions of MCH-FP health workers with women of reproductive age and their young children, the immunization status should be checked and those who need immunization should be referred. Improving the understanding which

each mother has regarding the additional doses her child needs has been identified as a key strategy for improving coverage (32, 33). Reducing rates of missed opportunities for immunization promotion should also improve the level of understanding among women of how many additional doses are needed, both for childhood immunizations and for TT immunizations for women of reproductive age.

Periodic home visitation by health workers to all women of reproductive age (especially to those living in slum households), the promotion of immunizations among those who need them, and targeted follow-up to those women and children in need of additional immunizations constitute one approach for improving coverage which is supported by the findings of this study. Infants who have not received their BCG immunization within the first three months of life constitute another readily identifiable group at high-risk for not obtaining the entire series of immunizations and therefore merit more intensive targeted promotion. As effective as these interactions appear to be, actual observations of field worker-client interactions suggest there is still a considerable room for improving the quality of promotion of immunizations at the time of home visits (15, 16).

The establishment of "user-friendly" EPI outreach sites in or adjacent to slum neighbourhoods will be important in narrowing the slum/non-slum gap in coverage, coupled with promotional campaigns which rely on word-of-mouth, door-to-door promotion. Although Zone 3 clients report that providers at the immunization sites are generally friendly, it is not uncommon for clients to have to pay for immunizations, and the hours of operation of the EPI centres are quite restricted (15). Other approaches to improving coverage include strengthening the knowledge of the immunization schedule among MCH-FP providers and other health practitioners in the area who themselves do not give immunizations, improving the understanding of mothers about the purpose of immunizations, and increasing the prevalence of client-retained immunization cards (15).

Finally, for the small percentage of the population which does not respond to the above efforts, then more intensive approaches such as setting up temporary immunization sites, can be implemented on an emergency basis, particularly when surveillance has detected geographic clusters of measles or neonatal tetanus cases.

Improving TT Coverage

Coverage of two TT immunizations among women with a child aged less than one year is quite impressive (85%). Only one-quarter of the women with a child aged less than one year have a TT card, however. Furthermore, only half of the women of reproductive age have obtained at least one TT immunization, and only one in 10 of the women of reproductive age have completed the entire series of five doses.

Although the Bangladesh EPI Programme adopted the WHO-recommended five dose TT strategy in 1993, the findings suggest that at the time the data for this study were collected in late 1995, the EPI program and MCH-FP workers were still limiting their promotion of TT immunization to pregnant women. Unfortunately, nationwide progress since 1993 in implementing this new policy has been slow.

Thus, there is a need to promote the more widespread use of TT immunization cards and the attainment of life-long immunity through the receipt of five TT immunizations. Also, greater emphasis on client-retained TT immunization cards is needed to raise awareness among women about the importance of receiving five TT immunizations and to help women remember how many additional doses they need. The TT immunization cards also enable health workers to accurately review the women's TT status at the time of a visit to the home or at the time of a visit to a health facility. Health workers can provide more appropriate advice to those women who have TT immunization cards.

A strategy for improving access to TT immunizations among women of reproductive age needs to be widely applied throughout the population and focused on young women who have not yet married or become pregnant. The most common reasons given by ever-pregnant younger women in Zone 3 for never having obtained a TT immunization are lack of information about the importance of TT immunizations and fear of receiving a TT immunization during pregnancy (15). Here, as was the case in Matlab in the early 1980s (34), there is reluctance of mothers to accept immunization during pregnancy because of a fear that it would harm the foetus (even though harmful effects on the foetus have never been documented).

Thus, a widespread promotional campaign may be needed in order to increase the awareness among young girls of the need to begin their series of five TT immunizations as early as possible to protect the first-born child and to ensure life-long immunity. Now that female enrollment of children in primary school is quite high in Bangladesh, it should be possible to immunize such girls at the beginning and end of each school year. The promotion of TT immunization among non-pregnant married women may improve access since these women would not have to be concerned about any ill effects of TT immunization on the foetus.

VI. Implications of the Findings for the Urban and National EPI Programme

The Need for a Strategy Directed Specifically to Slum Households

Thirty per cent of the Dhaka's entire population live in slums, and 50% live below the poverty line (9). The findings of the current study

support the need of the Urban EPI Programme in Bangladesh to develop and implement a special strategy for slum neighbourhoods (9). As in-migrants from rural areas continue to set up new households in the urban slums of Bangladesh, it will be important for the EPI Programme to promote immunization among the slum households. Frequent person-to-person contact for promotion of EPI services at readily accessible EPI sites should help gradually improve EPI coverage in the slum households. Innovative approaches for stimulating demand for EPI services and for facilitating access will also be needed. The number of immunization sites will need to be expanded as the number and size of slum neighbourhoods continues to increase. The location of sites will need to be periodically reviewed to ensure that all slum populations have ready access to EPI sites. Enhancing local coordination with government officials, local leaders, and health staff would strengthen partnerships with the community, thereby promoting local ownership of the EPI activities. Such coordination would optimize the use of existing EPI resources. Finally, slum-specific EPI strategies will need to recognize the fact that communications from field workers, volunteers, neighbours, and "miking" will be comparatively more effective than mass media communications (9).

The Importance of Increasing the Educational Level of Women

A final implication of these findings is that raising the overall level of education among women is perhaps one of the most significant contributions that can be made in the long-run to improve the immunization coverage and reduce the mortality of children aged less than five years. In the Zone 3 UPS sample of 6,527 women of reproductive age, 39% have had no formal education at all and only 37% have received more than a primary level of education.

Of all the variables included in our analysis of coverage in both women and children, maternal education has perhaps the strongest and most consistent effect. In other studies in Bangladesh (17, 20-23) as well

as in studies from other countries (18, 19, 20, 35), maternal education is a strong predictor of immunization coverage.

Our analysis of maternal TT2 coverage revealed that the strong effect of field worker contact was mediated entirely through uneducated mothers. Bhuiya et al. (21) found that field worker contact had its greatest impact on improving access to child immunization among mothers with no formal education. Thus, these findings suggest that ongoing contact with field workers through home visits to less educated mother will be one way to maintain and improve immunization coverage levels until the overall educational level of women improves over the next 10-15 years.

VII. Conclusion

Although Bangladesh has become a global leader in improving immunization coverage levels during the past decade, enormous challenges remain in order to meet the government's goal of 90% coverage for all immunizations by the year 2000, along with the eradication of poliomyelitis, the elimination of neonatal tetanus, and a 95% reduction in the number of measles deaths (36).

Based on the findings from this report, we have attempted to provide explanations for some of the shortcomings of the urban EPI program and some possible strategies for overcoming these shortcomings.

Immunizations are among the most cost-effective health interventions currently available with respect to their ability to prevent mortality and disability (37). The national health and family planning program should continue to give priority to strengthening the coverage, quality, and effectiveness of EPI activities during the coming decade, particularly in urban slum populations.

References

1. World Health Organization. 1995. Global Programme on Vaccines and Immunization Information System. Geneva: World Health Organization.

2. EPI Directorate of Health Services. 1995. Findings of the 1995 National Coverage Survey. Dhaka: Expanded Programme on Immunization, Directorate of Health Services, Government of Bangladesh.

3. Huq M. 1991. *Near Miracle in Bangladesh.* Dhaka: University Press Limited.

4. Ministry of Health and Family Welfare. 1995. *Reaching the People. Essential Services for Maternal and Child Survival and Family Planning.* Dhaka: Ministry of Health and Family Welfare.

5. Baqui, A.H., Q. Nahar, S. Amin A.S. Uzma, S.E. Arifeen. 1993. Epidemiology and causes of death among children in slums of Dhaka. In: *Second Annual Scientific Conference Programme and Abstracts.* Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh.

6. EPI Directorate of Health Services. 1990. Findings of the Vaccination Coverage Survey, Dhaka City Corporation, July 26, 1990. Dhaka: Expanded Programme on Immunization, Directorate of Health Services, Government of Bangladesh.

7. EPI Directorate of Health Services. 1993. Findings of the Vaccination Coverage Survey, Dhaka City Corporation, February 26, 1993. Dhaka: Expanded Programme on Immunization, Directorate of Health Services, Government of Bangladesh.

8. Laston, S.L., A.H. Baqui, N. Paljor, D.R. Silimperi. 1993. *Immunization Beliefs and Coverage in Dhaka Urban Slums. Working Paper No. 5, MCH-FP Extension Project (Urban).* Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh.

9. Tawfik Y., R. Khanam, M. Rasmuson, K. Bhattacharya. 1996. *Extending Immunization Services to the Urban Poor in Bangladesh: A Strategy for Action.* Dhaka: BASICS Urban EPI Project.

10. UNICEF/Dhaka. 1993. *Staying Alive: Urban Poor in Bangladesh.* Dhaka: UNICEF.

11. Atkinson S.J., J. Cheyne. 1994. Immunization in urban areas: issues and strategies. *Bulletin of the World Health Organization* 72:183-194.

12. Helen Keller International/Bangladesh. 1996. Report of Rounds 38 and 39-Urban: Nutritional Surveillance Project, June and August 1996 Data Collection. Dhaka: Helen Keller International/Bangladesh.

13. Coetzee N., D.S. Berry, M.E. Jacobs. 1991. Measles control in an urbanizing environment. *South African Medical Journal* 79:440-444.

14. Foster S.O., D.A. McFarland, A.M. John. 1993. Measles. In D.T. Jamison, W.H. Mosley, A.R. Measham, and J.L. Bobadilla (eds.), *Disease Control Priorities in Developing Countries.* New York: Oxford University Press, pp. 161-187.

15. Perry, H.B., S.E. Arifeen, I. Hossain, R. Weierbach. 1996. *Assessment of the Quality of Urban EPI Services in Bangladesh: Findings from Zone 3 of Dhaka City. Working Paper No. 24, MCH-FP Extension Project (Urban).* Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh.

16. Perry H., S. Begum, A. Begum, T. Kane, M.A. Quaiyum, A.H. Baqui. 1996. *Assessment of Quality of MCH-FP Services Provided by Field Workers in Zone 3 of Dhaka City and Strategies for Improvement. Working Paper No. 20, MCH-FP Extension Project (Urban).* Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh.

17. Majumder A.K., S. Aziz, J.C. Paul. 1994. Impact of socio-economic factors on immunisations among children and mothers in an urban area of Bangladesh. *Journal of Family Welfare* 40: 51-58.

18. Hanyon P., P. Byass, M. Yamuach, et al. 1988. Factors influencing vaccination compliance in periurban Gambian children. *Journal of Tropical Medicine and Hygiene* 91:29-33.

19. Akesode F.A. 1982. Factors affecting the use of primary health care clinics for children. *Journal of Epidemiology and Community Health* 36:310-314.

20. Barreto T.V., L.C. Rodrigues. 1992. Factors affecting childhood immunisation in an urban area of Brazil. *Journal of Epidemiology and Community Health* 4:357-361.

21. Bhuiya A., I. Bhuiya, M. Chowdhury. 1995. Factors affecting acceptance of immunization among children in rural Bangladesh. *Health Policy and Planning* 10:304-311.

22. Mitra, S.N., M.N. Ali, S. Islam, A. Cross, T. Saha. 1994. *Bangladesh Demographic and Health Survey 1993-1994.* Dhaka, Bangladesh: National Institute of Population Research and Training (NIPORT); Dhaka, Bangladesh: Mitra and Associates; Calverton, Maryland, Macro International Inc.

23. Jamil K., A. Bhuiya, K. Streatfield, N. Chakraborty. 1996. The immunization program: An impressive achievement, but challenges remain. In A. Kantner, A. Al-Sabir, N. Chakraborty (eds.) *Bangladesh Demographic and Health Survey 1993-94: Extended Analysis*. Dhaka and Honolulu: NIPORT and East-West Center Program on Population, pp. 158-179.

24. du Lou A.D., G. Pison. 1994. Barriers to universal child immunization in rural Senegal 5 years after the accelerated Expanded Programme on Immunization. 1994. *Bulletin of the World Health Organization* 72:751-759.

25. Berry D.J., D. Yach, M.H. Hennink. 1991. An evaluation of the National Measles Campaign in the new shanty areas of Khayelitsha. *South African Medical Journal* 79:433-436.

26. Rees H. 1991. 1991. Immunisation coverage and reasons associated with non-immunisation in Alexandria township. *South African Medical Journal* 80:378-381.

27. Limtragool P., P. Panichacheewakul, J. Stoeckel, A. Charoenchai. 1989. Health programme effects upon acceptance of immunisation in northeast Thailand. *Asia-Pacific Journal of Public Health* 3:26-31.

28. Limtragool P., J. Stoeckel, P. Panichacheewakul, A. Charoenchai. 1992. Factors affecting immunization coverage in northeast Thailand. In J. Stoeckel (ed.) *Intervention Research on Child Survival*. Singapore: McGraw-Hill Book Co., pp. 39-54.

29. Quaiyum, M.A., C. Tunon, A.H. Baqui, A. Quayyum, J. Khatun. 1996. *Impact of National Immunization Days on Polio-related Knowledge and Practice of Urban Women in Bangladesh. Working Paper No. 19, MCH-FP Extension Project (Urban).* Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh.

30. De Francisco A., J. Chakraborty. 1996. Maternal recall of tetanus toxoid vaccination. *Annals of Tropical Paediatrics* 16:49-54.

31. Cutts F.T., D.C. Glick, A. Gordon, K. Parker, S. Diallo, F. Haba, R. Stone. 1990. Application of multiple methods to study the immunization program in an urban area of Guinea. *Bulletin of the World Health Organization* 68:769-776.

32. Streatfield K., M. Singarimbun. 1988. Social factors affecting the use of immunization in Indonesia. *Social Science and Medicine* 27:1237-1245.

33. Streatfield K., M. Singarimbun, I. Diamond. 1990. Maternal education and child immunization. *Demography* 27:447-455.

34. Rahman M., L.C. Chen, J. Chakraborty, M. Yunus, A.S. Faruque, A.I. Chowdhury. 1982. Use of tetanus toxoid for the prevention of neonatal tetanus. 2. Immunization acceptance among pregnant women in rural Bangladesh. *Bulletin of the World Health Organization* 60:269-277.

35. Fassin D., E. Jeanne. 1989. Immunization coverage and social differentiation in urban Senegal. *American Journal of Public Health* 79: 509-511.

36. Ministry of Health and Family Welfare. 1994. *The Way Forward: Health and Nutrition Strategies for the Government of Bangladesh - UNICEF Programme of Cooperation 1996-2000.* Dhaka: Ministry of Health and Family Welfare.

37. World Bank. 1994. *Investing in Health: World Development Report 1993.* New York: Oxford University Press.

38. Arifeen S.E., A.Q.M. Mahbub. 1993. *A Survey of Slums in Dhaka Metropolitan Area- 1991. Working Paper No. 11, MCH-FP Extension Project (Urban).* Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh.

APPENDIX 1

Detailed Childhood Immunization Coverage Data

Table 1. Childhood Immunization Coverage Among 12-23-Month-Old Children in Zone 3 of Dhaka City, 1995†

Type of coverage	Non-slum household* (n = 405) (weighted)	Slum household* (n = 246) (weighted)	Total (n = 651) (weighted)	Slum household coverage as percentage of non-slum household coverage
BCG (day of survey)	95.5 (91.8-99.1)	77.5 (69.0-86.0)	85.2 (70.4-99.9)	81.2
BCG (by first birthday)	94.6 (89.7-99.4)	76.4 (70.1-82.7)	84.1 (70.2-98.1)	80.8
DPT1 (day of survey)	91.0 (87.6-94.3)	73.5 (63.0-84.0)	81.0 (65.6-96.3)	80.8
DPT1 (by first birthday)	90.6 (86.9-94.3)	72.4 (64.1-80.6)	80.2 (65.6-94.7)	79.9
DPT2 (on day of survey)	93.1 (88.3-97.8)	68.9 (65.0-72.9)	79.2 (64.4-94.0)	74.0
DPT2 (by first birthday)	91.0 (85.7-96.4)	67.6 (63.3-71.9)	77.6 (62.7-92.5)	74.3
DPT3 (on day of survey)	87.9 (85.3-90.6)	58.8 (51.3-66.4)	71.2 (52.5-90.0)	66.9
DPT3 (by first birthday)	86.2 (83.1-89.3)	57.2 (49.5-64.9)	69.5 (50.7-88.4)	66.4
OPV1 (on day of survey)	91.0 (87.6-94.3)	72.6 (61.2-84.0)	80.5 (64.1-96.7)	79.8

Table 1 (cont.)

Type of coverage	Non-slum household* (n=405) (weighted)	Slum household* (n=246) (weighted)	Total (n=651) (weighted)	Slum household coverage as percentage of non-slum household coverage
OPV1 (by first birthday)	90.6 (86.9-94.3)	71.4 (62.3-80.6)	79.6 (64.1-95.1)	78.8
OPV2 (on day of survey)	93.1 (88.3-97.8)	66.9 (61.7-72.2)	78.1 (61.4-94.8)	71.9
OPV2 (by first birthday)	90.9 (85.5-96.2)	64.8 (60.6-69.0)	76.0 (59.9-92.0)	71.3
OPV3 (on day of survey)	87.6 (84.6-90.7)	56.0 (48.9-63.1)	69.5 (49.6-89.3)	63.9
OPV3 (by first birthday)	85.9 (82.6-89.2)	54.3 (47.2-61.5)	67.8 (47.8-87.7)	63.2
Measles (on day of survey)	71.4 (66.8-76.1)	46.0 (42.3-49.7)	56.7 (46.7-66.9)	64.4
Measles (by first birthday)	64.7 (58.0-71.4)	42.3 (39.4-45.2)	51.7 (43.7-60.0)	65.4
Complete coverage at the time of the survey (BCG, OPV3, DPT3, measles)	69.0 (66.5-71.4)	38.3 (34.9-41.7)	51.3 (38.0-64.7)	55.5

Table 1 (cont.)

Type of coverage	Non-slum household* (n = 405) (weighted)	Slum household* (n = 246) (weighted)	Total (n = 651) (weighted)	Slum household coverage as percentage of non-slum household coverage
Complete coverage obtained by the first birthday (BCG, OPV3, DPT3, measles)	61.2 (56.5-66.0)	35.0 (32.4-37.6)	46.1 (35.6-56.7)	57.2
Percentage of completely vaccinated children who obtained all of their vaccinations before their first birthday	88.7	91.4	89.9	97.0
Percentage of children who have an immunization card at home	67.9	41.9	52.9	61.7

*Slum households are defined as those with a Household Index score of < 6 (see text for further details);

Note: 95% confidence intervals are shown in parentheses; all differences in coverage between the slum and non-slum households are statistically significant ($p < .05$).

Table 2. Comparison of Childhood Immunization Coverage by Timing of BCG Immunization

BCG dose provided during the first three months of life	Percentage of children completing their entire series of immunizations by the first birthday	Percentage of children completing their entire series of immunizations by the date of the household survey
yes (n=434)	58.1 (54.8-61.4)	62.7 (57.8-67.5)
no (n=217)	23.4 (8.1-38.7)	29.8 (10.6-49.0)
statistical significance	[§]	[§]

Note: 95% confidence intervals are shown in parentheses.

[§] $p < 0.001$

Table 3. Bivariate Relationships Between Family Demographic Background Variables and Complete Childhood Immunization Among 12-23-Month-Old Children

Type of family background characteristic	Percentage with complete immunization coverage (weighted)	n (unweighted)	Level of statistical significance
Birthplace of mother			
urban (slum)	44.2	128	
rural	48.7	383	
urban (non-slum)	72.6	112	<.001
Mother's age			
<20	56.8	88	
20-24	57.9	228	
25-29	54.4	183	
30+	35.3	152	<.001
Number of living children mother has			
1	57.7	230	
2	60.9	197	
3+	36.1	214	<.001

Table 3 (cont.)

Type of family background characteristic	Percentage with complete immunization coverage (weighted)	n (unweighted)	Level of statistical significance
Mother's education			
none	38.1	284	
1-5 years	49.0	155	
6-10 years	71.8	163	
11+ years	81.4	39	<.001
Length of time mother has been in Dhaka			
0-4 years	46.0	193	
5-14 years	50.5	231	
15+ years	56.9	227	>.05
Mother's marital status			
other (separated, divorced, or widowed)	24.3	27	
married	52.3	624	<.05

Table 3 (cont.)

Type of family background characteristic	Percentage with complete immunization coverage (weighted)	n (unweighted)	Level of statistical significance
Whether mother works for money (either inside or outside home)			
yes	29.4	83	
no	55.0	568	<.001
Father's occupation			
unemployed or manual/unskilled	33.7	120	
manual/skilled	57.6	129	
non-manual	57.2	334	<.001
Sex of child			
female	46.9	343	
male	56.7	308	<.05

Table 4. Bivariate Relationships Between Family Household Characteristics and Complete Childhood Immunization Among 12-23-Month-Old Children

Type of family household characteristic	Percentage with complete immunization coverage (weighted)	n (unweighted)	Level of statistical significance
Average monthly income			
0-2499 Tk	30.3	174	
2500-4999 Tk	60.7	223	
5000-7499 Tk	55.5	114	
7500+ TK	63.4	140	<.001
Housing characteristics			
Roof			
tin, bamboo, wood, or jhupri	44.0	408	
pucca	69.3	241	<.001
Wall			
tin, bamboo, wood, or jhupri,	34.9	216	
pucca	62.0	435	<.001

Table 4 (cont.)

Type of family household characteristic	Percentage with complete immunization coverage (weighted)	n (unweighted)	Level of statistical significance
Total number of rooms			
1	45.8	398	
2 or more	62.5	251	<.001
Type of sanitation			
primitive (hanging, open, dug, or no fixed site)	41.2	214	
latrine with no water seal	54.5	259	
latrine with water seal	62.7	176	<.001
Household possessions			
Khat			
no	38.9	54	
yes	58.7	569	<.01
Almirah		214	
no	35.3		
yes	59.9	435	<.001

Table 4 (cont.)

Type of family household characteristic	Percentage with complete immunization coverage (weighted)	n (unweighted)	Level of statistical significance
Table or chair			
no	37.3	280	
yes	63.3	369	<.001
Radio			
no	41.7	354	
yes	63.4	295	<.001
TV			
no	42.6	413	
yes	69.2	236	<.001
Fridge			
no	48.1	561	
yes	76.2	88	<.001
Household Index score			
< 3	33.9	146	
3-5	42.0	189	
6-8	65.2	178	
9+	74.3	136	<.001

Table 5. Bivariate Relationships of Programme and Geographic Characteristics With Complete Childhood Immunization Among 12-23-Month-Old Children

Characteristics	Percentage with complete immunization coverage (weighted)	n (unweighted)	Level of statistical significance
PROGRAMME CHARACTERISTICS			
Distance to nearest EPI Centre			
400+ metres	40.4	324	
200-399 metres	53.3	105	
<200 metres	54.1	222	<.05
Number of field worker contacts in past year			
0-2	46.6	331	
3+	55.4	318	<.05
Field worker referred child for immunization?			
no	47.0	357	
yes	55.3	294	<.05

Table 5 (cont.)

Characteristics	Percentage with complete immunization coverage (weighted)	n (unweighted)	Level of statistical significance
GEOGRAPHIC CHARACTERISTICS			
Area			
Rayer Bazar Intensive Area	59.5	143	
Lalbagh Intensive Area	54.9	191	
Bakshi Bazar Intensive Area	58.1	162	
Non-intensive Area	48.5	155	>.05
Type of neighbourhood			
predominantly slum	41.8	246	
predominantly non-slum	59.9	405	<.001

Table 6. Estimates of the Effects of Family Background, Family Household, Programme, and Geographic Characteristics on Childhood Immunization Coverage

Covariate	Effect on coverage		
	Estimated Beta	SE	Odds ratio (95% confidence interval)
Intercept	-2.43	.38	
FAMILY BACKGROUND CHARACTERISTICS			
Birthplace of mother	ns		
Mother's age (years)	ns		
Number of children living in the family			
1 or 2 (versus 3+)	.98[§]	.19	2.65 (1.81-3.88)
Mother's education			
6 or more years of education (versus 0-5)	.75[§]	.24	2.12 (1.33-3.38)
Mother's marital status	ns		
Length of time living in Dhaka	ns		
Mother employed?			
no (versus yes)	.88[‡]	.28	2.41 (1.38-4.20)
Husband's occupational group	ns		
Sex of index child	ns		

Table 6 (cont.)

Covariate	Effect on coverage: Estimated Beta	SE	Odds ratio (95% confidence interval)
FAMILY HOUSEHOLD CHARACTERISTICS			
Slum versus non-slum household	.80[§]	.22	2.23 (1.46-3.41)
PROGRAM CHARACTERISTICS			
Distance to nearest EPI Centre			
< 400 metres (versus 400+)	.64[‡]	.23	1.90 (1.21-2.99)
Field worker referral for immunization	ns		
GEOGRAPHIC AREA			
Area of Zone 3	ns		
-2 log likelihood	737.41		
number of observations	639		
model degrees of freedom	5		

ns: not significant at the 0.05 level; [‡]$p < 0.01$; [§]$p < 0.001$
Note: the category in parenthesis represents the reference category;
the data have been weighted to be representative of Zone 3

APPENDIX 2

Detailed TT Immunization Coverage Data

Table 1. TT Coverage Among the Women of Zone 3

Type of assessment	All women of reproductive age			Among married women who have ever been pregnant			Among women with a child aged less than one year		
	Slum households (n = 2675	Non-slum households (n = 3837)	Total (n = 6527)	Slum households (n = 2199)	Non-slum households (n = 2484)	Total (n = 4694)	Slum households (n = 400)	Non-slum households (n = 303)	Total (n = 707)
Percentage with 0 TT immunization	43.1[§] 42.0-44.2)	51.2[§] (48.6-53.7)	47.8 (43.5-52.0)	33.0[*] (26.9-36.7)	30.3[*] (28.5-32.0)	31.6 (29.1-34.0)	15.8[§] (6.8-24.9)	3.2[§] (1.9-4.8)	10.8 (1.5-19.9)
Percentage with 1 or more	56.9[§] (55.7-58.0)	48.8[§] (46.2-51.4)	52.2 (47.9-56.5)	67.0[*] (63.6-70.4)	69.7[*] (68.0-71.5)	68.4 (66.0-70.9)	84.2[§] (75.1-93.2)	96.8[§] (95.5-98.1)	89.2 (80.1-98.5)
Percentage with 2 or more	50.5[§] (50.0-50.9)	45.2[§] (42.5-47.9)	47.4 (43.7-51.1)	60.3[§] (58.7-61.9)	66.5[§] (64.6-68.4)	63.5 (60.5-66.4)	79.5[§] (71.9-87.2)	94.2[§] (91.5-96.9)	85.4 (76.8-94.0)
Percentage with 5 or more	11.6[*] (8.8-14.4)	11.1[*] (10.7-11.4)	11.3 (9.7-12.9)	14.2[‡] (11.3-17.1)	17.6[‡] (16.8-18.4)	15.9 (15.5-16.3)	14.9[§] (12.2-17.6)	29.2[§] (16.2-42.2)	20.6 (12.3-29.0)

Table 1 (cont.)

Type of assessment	All women of reproductive age			Among married women who have ever been pregnant			Among women with a child aged less than one year		
	Slum households (n = 2675	Non-slum households (n = 3837)	Total (n = 6527)	Slum households (n = 2199)	Non-slum households (n = 2484)	Total (n = 4694)	Slum households (n = 400)	Non-slum households (n = 303)	Total (n = 707)
Average number of TT immunizations	1.8[‡]	1.7[‡]	1.7	2.2[§]	2.5[§]	2.3	2.7[§]	3.4[§]	3.0
Percentage with a TT card	9.4[§]	4.8[§]	6.7	11.4[§]	6.5[§]	8.9	28.3[§]	16.6[§]	23.5

Note: all percentages are weighted, n's are unweighted; 95% confidence intervals are shown in parentheses
[*]$p > 0.05$; [†]$p < .01$; [††]$p < .01$, [§]$p < .001$ (for slum/non-slum comparisons)

Table 2. Bivariate Relationships Between Family Demographic Background Variables and TT2 Coverage Among Mothers With a Child Aged Less Than One Year

Type of family background variable	Percentage of mothers with at least 2 TT immunizations (weighted)	n (unweighted)	Level of statistical significance
Birthplace of mother			
rural	81.6	429	
urban (slum)	82.2	136	
urban (non-slum)	97.4	116	<.001
Mother's age (in years)			
<20	86.0	126	
20-24	88.5	259	
25-29	83.5	201	
30+	78.8	121	>.05
Number of living children mother has			
1	87.0	262	
2	86.8	204	
3+	81.1	241	>.05

Table 2 (cont.)

Type of family background variable	Percentage of mothers with at least 2 TT immunizations (weighted)	n (unweighted)	Level of statistical significance
Mother's education			
none	75.0	286	
1-5 years	92.0	211	
6-10 years	94.0	178	
11+ years	99.1	32	<.001
Length of time mother has been in Dhaka			
0-4 years	78.5	213	
5-14 years	86.8	256	
15+ years	88.9	237	<.05
Mother's marital status			
other (separated, divorced or widowed)	85.3	20	
married	85.0	687	>.05

Table 2 (cont.)

Type of family background variable	Percentage of mothers with at least 2 TT immunizations (weighted)	n (unweighted)	Level of statistical significance
Whether mother works for money (either inside or outside of home)			
yes	79.5	75	
no	85.6	632	>.05
Use of modern contraception by mother			
yes	91.6	239	
no	81.7	468	<.001
Father's occupation			
manual/unskilled	69.2	124	
manual/skilled	85.2	154	
non-manual	89.4	365	<.001

Table 3. Bivariate Relationships Between Family Household Characteristics and TT2 Coverage Among Mothers With a Child Aged Less Than One Year

Type of family household characteristic	Percentage of mothers with at least 2 TT immunizations (weighted)	n (unweighted)	Level of statistical significance
Average monthly income			
0-2499 Tk	79.7	193	
2500-4999 Tk	81.2	254	
5000-7499 Tk	96.4	132	
7500+ TK	89.9	128	<.001
Housing characteristics			
Roof			
tin, bamboo, wood, or jhupri	82.4	459	
pucca	91.9	246	<.01
Wall			
tin, bamboo, wood, or jhupri	90.6	449	
pucca	76.8	258	<.001

Table 3 (cont.)

Type of family household characteristic	Percentage of mothers with at least 2 TT immunizations (weighted)	n (unweighted)	Level of statistical significance
Total number of rooms			
1	81.8	460	
2 or more	91.2	247	<.01
Type of sanitation			
primitive (hanging, open, dug, or no fixed site)	77.9	218	
latrine with no water seal	86.3	313	
latrine with water seal	93.6	176	<.001
Household possessions			
Khat			
no	66.4	58	
yes	86.8	649	<.001
Almirah			
no	71.6	251	
yes	91.8	456	<.001

Table 3 (cont.)

Type of family household characteristic	Percentage of mothers with at least 2 TT immunizations (weighted)	n (unweighted)	Level of statistical significance
Table or chair			
no	78.2	327	
yes	91.1	380	<.001
Radio	79.1	435	
no			
yes	94.1	272	<.001
TV			
no	80.6	469	
yes	94.7	238	<.001
Fridge	84.3	638	
no			
yes	93.7	69	>.05
Household Index score			
< 3	68.9	152	
3-5	85.6	249	
6-8	93.2	179	
9+	95.9	125	<.001

Table 4. **Bivariate Relationships Between Programme and Geographic Characteristics and TT2 Coverage Among Mothers With a Child Aged Less Than One Year of Age**

Characteristic	Percentage of mother with at least 2 TT immunizations (weighted)	n (unweighted)	Level of statistical significance
PROGRAMME CHARACTERISTICS			
Distance to nearest EPI Centre			
400+ meters	79.1	102	
200-399 meters	83.8	352	
<200 meters	88.6	253	<.05
Number of field worker contacts in past year			
0-1	78.0	303	
2+	89.8	404	<.001

Table 4 (cont.)

Characteristic	Percentage of mother with at least 2 TT immunizations (weighted)	n (unweighted)	Level of statistical significance
GEOGRAPHIC CHARACTERISTICS			
Area			
Rayer Bazar Intensive Area	86.4	178	
Lalbagh Intensive Area	84.7	183	
Bakshi Bazar Intensive Area	78.9	181	
Non-intensive Area	85.7	165	>.05
Type of neighbourhood			
predominantly slum	77.9	278	
predominantly non-slum	91.2	429	<.001

Table 5. Estimates of the Effects of Family Background, Family Household, Programme, and Geographic Characteristics on TT2 Coverage Among Women With a Child Aged Less Than One Year

Covariates	Effect on Coverage: Estimated Beta	SE	Odds ratio (95% confidence interval)
Intercept	-.12	.35	
FAMILY BACKGROUND VARIABLES			
Birthplace of mother			
non-slum urban area (versus rural or urban non-slum area)	1.44[†]	.61	4.20 (1.28-13.83)
Mother's age	ns		
Number of living children mother has	ns		
Mother's education			
some (versus none)	1.39[§]	.29	4.00 (2.25-7.09)
Length of time in Dhaka	ns		
Mother employed	ns		
Marital status of mother	ns		
Husband's occupational group	ns		

Table 5 (cont.)

Covariates	Effect on Coverage: Estimated Beta	SE	Odds ratio (95% confidence interval)
FAMILY HOUSEHOLD CHARACTERISTICS			
Household Index	ns		
PROGRAM CHARACTERISTICS			
Distance to nearest EPI Centre			
<400 meters (versus 400+)	.94‡	.33	2.57 (1.34-4.93)
Number of field worker contacts in past year			
2+ (versus <2)	1.53§	.28	4.63 (2.67-8.03)
GEOGRAPHIC AREA			
Area of Zone 3	ns		
-2 log likelihood	389.39		
number of observations	705		
model degrees of freedom	4		

ns: not significant at the 0.05 level; †p <0.05; ‡p <0.01; §p <0.001
Note: the category in parenthesis represents the reference category;
the data have been weighted to be representative of Zone 3

Table 6. Analysis of Interaction Effects Identified in the Multivariate Logistic Regression Model for TT2 Coverage Among Mothers With a Child Aged Less Than One Year

Interaction effect		Percentage of mothers with at least 2 TT immunizations (weighted)		Percentage difference
Educational level and number of field worker contacts	number of field worker contacts in previous year	mother has some education (n = 368)	mother has no education (n = 282)	
	2+ (n = 386)	94.2	87.4	6.8†
	0-1 (n = 264)	92.3	56.8	35.5§
	percentage difference	1.9*	30.6§	
Educational level and distance from nearest EPI centre	distance	mother has some education (n = 373)	mother has no education (n = 302)	
	< 400 m (n = 576)	94.9	75.4	19.5§
	400+ m (n = 99)	81.3	77.3	4.0*
	percentage difference	13.6†	-1.9*	

*p > 0.05; †p < 0.05; §p < 0.001

Table 7. Bivariate Relationships Between Family Demographic Background Variables and Access to TT Immunizations Among Women of Reproductive Age

Type of family background variable	Percentage of women who had received at least one TT immunization during the reproductive years (weighted)	n (unweighted)	Level of statistical significance
Birthplace of woman			
urban (slum)	42.2	1642	
rural	55.9	3228	
urban (non-slum)	54.9	1359	<.001
Woman's age			
15-19	28.1	1521	
20-24	65.5	1486	
25-29	74.2	1309	
30+	48.3	2211	<.001
Number of living children woman has			
0	18.4	2159	
1	81.4	1241	
2	76.5	1243	
3+	58.7	1884	<.001

Table 7 (cont.)

Type of family background variable	Percentage of women who had received at least one TT immunization during the reproductive years (weighted)	n (unweighted)	Level of statistical significance
(among only currently married women)			
0	31.3	2159	
1	84.1	1241	
2	78.2	1243	
3+	61.3	1884	<.001
Woman's education			
none	51.9	2453	
1-5 years	57.0	1692	
6-10 years	49.1	1850	
11+ years	50.7	532	<.001
Length of time woman has been in Dhaka			
0-4 years	52.6	1529	
5-14 years	58.9	2689	
15+ years	50.0	2118	<.001

Table 7 (cont.)

Type of family background variable	Percentage of women who had received at least one TT immunization during the reproductive years (weighted)	n (unweighted)	Level of statistical significance
Woman's marital status			
never married	11.6	1441	
married	67.0	4613	
other (separated, divorced or widowed)	39.4	473	<.001
Whether woman works for money (either inside or outside of home)			
yes	45.3	1218	
no	54.1	5309	<.001
Husband's occupation (analysis limited to currently married women)			
unemployed	51.0	120	
manual/unskilled	61.6	720	
manual/skilled	69.5	930	
non-manual	70.0	2496	<.001

Table 8. Bivariate Relationships Between Family Household Characteristics and Access to TT Immunizations Among Women of Reproductive Age

Type of family household characteristic	Percentage of women who had received at least one TT immunization during the reproductive years (weighted)	n (unweighted)	Level of statistical significance
Average monthly income			
0-2499 Tk	57.3	1453	
2500-4999 Tk	54.9	2014	
5000-7499 Tk	52.4	1289	
7500+ TK	44.6	1771	<.001
Housing characteristics			
Roof			
tin, bamboo, wood, or jhupri	53.8	3635	
pucca	50.1	2877	<.01
Wall			
tin, bamboo, wood, or jhupri	56.7	1678	
pucca	50.5	4849	<.001

Table 8 (cont.)

Type of family household characteristic	Percentage of women who had received at least one TT immunization during the reproductive years (weighted)	n (unweighted)	Level of statistical significance
Total number of rooms			
1	58.8	3283	
2 or more	45.2	3232	<.001
Type of sanitation			
primitive (hanging, open, dug, or no fixed site)	55.3	1695	
latrine/no water seal	53.5	2520	
latrine/water seal	49.1	2300	<.001
Household possessions			
Khat			
no	54.8	410	
yes	52.1	6105	>.05
Almirah			
no	57.0	1577	
yes	50.9	4938	<.001

Table 8 (cont.)

Type of family household characteristic	Percentage of women who had received at least one TT immunization during the reproductive years (weighted)	n (unweighted)	Level of statistical significance
Table or chair			
no	57.3	2154	
yes	50.1	4361	<.001
Radio			
no	53.7	3219	
yes	50.8	3296	<.05
TV			
no	56.3	3470	
yes	47.5	3045	<.001
Fridge			
no	54.1	5245	
yes	44.8	1270	<.001
Household Index score			
< 3	55.9	987	
3-5	57.5	1688	
6-8	52.1	1855	
9+	46.0	1982	<.001

Table 9. Bivariate Relationships Between Programme and Geographic Characteristics and Access to TT Immunizations Among Women of Reproductive Age

Characteristic	Percentage of women who had received at least one TT immunization during the reproductive years, (weighted)	n (unweighted)	Level of statistical significance
PROGRAMME CHARACTERISTICS			
Distance to nearest EPI Centre			
400+ meters	53.0	907	
<400 meters	52.1	5605	>.05
Number of field worker contacts in past year			
0	30.1	2808	
1	58.0	1083	
2	70.8	802	
3+	76.8	1746	<.001
(among only currently married women)			
0	56.4	1005	
1	55.4	1060	
2	73.7	837	
3+	75.8	1711	<.001

Table 9 (cont.)

Characteristic	Percentage of women who had received at least one TT immunization during the reproductive years (weighted)	n (unweighted)	Level of statistical significance
GEOGRAPHIC CHARACTERISTICS			
Area			
Rayer Bazar Intensive Area	54.1	1479	
Lalbagh Intensive Area	51.8	1775	
Bakshi Bazar Intensive Area	54.0	1592	
Non-intensive Area	51.8	1666	>.05
Type of neighbourhood			
predominantly slum	56.0	1940	
predominantly non-slum	50.3	4572	<.001

Table 10. Estimates of the Effects of Family Background, Family Household, Programme and Geographic Characteristics on Access to TT Immunizations Among Women of Reproductive Age

Covariates	Effect on Access		
	Estimated Beta	SE	Odds ratio (95% confidence interval)
Intercept	-3.29	.12	
FAMILY BACKGROUND VARIABLES			
Birthplace of woman	ns		
Woman's age			
15-19 (versus 30+)	0.61[§]	.09	1.85 (1.54-2.20)
20-29 (versus 30+)	1.32[§]	.07	3.75 (3.26-4.29)
Woman's education			
1-5 years (versus none)	0.35[§]	.08	1.42 (1.21-1.66)
6+ years (versus none)	.50[§]	.07	1.64 (1.44-1.89)
Length of time in Dhaka	ns		
Woman's marital status			
currently married (versus never married)	2.68[§]	.11	14.63 (11.76-18.09)
separated, divorced, or widowed (versus never married)	2.25[§]	.14	9.47 (7.21-12.48)
Woman's employment status	ns		

Table 10 (cont.)

Covariates	Effect on Access: Estimated Beta	SE	Odds ratio (95% confidence interval)
FAMILY HOUSEHOLD CHARACTERISTICS			
Slum versus non-slum household	ns		
PROGRAM CHARACTERISTICS			
Distance to nearest EPI Centre	ns		
Number of field worker contacts in past year			
2+ (versus 0-1)	.86[5]	.07	2.37 (2.06-2.71)
GEOGRAPHIC AREA			
Area of Zone 3	ns		
-2 log likelihood	6746.74		
number of observations	6527		
model degrees of freedom	7		

ns: not significant at the 0.05 level; [1]$p < 0.05$; [2]$p < 0.01$; [5]$p < 0.001$
Note: the category in parenthesis represents the reference category; the data have been weighted to be representative of Zone 3

Table 11. Analysis of Interaction Effects Identified in the Multivariate Logistic Regression Model for Access to TT Immunizations

Interaction effect		Percentage of women who had received at least one TT immunization during the reproductive years (weighted)			
Woman's education and woman's age	Woman's age	Woman's education			Statistical significance
		0 years (n = 2480)	1-5 years (n = 1547)	6+ years (n = 2411)	
	15-19 years (n = 1548)	28.8	37.1	22.1	§
	20-29 years (n = 2664)	73.8	76.2	62.3	§
	30+ years (n = 2227)	41.7	50.9	59.4	§
	statistical significance	§	§	§	

Table 11 (cont.)

Interaction effect		Percentage of women who had received at least one TT immunization during the reproductive years (weighted)			
		Marital status			
Marital status and woman's education	Woman's education	Never married (n = 1458)	Currently married (n = 4464)	Separated, divorced, or widowed (n = 517)	Statistical significance
	0 years (n = 2480)	3.6	60.6	36.4	§
	1-5 years (n = 1547)	8.0	71.1	41.4	§
	6+ years (n = 2411)	14.8	72.1	51.9	§
	statistical significance	§	§		

Table 11 (cont.)

Interaction effect		Percentage of women who had received at least one TT immunization during the reproductive years (weighted)			
Number of field worker visits and woman's age	Woman's age	Number of field worker visits 0-1 (n=3891)	2+ (n=2547)	Difference	Statistical significance
	15-19 (n= 1548)	21.5	75.2	53.7	§
	20-29 (n=2664)	51.0	89.4	38.4	§
	30+ (n=2227)	39.8	57.5	17.7	§
	statistical significance	§	§		

Table 11 (cont.)

Interaction effect		Percentage of women who had received at least one TT immunization during the reproductive years (weighted)			
Number of field worker visits and woman's age	Woman's age	Number of field worker visits			Statistical significance
		0-1 (n = 1949)	2+ (n = 2515)	Difference	
(analysis limited to married women)	15-19 (n = 515)	53.5	74.5	21.0	§
	20-29 (n = 2091)	69.7	89.4	19.7	§
	30+ (n = 1858)	44.4	57.8	13.4	§
	statistical significance	§	§		

*p > 0.05; §p < 0.001

APPENDIX 3

Issues in Defining Slum Versus Non-slum Households

The original sampling frame developed in 1994 for the Urban Panel Survey classified Zone 3 into neighbourhoods which were predominantly either "slum" or "non-slum." The following three criteria were required for a neighbourhood to be classified as a slum:

1. predominantly poor housing;
2. very high-housing density; and
3. poor sewerage and drainage.

"Poor housing" was defined as a shack, a flimsy ("kutcha") structure, or an old building in bad condition. A high-housing density was defined as more than 300 persons per acre or more than three adults per room. Poor sewerage and drainage were defined as inadequate water supply, irregular or no clearance of garbage, few or no paved streets, insufficient or absent street lighting, and little or no access to natural gas. This is the same definition as the one which was used in a 1991 ICDDR,B survey of slums located throughout the Dhaka Metropolitan Area (38).

According to the sampling strategy worked out for the Urban Panel Survey, Zone 3 was divided into three Intensive Areas for testing MCH-FP interventions and a control Non-Intensive Area. Each of these four areas were then divided into Primary Sampling Units which were predominantly slum or predominantly non-slum neighbourhoods. From these eight strata, clusters of approximately 40 households were selected using a varying sampling probability, so that approximately 700 slum households (that is households located in a predominantly slum neighborhood) and 1,000 non-slum households in each of the four Areas would be included in the final sample.

The analytical problem which arises here is that the slum neighbourhoods include some households which are not slum households, while the non-slum clusters include some slum households. Small pockets of slum households with 10-20 families are not uncommon.

There are three choices available for defining the slum/non-slum status of a mother or child:

1. by its location in a slum or non-slum "neighbourhood" (according to the initial mapping exercise carried out in 1994 for the Urban Panel Survey),
2. by a single household characteristic (such as a roof made of non-permanent material), or
3. by a composite index of household characteristics, such as the Household Index score, described in the Methods section.

The correspondence between these three classification criteria is substantial, with the three correlation coefficients ranging between 0.52 and 0.65.

Households with an index score of less than six were defined as slum households for our analysis on the basis of the findings in Tables 1 and 2: as the Household Index score rises above five, the percentage of households with a non-pucca roof, only one room, and no modern toilet begins to decline rapidly, while for households with a score of five or less almost none have a roof of permanent material, more than one room, or modern toilet facilities.

Compared to the slum/non-slum status as determined by neighbourhood characteristics, the slum/non-slum status based on Household Index score yields a higher percentage of slum households with a less-favourable housing characteristic for eight of the 10 characteristics analyzed. Also, the percentage of non-slum households (as defined by the Housing Index score) with a less-favorable housing characteristic is lower in all cases when compared to slum/non-slum percentages as determined on the basis of neighbourhood characteristics (Table 2).

The dichotomous classification based on the Household Index score correctly predicts the slum/non-slum status (as defined by neighbourhood characteristics) in 81% of the cases, and it correctly predicts the slum/non-slum status (as defined by whether the roof is composed of non-permanent or permanent material) of 82% of the households (calculations not shown).

Table 3 compares the favourableness of three housing characteristics by slum/non-slum status using the different three methods of classifying households as slum or non-slum. For the three characteristics selected (type of roof, number of rooms, and type of sanitation), the Household Index score classification more accurately classifies households by slum and non-slum status than does the neighbourhood classification scheme or the type of roof. Thus, the Household Index score appears to be a better overall predictor of slum household status than does the type of neighbourhood or type of roof.

Another advantage of using the Household Index score of <6 as the definition of a slum household is that it maximizes the slum/non-slum differential in childhood immunization coverage and therefore serves to highlight even further the important effect of slum status on immunization coverage. As Table 4 indicates, the percentage difference in childhood immunization coverage among the slum and non-slum households is greatest when the classification scheme is based on the Household Index score.

Table 1. Housing Characteristics According to Household Index Score

	Percentage of houses with the housing characteristic*											
	Household Index score*											
Housing characteristic	0 (n = 28)	1 (n = 65)	2 (n = 71)	3 (n = 77)	4 (n = 58)	5 (n = 58)	6 (n = 60)	7 (n = 45)	8 (n = 51)	9 (n = 23)	10 (n = 30)	11 (n = 56)
Non-pucca roof	100	100	99	97	94	88	58	72	40	25	14	0
Non-pucca wall	100	99	76	77	38	22	4	2	2	0	0	0
Only 1 room	100	99	93	86	74	91	78	58	27	28	0	0
No toilet**	100	100	100	91	93	98	67	72	52	43	11	0
No khat	100	8	21	3	6	0	0	0	0	0	0	0
No table or chair	100	65	95	71	69	29	16	7	0	0	0	0
No almirah	100	99	67	63	26	7	13	0	0	0	0	0
No radio	100	95	80	62	61	60	71	27	46	5	1	0
No TV	100	100	100	95	94	69	79	43	35	4	2	0
No fridge	100	100	100	100	100	100	100	100	92	88	70	0

*The households in this analysis are those which have a child aged 12-23 months;
** Either no sanitation whatsoever or a latrine without a water seal

Table 2. Characteristics of Slum and Non-Slum Households as Defined by Household Index Score and by Neighbourhood Type

	Percentage of households with the particular housing characteristic*			
	Household Index score		Neighbourhood type	
Housing characteristic	<6 (n=358)	6+ (n=265)	Predominantly slum (n=298)	Predominantly non-slum (n=325)
Non-pucca roof	96	37	96	48
Non-pucca wall	67	2	69	13
Only 1 room	90	33	84	50
No toilet**	97	42	96	53
No khat	15	0	14	4
No table or chair	76	5	71	23
No almirah	58	3	55	17
No radio	74	30	69	43
No TV	93	33	86	50
No fridge	100	73	99	79

*The households in this analysis are those which have a child aged 12-23 months.
**Either no sanitation whatsoever or a latrine without a water seal.

Table 3. Comparison of Classification of Households as Slum or Non-Slum by Different Criteria*

Slum/non-slum classification procedure	Percentage of households with non-permanent roof	Percentage of households with only 1 room	Percentage of households with no modern sanitation**
By Household Index score			
HHI < 6 (n = 358)	96.3	89.8	96.6
HHI 6 + (n = 265)	36.7	35.2	42.4
By neighbourhood			
predominantly slum neighbourhood (n = 298)	95.7	84.5	96.0
predominantly non-slum neighbourhood (n = 325)	48.1	50.3	53.0
By type of roof			
non-permanent material (n = 442)	100.0	90.1	79.6
permanent material (n = 181)	0.0	35.7	34.8

*The households in this analysis are those which have a child aged 12-23 months.
** Either no sanitation whatsoever or a latrine without a water seal.

Table 4. Complete EPI Coverage Among 12-23-Month-Old Children by Various Criteria for Defining Slum/Non-Slum Status

Slum/non-slum classification procedure	Percentage with complete EPI coverage	Slum/non-slum difference
By Household Index score		
HHI <6 (n=358)	38.3	
HHI 6+ (n=265)	69.0	
slum/non slum difference		30.7
By neighbourhood		
predominantly slum neighbourhood (n=298)	42.0	
predominantly non-slum neighbourhood (n=325)	59.9	
slum/non-slum difference		17.9
By type of roof		
non-permanent material (n=442)	44.0	
permanent material (n=181)	69.3	
slum/non-slum difference		25.3

APPENDIX 4

Effects of WHO Standards on Childhood EPI Coverage Calculations

As mentioned in the Methods section, coverage was calculated after disqualifying those immunizations which were not given at the proper ages or according to the intervals specified by the World Health Organization (WHO). Here, we will provide a brief discussion of the effects of this "correction factor" on the overall childhood immunization coverage.

First of all, if no correction factor had been incorporated into the analysis, the overall coverage would have been 61.8% rather than the 51.3% which we have reported here. Seventeen per cent (65/385) of the fully vaccinated children (regardless of the validity of the immunization as determined from the available dates of the immunization) had either received an immunization at an earlier age than specified by WHO criteria or had obtained a second or third dose of DPT or OPV less than four weeks after the previous dose. These findings do not differ greatly among children whose mothers did not have an immunization card compared to mothers who had one (Table 1) although, of course, the overall coverage rate among those children whose mothers did not have an immunization card is considerably lower than among those with cards.

Table 1. Comparison of Calculated Coverage Rates With and Without WHO Age Criteria Among Those With and Without Cards

Complete coverage rate	Calculated without applying WHO criteria ("crude" coverage)	Calculated using WHO criteria ("corrected" coverage)	Percentage of "crude" coverage which is "correct"
Among children whose mother had an immunization card (n=330)	76.5% (253/330)	65.7% (217/330)	85.8% (217/252)
Among children whose mother did not have an immunization card (n=294)	45.2% (133/294)	35.0% (103/294)	77.4% (103/133)
Among all children (n=624)	61.8% (385/624)	51.3% (320/624)	83.1% (320/385)

When the "corrected" coverage is compared to the "crude" coverage for each specific antigen and when these data are compared among those with and with EPI cards, the findings, as shown in Table 2, indicate that there are no notable differences between those with and those without cards regarding the percentages of invalid immunizations.

Table 2. Percent of Immunizations Given at the Appropriate Time According to WHO Criteria

Immunization	Child has card	Child does not have card	All children combined
BCG	100.0 (n = 330)	100.0 (n = 202)	100.0 (n = 532)
DPT1	94.6 (n = 330)	95.5 (n = 202)	95.0 (n = 532)
OPV1	94.7 (n = 330)	95.5 (n = 199)	95.0 (n = 529)
DPT2	99.2 (n = 314)	97.4 (n = 188)	98.5 (n = 502)
OPV2	99.1 (n = 314)	97.8 (n = 181)	98.6 (n = 487)
DPT3	99.2 (n = 285)	98.9 (n = 163)	99.1 (n = 448)
OPV3	99.0 (n = 285)	96.9 (n-156)	98.3 (n = 441)
measles	89.2 (n = 256)	87.3 (n = 143)	88.5 (n = 400)

Most EPI coverage surveys use COSAS software for calculating coverage. The COSAS calculation of coverage involves ignoring the dates of childhood immunization given by mothers who do not have immunization cards. The COSAS programme than computes a correction factor based on the percentage of immunizations which are invalid as determined from the immunization dates given on the cards, and then applies this correction factor to the remainder of the children whose mother said that they had received the particular antigen but no card was available for review. This procedure yields an overall coverage of 53.0% which is virtually the same as the level of 51.3% obtained by using the dates given by mothers who did not have cards.

APPENDIX 5

Further Analyses of Relationship Between Distance to Nearest EPI Centre and Coverage Depending on Level of Field Worker Contact

In exploring the question of whether more frequent field worker visits might offset the disadvantages conveyed by greater distance from the closest EPI centre, Tables 1 and 2 show that as the number of field worker visits increases, the negative effect of distance from the nearest EPI centre on both childhood immunization and maternal TT2 immunization is nearly eliminated.

Table 1. Childhood Immunization Coverage by Distance From Nearest EPI Centre and Level of Field Worker Contact

	Childhood immunization coverage		
Number of field worker contacts in previous year	Distance to nearest EPI centre <400 meters (n=510)	Distance to nearest EPI centre 400+ meters (n=113)	Percentage difference
3-4 (n=234)	65.7	59.5	6.2*
0-2 (284)	48.5	36.1	12.4*
Percentage difference	17.2§	23.4*	

note: The analysis is limited to children aged 12-23 months whose mothers reported 0-4 field worker contacts
$p > 0.05$; †$p < 0.05$; ‡$p < 0.01$; §$p < 0.001$

Table 2. Maternal TT2 Immunization Coverage by Distance From Nearest EPI Centre and Level of Field Worker Contact

	Maternal TT2 immunization coverage		
Number of field worker contacts in previous year	Distance to nearest EPI centre <400 metres (n=576)	Distance to nearest EPI centre 400+ metres (n=99)	Percentage difference
2+ (n=333)	91.1	87.7	3.4*
0-1 (n=243)	80.4	58.9	21.5*
Percentage difference	10.7§	28.8‡	

Note: The analysis is limited to mothers with a child aged less than one year, and coverage is defined as receipt of at least 2 TT immunizations
*p >0.05; ‡p<0.01; §p<0.001

MCH-FP Extension Work at the Centre

An important lesson learned from the Matlab MCH-FP project is that a high CPR is attainable in a poor socioeconomic setting. The MCH-FP Extension Project (Rural) began in 1982 in two rural areas with funding from USAID to examine how elements of the Matlab programme could be transferred to Bangladesh's national family planning programme. In its first years, the Extension Project set out to replicate workplans, record-keeping and supervision, within the resource constraints of the government programme.

During 1986-89, the Centre helped the national programme to plan and implement recruitment and training, and ensure the integrity of the hiring process for an effective expansion of the work force of governmental Family Welfare Assistants. Other successful programme strategies scaled up or in the process of being scaled up to the national programme include doorstep delivery of injectable contraceptives, management action to improve quality of care, a management information system, and developing strategies to deal with problems encountered in collaborative work with local area family planning officials. In 1994, this project started family planning initiatives in Chittagong, the lowest performing division in the country.

In 1994, the Centre began an MCH-FP Extension Project (Urban) in Dhaka (based on its decade long experience in urban health) to provide a coordinated, cost-effective and replicable system of delivering MCH-FP services for Dhaka urban population. This important event marked an expansion of the Centre's capacity to test interventions in both urban and rural settings. The urban and rural extension projects have both generated a wealth of research data and published papers.

The Centre and USAID, in consultation with the government through the project's National Steering Committees, concluded an agreement for new rural and urban Extension Projects for the period 1993-97. Salient features include:

- To improve management, quality of care and sustainability of the MCH-FP programmes
- Field sites to use as "policy laboratories"
- Close collaboration with central and field level government officers
- Intensive data collection and analysis to assess the impact
- Technical assistance to GoB and NGO partners in the application of research findings to strengthen MCH-FP services.

The Division

The reconstituted Health and Population Extension Division (HPED) has the primary mandate to conduct operations research to scale up the research findings, provide technical assistance to NGOs and GoB to strengthen the national health and family planning programme.

The Division has a long history of accomplishments in applied research which focuses on the application of simple, effective, appropriate and accessible health and family planning technologies to improve the health and well-being of the underserved and population-in-need. There are several projects in the Division which specialize in operations research in health, family planning, environmental health and epidemic control measures which cuts across several Divisions and disciplines in the Centre. The MCH-FP Extension Project (Rural), of course, is the Centre's established operations research project but the recent addition of its urban counterpart - MCH-FP Extension Project (Urban), as well as Environmental Health and Epidemic Control Programmes have enriched the Division with a strong group of diverse expertise and disciplines to enlarge and consolidate its operations research activities. There are several distinctive characteristics of these endeavors in relation to health services and policy research. First, the public health research activities of these Projects focus on improving programme performances which has policy implications at the national level and lessons for international audience. Secondly, these Projects incorporate the full cycle of conducting applied programmatic and policy relevant research in actual GoB and NGO service delivery infrastructures; dissemination of research findings to the highest levels of policy makers as well as recipients of the services at the community level; application of research findings to improve programme performance through systematic provision of technical assistance; and scaling-up of applicable findings from pilot phase to the national programme at Thana, Ward, District and Zonal levels both in the urban and rural settings.

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