Simultaneity in maternal-child health care utilization and contraceptive use: Evidence from developing countries

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ABSTRACT

This study examines the synergistic relationship between the utilization of maternal-child health (MCH) care and contraceptive use, and the causal mechanism that operates at individual and household levels facilitating joint determination of these interventions. Although conceptualizing a relationship between contraceptive use and utilization of health services is easy, testing statistically the simultaneity in the relationship is difficult. The high correlation between the use of contraceptives and MCH interventions may be due to the independent effect of one on the other or it may be due to an association of both with the same or similar background factors. Latent class structural equation models are used to examine the relationship between these two interventions, controlling for endogeneity. The study addresses some methodological issues in analyzing binary outcome variables with endogeneity. The data for this study are derived from six Demographic and Health Surveys (DHS): Zimbabwe from Sub-Saharan Africa, Thailand from Asia, Egypt and Tunisia from North Africa, and Guatemala and Colombia from Latin America. The results show that in all the six study countries contraceptive use and MCH care utilization are directly and significantly associated, independent of intervening factors, suggesting that families develop a joint demand for quality of health and for fewer children and translate these demands into action by utilizing health services for mothers and for children, and by voluntary fertility regulation. These findings provide evidence of the importance of integrating family planning and MCH services and address important programmatic issues.

INTRODUCTION

Since the advent of the classical demographic transition theory, the relationship between infant mortality and fertility has been widely studied. A general consensus developed that changes in fertility behavior can alter survival chances among infants and children, and similarly, reduction in infant mortality leads to fertility decline. Empirical studies show that the estimated negative correlation between family planning use and infant mortality is extremely high (Caldwell, 1986). There is growing evidence that the socioeconomic and proximate factors that are responsible for changes in fertility are also responsible for changes in child mortality. Studies have shown that acceptors of contraceptives are more likely to be users of maternal and child health services like prenatal care, delivery care by trained health personnel and at institutional facilities, immunization and oral rehydration therapy(ORS) (Warren et al., 1987); correspondingly, women who use maternal and child health services are more likely to use contraceptions (Monteith et. al., 1987).

The high correlation between the use of contraceptives and maternal-child health(MCH) services may be due to the independent effect of one on the other (Wilopo and Mosley, 1992) or it may be due to an association of both with the same or similar background factors (Winikoff, 1988). This study specifically attempts to elaborate on the direction of the causal relationship between the utilization of MCH and family planning interventions -- does the use of prenatal care, delivery care by professional health personnel and at institutional facilities, immunization for children and herself independently influence the use of contraceptives and vice versa? Or, are the observed high correlations between these interventions spurious, meaning that, they do not affect each other independently, but rather through a set of common determinants.

The answer to above questions has important policy implications. If the relation between the two is due to endogeneity, this would imply the importance of integrating family planning programs with the MCH service. On the other hand, if the relationship is spurious, i.e., the observed high correlation is due to the common association of covariates (e.g., education, economic status, proximity to service facilities, etc) that would imply the importance of enhancing those factors to promote the utilization of these services.

Family planning programs and maternal and child health (MCH) programs are typically operated under or monitored by the ministry of health in the developing countries, but in many instances implemented by separate organizations. Typically, the implementing organizations operate vertically with a set of specific objectives to expedite the outcome in the shortest possible time, independent of administrative collaboration with other intervention programs. The remarkable success of family planning programs in bringing about fertility transition in a relatively short period in certain developing countries without an associated overall economic development is largely attributed to this kind of effort.

The attempt to integrate family planning programs with child health interventions and maternal health care services is not new. Immediately after introduction of family planning programs in developing countries in the late 1960s and early 1970s the need for integration of FP programs was emphasized, first with the health sector and subsequently with overall developmental programs (Taylor and Berelson, 1971; Taylor et al., 1983). The major underlying objective of the integration was to make family planning more acceptable. The secondary objectives were to make the program efficient and cost effective through better utilization of health personnel and health centers (Mosley and Sirageldin, 1987). However, the integration idea was often opposed on the ground that integration would increase the work load of family planning/health workers and reduce the coverage area. Large scale experimental studies were carried in many developing countries to assess the effectiveness of integrating family planning with MCH services and with other health services (e.g., nutrition, malaria eradication, parasitic control programs), as well as with other development activities (e.g., female education, income generation). These studies showed varying results. In Harare, the FP program was integrated with existing hospitals under the assumption that mothers would seek contraceptive methods concurrently with each visit to the hospital with their children. The program resulted in high acceptance of contraceptives with less inconvenience for the mothers (Verkuyl et. al., 1990). In Tunisia, the effectiveness of offering family planning services alone versus offering both family planning and MCH services in rural areas showed that the performance was best where FP program was operating alone only (Population Council, 1993). At times, then, integrated programs have been less successful than desired (Rosenfeld, 1984), especially when this was attempted in settings where the overall government infrastructure was weak.

Although extensive research has been conducted on integration of health and family planning programs since late 1960s, majority of these studies focused on efficiency, efficacy and cost-effectiveness of service delivery, but ignored the behavioral aspects of the acceptors. Only recently has the attempt been made to understand the socioeconomic, behavioral and structural determinants of simultaneity in contraceptive use and health care utilization, as well as, the impact of the service availability on the joint utilization of the intervention programs (Mosley, Wong and Shah, 1988; Stewart and Sommerfelt, 1991; Wilopo and Mosley 1992; Wong and Agarwal, 1992; Agarwal, 1994; Zerai and Tsui, 1995).

Most of the theories concerning determinants of use of contraceptives and of health interventions have treated the two behaviors as independent, ignoring the 'synergism' they may possess -- the use of one may potentiate the acceptance and use of the other. Theories on contraceptive use behavior emphasize a demand-supply paradigm (Becker, 1976, 1960; Easterlin, 1975; Easterlin and Crimmins, 1985), a household decision-making process, a household's maximization of utility, and ideational factors (Cleland and Wilson, 1987). On the other hand, theories on use of preventive health care services build on models of health behavior (predisposing factors, need factors and enabling factors) for understanding the determinants of use (Andersen, 1968). These conceptual frameworks fail to consider the interaction of factors that affect both contraceptive use and maternal-child health care utilization.

Contraceptive behavior reflects the interaction of demand, supply and subjective constraints related to its access (Simmons, 1992). Social, economic and cultural/ideational factors influence the demand-supply dyad and through some decision-making process couples make a "rational" and "conscious choice" to adopt contraception (Coale, 1973). Similarly, use of MCH services reflects the interaction of demand, supply and constraints attached to their access. Through a sequence of steps households (particularly mothers) 'perceive the need' (demand), and utilize the service, a process facilitated by 'enabling factors' (supply). Social, economic and structural elements also influence this decision-making process. Cultural and ideational factors affect health behavior in ways similar to their effect on contraceptive use behavior. This commonness dictates us to posit that the determinants of utilization of intervention programs like contraceptive use and MCH programs operate in a similar fashion at individual and household levels.

From a demographic point of view, little knowledge has been accumulated on how a woman decides *simultaneously* about the utilization of health care, one for the survival of her children and the other for her own fertility control.

This study examines the joint determination of utilizing MCH and family planning interventions at individual and household level, and the influence of societal and structural contexts on utilization behaviors. The contraceptive prevalence and utilization of MCH interventions (e.g., prenatal care, institutional delivery, immunization for pregnant mothers and for children) vary dramatically across the regions and across the countries. Similarly, cultural background, infrastructure and contextual setting of the countries vary significantly. To have a coherent understanding of these complex diversities in health behavior, this study analyzed Demographic and Health Surveys (DHS) conducted during 1986 to 1989 in six developing countries, to examine the simultaneity in use of contraceptives and MCH interventions.

DATA AND METHODS

The data for this study are derived from the six Demographic and Health Surveys (DHS): Zimbabwe from Sub-Saharan Africa, Thailand from Asia, Egypt and Tunisia from North Africa, and Guatemala and Colombia from Latin America -- all of which have individual level information on contraceptive use and utilization of maternal and child health interventions, and cluster level information on service availability.

Although DHS-I phase collected data from 34 countries, only 13 countries have cluster level information on service availability (SA); the SA questionnaire could be matched with individual women respondents at the cluster level in 11 countries. Among four African countries with information on service availability, only Zimbabwe has more than 10 percent of modern contraceptive prevalence. The other three countries (Burundi, Togo and Uganda) are excluded from the present study since a skewed distribution of the outcome variable and the associated sparse covariate matrix will make model parameter estimation unstable. Among Asian countries, only Thailand has information on service availability. Although such information is available from four Latin American countries, two (Ecuador and Dominican Republic) did not collect information on immunization, and were excluded from this study.

This study used the data from both the individual and service availability (SA) surveys, and quality of both was assessed to validate the findings of the present research. The quality of DHS-I data is elaborately discussed elsewhere (IRD, 1990). The analyses in this study are based on both the individual level and SA data related to the use of family planning and MCH interventions so that the relation of the two could be evaluated controlling for the effect of service availability. The cluster level

SA data were matched to each woman by merging with the individual level data. The values of SA data were assigned to all the respondent women of the same cluster. The statistical issues relating to the combining of individual level and cluster level data are discussed elsewhere (Ahmed 1996; Pullum 1991).

Sample Selection Criteria

Women who have at least one child below five years of age are included in this study. The World Health Organization (WHO) recommends completion of immunizations by nine months of age. For this study, only the last child aged above nine months is included, as complete immunization history is more likely to be available for such children. In the DHS, the complete immunization data were only available from women who could show the "health card" for immunization of their children to the survey interviewers. Both of these criteria, possession of health card and age-adequate immunization, may bias the result of the association of contraceptive use with immunization utilization. The children of older age are likely to have completed the immunization and therefore less likely to keep the card at the household, and the reverse is likely for the younger children. This may bias the association of immunization with contraceptive use, as women with a younger child are less likely to use contraceptives. However, as the sample for this study consisted of only women who had children at least nine months of age, we assume bias will be minimum. The sample of this study ranges from 1497 to 1932 women (Table 1). The table also shows the distribution of contraceptive use and MCH care utilization among the study sample, suggesting wide variability in the utilization levels across the selected sampled countries.

- Table 1 -

Analytical Strategy

Statistical models for analyzing relationship between contraceptive use and MCH care utilization

The dependence of use of contraceptives on the use of maternal and child health (MCH) interventions, and vice versa, could be estimated mathematically by the following equations -

$$E(Y_{ij}) = \beta_{10} + \beta_{11}X_{ij} + \beta_{12}W_{ij} + \beta_{13}Z_{ij} + U_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$
$$E(Z_{ijk}) = \beta_{20} + \beta_{21}X_{ij} + \beta_{22}W_{ij} + \beta_{23}Y_{ij} + V_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where Y_{1ij} is the contraceptive use variable, Z_{ij} is a vector of MCH care variables(TT immunization for women, prenatal care, delivery care from health professionals and institutional facilities, and immunization for children) and Z_{ijk} is the value of the k^{th} MCH care utilization related variable for the i^{th} individual in the j^{th} cluster, X_{ij} is a vector of background variables, W_{ij} is a vector of program variables, and U_{ij}, V_{ij} are the error terms for the i^{th} individual in the j^{th} cluster.

Because of the simultaneity in the relationships between the two endogenous variables in the equations (1) and (2), the error terms, U_{ij} and V_{ij}, are correlated with the right-hand endogenous variables, and the usual assumption of independence will be violated if standard regression models are used. Since various methods are available for correcting endogeneity[1], mostly rather complex, we will discuss the choice of analytical methods and the justification for using the particular method applied in this study.

Econometricians use multiple-equation models to describe systems in which variables have simultaneous effects on each other (Heckman 1978). Each equation in the system represents a structural relation, and the system is analyzed by two-stage procedure. Several statistical procedures have been proposed in the literature for correcting endogeneity. Recently, there is a surge of interest in using simultaneous equation models where the limited dependent variables are mutually dependent. Since the publication of the influential book by Maddala (1983) that presented the two-stage probit method for modeling discrete outcomes, and subsequent development of computer software by Greene (1992), the two stage probit model has been extensively used by econometricians, as well, as by sociologists (Guilkey, Bollen and Mroz, 1995). Two other methods that appeared in the literature for estimating structural equation parameters with limited dependent variables are Full Information Maximum Likelihood (FIML) method and Generalized Method of Moments (GMM) method. After comparing these three most employed methods, Guilkey et al. (1995) recommended two-stage probit model for analyzing discrete outcomes with endogenous explanatory variables. However, the efficiency of the method has been questioned. The estimation of the two stage probit method follows from the method proposed by Amemiya (1979), based on work by Nelson and Olson (1978). In the same work, Amemiya (1979) suggested that Generalized Least Square (GLS) estimates are more efficient than two-stage probit models. Another limitation is that two-stage probit model cannot handle more than two endogenous variables simultaneously. Considering all these, we applied Latent Class Structural Equation models. The reasons for selecting the latent class structural equation models are explained below:

In this study we have hypothesized that two sets of outcome variables, contraceptive use (CONTUSE) and use of MCH interventions (MCHUSE), are interrelated and simultaneously determined (simultaneity). It is postulated that the two variables are simultaneously related, independent of common determinants, and are endogenously determined by certain exogenous variables (covariates). It is further conceptualized that CONTUSE and MCHUSE are latent variables because we cannot measure (or observe) them directly, but observe through a set of related variables. The CONTUSE variable is observed by two proxy variables: current contraceptive use and past contraceptive use (before the birth of the index child). Similarly, the latent variable MCHUSE consists of five variables: prenatal TT use, prenatal care and delivery care by trained health personnel, and DPT-3 immunization use. The relationship is shown graphically in Fig. 1. In this study we used the general structural system, commonly known as LISREL (LInear Structural RELations) models, for estimating simultaneous equations.

- Fig. 1 -

In LISREL standard notation (Joreskog and Sorbom, 1989), the latent endogenous variables are designated by η_i and latent exogenous variables by ξ_i for the i^{th} individual. Let CONTUSE be η_{i1} and MCHUSE be η_{i2}. According to our model, the latent variables are modeled as -

$$\eta_{i1} = \beta_{12}\eta_{i2} + \gamma_{11}\xi_{i1} + \ldots\ldots + \gamma_{1p}\xi_{ip} + \zeta_{i1}$$
$$\eta_{i2} = \beta_{21}\eta_{i1} + \gamma_{21}\xi_{i1} + \ldots\ldots + \gamma_{2p}\xi_{ip} + \zeta_{i2}$$

With the above two equations, the simultaneity exists between the two latent endogenous variables, i.e., both η_{i1} and η_{i2} are explained partially by each other, for the *I*-th individual. The random errors, ζ_{ij} 's are unexplained component of the latent models, and have expected values of zero and are uncorrelated with the exogenous variables, ξ_{ik}'s, where j=1,2 and k=1,2,3,...,p. The constant terms are absent from the equations because the variables are deviating from their means. The β_{12} is the coefficient of the structural parameter that indicates the changes in the expected values of η_1, after a one unit increases in η_2, keeping ξ variables constant at their means *(ceteris paribus)*. Similarly, the parameter β_{21} indicates the influence of η_1 on η_2. The variable ξ's have similar interpretations. The β_{12} and β_{21} coefficients are associated with latent endogenous variables, and ξ's are associated with exogenous latent variables.

The construction of latent variables is justified for several reasons: (i) instead of dealing with multiple variables separately, we deal with a single construct; (ii) interpretations of the results are easier, because we deal with fewer variables; (iii) the result shows the group behavior, rather than that of a single entity. For example, the association between contraceptive use and one of the MCH care variables (or with all) may be weak, but together MCH care variables may have rather a stronger relationship. If the analyses are done separately, the relationship could not be discovered in such circumstances.

Measurement Issues of Structural Equations

Estimation method

Classically, the LISREL model solves the sets of structural equations by maximum likelihood (ML) method, particularly where both the observed and latent variables are assumed to be measured on a quantitative scale. However, when the assumption of normality is violated as a result of categorical variable(s) in the model, the ML method produces inefficient estimates. The issue of handling categorical/ordinal variables in the LISREL model is complex. In practice, as is the case with this study, categorical variables are commonly included in the model. Therefore, the problem of handling categorical variables in LISREL is discussed elaborately below.

Issues of categorical/ordinal variables in the LISREL model

In LISREL, generally, it is assumed that the observed and latent variables are continuous, at least approximately. However, in practice, the models frequently contain categorical or ordinal variables. The use of estimation by maximum likelihood methods in these cases yields biased parameter estimates and standard errors, and an incorrect X^2 as a measure of goodness-of-fit for the model, particularly when the estimation is based on product-moment (Pearson's) correlation matrix. To correct this problem and to estimate asymptotically efficient estimates, many methods have been proposed (Bollen, 1989). We have adopted the method as proposed by Joreskog (1986). In this method the correlations among the observed variables are measured by polychoric correlation (when both the variables are categorical) and by polyserial correlation (when one of the variables is categorical, and the other is continuous), instead of Pearson's correlation. A special case of correlation is called tetrachoric correlation when both of the variables are bernoulli. The polychoric and polyserial correlations are not the correlations computed from the actual scores but from theoretical correlations underlying the estimated variables. These correlations are estimated by maximum likelihood methods through iterations, where an underlying bivariate normal distribution is assumed.

As discussed earlier, the ML estimation, even with polychoric or polyserial correlations, does not yield efficient estimates. With categorical variables in the model, the estimation by Weighted Least Square (WLS) produces asymptotically correct estimates. The WLS method is considered as the "asymptotically distribution free best estimators" (Browne, 1984). In this method the inverse of the asymptotic covariance matrix of polyserial estimates are supplied as the weight for least square estimates. In this study, we have applied the WLS method for solving LISREL equations with polyserial and tetrachoric correlations.

Issues of identification

One important problem of structural equations is to determine if the parameters of interest are uniquely identified by the observed response. If the parameters are uniquely determined within the true parameter values, then they are termed identifiable. One necessary condition for a structural model to be identifiable is that the number of unique parameters must be less than the number of unique responses. To make all the important parameters identified, we imposed zero restrictions on certain coefficients (constrained to be equal to zero) considered insignificant statistically.

Testing for hypotheses

We have hypothesized that the observed relationship between contraceptive use and MCH care utilization is independent of covariates, i.e., not mediated through a set of covariates as common cause (hypothesis H1), and the acceptance of one intervention influences the adoption of the other interventions (hypotheses H2 for the influence of contraceptive use on MCH care utilization, and H3 for the reverse), and the directions of influence are reciprocal, rather a one-way or none(hypothesis H4).

The hypothesis H1 is equivalent to specifying that the correlation between contraceptive use (η_1) and utilization of MCH services (η_2) after elimination of ξ_i effects is not zero. To examine this hypothesis we fitted LISREL model with B=0, and estimated the covariance between η_1 and η_2 by estimating ψ_{21}. We reject the null hypothesis of spurious correlation, if the value of ψ_{21} is significantly (statistically) away from zero. The correlation between η_1 and η_2 is estimated by $\psi_{21}/(\psi_{11}\psi_{22})^{1/2}$. The results are shown in the model I of the structural equation tables (shown later).

In hypotheses H2 and H2, we considered that ζ_1 and ζ_2 are uncorrelated, and the correlation between η_1 and η_2 is accounted for by the direct causal relationship. The effect of η_2 on η_1 is measured by β_{12} and the effect of η_1 and η_2 is measured by β_{21}. The hypotheses will be tested by examining the β_{12} and β_{21} to see whether they deviate significantly (statistically) from zero. The hypotheses H2 and H3 are tested in the model II and model III, respectively.

In hypothesis H4 we hypothesized the reciprocal causal relationship between η_1 and η_2. To make models with reciprocal causation identified, one must exclude at least one exogenous variable ξ_i from each equation. It is best to exclude the variable that had least significant effect in the previous analyses. We will drop at least one variable from each equation by imposing zero restrictions during model estimation. The hypothesis will be tested to see whether β_{12} and β_{21} are significantly away from zero. We further imposed the restriction that $\beta_{12} = \beta_{21}$, as required for testing the reciprocity of η_1 and η_2 effects.

RESULTS

Table 2 shows the characteristics of the respondents, the households, the communities and the services in the six study countries. For Thailand and Egypt the data were available from rural areas only. In other four countries the result shows significant differences in the distribution of characteristics between urban and rural areas. Because of this variablility, we analyzed the data separately for urban and rural areas. From the household characteristics we constructed two composite variables: *healthy household* from drinking water and toilet facility, and *economic status* from possessions of the households.

- Table 2 -

Results of Structural Equation Model

The latent endogenous variable contraceptive use (CONTUSE) is constructed by two directly observed y-variables, current contraceptive use and past contraceptive use before the birth of the index children in all the countries, except Zimbabwe. In the case of Zimbabwe where data are not available on past contraceptive use, the latent variable contraceptive use is directly observed by current contraceptive use without any associated error. The latent endogenous variable MCH care utilization (MCHUSE) is constructed by four y-variables: use of TT during the pregnancy of the index child, prenatal and delivery care from trained health personnel, and DPT-3 immunization for the index children. In case of, selected variables are included one of the between any of these variables, The exceptions are rural areas of Zimbabwe, urban areas of Tunisia and Colombia that show high multicollinearity among the MCH variables; the variables with high multicollinearity are dropped.

All the latent exogenous variables are directly observed without any associated error, except service availability indices. The latent exogenous variable *service availability* is country specific and usually constructed with (i) distance of health facilities from the center of clusters, (ii) availability of CBD programs and mobile clinics in the clusters, and (iii) field workers visit of households. The exceptions are noted later. The availability of trained traditional birth attendants (TBAs) is not included in constructing the latent variable *service availability*[2]. No latent exogenous variable *service availability* is created for analyses in the urban areas of Tunisia and rural areas of Colombia where preliminary analyses show poor fit with the constructed latent variable; rather, the service availability variables are included separately.

Instead of fitting the same model across the countries (initial examinations showed poor fit with that approach), attempts have been made to find the best fit model in different country contexts. However, for this reason the models are quite different across the countries. If inclusion of any exogenous variable with insignificant statistic P>0.10 leads to a poor fit, the variable is excluded from the final models. The results of the *best-fitted* models are presented in the following sections. As an illustration, a complete model is presented in Fig. 2 from one of the study countries (Thailand).

- Fig. 2 -

Common determinants of contraceptive use and MCH care utilization

The coefficient γ estimates from the structural model shown in Fig. 1 are presented in Table 3 and 4 for exogenous variables, respectively for urban and rural areas. No distinct pattern of common predictors for both contraceptive use and MCH care utilization was found across all the urban areas (Table 3). In urban Colombia fertility related variables (children ever born and children dead) and contraceptive knowledge (a scaled variable constructed from the enumeration of methods reported by women) were commonly related to the use of both of these interventions. Service availability was the only common predictor in urban Zimbabwe.

- Table 3 -

Examination of rural areas shows that contraceptive knowledge is significantly related to contraceptive use and to MCH care utilization in all of the six study countries (Table 4). Education of women, fertility outcome (CEB and children dead), household conditions (healthy household and economic status), and service availability were also commonly related to contraceptive use and MCH care utilization in few settings.

- Table 4 -

Simultaneity between contraceptive use and MCH service utilization

The LISREL estimates pertaining to endogenous variables are summarized in Table 5. Four models are fitted to test the hypotheses H1 to H4 in each of the countries. Model I tests the null hypothesis (hypothesis H1) that the association between contraceptive use and MCH service utilization is spurious, i.e., mediated through a set of common explanatory variables. Model II tests the effect of contraceptive use on MCH care utilization (hypothesis H2). Model III tests the effect of MCH care utilization on contraceptive use (hypothesis H3). In Model IV we test the reciprocal relationship between these two outcome variables, i.e., the two variables are simultaneously related rather than one way or no causal relationship[3] (hypothesis H4).

The results consistently show that the use of contraception affects the utilization of MCH interventions (and vice-versa) independent of intervening variables. In model I, the partial covariance estimates psi (ψ_{21}) between CONTUSE

(η_1) and MCHUSE(η_2) , given the set of latent exogenous variables (ξ), were statistically significant in all the six countries, both in urban and rural areas. Therefore we reject the null hypothesis ($\psi_{21} = 0$) of spurious association between contraceptive use and MCH care utilization, i.e., the observed association is not due to the common set of predictors. The estimated partial correlation (η_1, η_2) $\{\psi_{21} / (\psi_{11} \psi_{22})^{½}\}$ were higher in the rural areas. This suggests a simultaneity between the utilization of two interventions, unexplained by the exogenous variables included in the model.

- Table 5 -

Examination of model II (coefficient β_{12} estimates) indicates that the MCH care utilization significantly influences contraceptive use, independent of the common determinants, in all the study countries. The reverse relationship examined from the coefficients of β_{21} (model III) was statistically significant in all the six countries as well (marginally in urban Zimbabwe).

Models II and III show the one way direction of association. In model IV, the β_{12} and β_{21} estimates are constrained to be equal[4], and the coefficients β_{12} and β_{21} indicate a reciprocal effect between contraceptive use and MCH service utilization, rather than a one way or no causal relationship, independent of common determinants. The estimates were significant in all the areas..

DISCUSSION

This study attempts to examine the common factors that determine the utilization of family planning and MCH services in developing countries; particularly we examined the simultaneity between these two behavioral outcomes. The most important findings are: (1) there is no distinct pattern of common exogenous predictors for contraceptive use and for MCH care utilization across the countries; (2) a scaled measure of contraceptive knowledge is strongly related to both contraceptive use and maternal-child health care utilization in all settings; and, (3) utilization of these interventions is simultaneously determined, that is, the families develop a joint demand for quality of health and for fewer children and translate these demands into action by adopting contraceptive methods and by utilizing health services for children and for mothers simultaneously. In all the six study countries, the association is positive and statistically significant (in Zimbabwe marginally significant), independent of other intervening covariates.

The study provides empirical evidence for the thesis that the utilization of one health intervention influences the acceptors to use other health services, independent of other factors. This finding has not only theoretical value but also important policy implications. The finding particularly suggests that if both family planning and MCH interventions are introduced and available, the likelihood of adoption of both are higher, compared to if only one is introduced or available. In general, the rationale for integration of family planning and MCH care services has been based on three premises: improving the efficiency and effectiveness of services; meeting clients need from "one-stop" service; and, accelerating the pace of health and demographic outcomes. This study further substantiates the rationality of integration; it is likely that if both kinds services are available, the use of both will be increased, compared to if only one type service is available.

It has long been believed by behavioral scientists that adoption of a new behavior is a process that involves passage through a sequence of behavioral changes that begin with awareness, extends through accumulation of knowledge, and ends in behavioral consolidation. According to these hierarchical behavioral models (McGuire, 1981), the consolidation of one behavior (e.g., adoption and use of contraceptives) may facilitate more rapid adoption of similar behavior (e.g., health care use or vice-versa). This study further substantiates these behavioral models, as well.

Although, this is a comparative study, the six countries could not be fitted with a common statistical model. Each of these countries is unique in its demographic and cultural background and the DHS data differ significantly by service availability variables across the countries. Preliminary examination revealed a poor fit if a common model is attempted across the countries. As a result, each country is analyzed with a separate model that fitted well statistically. For this reason, the countries could not be easily compared.

This study only included women who had a surviving child aged below five years. Due to this selection criterion, high risk women with higher mortality experience, that is, women who have no surviving children, might be excluded. This would bias the results showing the influence of proportion of children dead on the outcomes but should not influence the principal findings of this study.

Another area of concern is the reporting of TT use in DHS sample. If partly protected by earlier TT use, a woman may not be immunized during the last pregnancy. The survey did not consider a difference between one or two doses of TT. Moreover, the validity of DHS data on TT use is questioned on the ground that many women may not differentiate between TT use and any other injection during the pregnancy period (Buekens et al., 1995). The DHS data may suffer from recall bias, particularly the maternal care histories that are based on recall of retrospective events which may have occurred as far as five years ago. Moreover, the validity of response on the type of service provider for delivery care, particularly in distant past, is not evaluated.

Another challenge of this study was to analyze the data with *multiple binary outcome variables with endogeneity*. In recent years there is a growing interest in analyzing binary outcome variables containing endogenous outcome variables (Guilkey et al., 1995). Although some estimation methods are available in different disciplines, the properties and behavior of these estimators are still under investigation and have limitations in practice. The latent class structural equation method which was originally developed for continuous scale variables is used in this study,. Although recent implementation of these models allows binary /categorical variables, and hold asymptotic properties, there is lack of Monte Carlo evidence for judging their performance compared to other estimation procedures. Future research should address these issues. Moreover, research is needed to examine the properties of these models in relation to multi-level (contextual) and cluster data.

Developing countries are under increasing financial constraints both in national budgets and in availability of external donor funds, so to expand social services requires efficient and effective allocation of scarce public resources. This study attempts to provide information on the determinants of utilization of health and family planning services so that planning in the health sector can be more informed and effective. As primary health care programs expand, there is an increase in demand for services and for quality of care which leads to considerations of structural changes in delivery systems, changes in communication and information strategies, and integration and coordination of health activities with other development programs.

It is expected that these research findings will expand our basic understanding of the dynamics underlying behavioral modifications that foster positive changes in attitudes towards utilizing modern health care facilities by women in developing countries. This study also provides evidence for the importance of integrating family planning and MCH services. Program planners and policy makers will also benefit from this research in designing and implementing more effective family planning and MCH programs in developing countries.

NOTE

[1] Endogeneity indicates whether there is a overlap between the sets of unobservable variables that affect both of the simultaneous equations. If they do so, then the error terms are correlated and controlling for endogeneity by statistical methods is desired.

[2] Ideally, the observed variables that are included to construct a latent variable should not show an inverse association within the group. That could result in an underestimate of effects of the constructed latent variable on the endogenous variables. Analyses in the earlier sections show that availability of trained TBAs and other service availability related variables in the clusters are negatively related. Preliminary examination of the models with trained TBAs showed poor fit, and so TBAs were excluded from further analyses.

[3] Reciprocal relationships are examined by non-recursive models, and these models frequently impose *identification* problems. So, to estimate the reciprocal effects we must break the symmetry of the reciprocal relationship (that is why the hypotheses H2 and H3 are stated, instead of stating the hypothesis H4 only). For solution of ß's in H4 we must also constrain them to be equal. For an elaborate discussion on these issues see Hayduk (1987).

[4] To examine the reciprocal relationship by non-recursive models it is required to constrain $\beta_{12}=\beta_{21}$, for identification of ß's (Hayduk 1987).

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Fig. 1: Structural relationship between utilization of maternal and child health (MCH) and family planning (FP) interventions

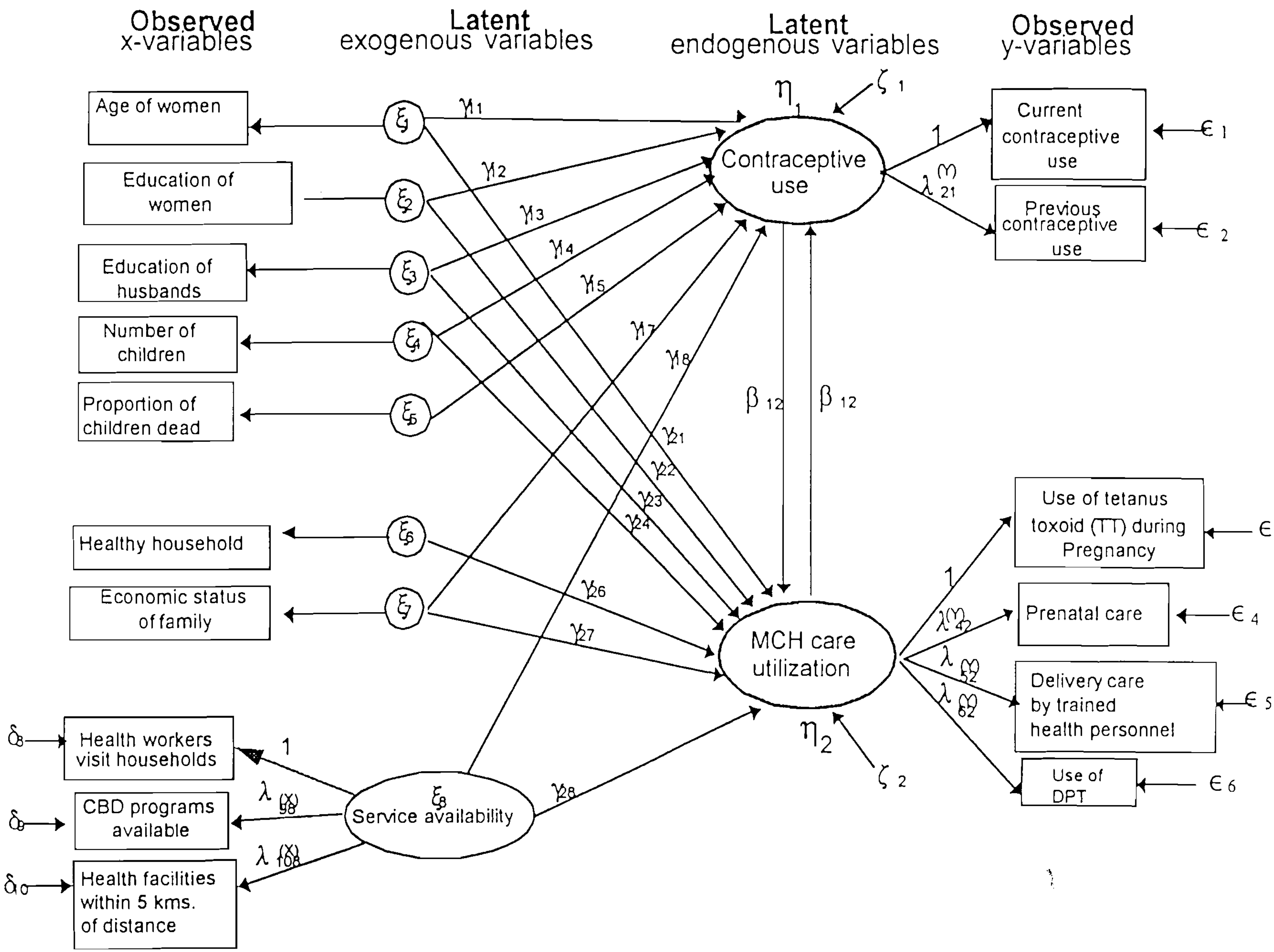
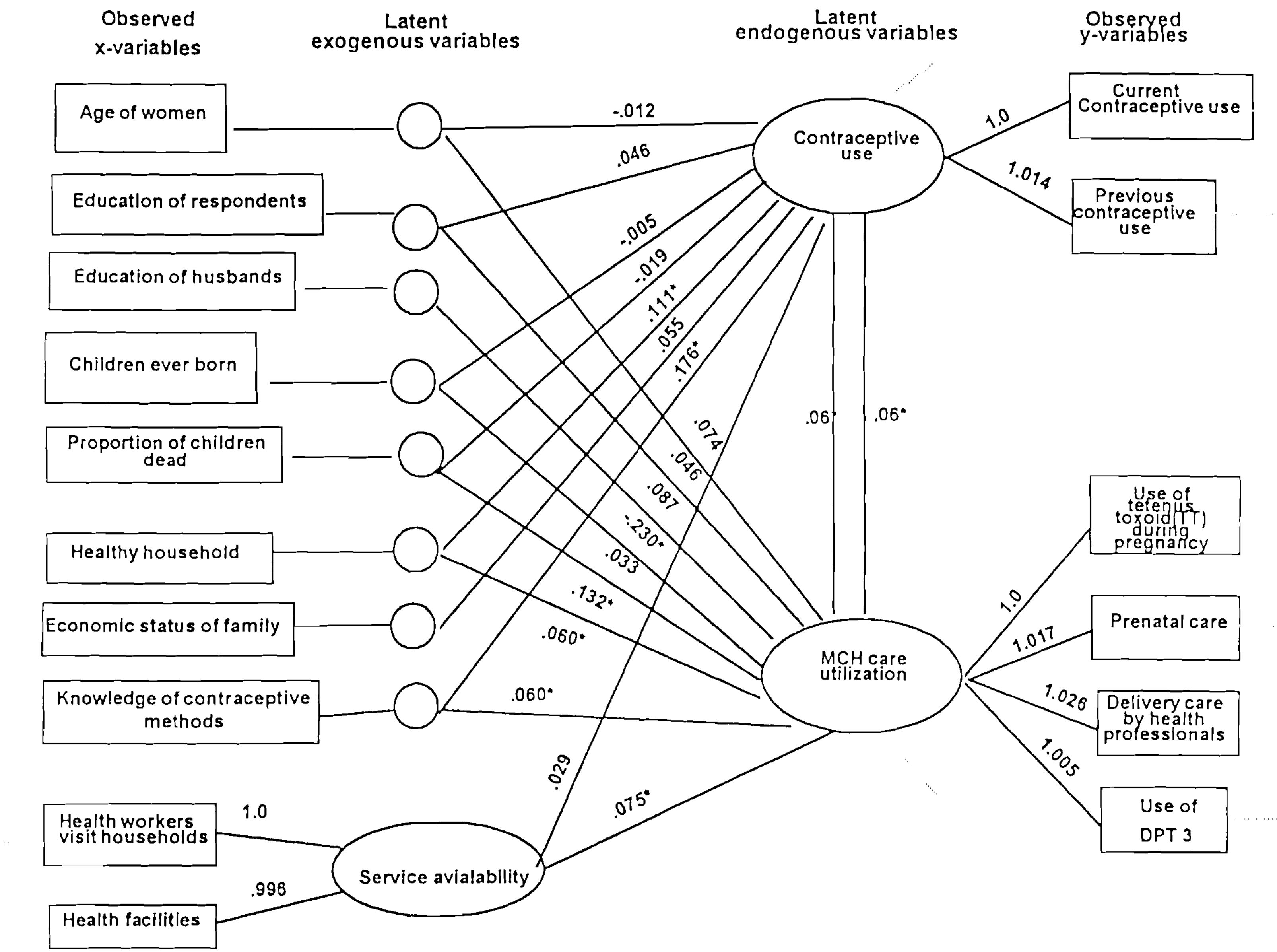


Fig. 2: Model for synergistic relationship between utilization of maternal and child health (MCH) and family planning (FP) interventions, Thailand (rural areas).



* Statistically significant (p<0.05, two sided)

Table 1: Percent distribution of contraceptive use and MCH care utilization in study countries.

Description	Thailand Rural	Zimbabwe Urban	Zimbabwe Rural	Zimbabwe Total	Egypt Rural	Tunisia Urban	Tunisia Rural	Tunisia Total	Colombia Urban	Colombia Rural	Colombia Total	Guatemala Urban	Guatemala Rural	Guatemala Total
Contraceptive use														
Current contraceptive use	68.9	58.1	48.8	51.6	31.2	67.8	39.4	56.0	68.9	53.3	63.9	34.1	12.9	17.9
Past contraceptive use (during closed interval)	48.8	na			24.5	48.8	24.3	38.6	59.2	40.3	53.1	26.0	7.4	11.8
MCH care utilization														
Tetanus toxoid(TT)	67.2	79.3	80.2	79.9	11.8	36.3	33.2	35.0	37.8	43.6	39.7	15.3	13.1	13.6
Prenatal care (from trained personnel)	75.6	95.9	91.9	93.1	45.7	74.1	45.3	62.1	83.7	59.7	76.0	52.4	29.9	35.2
Delivery care (from trained personnel)	65.6	90.9	64.3	72.2	21.6	87.5	50.0	71.9	85.3	51.2	74.3	50.6	21.7	28.6
Institutional delivery (at hospital/clinic)	59.5	72.5	61.5	64.8	na	86.7	50.1	71.4	na			na		
DPT 3 immunization														
Has card, and completed	23.4	65.3	67.8	67.1	20.0	72.1	60.7	67.3	42.0	37.8	40.6	36.4	29.3	31.0
Has card, not completed	4.6	2.1	7.8	6.1	31.5	2.9	8.2	5.1	6.0	7.6	6.5	16.5	26.4	24.1
At least once immunized	54.3	30.1	19.6	22.7	38.2	24.0	26.2	24.9	46.5	45.0	46.0	35.4	26.1	28.4
Never immunized	17.6	2.5	4.8	4.1	10.3	1.0	4.9	2.6	5.5	9.5	6.8	11.7	18.0	16.5
Measles immunization														
Has card, and completed	12.3	60.6	68.2	65.8	20.3	68.8	60.2	65.4	39.4	34.2	37.8	44.3	44.4	44.4
Has card, not completed	12.5	2.6	5.0	4.3	28.3	3.8	6.1	4.7	5.6	8.4	6.5	6.5	12.0	10.6
At least once immunized	56.4	34.0	21.8	25.6	42.1	26.2	29.4	27.4	50.6	49.6	50.2	39.5	29.8	32.3
Never immunized	18.7	2.8	5.0	4.3	9.3	1.2	4.3	2.5	4.4	8.2	5.2	9.7	13.9	12.8
N	1548	1221	521	1742	1891	1128	804	1932	1013	484	1497	393	1286	1669

Note: na Not available

Table 2: Characteristics of women, households, communities and services by urban-rural residence.

Description	Thailand Rural	Zimbabwe Urban	Zimbabwe Rural	Egypt Rural	Tunisia Urban	Tunisia Rural	Colombia Urban	Colombia Rural	Guatemala Urban	Guatemala Rural
Individual Characteristics										
Age (mean in years)	29.0	28.5	29.9*	29.5	31.0	32.0*	28.2	29.5*	29.0	28.7
Education (mean in years)	4.6	7.2	4.6*	2.0	4.6	1.0*	6.1	3.3*	3.9	1.4*
Husband's education (years)	5.4	7.5	5.2*	4.0	7.2	3.2*	6.7	3.2*	5.0	1.8*
Employment (% in formal sector)	61.9	43.2	32.4*	7.4	13.1	5.6	26.9	9.3*	22.4	10.9*
Children ever born (mean)	2.7	3.3	4.4*	4.5	3.5	4.7*	2.7	4.0*	3.7	4.2*
Proportion of children dead	0.03	0.04	0.07*	0.12	0.04	0.07*	0.03	0.05*	0.08	0.09
Knowledge of contraceptives	5.9	4.7	3.7*	3.5	5.4	4.4*	6.1	5.1*	4.3	2.4*
Characteristics of index child										
Age of child (in months)	30.9	30.5	26.9*	26.6	29.6	25.1*	30.9	28.0*	28.0	25.1*
Sex of child (male)	51.8	50.4	49.2	54.0	49.9	52.1	49.8	50.2	51.7	50.2
Household characteristics										
Source of drinking water (pipe/tap)	9.1	95.9	19.8*	92.7	92.9	65.9*	91.9	55.6*	63.4	34.4*
Toilet facility (sanitary)	55.0	99.2	47.0*	82.6	96.9	45.0*	94.6	48.5*	89.8	53.1*
Electricity	68.3	na	na	87.2	na	na	97.3	53.7*	77.9	24.2*
Has radio/tv (media access)	77.1	71.2	30.5*	na	93.6	71.6*	94.2	77.7*	76.8	60.2*
Has bicycle/boat/car (transportation)	72.0	36.1	26.5*	16.3	38.3	17.3*	40.3	22.9*	31.6	14.2*
Community characteristics										
Secondary school in cluster (within 5 km.)	34.0	82.0	34.9*	24.0	93.1	13.1*	99.0	31.4*	82.4	19.5*
Service availability										
Availability of CBD program	5.4	36.3	76.0*	55.5	98.8	71.9*	78.3	65.1*	57.5	31.7*
Availability of mobile clinics	23.5	12.4	41.0*	Na	21.5	60.3*	6.9	18.3*	na	na
Field workers visit	23.9	39.0	79.0*	na	26.1	28.6	56.7	48.8*	31.3	17.1*
Trained TBAs available	39.5	14.5	69.0*	31.7	na	na	9.1	16.9*	na	na
FP centers within 5 km.	84.2	82.8	46.3*	81.6	91.9	61.6*	97.7	52.1*	97.2	55.1*
MCH centers within 5 km.	84.2	86.5	47.3*	72.2	67.8	7.8*	95.8	34.1*	100.0	56.3*

* Urban-rural differences are statistically significant at $p<0.05$

Note: Figures are expressed as percentage if not other wise stated.

na Not available.

Table 3: The regression estimates of structural equations with latent variables: Urban

Estimates	Zimbabwe		Tunisia		Colombia	
	η_1 CONTUSE	η_2 MCHUSE	η_1 CONTUSE	η_2 MCHUSE	η_1 CONTUSE	η_2 MCHUSE
Lambda Y (λ_y) estimates						
Current contraceptive use	1.0	-	1.00	-	1.0	-
Past contraceptive use			0.995*	-	1.0*	-
Tetanus Toxoid(TT) use	-	1.00	-	1.00	-	1.0
Prenatal care	-	1.005*	-	1.013*	-	1.007*
Delivery care			-	1.008*	-	1.002*
DPT-3 use						
Gamma (γ) estimates						
Age	-0.025	-0.041	-0.011	-0.055	0.097	-0.039
Education	0.174*	-0.197*	0.187*	-0.040	0.069	-0.052
Education of husband						
Employment	0.103	-0.073				
Children ever born(CEB)			0.206*	-0.0818	0.133*	-0.089†
Children dead	-0.053	0.0^c	-0.133*	0.016	-0.091*	0.051†
Healthy household	0.070	0.089†			0.069*	-0.008
Economic status			0.0a	-0.035	0.040	0.0
Knowledge of contraception	0.0^c	0.137*	0.248*	0.0b	0.239*	0.102*
Service availability	0.099†	0.106*	0.044	-0.013	0.0c	0.024
Model fitness indexes						
X^2 (P values) df	22.22 (p=0.990), 40		50.93 (p=0.667), 56		85.73 (p=0.112), 71	
Goodness of fit index(GFI)	0.997		0.996		0.996	
AGFI	0.994		0.994		0.994	
Root mean square	0.045		0.075		0.067	

Significance level: * $p<0.05$, †$p<0.10$

aOther Lambda X's were directly observed.

[b]Variables used to construct latent variable *service availability.*

Table 4: The regression estimates of structural equations with latent variables: Rural

Estimates	Thailand η_1 CONTUSE	Thailand η_2 MCHUSE	Zimbabwe η_1 CONTUSE	Zimbabwe η_2 MCHUSE	Egypt η_1 CONTUSE	Egypt η_2 MCHUSE	Tunisia η_1 CONTUSE	Tunisia η_2 MCHUSE	Colombia η_1 CONTUSE	Colombia η_2 MCHUSE	Guatemala η_1 CONTUSE	Guatemala η_2 MCHUSE
Lambda Y (λ_y) estimates												
Current contraceptive use	1.0	-	1.0	-	1.0	-	1.00	-	1.00	-	1.0	-
Past contraceptive use	1.014*	-			0.930*	-	1.145*	-	0.998*	-	1.007*	-
Tetanus Toxoid(TT) use	-	1.00	-	1.00	-	1.0	-	1.00	-	1.00	-	1.0
Prenatal care	-	1.017*	-	0.976*	-	0.931*	-	1.398*	-	1.023*	-	1.036*
Delivery care	-	1.026*	-	0.526*	-	1.359*	-	1.255*	-	1.028*	-	0.361*
DPT-3 use	-	1.005*			-	1.250*	-	0.550*	-	1.013*	-	0.346*
Gamma (γ) estimates												
Age	-0.012	0.074	-0.019	-0.056	0.027	0.032	0.093	-0.097	-0.007	0.017	0.065	0.069
Education	0.046	0.033			0.105*	0.071*	0.113*	0.041	0.137*	0.061	0.150*	0.191*
Education of husband	0.0c	0.087			0.0c	0.066*						
Employment			0.0c	-0.028								
Children ever born(CEB)	-0.005	-0.230*			0.287*	-0.123†	0.068	-0.103	0.162	-0.120	0.133*	0.080†
Children dead	-0.019	0.033	-0.037	-0.123*	-0.168*	0.063*	-0.075*	0.0	0.0c	-0.060†	0.133	0.134*
Healthy household	0.111*	0.132*	0.067†	0.0c	0.097*	0.053*	0.043	0.091*			-0.098*	0.0c
Economic status	0.055	0.060*	0.061	0.039	0.104*	0.051*	0.0c	0.057*	0.190*	0.072*	0 0c	0.073*
Knowledge of contraception	0.176*	0.060*	0.193*	0.188*	0.222*	0.061*	0.243*	0.110*	0.216*	0.116*	0.211*	0.165*
Service availability	0 029	0 075*	0.001	0.055*	0.160*	0.0c	0.160*	0.112*	0.008* (0.106†	0.110* 0.0c)	0.258*	0 107*
Model fitness indexes												
X^2 (P values) df	108.32 (0.148) 94		80.41 (p=0.126), 67		124.17 (p=.152), 109		105.90 (p=.209) 95		35.64 (p=0.707), 41		100.89 (p=.373) 95	
Goodness of fit index(GFI)	0.997		0.993		0.995		0.997		0.994		0.995	
AGFI	0.995		0.989		0.993		0.996		0.984		0.993	
Root mean square	0.044		0.039		0.031		0.044		0.037		0.040	

Significance level: * $p<0.05$, †$p<0.10$

aCBD programs available (proximity of health facilities in the parenthesis); service availability variable was not created.

cConstrained to 0 (for identification of the model)

Table 5: Summary of Results from Latent Variable Structural Equation Models: ß estimates

Description	Model I		Model II	Model III	Model IV
	Covariance (ψ)	Correlation $\psi_{21}/(\psi_{11}\psi_{22})^{1/2}$	CU→MCH ($\eta 21$)	CU←MCH ($\eta 12$)	CU↔MCH $\beta_{12}=\beta_{21}$
Thailand					
Rural	0.101*	0.120	0.115*	0.124*	0.060*
Zimbabwe					
Urban	0.092†	0.099	0.099†	0.101†	0.059*
Rural	0.123†	0.228	0.132*	0.391*	0.097*
Egypt					
Rural	0.037*	0.153	0.095*	0.249*	0.068*
Tunisia					
Urban	0.071*	0.080	0.085*	0.076*	0.042*
Rural	0.045*	0.171	0.136*	0.213*	0.085*
Colombia					
Urban	0.107*	0.119	0.126*	0.112*	0.059*
Rural	0.072*	0.085	0.088*	0.084*	0.041*
Guatemala					
Rural	0.197*	0.319	0.323*	0.314*	0.159*

*Significant at $p<0.05$

† Significantly at $p<0.10$