CHAPTER 2

Impacts of Contraception, Breastfeeding and Infant Mortality on Fertility

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1. INTRODUCTION

This chapter focusses on four fertility determinants, three major proximate determinants: marriage, contraception and postpartum infecundability (especially through breastfeeding) and an important bio-social factor: infant mortality. Infant mortality is not a proximate determinant, but it is in a sense one of the biological and behavioral factors whose influence on the level of fertility is still important in developing countries.

"The proximate determinants" of fertility are the biological and behavioral factors through which social, economic and environmental variables affect fertility (Bongaarts and Potter, 1983). These relationships were first recognized in a now classical study by Davis and Blake (1956), who identified a set of 11 "intermediate fertility variables." Bongaarts (1978) later restricted the factors to the only four most important variables: marriage (or one aspect of exposure to intercourse), contraception (or exposure to risk of conception), induced abortion (one aspect of gestational outcome), and breastfeeding (the most important determinant of the duration of infecundity fowllowing a birth). Other intermediate variables (such as primary and secondary sterility or infecundity, coital frequency, temporary separations between married couples and other reasons for involuntary abstinence) were not included, largely on the basis of the expectation that their fertility impact would not vary greatly across countries. Unfortunately, despite of the known importance of induced abortion in many soceities (Note 1), this factor is excluded from the analysis because abortion rates are poorly reported.

The article is composed of two parts. The first part takes a bird's-eye view of levels and trends of fertility, the major proximate determinants and infant mortality assessed from the DHS data for 28 developing countries. It describes country differences in total fertility rate, total marital fertility rate, contraceptive prevalence rate, mean breastfeeding duration, infant mortality rate, etc. in isolation. In the second part, the Bongaarts aggregate model is applied to the DHS data with the aim of providing an overview of the contribution of each of the three main proximate determinants to the level of fertility, to cross-country differences in fertility, and to recent trends in fertility.

2. LEVELS AND TRENDS OF FERTILITY IN RELATION TO THE MAJOR PROXIMATE DETERMINANTS AND INFANT MORTALITY IN DHS COUNTRIES

1) Fertility

The data collected in the reproduction section of the DHS questionnaire present information on fertility. Each woman was asked questions about the number of children living with her and a complete birth history was collected, including the sex and date of birth of each child and its survival status.

Age-specific fertility rates (ASFR) are calculated from the birth history by dividing the number of births to women in a specified age group, during a specified time period, by the number of woman-years of exposure during the same period. And the total fertility rate (TFR) is calculated by summing the age-specific fertility rates.

a) TFR from DHS Data

Total fertility rates for women 15-44 for the period 0-2 years prior to the survey are presented in Table 1 (the 3rd column). The TFR is highest in sub-Saharan African coutries such as Uganda (7.20), Mali (6.94), Burundi (6.54), and lowest in Asian coutries such as Thailand (2.23), Sri Lanka (2.67), Indonesia (3.03). In North Africa and Latin America and the Caribbean, total fertility rates are lower than in sub-Saharan Africa (except for Guatemala and Bolivia) and higher than in Southeast Asian countries.

b) Recent Changes in TFR

Table 1 Major Indicators on Fertility, Proximate Determinants, and Infant Mortality, DHS

Country	(Year of Survey)	TFR	TMFR	Contraceptive Prevalence Rate	Mean or Median Duration of Postpartum Interval				Infant Mortality Rate	(Year)
					Breastfeeding (months)	Nonsusceptible (months)	Amenorrhea (months)	Abstinence (months)		
ASIA										
Indonesia	(87)	3.03	3.99	47.7	25.1	12.5	11.0	5.3	70	(1982-87)
Pakistan	(90/91)	..	..	..	20.0	10.3	8.9	4.7	91	(1985-90)
Sri Lanka	(87)	2.67	3.36	61.7	..	..	..	..	..	
Thailand	(87)	2.23	2.85	65.5	16.6	8.7	7.2	3.5	35	(1982-87)
LATIN AMERICA/CARIBBEAN										
Bolivia	(89)	4.93	5.66	30.3	16.2	13.4	11.0	6.1	96	(1979-89)
Brazil	(86)	3.37	4.05	66.2	9.2	5.6	4.2	3.0	76	(1981-86)
Colombia	(86)	3.17	3.88	64.8	11.1	8.5	5.0	5.8	33	(1981-86)
Dominican Republic	(86)	3.64	4.50	49.8	9.3	7.3	4.9	4.3	68	(1981-86)
Ecuador	(87)	4.13	4.98	44.3	14.5	9.5	8.4	3.2	58	(1982-86)
Guatemala	(87)	5.50	6.47	23.2	20.0	14.0	12.4	6.2	73	(1982-87)
Mexico	(87)	3.99	4.92	52.7	10.5	7.5	5.6	4.4	47	(1982-87)
Peru	(86)	4.04	5.00	45.8	16.0	11.0	8.8	5.7	76	(1981-86)
Trinidad and Tobago	(87)	3.05	3.27	52.7	..	..	..	..	..	
NORTH AFRICA										
Egypt	(88/89)	4.51	5.66	37.8	17.3	9.2	8.2	3.2	73	(1984-88)
Morocco	(87)	4.45	6.29	35.8	14.4	..	8.7	..	73	(1982-86)
Sudan		..	..	..	19.5	15.2	13.9	5.0	70	(1985-90)
Tunisia	(88)	4.13	5.65	49.8	15.5	7.8	7.2	1.8	50	(1983-87)
SUB-SAHARAN AFRICA										
Botswana	(88)	4.68	4.76	33.0	18.8	15.6	11.6	12.7	37	(1983-88)
Burundi	(87)	6.54	7.55	8.7	23.8	19.9	19.1	3.5	75	(1982-86)
Ghana	(88)	6.10	6.66	12.9	20.4	18.1	14.0	13.5	77	(1983-87)
Kenya	(88/89)	6.52	7.50	26.9	19.4	12.6	10.9	5.9	60	(1984-89)
Liberia	(86)	6.35	6.76	6.4	17.0	15.4	11.2	13.2	144	(1981-86)
Mali	(87)	6.94	7.14	4.7	21.6	16.8	15.3	7.0	108	(1982-86)
Nigeria	(90)	..	..	..	19.5	19.0	14.6	10.8	87	(1985-90)
Senegal	(86)	6.21	6.93	11.3	18.8	18.0	16.2	7.9	86	(1981-86)
Togo	(88)	6.12	6.76	33.9	22.6	20.3	14.4	17.5	81	(1983-87)
Uganda	(88/89)	7.20	7.77	4.8	18.6	13.7	12.7	4.1	101	(1983-88)
Zimbabwe	(88/89)	5.27	6.02	43.1	19.3	13.6	12.6	4.3	53	(1983-88)
		1)	2)	3)	4)	4)	4)	4)	5)	5)

(Notes)
1) For the period 0-2 years prior to the survey, for women at ages 15-44, Arnold and Blanc(1990,p.3).
2) For the period 0-2 years prior to the survey, for women, 0-29 years since first marriage, Arnold and Blanc(1990,p.6).
3) Of currently married women at ages 15-49 (figures for Brazil and Guatemala are for women 15-44), Rutenberg et al.(1991,p.13).
4) Data in Studies in Family Planning, volume 19-23.
5) Data in Studies in Family Planning, volume 19-23.
Two dots (..) indicate that data are not available.

Table 2 Total Fertility Rates for Women 15–34 for the Periods 0–3, 4–7, 8–11, and 12–15 Years Prior to the Survey, DHS, 1986–89

Country	Years Prior to the Survey 0–3 (1)	4–7 (2)	8–11 (3)	12–15 (4)	(4)-(1)	(4)-(1)/(4) (%)
ASIA						
Indonesia	2.70	3.55	3.93	4.42	1.72	38.9
Sri Lanka	2.27	2.73	2.95	3.14	0.87	27.7
Thailand	1.91	2.39	2.86	3.56	1.65	46.3
LATIN AMERICA/CARIBBEAN						
Bolivia	3.84	4.22	4.68	4.43	0.59	13.3
Brazil	2.96	3.44	3.55	3.90	0.94	24.1
Colombia	2.67	3.24	3.40	3.85	1.18	30.6
Dominican Republic	3.15	3.60	4.11	4.77	1.62	34.0
Ecuador	3.26	4.01	4.19	4.81	1.55	32.2
Guatemala	4.37	5.10	5.03	5.05	0.68	13.5
Mexico	3.31	3.63	4.21	4.83	1.52	31.5
Peru	3.22	3.98	4.43	4.77	1.55	32.5
Trinidad and Tobago	2.68	2.98	2.86	3.16	0.48	15.2
NORTH AFRICA						
Egypt	3.78	4.08	4.41	4.90	1.12	22.9
Morocco	3.31	4.16	4.67	5.11	1.80	35.2
Tunisia	3.29	3.78	4.11	4.32	1.03	23.8
SUB-SAHARAN AFRICA						
Botswana	3.64	4.22	4.67	4.86	1.22	25.1
Burundi	4.65	5.22	4.92	5.01	0.36	7.2
Ghana	4.55	4.65	4.88	5.11	0.56	11.0
Kenya	5.05	5.42	5.84	6.19	1.14	18.4
Liberia	4.89	5.06	4.90	4.70	-0.09	-4.0
Mali	5.28	5.85	5.69	5.35	0.07	1.3
Senegal	4.87	5.59	5.43	5.56	0.69	12.4
Togo	4.59	5.19	5.14	5.51	0.92	16.7
Uganda	5.54	5.57	5.91	6.07	0.53	8.7
Zimbabwe	4.09	4.96	5.00	5.30	1.21	22.8

(Source) Arnold and Blanc (1990, p.15).

Trends in fertility for about 15 years preceding a survey can be assessed using the data obtained in the birth history. Table 2 shows TFR for women 15-34 for four-year periods prior to the survey. Rates are cumulated only up to age 34 in order to avoid truncation bias.

Overall fertility up to age 34 has declined steadily over the last 15 years, except for Liberia, which is the only country whose TFR up to age 34 rose from 4.70 in 12-15 years prior to the survey to 4.89 in 0-3 years prior to the survey. In sub-Saharan Africa, Arnold and Blanc (1990) indicated that there was a temporary increase in fertility around a time followed by a decrease. This pattern was thought to result from the forward displacement in time of births among older women in combination with accurate reporting among younger women. While it is possible that a temporary increase in fertility actually occurred, as a result of decreases in breastfeeding or secondary sterility, for example, it is more likely that "birth displacement" is the principal factor (Arnold and Blanc, 1990).

Comparing the TFR for the period 12-15 years before the survey to that for the most recent four-year period, there were the largest reductions of 46 percent in Thailand, followed by 39 percent in Indonesia, 35 percent in Morocco, and 34 percent in Dominican Republic. The most substantial decline of TFRs occured in four countries. A decrease of 1.80 in Morocco (the decrease corresponds to about 2 children), followed by 1.72 in Indonesia, 1.65 in Thailand, and 1.62 in Dominican Republic were reported. On the other hand, other than Liberia, whose TFR rose slightly upward, fertility reductions have remained at a minimum level of 1.3 percent in Mali, followed by 7.2 percent in Burundi and 8.7 percent in Uganda. The extent of decline in the TFRs were less than 1 child in such countries as Burundi, Ghana, Mali, Senegal, Togo, Uganda, Sri Lanka, Bolivia, Brazil, Guatemala, and Trinidad and Tobago.

There are 3 countries in sub-Saharan Africa: Botwana, Zimbabwe and Kenya, in which long-term declines in fertility have taken place. The declines over the period are 25, 23 and 18 percent, respectively. Hammerslough (1991, p.1288) recognized these three as the first sub-Saharan African countries to enter into the fertility transition. Among the remaining sub-Saharan countries, small but consistent declines appear in Ghana and Uganda. In Burundi, Mali, Liberia, Senegal, and Togo the patterns over time are more irregular, suggesting some extent of "birth displacement" (Arnold and Blanc, 1990, p.16).

c) Recent Changes in ASFR

Figure 1 shows age-specific fertility rates for the two calender periods. The decline in fertility is more evident in the elder age groups. For example, over the period covered by the two rates, the ASFR for women 40-44 has decreased by one-third or more in the Dominican Republic and Thailand. It suggests that couples' desire for the numbers of children have reduced and use of contraception have increased as a means. A change in the fertility of women 15-19 is also a significant factor in most of the countries in which a drop in fertility has occurred. In Morocco, fertility among teenagers decreased by about 37 percent or 28 births per 1000 women.

2) Marriage

The total marital fertility rate (TMFR) provides a summary of the age-specific marital fertility rate. TMFR for the 3 years prior to the survey are shown in Table 1. It is not possible to estimate fertility rates which include only exposure within marriage because a complete marriage history was not collected in DHS surveys. Thus, the marital fertiliy rates presented in the table may underestimate the true level of fertility within marriage (Arnold and Blanc, 1990, p.2).

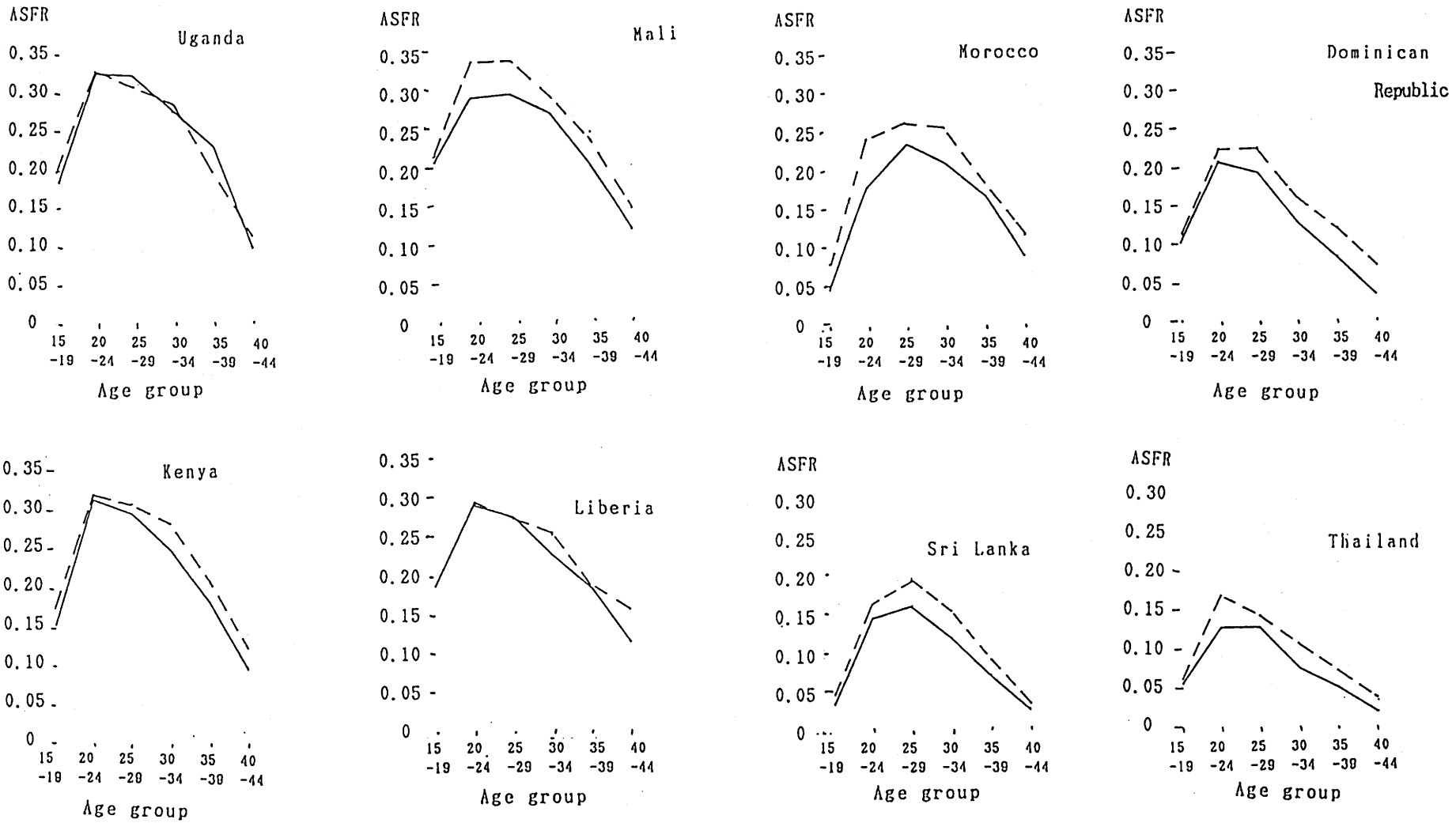
Marital fertility rates cumulated up to duration 29 years since first marriage vary between 2.85 in Thailand and 7.77 in Uganda. All of the sub-Saharan countries, except Botswana, have TMFRs over 6.0 children per woman. Relatively low marital fertility rates in Botswana may be the result of high levels of premarital childbearing and delayed entry into formal marriage (Lesetedi, et al., 1989). Trinidad and Tobago also has unusually low marital fertility for its region; this is probably related to the large number of couples who live together without being married or who are involved in a visiting relationship (Health et al., 1988). In Trinidad and Tobago, both types of relationships, which are characterized by lower fertility than formal marriages, are included in calculation of marital fertility rates. This would tend to depress the overall level of marital fertility (Arnold and Blanc, 1990, p.6). The relationship between nuptiality and fertility has been discussed in detail in Chapter 3.

3) Contraception

a) Contraceptive Prevalence

The DHS data present such information on fertility as knowledge of contraception by method, current use of contraception by method, by age, by number of living children, by desire for more children, by education, and by residence (urban or rural), and ever use of contraception by method. Table 3 shows the current use of contraception by method among married women of reproductive ages (15-49). The contraceptive prevalence rate ranges from less than 5 percent in Mali (4.7) and Uganda (4.8) to 65 percent or more in Brazil (66.2),

Figure 1 Age-specific Fertility Rates for the Periods 0-3 and 4-7 Years prior to the Survey, DHS



(Source) Arnold and Blanc(1990), p13

Table 3 Percent Distribution of Currently Married Women 15–49 Who Are Currentry Using Specific Contraceptive Methods, DHS

Country	Any Method	Pill	IUD	Injection	Vaginal Methods	Condom	Female Sterili-zation	Male Sterili-zation	Any Modern Method	Periodic Absti-nence	With-drawal	Other Methods	Total Tradi-tional
ASIA													
Indonesia	47.7	16.1	13.2	9.4	0.0	1.6	3.1	0.2	43.9	1.2	1.3	1.8	3.8
Sri Lanka	61.7	4.1	2.1	2.7	0.0	1.9	24.9	4.9	40.6	14.9	3.4	2.8	21.1
Thailand	65.5	18.6	6.9	8.5	0.0	1.1	22.8	5.7	63.6	0.9	0.9	0.1	1.8
LATIN AMERICA/CARBBEAN													
Bolivia	30.3	1.9	4.8	0.7	0.1	0.3	4.4	0.0	12.2	16.1	1.0	0.9	18.0
Brazil	66.2	25.2	1.0	0.6	0.5	1.7	26.8	0.8	56.5	4.0	5.0	0.7	9.7
Colombia	64.8	16.4	11.0	2.4	2.3	1.7	18.3	0.4	52.4	5.7	5.7	0.9	12.3
Dominican Republic	49.8	8.8	3.0	0.1	0.2	1.4	32.9	0.1	46.5	1.4	1.5	0.6	3.3
Ecuador	44.3	8.5	9.8	0.7	1.2	0.6	14.9	0.0	35.8	6.1	2.0	0.4	8.5
Guatemala	23.2	3.9	1.8	0.5	0.4	1.2	10.3	0.9	19.0	2.8	1.2	0.1	4.2
Mexico	52.7	9.8	10.2	2.8	0.6	1.9	18.7	0.8	44.6	4.4	3.5	0.2	8.1
Peru	45.8	6.5	7.3	1.3	1.0	0.7	6.1	0.0	23.0	17.7	3.6	1.4	22.7
Trinidad and Tobago	52.7	14.0	4.4	0.8	5.0	11.8	8.2	0.2	44.4	2.6	5.3	0.4	8.3
NORTH AFRICA													
Egypt	37.8	15.3	15.8	0.1	0.4	2.4	1.5	0.0	35.5	0.6	0.5	1.3	2.4
Morocco	35.8	22.9	2.9	0.3	0.1	0.5	2.2	0.0	28.9	2.3	3.1	1.5	6.9
Tunisia	49.8	8.8	17.0	0.8	1.0	1.3	11.5	0.0	40.4	6.3	2.4	0.7	9.4
SUB-SAHARAN AFRICA													
Botswana	33.0	14.8	5.6	5.4	0.0	1.3	4.3	0.3	31.7	0.2	0.3	0.8	1.3
Burundi	8.7	0.2	0.3	0.5	0.0	0.1	0.1	0.0	1.2	4.8	0.7	2.0	7.5
Ghana	12.9	1.8	0.5	0.3	0.3	0.3	1.0	0.0	4.2	6.2	0.9	1.6	8.7
Kenya	26.9	5.2	3.7	3.3	0.4	0.5	4.7	0.0	17.9	7.5	0.2	1.3	9.0
Liberia	6.4	3.3	0.6	0.3	0.2	0.0	1.1	0.0	5.5	0.6	0.1	0.2	0.9
Mali	4.7	0.9	0.1	0.1	0.1	0.0	0.1	0.0	1.3	1.3	0.1	2.0	3.4
Senegal	11.3	1.2	0.7	0.1	0.1	0.1	0.2	0.0	2.4	0.9	0.1	7.9	8.9
Togo	33.9	0.4	0.8	0.2	0.6	0.4	0.6	0.0	3.1	6.4	2.3	22.0	30.8
Uganda	4.8	1.1	0.2	0.4	0.0	0.0	0.8	0.0	2.5	1.6	0.3	0.4	2.4
Zimbabwe	43.1	31.0	1.1	0.3	0.0	1.2	2.3	0.2	36.1	0.3	5.1	1.6	7.0

(Note) Figures for Brazil and Guatemala are for women 15-44.
(Source) Rutenberg et al.(1991), p.13.

Thailand (65.5), and Colombia (64.8). If only modern methods of contraception are considered, the lowest prevalence rates, less than 3 percent, are found in Burundi (1.2), Mali (1.3), and Uganda (2.5). Thailand (63.6), Brazil (56.5), and Colombia (52.4) have the highest prevalence rates for modern methods.

Percent distribution of contraceptive methods of currently married women aged 15-49 is also shown in Table 3. The pill is most popular in Zimbabwe, Brazil, and Morocco (respectively 31.0, 25.2, and 22.9 percent). Looking at the practice pattern of other modern methods, percent of IUD is highest in Tunisia (17.0), Egypt (15.8) and Indonesia (13.2); percent of injection is highest in Indonesia (9.4), Thailand (8.5) and Botswana (5.4); percent of vaginal methods is highest in Trinidad and Tobago (5.0), Colombia (2.3) and Ecuador (1.2); percent of condom is highest in Trinidad and Tobago (11.8), Egypt (2.4) and Sri Lanka, Mexico (1.9); percent of female sterilization is highest in Dominican Republic (32.9), Brazil (26.8) and Sri Lanka (24.9); percent of male sterilization is highest in Thailand (5.7), Sri Lanka (4.9) and Guatemala (0.9).

The DHS results show trends towards an increasing prevalence of sterilization in most countries (Rutenberg and Landry, 1991). In 1990, nearly a half of all couples in developing world were protected from pregnancy by contraceptive use, and almost one-fourth had undergone sterilization (Ross, 1992). Female sterilization, the most commonly used contraceptive method in developing countries, and male sterilizaion, the third most widely used method, accounted for 45 percent of contraceptive use in developing countries (United Nations, 1989). The widespread popularity of sterilization is supposed to be a reflection of the fact for fecund women who have realized their desired family size, sterilization (male or female) is a safe and highly effective method for averting unwanted births (Rutenberg and Landry, 1991). Sterilization is an attractive service component for health and family planning providers for the same reasons as well as its relatively low cost (AVSC, 1989).

In general the pill predominates in sub-Saharan Africa, while female sterilization is most widely used method in Latin America. This reflects, as Rutenberg et al. (1991) pointed out, different attitudes towards family size and the use of contraceptives. That is, women in sub-Saharan Africa desire large families and use contraception mainly to space births, while women in Latin America use contraception more frequently to terminate childbearing and limit their family size to a relatively small number of children.

Traditional methods predominate in sub-Saharan countries, for example Burundi, Ghana, Kenya, Mali, Senegal, and Togo. Especially in Togo, 30.8 percent of married women were using any traditional method, but only 3 percent were using a modern method. And it is outstanding in Togo that 22.0 percent reported "other methods," which includes herbs, folk methods, and all country-specific methods (eg. prolonged abstinence).

The proportion of the specific contraceptive methods to all methods is shown in Table 4. Percent of any modern method is highest in Thailand (97.1), Botswana (96.1) and Egypt (93.9). Percent of any traditional method is highest in sub-Saharan African countries such as Togo (90.9), Burundi (86.2) and Senegal (78.8).

b) Changes in Contraceptive Prevalence between WFS and DHS

The contraceptive prevalence rates for 15 countries that participated in both the DHS and WFS (World Fertility Survey) programs are shown in Table 5. Contraceptive use has increased in all countries for which trend data are available. Among the 15 countries, Kenya, Senegal, Thailand and Sri Lanka showed the highest rates of increase in contraceptive use, respectively 286, 175, 100 and 94 percent, while Trinidad and Tobago, Ecuador and Ghana showed the lowest increase, respectively 2, 29 and 30 percent.

c) Relationship between Contraceptive Use and Fertility

Figure 2 shows the relation of contraceptive prevalence rates to TFR for 25 countries for which the DHS data are available. The correlation across countries between the current contraceptive use and fertility level is, as might be expected, negative and very high ($r=-0.93$, $R^2=0.86$). Weinberger (1991) has pointed out similarly strong relationship between contraceptive prevalence and TFR for 104 countries from the data mainly collected by the United Nations (1991), concluding that rising use of contraception is indisputably the main proximate determinant of the ongoing fertility decline in developing countries.

In figure 2 there are a few exceptions worth noting. In Kenya, Togo, and Zimbabwe, the actual TFR is more than one child higher than the value expected on the basis of the contraceptive prevalence rate. Freedman and Blanc (1991) gave several possible explanation for this type of inconsistency, including unusually high levels of contraceptive failure, redundant use or inefficient use, compensating trends in marriage patterns or postpartum infecundability, and the lag effect of rapid changes in contraceptive pervalence (Bongaarts, 1987).

4) Postpartum Infecundability

The presented DHS data on postpartum infecundability include (1) the duration of breastfeeding (B), (2) postpartum non-susceptible duration (Ns), (3) the duration of postpartum amenorrhea (Am), and (4) the duration of postpartum abstinence (Ab).

The non-susceptible duration means postpartum

Table 4 Percent Distribution of Contraceptive Users, DHS

Country	Any Method	Pill	IUD	Injection	Vaginal Methods	Condom	Female Sterilization	Male Sterilization	Any Modern Method	Periodic Abstinence	Withdrawal	Other Methods	Total Traditional
ASIA													
Indonesia	100.0	33.8	27.7	19.7	0.0	3.4	6.5	0.4	92.0	2.5	2.7	3.8	8.0
Sri Lanka	100.0	6.6	3.4	4.4	0.0	3.1	40.4	7.9	65.8	24.1	5.5	4.5	34.2
Thailand	100.0	28.4	10.5	13.0	0.0	1.7	34.8	8.7	97.1	1.4	1.4	0.2	2.7
LATIN AMERICA/CARBBEAN													
Bolivia	100.0	6.3	15.8	2.3	0.3	1.0	14.5	0.0	40.3	53.1	3.3	3.0	59.4
Brazil	100.0	38.1	1.5	0.9	0.8	2.6	40.5	1.2	85.3	6.0	7.6	1.1	14.7
Colombia	100.0	25.3	17.0	3.7	3.5	2.6	28.2	0.6	80.9	8.8	8.8	1.4	19.0
Dominican Republic	100.0	17.7	6.0	0.2	0.4	2.8	66.1	0.2	93.4	2.8	3.0	1.2	6.6
Ecuador	100.0	19.2	22.1	1.6	2.7	1.4	33.6	0.0	80.8	13.8	4.5	0.9	19.2
Guatemala	100.0	16.8	7.8	2.2	1.7	5.2	44.4	3.9	81.9	12.1	5.2	0.4	18.1
Mexico	100.0	18.6	19.4	5.3	1.1	3.6	35.5	1.5	84.6	8.3	6.6	0.4	15.4
Peru	100.0	14.2	15.9	2.8	2.2	1.5	13.3	0.0	50.2	38.6	7.9	3.1	49.6
Trinidad and Tobago	100.0	26.6	8.3	1.5	9.5	22.4	15.6	0.4	84.3	4.9	10.1	0.8	15.7
NORTH AFRICA													
Egypt	100.0	40.5	41.8	0.3	1.1	6.3	4.0	0.0	93.9	1.6	1.3	3.4	6.3
Morocco	100.0	64.0	8.1	0.8	0.3	1.4	6.1	0.0	80.7	6.4	8.7	4.2	19.3
Tunisia	100.0	17.7	34.1	1.6	2.0	2.6	23.1	0.0	81.1	12.7	4.8	1.4	18.9
SUB-SAHARAN AFRICA													
Botswana	100.0	44.8	17.0	16.4	0.0	3.9	13.0	0.9	96.1	0.6	0.9	2.4	3.9
Burundi	100.0	2.3	3.4	5.7	0.0	1.1	1.1	0.0	13.8	55.2	8.0	23.0	86.2
Ghana	100.0	14.0	3.9	2.3	2.3	2.3	7.8	0.0	32.6	48.1	7.0	12.4	67.4
Kenya	100.0	19.3	13.8	12.3	1.5	1.9	17.5	0.0	66.5	27.9	0.7	4.8	33.5
Liberia	100.0	51.6	9.4	4.7	3.1	0.0	17.2	0.0	85.9	9.4	1.6	3.1	14.1
Mali	100.0	19.1	2.1	2.1	2.1	0.0	2.1	0.0	27.7	27.7	2.1	42.6	72.3
Senegal	100.0	10.6	6.2	0.9	0.9	0.9	1.8	0.0	21.2	8.0	0.9	69.9	78.8
Togo	100.0	1.2	2.4	0.6	1.8	1.2	1.8	0.0	9.1	18.9	6.8	64.9	90.9
Uganda	100.0	22.9	4.2	8.3	0.0	0.0	16.7	0.0	52.1	33.3	6.3	8.3	50.0
Zimbabwe	100.0	71.9	2.6	0.7	0.0	2.8	5.3	0.5	83.8	0.7	11.8	3.7	16.2

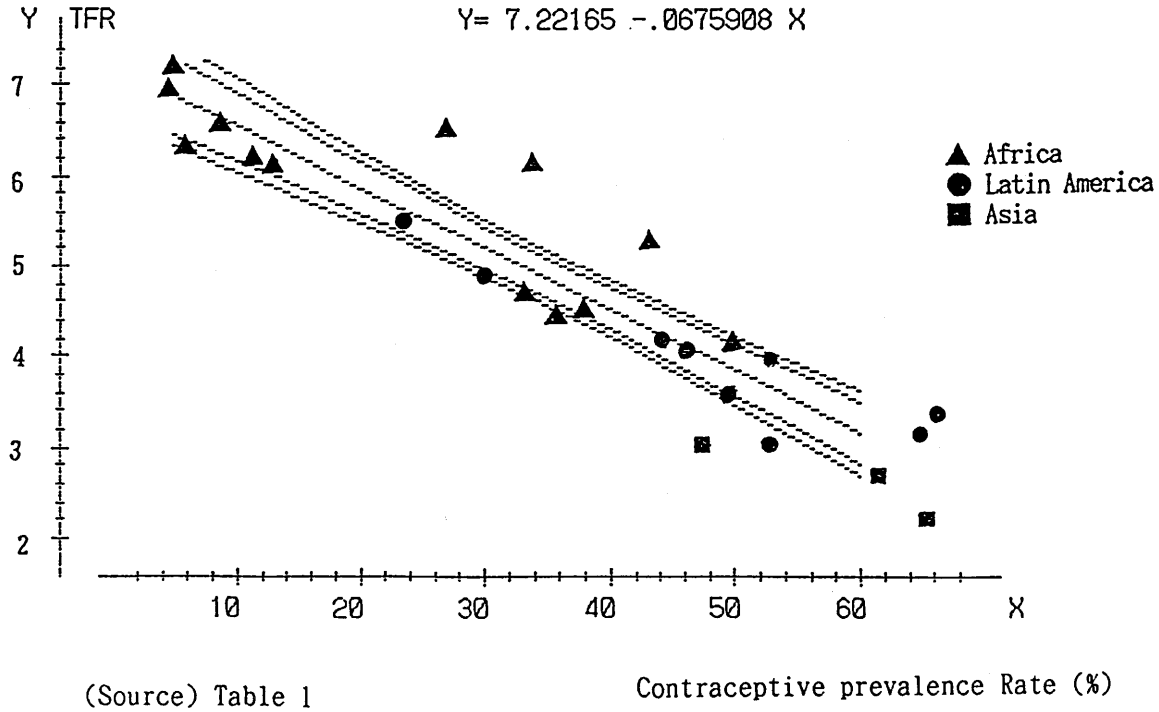
(Note) Caluculated from Table 3.

Table 5 Trends in Contraceptive Prevalence between WFS and DHS Surveys

Country	Contraceptive Prevalence Rate (%) WFS (Year) (1)	DHS (Year) (2)	(2)-(1)	(2)-(1) / (1) (%)
ASIA				
Indonesia	26 ('76) a	48 ('87)	22	85
Thailand	33 ('75)	66 ('87)	33	100
Sri Lanka	32 ('75)	62 ('87)	30	94
LATIN AMERICA /CARBBEAN				
Colombia	43 ('76)	65 ('86)	22	51
Dominican Republic	32 ('75)	50 ('86)	18	56
Ecuador	34 ('79)	44 ('87)	10	29
Mexico	30 ('76)	53 ('87)	23	77
Peru	31 ('77)	46 ('86)	15	48
Trinidad and Tobago	52 ('77)	53 ('87)	1	2
NORTH AFRICA				
Egypt	24 ('80)	38 ('88)	14	58
Morocco	20 ('80)	36 ('87)	16	80
Tunisia	31 ('78)	50 ('88)	19	61
SUB-SAHARAN AFRICA				
Ghana	10 ('79)	13 ('88)	3	30
Kenya	7 ('77)	27 ('89)	20	286
Senegal	4 ('78)	11 ('86)	7	175

(Note) a) Java and Bali
(Source) Weinberger (1991), p. 569.

Figure 2 Relationship between Contraceptive Prevalence Rates and Total Fertility Rates 25 Countries, DHS



(Source) Table 1

amenorrheic and/or abstaining duration, which corresponds to actual postpartum infecundable duration (i). It is an indicator directly representing the fertility reducing effect of the postpartum infecundability. The mean or median months of the 4 indicators (B, Ns, Am, Ab) in each country are shown in Table 1. Figure 3 illustrates the relationship of indicators on postpartum infecundability. The duration of postpartum infecundability is determined by 3 elements: (a) minimum infecundable duration; without breastfeeding the average amenorrheic interval is short-usually 1.5-2 months (Leridon, 1977). (b) infecundable duration physiologically prolonged by breastfeeding, which nearly corresponds to postpartum amenorrhea. (c) infecundable duration due to postpartum abstinence, which corresponds to abstaining duration. Then the longest duration in the above three (a, b, or c) is the actual postpartum infecundable duration for an individual woman.

a) Non-Susceptible Duration (Ns)

The mean or median non-susceptible duration (months) was longest in Togo (20.3), Burundi (19.9), and Nigeria (19.0); shortest in Brazil (5.6), Dominican Republic (7.3), and Mexico (7.5) (Table 1, Column 7).

b) Postpartum Amenorrhea and Breastfeeding

The mean or median duration (months) of postpartum amenorrhea was longest in Burundi (19.1), Senegal (16.2), and Mali (15.3); while shortest in Brazil (4.2), Dominican Republic (4.9), and Colombia (5.0) (Table 1, Column 8). The mean or median duration (months) of breastfeeding was longest in Indonesia (25.1), Burundi (23.8), and Togo (22.6); while shortest in Brazil (9.2), Dominican Republic (9.3), and Mexico (10.5) (Table 1,Column 6). It is known that the longer the duration of breastfeeding, the longer the duration of amenorrhea, at least at the aggregate level (Bongaarts and Potter, 1983). Thapa et al. (1991), replicating the Bongaarts' model, gave the following regression equation:

$$Y = 2.052\exp(0.1138B - 0.00124B^2)$$

B: median duration of breastfeeding (months)

Y: median duration of amenorrhea (months)

Rutstein (1991) also gave the following results for 23 DHS counries:

$$Y = 0.10 + 1.27F + 0.35A$$

F: median duration of full breastfeeding (months)

A: median duration of any breastfeeding (months)

Y: median duration of amenorrhea (months)

Trussell, et al. (1992) presented results of recent breastfeeding trends and differentials in developing countries that participated in the WFS or DHS. Durations of breastfeeding were always longer among rural women, and the nearly universal tendency for durations to decline with increased education. They found that overall trends are mixed, with durations declining in some countries and increasing in others. Nevertheless, there were increases in populations residing in the urban areas almost in all countries (Trussell, et al., 1992).

c) Postpartum Abstinence

The mean duration (months) of postpartum abstinence was longest in Togo (17.5), Ghana (13.5), and Liberia (13.2); shortest in Tunisia (1.8), Brazil (3.0), and Egypt and Ecuador (3.2) (Table 1, Column 9). In three sub-Saharan countries (Togo, Liberia, and Botswana) mean or median duration of postpartum abstinence is longer than that of amenorrhea. In most countries other than these, however, mean or median duration of amenorrhea is longer than that of abstinence. It shows, that is, generally length of nonsusceptible duration is determined by the length of amenorrhea, that is, breastfeeding.

5) Other Factors Influencing Fecundity

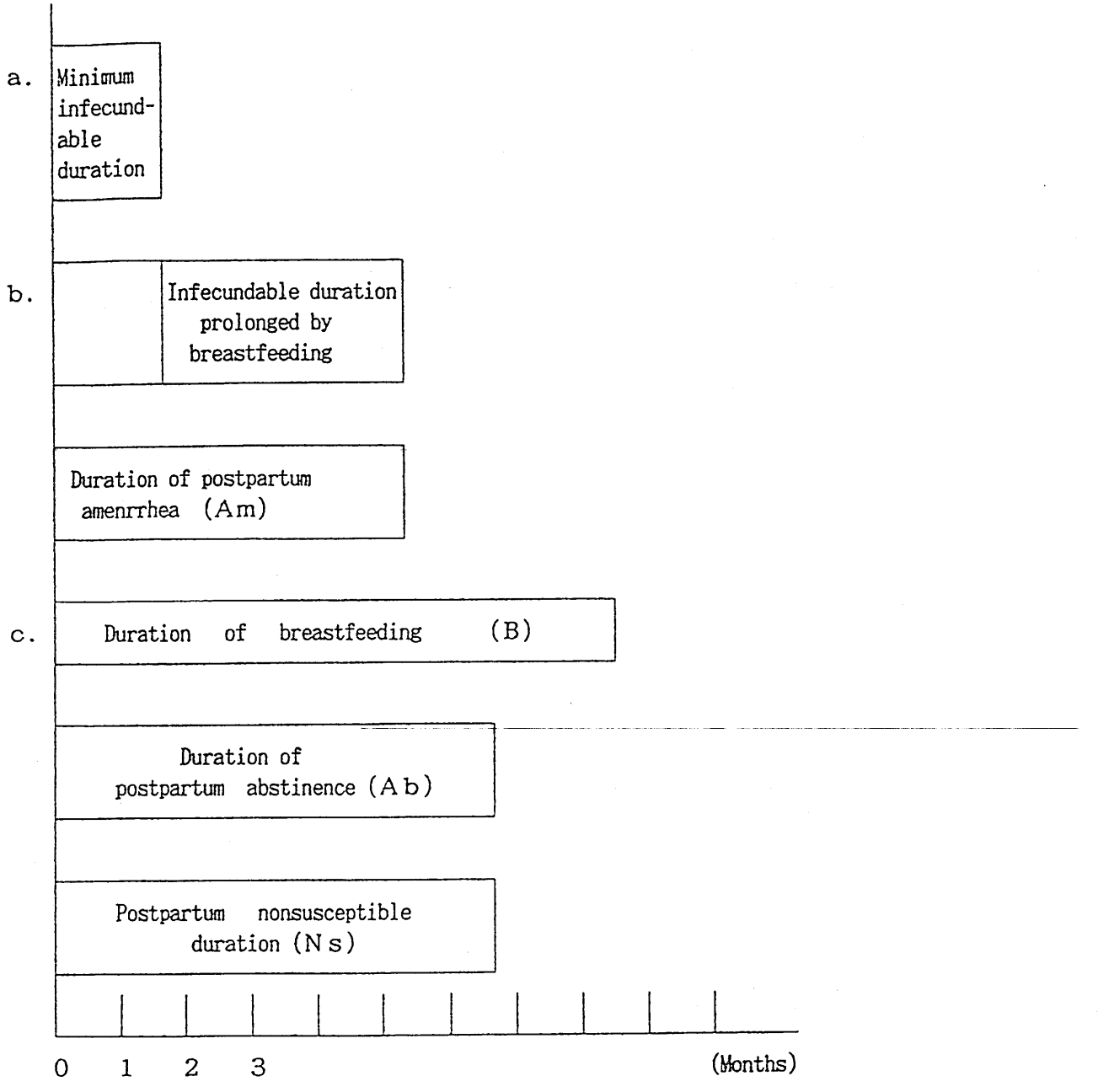
Fecundability, one of the proximate determinants of fertility, is considered largely to be determined by coital frequency (Bongaarts and Potter, 1983). DHS attempted to collect sexual activity data in a number of developing countries. An analysis of coital activity among married Thai women resulted in such relationship between coital frequency and breastfeeding and contraception that (1) frequent night time breastfeeding is associated with lower coital activity, (2) considerable overlap is apparent between the period of postpartum abstinence and amenorrhea, (3) the overlap between contraceptive use and sexual inactivity, however, is fairly modest, especially for users of reversible methods, (4) contraceptive use generally is associated with greater coital activity (Knodel and Chayovan, 1991).

6) Infant Mortality

In many countries, declines in infant mortality have been followed by reductions in fertility and the relationship between them (sometimes called the "child-survival hypothesis") has been examined and discussed extensively. A World Bank study (Bulatao and Elwyn, 1985) has indicated that a sustained fertility decline is unlikely in countries with less than 53 years of life expectancy.

McNamara (1982) summarizes the mechanism into the three theories: (1) Theory concerning the physiological effects that may occur in societies where breastfeeding is widely practiced. The death of a child shortens the amenorrhea associated lactation and thereby may increase fecundity and shorten intervals between births. Empirical studies indicate that this effect is not large (Preston, 1978). (2) Theory concerning with the "replacement effect," that is, that parents are motivated to produce additional children to replace those that are lost. (3) Theory concerning "insurance effect," that is an idea that parents do not limit their children until they

Figure 3 Illustration of Indications on Postpartum Infecundability



(Note) The nonsusceptible duration means postpartum amenorrheic and/or abstaining duration, This illustration gives an example in which Ab corresponds to Ns because Ab is longer than Am. In general, Am is longer than Ab, and Am corresponds to Ns

are reasonably sure that a sufficient number will survive to adulthood. The third theory seems now most widely accepted (McNamara, 1982).

Infant mortality rates for each country in recent years from DHS data are shown in Table 1 (Column 10). The rates (per 1000 live births) are higher than 100 in Liberia (144), Mali (108) and Uganda (101), while less than 40 in Colombia (33), Thailand (35) and Botswana (37).

Table 6 shows trends in infant mortality rates (IMR). Comparing the IMRs in 1955-60 (estimated by the United Nations) to the IMRs for the most recent period (from DHS data), there were the largest reductions of 70 percent in Botswana, followed by 69 percent in Tunisia and 68 percent in Colombia. In absolute terms, there were the largest amounts to a decrease in the IMR (per 1000 live births) of 113 in Tunisia (from 163 to 50), followed by 112 in Togo, and 110 in Egypt. On the other hand, Uganda, Liberia, and Brazil showed the smallest decline in infant mortality rate, in which amounts to a decrease in the IMR was 39, 41, and 46, respectively.

Figure 4 shows the relationship between infant mortality rates and TFRs for 23 countries for which the DHS data are available. There is a fairly strong relationship between infant mortality and fertility level ($r=0.62$, $R^2=0.38$). It is relevant in this respect that the only three sub-Saharan countries with significant recent fertility declines (backed by substantial increases in contraceptive prevalence) are Kenya, Botswana, and Zimbabwe, all of which have substantially higher life expectancies, as well as lower infant mortality rates, than sub-Saharan Africa as a whole. They also rank higher than sub-Saharan Africa as a whole on levels of educational attainment and income. (Freedman and Blanc, 1991).

3. SOME PATTERNS OF THE PROXIMATE DETERMINANTS AND FERTILITY: AN APPLICATION OF THE BONGAARTS MODEL

This section employs a model developed by Bongaarts (1982) to relate the level of fertility to three major proximate determinants of fertility. Indices of fertility effect of non-marriage, Cm; contraception, Cc; and postpartum infecundability, Ci; are presented. The indices can, in theory, range from 0.0 to 1.0, with lower values indicating a greater fertility-reducing effect. Although that the three indices (Cm, Cc, and Ci) are calculated in different ways makes it a question to compare the fertility-reducing effects of the different kinds of indices (eg. to compare Cc with Ci), it is sufficiently meaningful to compare each one kind of index in differnt time or cross-nationally. To examine these aggregate indices, which are estimated from the DHS data, between DHS countries enables characterizing the countries with regard to the patterns or combination of the level of proximate determinants and fertility. Moreover, aggregate indices estimated from WFS data are compared with that estimated from DHS. These examination will lead to better understanding of the differences in biological and behavioral mechanisms of fertility decline in the developing countries.

1) Indices of Fertility Effect of Non-Marriage (Cm)

In the Bongaarts model, index of fertility-reducing effect of non-marriage (Cm) is defined: Cm=TFR/TMFR (Cm equals 1 if all women of reproductive age are married and 0 in the absence of marriage).

Arnold and Blanc (1990) presented the TFR and TMFR for 25 countries for the period 0-2 years prior to the survey, from the DHS data (shown in Table 1, Columns 3 and 4). It should be noted that the presented TFRs are for women at ages 15-44, while the presented TMFRs are for 0-29 years since first marriage. Because the denominators do not accord, the true value of Cm cannot be calculated from the presented TFR and TMFR. Only an "approximate" value of Cm can be calculated from the TFR and TMFR presented in Table 1 (Columns 3 and 4).

The "approximate" values of Cm are shown in Table 7 (Column 3). They are very high (close to 1.0) in Botswana (0.983), Mali (0.972), Liberia (0.939), and Trinidad and Tobago (0.933), while lowest (greatest in fertility reducing effect) in Morocco (0.707), Tunisia (0.731), and Indonesia (0.759). Higher Cm generally means the condition of earlier marriage and higher proportion of currently married women, but can be caused by higher levels of extra-marital (premarital) childbearing, larger number of couples who live together without being married or who are involved in a visiting relationship. Further discussion is difficult for more detailed information being not available.

2) Indices of Fertility Effect of Contraception (Cc)

In the Bongaarts model, index of fertility-reducing effect of contraception (Cc) is given by the following equation.

$$Cc = 1 - 1.08 \times u \times e$$

where

- Cc: index of contraception (equals 1 in the absence of contraception and 0 if all fecund women use 100% effective contraception).
- u: proportion currently using contraception among married women of reproductive age.
- e: average use-effectiveness of contraception (Note 2).

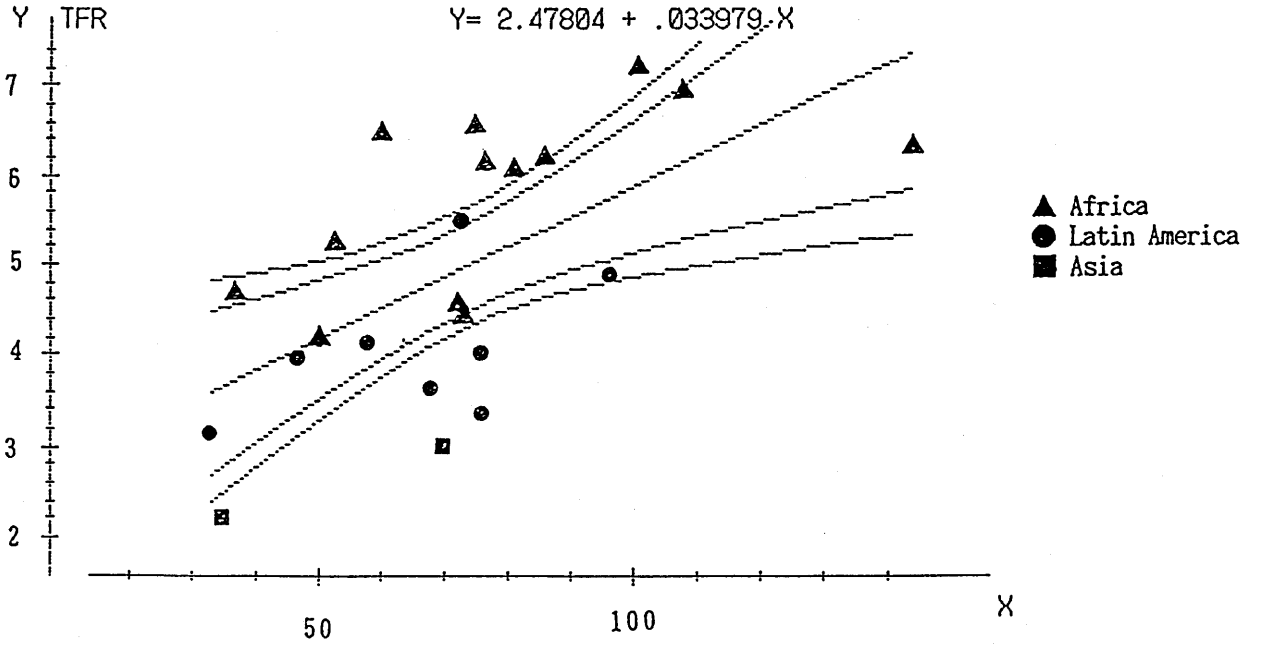
Indices of fertility effect of contraception (Cc)

Table 6 Trends in Infant Mortality Rate (per 1,000 Live Births)

Country	Infant Mortality Rate (UN estimates) 1955-60 (1)	'60-65 (2)	'65-70 (3)	'70-75 (4)	'75-80 (5)	'80-85 (6)	Infant Mortality Rate (DHS estimate) (7)	(Year)	(1)-(7)	(1)-(7)/(1) (%)
ASIA										
Indonesia	145	133	124	114	105	95	70	(1982-87)	75	52
Pakistan	170	155	145	140	130	120	91	(1985-90)	79	46
Thailand	114	95	84	65	56	-	35	(1982-87)	79	69
LATIN AMERICA /CARBBEAN										
Bolivia	170	164	157	151	138	124	96	(1979-89)	74	44
Brazil	122	109	100	91	79	-	76	(1981-86)	46	38
Colombia	104	84	74	65	55	-	33	(1981-86)	71	68
Dominican Republic	133	117	105	94	84	-	68	(1981-86)	65	49
Ecuador	130	119	107	95	82	-	58	(1982-86)	72	55
Guatemala	131	119	108	95	82	70	73	(1982-87)	58	44
Mexico	98	86	79	69	60	53	47	(1982-87)	51	52
Paraguay	91	81	67	53	49	45	34	(1985-90)	57	63
Peru	148	136	126	110	105	-	76	(1981-86)	72	49
NORTH AFRICA										
Egypt	183	175	170	150	120	100	73	(1984-88)	110	60
Morocco	170	155	138	122	110	97	73	(1982-86)	97	57
Sudan	175	165	156	145	131	118	70	(1985-90)	105	60
Tunisia	163	155	138	120	88	71	50	(1983-83)	113	69
SUB-SAHARAN AFRICA										
Botswana	122	115	110	95	82	76	37	(1983-88)	85	70
Burundi	158	145	140	135	130	-	75	(1982-86)	83	53
Ghana	137	127	117	107	103	98	77	(1983-87)	60	44
Kenya	130	118	108	98	88	80	60	(1984-89)	70	54
Liberia	185	176	167	155	143	-	144	(1981-86)	41	22
Mali	211	208	206	203	191	180	108	(1982-86)	103	49
Nigeria	194	185	172	148	124	114	87	(1985-90)	107	55
Senegal	184	176	168	162	154	-	86	(1981-86)	98	53
Togo	193	170	141	121	11	102	81	(1983-87)	112	58
Uganda	140	125	118	116	114	112	101	(1983-88)	39	28
Zimbabwe	113	106	101	93	86	76	53	(1983-88)	60	53

(Source) *Studies in Family Planning*, volume 19-23.

Figure 4 Relationship between Infant Mortality Rates and Total Fertility Rates, DHS



(Source) Table 1

Infant mortality rate (per 1,000 live births)

Table 7 The Three Bongaarts Indices and The Total Fertility Rate, WFS and DHS

Country	Survey	Cm	Cc	Ci	Cc×Ci	TFR	TF Counted Backward
ASIA							
Indonesia	WFS	0.752	0.771	0.574	0.443	4.51	-
Indonesia	DHS	(0.759)	0.536	0.645	0.346	3.03	11.5
Sri Lanka	DHS	(0.795)	0.417	-	-	2.67	-
Thailand	DHS	(0.782)	0.335	0.735	0.247	2.23	11.6
LATIN AMERICA/CARBBEAN							
Bolivia	DHS	(0.871)	0.739	0.627	0.463	4.93	12.2
Brazil	DHS	(0.832)	0.351	0.830	0.291	3.37	13.9
Colombia	WFS	0.602	0.633	0.846	0.536	4.27	-
Colombia	DHS	(0.817)	0.379	0.741	0.281	3.17	13.8
Dominican Republic	WFS	0.689	0.697	0.852	0.594	5.39	-
Dominican Republic	DHS	(0.809)	0.488	0.775	0.378	3.64	11.9
Ecuador	WFS	0.656	0.709	0.782	0.554	4.98	-
Ecuador	DHS	(0.829)	0.571	0.714	0.408	4.13	12.2
Guatemala	DHS	(0.850)	0.775	0.615	0.477	5.50	13.6
Mexico	WFS	0.684	0.730	0.842	0.615	5.93	-
Mexico	DHS	(0.811)	0.482	0.769	0.371	3.99	13.3
Peru	WFS	0.629	0.755	0.769	0.581	5.35	-
Peru	DHS	(0.808)	0.599	0.678	0.406	4.04	12.3
Trinidad and Tobago	WFS	0.702	0.569	0.887	0.505	3.18	-
Trinidad and Tobago	DHS	(0.933)	0.531	-	-	3.05	-
NORTH AFRICA							
Egypt	WFS	0.707	0.810	0.683	0.553	5.21	-
Egypt	DHS	(0.797)	0.633	0.722	0.457	4.51	12.4
Morocco	WFS	0.723	0.840	0.732	0.615	5.82	-
Morocco	DHS	(0.707)	0.664	-	-	4.45	-
Tunisia	WFS	0.655	0.747	0.742	0.554	5.83	-
Tunisia	DHS	(0.731)	0.520	0.760	0.395	4.13	14.3
SUB-SAHARAN AFRICA							
Botswana	DHS	(0.983)	0.677	0.587	0.397	4.68	12.0
Burundi	DHS	(0.866)	0.932	0.521	0.485	6.54	15.6
Ghana	WFS	0.819	0.923	0.666	0.615	6.22	-
Ghana	DHS	(0.916)	0.893	0.546	0.488	6.10	13.6
Kenya	WFS	0.790	0.944	0.695	0.656	7.40	-
Kenya	DHS	(0.869)	0.754	0.643	0.485	6.52	15.5
Liberia	DHS	(0.939)	0.939	0.590	0.554	6.35	12.2
Mali	DHS	(0.972)	0.962	0.567	0.545	6.94	13.1
Senegal	WFS	0.860	0.980	0.661	0.648	6.90	-
Senegal	DHS	(0.896)	0.909	0.548	0.498	6.21	13.9
Togo	DHS	(0.905)	0.740	0.515	0.381	6.12	17.7
Uganda	DHS	(0.927)	0.957	0.621	0.594	7.20	13.1
Zimbabwe	DHS	(0.875)	0.595	0.623	0.371	5.27	16.2

(Note) Cm, Cc, Ci, Cc×Ci, and TFR for the WFS data were presented by United Nations (1987).
Cm, Cc, Ci, and Cc×Ci for the DHS data were caluculated with the application of the Bongaarts model to the DHS data (table 1).
The values of Cm for the DHS (in parentheses) are approximate.
"TF counted backward" were calculated by use of the following equation, assuming that induced abortion is absent (Ca=1): TF = TFR / (Cm×Cc×Ci).

estimated from the DHS data are shown in Table 7 (Column 4). They are very high (smaller in fertility reducing effect) in Mali (0.962), Uganda (0.957), Liberia (0.939), Burundi (0.932), and Senegal (0.909), while lowest (greatest in effect) in Thailand (0.335), Brazil (0.351), and Colombia (0.379).

Comparing Cc from DHS data with Cc from WFS data (in Table 7), the values lowered (became greater in fertility-reducing effect) in all countries comparable between WFS and DHS. These changes are supposed to be the combined results of increased contraceptive prevalence and increased contraceptive effectiveness (from traditional to modern methods).

3) Indices of Fertility Effect of Postpartum Infecundability (Ci)

The index of fertility-reducing effect of postpartum infecundability (Ci) is estimated as

$$Ci = 20/(18.5+i)$$

where

Ci: index of postpartum infecundability (equals 1 in the absence of lactation and postpartum abstinence and 0 if the duration of infecundability is infinite).

i: average duration of postpartum infecundability caused by breastfeeding or postpartum abstinence.

Indices (Ci) estimated from the DHS data are shown in Table 7 (Column 5). They are very high (smaller in fertility reducing effect) in Brazil (0.830), Dominican Republic (0.775), Mexico (0.769), and Tunisia (0.760), while lowest (greater in effect) in Togo (0.515), Burundi (0.521), Ghana (0.546), and Senegal (0.548).

Comparing Ci from DHS data with Ci from WFS data (in Table 7), the values rose (became smaller in fertility-reducing effect) in 3 countries: Indonesia, Egypt, and Tunisia, while the values lowered (became greater in fertility-reducing effect) in 8 countries: Colombia, Dominican Republic, Equador, Mexico, Peru, Ghana, Kenya, and Senegal. Theoretically Ci rises (becomes smaller in effect) as postpartum breastfeeding or abstaining duration shortens. It is widely observed that the duration of breastfeeding has declined accompanied with urbanization and industrialization in developing countries. On the other hand, Ci falls (becomes greater in effect) as postpartum breastfeeding or abstaining duration lengthens. The result from this analysis appears paradoxical and not easy to explain. The promotion of breastfeeding and birth spacing in developing countries in recent years, encouraged by the World Health Orgainzaion and other international agencies and each government from the viewpoint of family planning and mother and child health, may contribute to it to a certain extent (Note 3). This possibility should be examined.

4) Patterns of the Proximate Determinants and Fertility

Among the three indices (Cm, Cc, Ci), the variation of Cc is the greatest (from 0.962 in Mali to 0.335 in Thailand), suggesting that the role of contraception is the greatest in determining the fertility levels of the DHS countries. It strengthens the viewpoint that contraception has played the greatest role in the process of fertility decline in DHS countries.

The values of $Cc \times Ci$, which indicate the combined effects of breastfeeding and contraception, are shown in Table 7 (Column 6). In general, the two values of Cc and Ci tend to change to the opposite directions in the process of modernization; for example, with industrialization, contraceptive prevalence increases (the value of Cc falls) and breastfeeding duration diclines (the value of Ci rises). Comparing Burundi and Kenya, whose TFRs from DHS are similar (6.54 and 6.52, respectively) and whose $Cc \times Ci$ values are equal as 0.485 (Table 7), patterns of the proximate determinats are different. The fertility-reducing effect of contraception is greater in Kenya ($Cc=0.754$) than that in Burundi ($Cc=0.932$), while the fertility-reducing effect of postpartum infecundability is greater in Burundi ($Ci=0.521$) than that in Kenya ($Ci=0.643$). In Kenya greater fertility-reducing effect of contraception was offset by smaller fertility-reducing effect of postpartum infecundability (shorter amenorrheic or abstaining duration).

Figure 5 shows patterns of the three proximate determinants (Cm, Cc, and Ci) from the DHS data, classified by fertility levels (values of Cm are approximate, as mentioned above). At the level of high fertility (Ⅰ: TFR is more than 6.0) the values of Cc is highest (smallest in effect), with lowest Ci (greatest in effect). At the level of middle high fertility (Ⅱ: TFR: 4.0-5.9) the values of Cc fall (become greater in effect). At the level of middle low fertility (Ⅲ: TFR: 2.0-3.9) the values of Cc are still more low (still more greater in effect). In the meantime the values of Cm fall (become greater in effect) and the values of Ci rise (become smaller in effect) gradually. This pattern is thought to represent a process of fertility decline (from phase Ⅰ to Ⅱ and Ⅲ) which is probably observed universally. The far more steep movement of the value of Cc (compared with Cm and Ci) also suggest that the contribution of contraception to recent fertility reduction in developing countries is the most important.

5) Examination of Total Fecundity

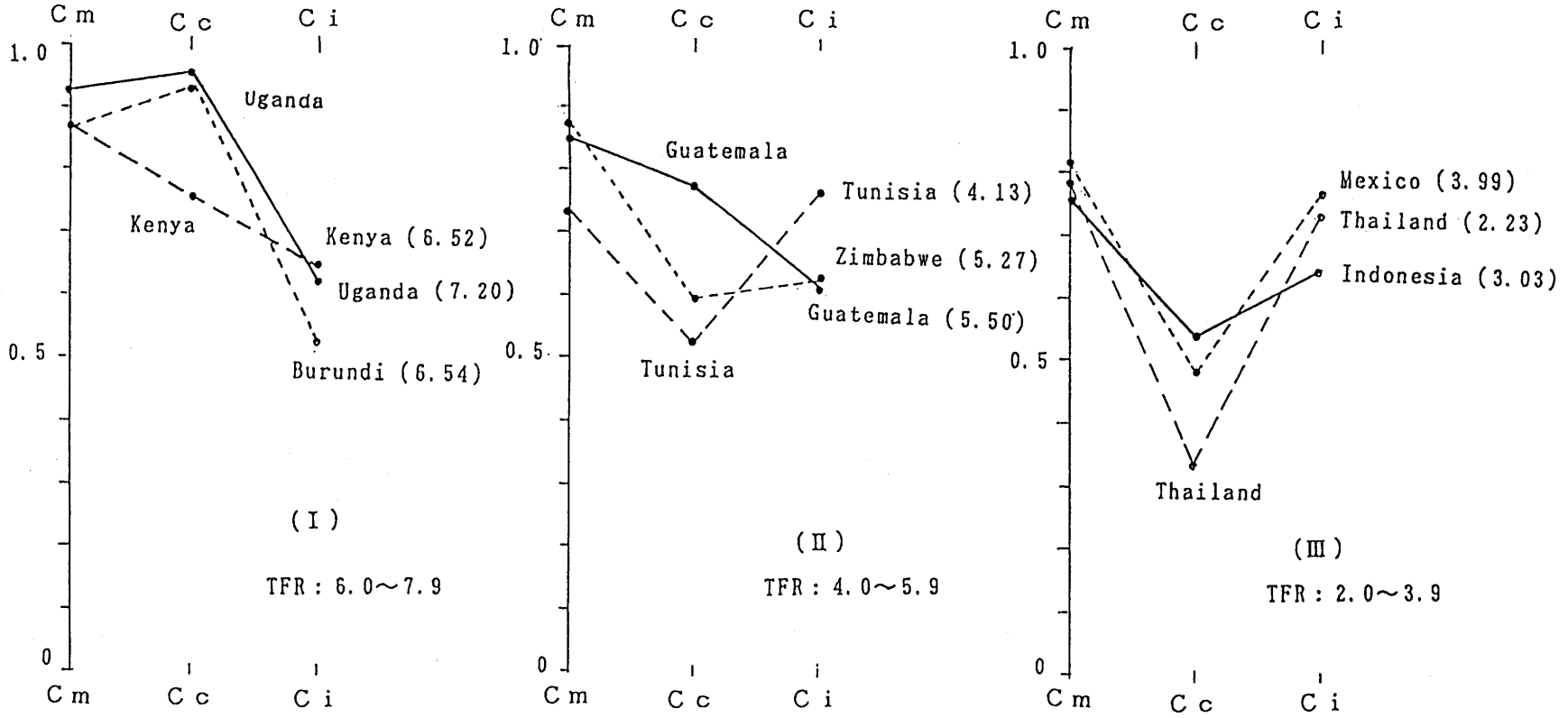
In the aggregate fertility model of Bongaarts, the following equation is given.

$$TFR = Cm \times Cc \times Ca \times Ci \times TF$$

where

Ca: index of induced abortion (equals 1 in the

Figure 5 Patterns of three proximate determinants, by three levels of fertility, DHS



(Note) Figures in parentheses are total fertility rates, Values of Cm are approximate

(source) Table 7

absence of induced abortion and 0 if all pregnances are aborted).

TF: a maximum level to which fertility will increase, if the fertility-inhibiting effects of (1) delayed marriage and marital disruption, (2) all practice of contraception and induced abortion, and (3) the practice of lactation and postpartum abstinence are removed.

Bongaarts (1982) estimated average value of TF as 15.3 births per woman.

If induced abortion is assumed to be absent (Ca=1), the equation can be rearranged as:

$$TF = TFR/(Cm \times Cc \times Ci)$$

The TF counted backward using the above equation are shown in Table 7 (Column 8). It is noteworthy that the calculated values of TF are under 15.3 in most countries, especially low in Indonesia (11.5), Thailand (11.6), Dominican Republic (11.9), Botswana (12.0), Bolivia, Liberia and Equador (12.2), Peru (12.3), and Egypt (12.4). Accodiong to Bongaarts (1978), the large majority of populations can be expected to have TFs between 13 and 17 births per woman. Lower TFs are only found in exceptional cases, such as in populations with a high incidence of disease-induced sterility or in populations where spousal separation is unusually frequent or prolonged (Bongaarts and Potter, 1983, p.87). Possible causes in the analysis are as follows;

(1) "Approximate" values of Cm is possibly higher than the true values of Cm (above mentioned), while another possibility is that there were considerable numbers of extra-marital childbearing.

(2) The fertility-inhibiting effects of the proximate detrminants excluded from this analysis, for example, induced abortion and separation, may be more than expected.

(3) The real total fecundity of the DHS countries may be lower than 15.3 due to the existence of malnutrition, sexually transmitted diseases, and other low health conditions which reduce fecundity from the normal level.

4. SUMMARY AND CONCLUSION

This chapter focusses on three major proximate determinants, that is, marriage, contraception and postpartum infecundability (especially breastfeeding) and infant mortality. The first part of the chapter describes the outline of levels and trends of fertility, the three major proximate determinants and infant mortality from the DHS data for 28 developing countries.

Although almost all DHS countries have experienced fertility reduction and accompanying increase of contraceptive prevalence more or less in recent years, there still remains remarkable differences both in fertility levels and contraceptive prevalence levels among them. The TFR ranges from 2.23 in Thailand to 7.20 in Uganda , and the contraceptive prevalence rate varies between 4.7 percent in Mali and 66.2 percent in Brazil. Especially among sub-Saharan African countries the tendency of low contraceptive use and high fertility is outstanding, however, in three countries: Botswana, Zimbabwe, and Kenya, long-term declines in fertility have taken place.

Among DHS countries mean or median duration of postpartum amenorrhea ranges from 4.2 months in Brazil to 19.1 months in Burundi. In most countries mean or median duration of amenorrhea is longer than that of postpartum abstinence. It shows that length of non-susceptible duration is determined by the length of amenorrhea, that is, breastfeeding.

Infant mortality rates have declined in all DHS countries for which trend data are available, and it ranges from 33 per 1000 live births in Colombia to 144 in Liberia. There is a fairly strong correlation between infant mortality and fertility level ($r=0.62$). It is certain that a sustained fertility decline is unlikely without declines in infant mortality, but infant mortality is not a proximate determinant. The relation of infant mortality to fertility is indirect.

In the second part of the chapter, the Bongaarts aggregate model is applied to the DHS data. In the application one problem is that a complete marriage history was not collected so the marital fertility rates may be underestimated. As a result, the true value of Cm (index of fertility reducing effect of non-marriage) cannot be calculated. An approximate value of Cm is probably higher (smaller in effect) than the true Cm.

Despite some problems with the application, the model does provide a useful means of summarizing the importance of the three main proximate determinants among 22 DHS countries. The index of fertility reducing effect of contraception (Cc) indicates that this factor is more important in some countries such as Thailand (0.335), Brazil (0.351), Colombia (0.379), etc. The index of postpartum infecundability (Ci) indicates that this factor is more important in some countries namely, Togo (0.515), Burundi (0.521), Ghana (0.546), Senegal (0.548), etc. Approximate index of marriage indicates that this factor is possible to be more important in some countries such as Morocco (0.707), Tunisia (0.731), Indonesia (0.759), etc.

Over all, although all three factors must be considered as important to account for variations on fertility among developing countries, there are some grounds indicating that contraception has played the greatest role in producing differences in national fertility levels among DHS countries: (1) The correlation across 25 DHS countries between the contraceptive prevalence and TFR

is very high (r=-0.93). (2) Although all three indices range widely in value, the index of contraception varies most. (3) In the process of fertility decline (from high to middle high and middle low level of fertility), the movement of the value of Cc is far more steep, although all three of the proximate determinants vary according to the level of fertility.

In other words, an increase in effect of contraception (an increase in prevalence and effectiveness) is needed in order that fertility level may change from high (TFR: more than 6) to middle high level (TFR: 4.0-5.9). And additional increase in effect of contraception is necessary in order to realize further reduction of fertility, from middle high to middle low level (TFR: 2.0-3.9).

In the context of very high fertility level, there is a considerable potential for fertility increase if the duration of breastfeeding declines without a compensating increase in contraceptive practice. However, the fertility impact of postpartum infecundability (practice of extended breastfeeding or abstenence) becomes less important as fertility level drops from high to middle levels. Recently breastfeeding tends to be regarded as an important determinant of birth interval length and thus the health and welfare of the children rather than an effective means of reducing high fertility levels (Rutstein,1991). Further study and analyses are needed in the relationship between fertility levels, proximate determinants, infant mortality, and family planning efforts in the developing countries to make generalized statements in this regard.

NOTES

1) Induced abortion may contribute to lower-than-expected fertility in the Caribbean, although adequate statistics regarding abortion incidence are not available (Weinberger, 1991, p.556).

2) Average use-effectiveness, e, is estimated as the weighted average of the method specific use-effectiveness levels, e(m), with the weights equal to the proportion of women using a given method, u(m): $e = \Sigma e(m)u(m)/u$. The e(m) values in this calculation follows Bongaarts and Potter(1983). Bongaarts adapted the values from a study by Laing (1978).

3) The health and fertility implications of breastfeeding patterns in developing countries have received much attention in recent years. Prompted in part by the perceived increasing popularity of artificial feeding during the 1970s, and by the reported declines in average durations and proportions of women initially breastfeeding in several developing countries, health organizations such as WHO and UNICEF have placed breastfeeding promotion high on their health-policy agendas (Trussll, et al., 1992).

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