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Fertility and Contraception: An Analysis with National Level Data

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Abstract

Analyses of data from recent demographic surveys reveal that fertility has declined quite significantly in many countries, and most demographers and population analysts agree that a large part of this decline may be attributed to an increase in the use of contraception among couples of reproductive age. There is a direct linkage between the use of contraception and fertility decline, and this paper attempts to uncover the correlates of the use of contraception, and hence of fertility decline, by analyzing national level data from 93 countries of Sub-Saharan Africa, Near East and North Africa, Asia and Pacific, Latin America and Caribbean, and East Europe and Central Asian Republics.

The data were taken from Population Reports (vol. 27(2), July 1999:24-27), and from the 1997 World Population Data Sheet. The main variable of interest is the percentage of couples using contraception which has been collapsed into three groups of countries: group 1 (low rates of use), group 2 (medium rates of use), and group 3 (high rates of use). The technique called canonical discriminant analysis has been used to identify those variables that discriminate among the groups most.

The analysis shows that the total fertility rate is the most influential variable in discriminating among the groups of countries with low (group 1), medium (group 2), and high (group 3) rates of the use of contraception, followed by the percentage of children under 15 years of age, human development index, urban population, population growth rate, gross national product, and child mortality, in that order.

Policy implications are discussed.

Keywords

Fertility, contraception, canonical discriminant analysis, cross-cultural research

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INTRODUCTION

The recent decades have witnessed a proliferation of research undertakings aimed at identifying factors that influence fertility around the world. The phenomenon gained momentum particularly in the wake of the perception of how quickly populations in different countries had been multiplying. The purpose was to identify the population groups more prone to producing large numbers of children in different sociocultural settings (Agyei and Mbamanya, 1989; Sufian and Johnson, 1989; Fargues, 1988; Gueye and Van de Walle, 1988; Poston and Gu, 1987). Needless to say, the knowledge of such determinants is a prerequisite for adopting effective strategies to slow down the pace of population growth that is alarming in many developing countries. The principal purpose behind mounting family planning programs in developing countries was to reduce this rapid population growth. The underlying rationale was that there was a latent demand for contraception among couples of reproductive age in almost every population. Recent evidence from a number of demographic surveys reveals that fertility has declined quite significantly in many developing countries, and most demographers and population analysts agree that a substantial part of this decline may be attributed to an increase in the use of contraception among couples of reproductive age (Berelson, Mauldin and Segal, 1980; Bongaarts, 1986; DaVanzo and Haaga, 1982; Lapham and Mauldin, 1985).

The direct linkage between contraceptive use and fertility decline has aroused widespread interest among researchers to uncover the factors that influence women to use contraception. The social scientists believe that both socioeconomic development and family planning programs play, independently as well as interactively, important roles in reducing fertility. The interactive role exists to the extent that socioeconomic development provides important grounds for the successful operation of the family planning programs (Lerman et al., 1989).

This paper endeavours to identify the correlates of contraceptive use by analyzing aggregate level data from a number of countries.

DATA AND METHODS

Data and Variables

The Center for Communication Programs (1999), Johns Hopkins University, Maryland, U.S.A., has compiled data in Population Reports on a number of sociodemographic variables from United Nations (UN), United Nations Children's Fund (UNICEF), United Nations Development Programme (UNDP), and Population Reference Bureau on 139 countries from Sub-Saharan Africa, Near East and North Africa, Asia and Pacific, Latin America and Caribbean, and East Europe and Central Asian Republics. The data in this analysis have been taken from this Population Reports as well as from the 1997 World Population Data Sheet (Population Reference Bureau, 1997).

The main variable of interest in this paper is the percentage of couples using contraceptives. This percentage of contraceptive users varies from lows of 2 in Guinea, 3 in Mauritania, 4 in Ethiopia and Niger to highs of 75 in Costa Rica and Mauritius, 77 in Brazil, 79 in South Korea, and 83 in China. For the purpose of the present analysis the values of this variable have been collapsed and the variable renamed as contraceptive level (CLEV) to form three groups of countries: countries with low rates of contraceptive use (group 1 (CLEV = L): percentages 2-29),

countries with medium rates of contraceptive use (group 2 (CLEV = M): percentages 30-56), and countries with high rates of contraceptive use (group 3 (CLEV = H): percentages 57-83). It can be seen that roughly an equal class interval of 27 has been used to yield the three groups of countries.

The aim of this paper is to identify those variables that contribute most in discriminating among the three groups of countries. The groups may not differ equally on all variables – some variables may be more important than others in discriminating among the three groups. In such a case, these more important variables should be of greater concern to the governments seeking to raise the rates of contraceptive users in their respective countries.

The variables which are used to discriminate among the three groups are: probability of dying between birth and exactly five years of age per 1000 live births (CMORT: X_1), percentage of the total population living in urban areas (URB: X_2), percentage of the total population under 15 years of age (CHILD: X_3), human development index (ranging from 0 to 1.0) based on three dimensions of human development: life expectancy, educational attainment, and per capita income (INDEX: X_4), total fertility rate defined as the number of children a woman would have if she survived to the end of her reproductive period and experienced a given set of age-specific birth rates (TFR: X_5), population growth rate (PGR: X_6), and gross national product (GNP: X_7). A detailed discussion of the variables, their measures, data sources, etc., have been presented in Population Reports and 1997 World Population Data Sheet.

Data for all the above eight variables were available only for 93 countries out of 139 listed in Population Reports, and are shown in table 1. This analysis is based on data of these 93 countries of which 36 belong to group 1, 28 belong to group 2, and the rest 29 belong to group 3.

The choice of these discriminating variables was guided by theoretical reasoning as well as by availability of data. A high probability of death among infants and young children motivates a deliberately high fertility level and an avoidance of contraception (Rogers, 1973: 86). Most studies on the relationship between child mortality and contraceptive use suggest that the likelihood to contracept is lower among couples who have lost one or more children through death than those who have not (Rutstein, 1971; Adlakha, 1973; Rizk et al., 1980; Heer, 1983; Tuladhar, 1985; Johnson and Sufian, 1992; Nazar-Beutelspacher et al., 1999). Place of residence (urban/rural) has been found to be an important determinant of contraceptive use (Lightbourne, 1980; Tuladhar, 1985; Nazar-Beutelspacher et al., 1999). Urban areas are usually the centres of political and economic power and a great part of national resources and social services are concentrated in them. People living in urban areas enjoy relatively more opportunities of modern life which is conducive to have smaller family size and, as such, are more motivated to use contraception than their rural counterparts. Also, contraceptive use is lower among young married women with fewer children than among other married women (Monteith et al., 1988).

Table 1. Classification of 93 countries into three groups according to levels of contraceptive use, and values of seven discriminating variables

COUNTRY	CLEV	CMORT	URB	CHILD	INDEX	TFR	PGR	GNP
Group1 (Low rate of contraceptive use)								
GUINEA	L	201	29	47	0.398	5.7	2.4	550

MAURITANIA	L	183	39	45	0.447	5.5	2.7	460
ETHIOPIA	L	175	15	48	0.298	7	2.5	100
NIGER	L	320	15	49	0.298	7.5	3	220
MOZAMBIQUE	L	208	28	46	0.341	5.6	2.2	80
NIGERIA	L	187	16	46	0.456	6.2	3	260
MALI	L	239	26	50	0.375	6.7	3.1	250
BURKINA FASO	L	169	15	48	0.304	6.7	2.9	230
BURUNDI	L	176	6	47	0.324	6.5	2.5	160
COTE D'IVOIRE	L	150	46	45	0.422	6.1	2.7	660
GAMBIA	L	87	26	41	0.391	5.6	2.4	320
TOGO	L	125	30	46	0.469	5.4	2.6	310
SENEGAL	L	124	43	45	0.426	5.7	2.8	600
YEMEN	L	100	25	47	0.449	6.7	2.9	260
CENTRAL AFRICAN REPUBLIC	L	173	39	43	0.378	5.1	2.1	340
UGANDA	L	137	11	47	0.404	6.9	2.9	240
BENIN	L	167	36	49	0.421	6.3	3	370
CAMEROON	L	99	44	44	0.536	5.2	2.7	650
MADAGASCAR	L	158	22	44	0.453	6	2.9	230
TANZANIA	L	143	21	46	0.421	5.7	2.5	120
PAKISTAN	L	136	28	41	0.508	5.6	2.8	460
HAITI	L	132	32	43	0.43	4.8	2.1	250
BHUTAN	L	121	15	43	0.459	5.6	3.1	420
LAOS	L	122	19	45	0.491	5.6	2.6	350
GHANA	L	107	36	45	0.544	5.4	2.9	390
SWAZILAND	L	94	30	43	0.644	5.2	3.2	1170
COMOROS	L	93	29	48	0.506	5.1	2.8	470
RWANDA	L	170	5	48	0.379	6	2.1	180
MALAWI	L	215	18	48	0.399	5.9	1.7	170
OMAN	L	18	72	36	0.725	7.1	3.9	4820
LESOTHO	L	137	16	41	0.582	4.3	2.1	770
ZAMBIA	L	202	42	45	0.431	6.1	2	400
PAPUA NEW GUINEA	L	112	15	42	0.57	4.8	2.4	1160
UNITED ARAB EMIRATES	L	10	82	30	0.812	4.9	2.2	17400
NAMIBIA	L	75	32	42	0.638	5.1	1.7	2000
NEPAL	L	104	10	42	0.463	4.6	2.5	200
Group2 (Medium rate of contraceptive use								
GUATEMALA	M	55	39	45	0.624	5.1	2.9	1340
BOTSWANA	M	49	27	43	0.609	4.1	1.2	3020
KENYA	M	87	27	46	0.519	4.7	2.1	280
JORDAN	M	24	78	42	0.715	4.4	2.5	1510
KUWAIT	M	13	96	29	0.833	3.2	2.2	17390
SYRIA	M	33	51	45	0.663	4.7	2.8	1120
PHILIPPINES	M	41	47	38	0.74	3.7	2.3	1050
INDIA	M	108	26	35	0.545	3.4	1.9	340
BOLIVIA	M	96	58	41	0.652	4.2	2	800
EGYPT	M	73	44	39	0.616	3.3	2	790
ZIMBABWE	M	80	31	45	0.56	4	1.2	540
MALAYSIA	M	11	51	36	0.768	3.2	2.1	3890
LATVIA	M	20	69	20	0.744	1.1	-0.6	2270
BANGLADESH	M	109	16	42	0.44	3.3	1.8	240
NICARAGUA	M	57	63	44	0.616	3.9	3.2	380
VENEZUELA	M	25	85	38	0.792	2.9	2	3020
SOUTH AFRICA	M	65	57	35	0.695	3.3	1.6	3160
HONDURAS	M	45	47	44	0.641	4.4	2.8	600
MOROCCO	M	72	51	36	0.582	3.1	1.7	1110
BELARUS	M	18	69	22	0.763	1.3	-0.4	2070
ALGERIA	M	39	50	39	0.665	4.1	2.4	1600
EL SALVADOR	M	36	45	39	0.674	3.6	2.3	1610

TRINIDAD AND TOBAGO	M	17	65	30	0.797	1.7	0.7	3770
LEBANON	M	37	87	34	0.749	2.4	1.6	2660
INDONESIA	M	68	31	34	0.681	2.8	1.6	980
BARBADOS	M	12	38	24	0.857	1.8	0.5	6560
PARGUAY	M	33	50	42	0.73	4.4	2.7	1690
UZBEKISTAN	M	60	38	41	0.72	3.2	2	970
Group3 (High rate of contraceptive use)								
ECUADOR	H	39	59	36	0.747	3.3	2.1	1390
ROMANIA	H	26	55	20	0.752	1.3	-0.1	1480
PANAMA	H	20	55	33	0.791	2.7	1.8	2750
KAZAKSTAN	H	44	56	30	0.74	1.8	0.5	1330
LITHUANIA	H	15	68	22	0.761	1.4	-0.1	1900
TUNISIA	H	33	58	35	0.695	2.8	1.6	1820
MONGOLIA	H	150	55	29	0.618	2.7	1.4	310
BAHRAIN	H	22	88	31	0.832	2.8	1.9	7840
BAHAMAS	H	21	86	22	0.851	2	1.5	11940
JAMAICA	H	11	50	36	0.734	2.8	1.7	1510
TURKEY	H	45	63	32	0.728	2.6	1.5	2780
DOMINICAN REPUBLIC	H	53	61	36	0.726	3.2	2.1	1460
PERU	H	56	70	36	0.739	3.5	2.2	2310
VIET NAM	H	43	20	40	0.664	2.7	1.5	240
SRI LANKA	H	19	22	35	0.721	2.2	1.2	700
MEXICO	H	35	71	36	0.786	3	2.2	3320
CZECH REPUBLIC	H	7	77	18	0.833	1.2	-0.2	3870
ESTONIA	H	14	70	20	0.773	1.2	-0.4	2860
COLOMBIA	H	30	70	33	0.768	3	2	1910
HUNGARY	H	11	64	18	0.795	1.3	-0.4	4120
SINGAPORE	H	4	100	23	0.888	1.6	1	26730
THAILAND	H	38	19	30	0.753	2	1.1	2740
MAURITIUS	H	23	43	27	0.764	2	1	3380
COSTA RICA	H	14	44	33	0.801	2.7	1.8	2610
POLAND	H	11	62	23	0.802	1.5	0.1	2790
BULGARIA	H	19	68	18	0.758	1.1	-0.6	1330
BRAZIL	H	44	76	32	0.739	2.3	1.5	3640
SOUTH KOREA	H	6	74	23	0.852	1.6	1	9700
CHINA	H	47	29	26	0.701	1.8	1	620

Another discriminating variable is the human development index based on life expectancy, educational attainment, and per capita income. Women's education has been consistently found to have positive effect on contraceptive use (Cochrane, 1979; Johnson-Ascadi and Weinberger, 1980; Nortman, 1982; Lesthaeghe et al., 1983; Gomes, 1984; Mason, 1985; Nazar-Beutelspacher et al., 1999). Education increases awareness and receptivity to 'new technologies', and provides women better opportunities of life, such as, formal-sector employment that clearly conflicts with the time demands of child care, and as a result, better educated women are more likely to desire fewer children and hence have the higher motivation for contraception (Monteith et al., 1988: 99). Njogu found that in Kenya an increase in the proportions of better educated women and of women who want to cease childbearing were the primary sources for the increase in contraceptive use (Njogu, 1991). Since educational attainment is a component of the composite measure of human development index, it has not been used separately as a discriminating variable. Borg (1989) observed a negative relationship between income and fertility. A similar finding has echoed in a study by Shapiro and Tambashe (1994) who found that women with high economic

status were more likely to use contraception than women of low economic status. They argue that infant and child mortality is usually lower among higher income families with a consequent greater number of surviving children, and hence greater motivation to use contraception. Our hypothesis is that there is a positive correlation between the human development index and contraceptive use.

Total fertility rate is negatively correlated with contraceptive use – the higher the contraceptive use the lower the fertility (Monteith, et al., 1988). Also, the perception of a high fertility may produce a community level effect on contraceptive use. In a society with a high total fertility rate, women are more likely than not to observe many families with large numbers of children around. They also observe how having such large numbers of children has impeded providing them (the children) better health facilities, education, housing spaces and so on, in those families. This may lead women to develop a desire to have smaller number of children, and hence to contracept. The effect of population growth can be similarly explained. We also hypothesize that the higher the gross national product the higher the rate of contraceptive use.

Technique of Analysis

The technique called canonical discriminant analysis has been used to analyze data in this paper. This technique is appropriate when there are two or more groups that can be assumed to differ on several interval or ratio level variables and the researcher wants to identify those variables that discriminate among the groups most (Nie et al., 1975; Bennett and Bowers, 1976; Klecka, 1980). The technique assumes that the discriminating variables follow the multivariate normality given by

$$f(X, \mu, \Sigma) = \frac{1}{(2\pi)^{p/2} |\Sigma|^{1/2}} e^{-\frac{1}{2}(X-\mu)' \Sigma^{-1} (X-\mu)}$$

where X' = vector of variables (X_1, X_2, …..,X_7)
μ = mean vector of the variables X_1, X_2, …..,X_7
Σ = common covariance matrix.

The canonical discriminant functions to be derived are of the form

$$F = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots + B_7 X_7$$

where Xs are the discriminating variables, and βs are the unstandardized coefficients. The standardized coefficients are given by

$$\gamma_i = \beta_i \sqrt{\frac{w_{ii}}{n-g}}$$

where w_{ii} = within sum of squares of the variable X_i
g = number of groups = 3
n = total number of cases over all the groups.

FINDINGS

The mean values of the discriminating variables for the three groups of countries are presented in table 2.

Table 2. Mean values of the discriminating variables for the three groups of countries

Variable	**Group 1** Low rate of contraceptive use	**Group 2** Medium rate of contraceptive use	**Group 3** High rate of contraceptive use
Child mortality (X_1)	143.58	49.39	31.03
Urban population (X_2)	28.14	51.29	59.76
Children under 15 years of age (X_3)	44.58	37.43	28.72
Human development index (X_4)	0.46	0.68	0.76
Total fertility rate (X_5)	5.78	3.40	2.21
Population growth rate (X_6)	2.61	1.83	1.10
Gross national product (X_7)	1028.00	2313.00	3772.00

The multivariate measure of group differences, Wilk's lambda, is given by

$$\Lambda = \prod_{i=r+1}^{q} \frac{1}{1+\lambda_i}$$

where r is the number of discriminant functions already derived, q is the maximum number of discriminant functions, and λ_i is the eigen value associated with the ith discriminant function. The value of Wilk's lambda is 0.1296 for r = 0, that is, before deriving any function. This small value of Λ which is an inverse measure suggests that the selected variables will discriminate among the groups quite effectively. This is not counter to our expectation since the group means differ on each variable, in some cases, quite markedly (see table 2).

The standardized canonical coefficients are presented in table 3.

Table 3. Standardized canonical coefficients

Variables	First discriminant function	Second discriminant function
Child mortality (X_1)	0.0746	- 1.0158
Urban population (X_2)	- 0.3139	0.4822
Children under 15 years of age (X_3)	- 0.9087	2.6313
Human development index (X_4)	- 0.6422	- 0.2038
Total fertility rate (X_5)	2.6946	- 0.5579
Population growth rate (X_6)	- 0.3115	- 0.7064
Gross national product (X_7)	0.2608	0.0842

The associated discriminant functions are

$Y_1 = 0.0746Z_1 - 0.3139Z_2 - 0.9087Z_3 - 0.6422Z_4 + 2.6946Z_5 - 0.3135Z_6 + 0.2608Z_7$

$Y_2 = -1.0158Z_1 + 0.4822Z_2 + 2.6313Z_3 - 0.2038Z_4 - 0.5579Z_5 - 0.7064Z_6 + 0.0842Z_7$

where Zs are Xs expressed in standardized forms.

To gauge the efficiency of the discriminant functions in discriminating among the three groups, the eigen values and canonical correlations have been calculated and are presented in table 4. It can be observed from the table that 94.7 percent of the total discriminable variance 5.3031 ($= \lambda_1 + \lambda_2$), is accounted for by the first discriminant

Table 4. Eigen values and canonical correlations

Discriminant function	Eigen value	Relative percentage	Canonical correlation
i	λ_i		R_i
1	5.0218	94.70	0.9070
2	0.2813	5.30	0.4263

function Y_1, while Y_2, the second discriminant function, accounts for only 5.3 percent of the total discriminating power. This implies that the efficiency of Y_1 to discriminate among the three groups of countries is very high. This contention is strengthened by the examination of canonical correlations that shows that Y_1 is strongly related to the groups ($R_1 = 0.9070$) while Y_2 has a much weaker relationship ($R_2 = 0.4263$) with the groups.

The adequacy of the discriminant functions as well as the effectiveness of the discriminating variables have also been judged by examining the number of correctly classified cases. Table 5 shows this classification of the countries, and table 6 shows the countries that are misclassified. It can be seen from table 5 that almost 98 percent of the countries (91 out of 93) have been correctly classified, showing the appropriateness of the technique employed.

Table 5. Classification of countries by contraceptive use levels

		Classified into		
		L	M	H
Original levels	L	36	0	0
	M	**0**	**28**	**0**
	H	0	2	27

Table 6. Misclassified countries

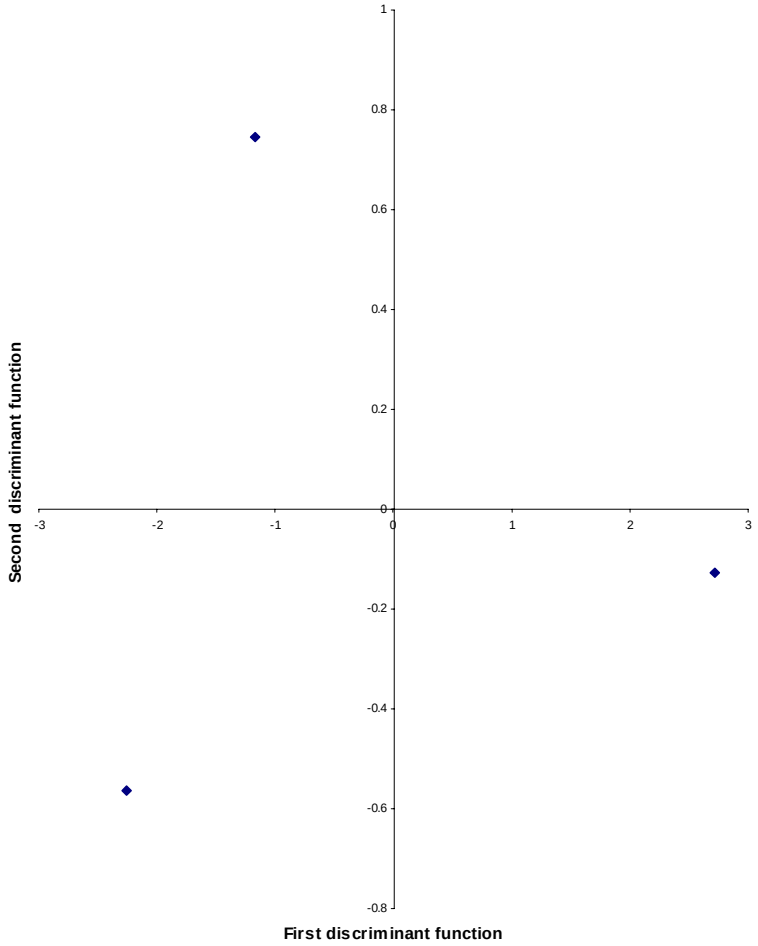
Countries	Original levels	Misclassified into
Peru	H	M
Kazakstan	H	M

Figure 1 shows the diagram of the group centroids (table 7) in the space where the first and second discriminant functions represent the horizontal and vertical axes respectively. The diagram shows a wide separation among the three groups implying that the variables have been selected quite appropriately for discriminating among the groups.

Table 7. Mean discriminant function scores

Functions	Group 1 (low)	Group 2 (medium)	Group 3 (high)
First discriminant function	2.7216	-1.1651	-2.2537
Second discriminant function	-0.1269	0.7455	-0.5623

Figure 1 (group 1 lower right quadrant; group 2 upper left quadrant; group 3 lower left quadrant)



Having judged the adequacy of the technique employed and effectiveness of the variables to discriminate among the groups we may now proceed to interpret the discriminant functions. The absolute values of the canonical coefficients for a given function represent the relative contributions of the associated variables to the function score. The positive sign of a coefficient indicates that the contribution of the associated variable to the function score is positive, while the negative sign of a coefficient implies that the associated variable contributes negatively to the score. Table 3 shows that, for the first function, the total fertility rate has the highest contribution (2.6946), and as such, is the most influential variable in discriminating among the three groups. The positive sign of the coefficient indicates that the total fertility rate contributes positively to the first discriminant function score and hence increases the likelihood that the corresponding country will belong to group 1 (low contraceptive use), as is evident from Figure 1.

The second most influential variable in discriminating among the groups is the percentage of children under 15 years of age (-0.9087). The negative sign implies that as this percentage decreases the value of the discriminant function score increases and the likelihood for the country to belong to group 1 increases. This variable is followed by human development index (-0.6422), urban population (-0.3139), population

growth rate (-0.3115), gross national product (0.2608), and child mortality (0.0746), in that order.

It can be observed from table 3 that the percentage of children under 15 years of age is the most influential variable for the second discriminant function (2.6313), followed by child mortality (-1.0158), and population growth rate (-0.7064). However, since the second discriminant function is left to account for only 5.3 percent of the total discriminating power, our interest lies mainly in the first discriminant function. Also, most of the variables contribute quite significantly for both functions, and as a result, the functions themselves cannot be interpreted meaningfully.

The relationship between a variable and a function, unaffected by relationships with other variables, is measured by total structure coefficients, presented in table 8. A large value of a coefficient indicates that the function and the associated variable are carrying the same amount of information. Two correlated variables share contributions to the discriminant score, and as a result, the standardized coefficients, which measure their contributions, may be smaller than when only one of the variables is used, or may be larger but with opposite signs so that the balance of the contributions is retained.

Table 8 shows that all variables except gross national product have high structure coefficients on the first function. The standardized coefficients for child mortality, urban population, and population growth rate are low (0.0746, -0.3139, and –0.3115 respectively) but their structure coefficients are quite large (0.8430, -0.6603, and 0.6832). This may be due to a high correlation between child mortality and each of urban population (-0.6719), children under 15 years of age (0.7200), human development index (-0.9097), total fertility rate (0.7818); between urban population and each of child mortality (-0.6719), children under 15 years of age (-0.6636), human development index (0.7731), total fertility rate (-0.6047), and gross national product (0.6181); and between population growth rate and each of children under 15 years of age (0.8403), and total fertility rate (0.8404) so that the net effects represent the true effects upon the discriminant score (correlation table not shown here). A similar interpretation of the total structure coefficients on the second discriminant function can be made.

Table 8. Total canonical structure coefficients

Variables	**First discriminant** function	**Second discriminant** function
Child mortality (X_1)	0.8430	- 0.0871
Urban population (X_2)	- 0.6603	- 0.0625
Children under 15 years of age (X_3)	0.7734	0.5481
Human development index (X_4)	- 0.8902	-0.1044
Total fertility rate (X_5)	0.9570	0.2176
Population growth rate (X_6)	0.6832	0.3737
Gross national product (X_7)	-0.2990	-0.1995

SUMMARY AND DISCUSSIONS

The percentage of couples using contraceptives for 93 countries from Sub-Saharan Africa, Near East and North Africa, Asia and Pacific, Latin America and Caribbean,

and East Europe and Central Asian Republics has been used to classify them (the countries) into three groups: low rate of contraceptive use (group 1), medium rate of contraceptive use (group 2), and high rate of contraceptive use (group 3). The seven variables used to discriminate among the groups are: child mortality, urban population, children under 15 years of age, human development index, total fertility rate, population growth rate, and gross national product. Data for all these variables have been taken from 1997 World Population Data Sheet as well as from Population Reports compiled by the Center for Communication Programs, Johns Hopkins University, Maryland, U.S.A. The technique employed to identify variables that discriminate among the groups most is the discriminant analysis.

The two possible discriminant functions, Y_1 and Y_2, have accounted for approximately 95 percent and 5 percent of the total discriminating power of the seven variables, indicating that Y_1 is highly effective in discriminating among the three groups – a finding consistent with the high value of the associated canonical correlation of Y_1 ($R_1 = 0.9070$). The appropriateness of the technique used and the adequacy of the variables selected are strongly demonstrated by the fact that 98 percent of the countries (91 out of 93) have been correctly classified, and by the wide separation of the three groups in the plot of the group centroids(see Figure 1).

The total fertility rate has emerged as the most influential discriminating variable, followed by percentage of the total population under 15 years of age, human development index, percentage of the total population living in urban areas, population growth rate, and gross national product. Although, the standardized canonical coefficient associated with child mortality is very small, its structure coefficient on the first discriminant function is very high, implying that its contribution to the discriminant score measured by the standardized coefficient was heavily shared by other correlated variables. An examination of the structure coefficients shows that all the variables used in the analysis except gross national product have contributed quite significantly in discriminating among the three groups of countries. Both the standardized coefficient and structure coefficient of the gross national product are low, showing that this variable has consistently been found to have made small contribution to the discriminant score.

There are three main limitations of the study. It is obvious that there is an element of arbitrariness in classifying the countries into three groups. The criterion of an equal class interval to decide the cutting points on the percentage of contraceptive use to form the three groups cannot be considered as a firm criterion. However, this type of arbitrariness is inherent in all such classifications, and except at the borderlines, there are strong grounds for broadly differentiating the groups based on contraceptive use rates. In order for the discriminant analysis technique to be applicable, the discriminating variables are to follow multivariate normality – a requirement that has not been examined here. However, the technique is very robust and a strong adherence to the assumptions is not necessary (Nie et al., 1975; Lachenbruch, 1975). The correct classification of 98 percent of the countries reveals that the violations of assumptions, if any, have not been harmful at all. The third limitation is that, because the study is based on aggregate level data, the findings may not hold for individual couples. An inappropriate application of aggregate level results to a lower level of analysis has been called the ‘ecological fallacy’ (Robinson, 1950).

The finding that the total fertility rate is the most important discriminator among the three groups of countries is very significant. Understandably, the higher the total fertility rate the higher the likelihood for a country to belong to the group of countries having low use of contraceptives. Table 1 shows that almost all the countries (except

a few) that belong to this group have impoverished socioeconomic conditions. Given that socioeconomic and developmental factors significantly exert independent as well as joint influence on fertility, large segments of populations in these countries do not perceive a lower fertility to be of benefit to them and hence will continue to avoid the use of contraceptives, no matter how successfully the family planning services are made available to them. One reason for this may be that the family planning programs operate in an aggregate setting that is provided by a broad spectrum of socioeconomic development.

The second most influential variable is the percentage of children under 15 years of age. The negative sign implies that as this percentage decreases the value of the discriminant function score increases and the country tends to belong to group 1 – a finding contrary to our expectation. It is difficult to interpret as to why when the percentage of children under 15 years of age increases the country tends to belong to the group of higher contraceptive use. However, the structure coefficient of this variable is very large and positive, suggesting that its contribution to the discriminant score was also heavily shared by other correlated variables.

The third most influential variable is the human development index which is a composite of three variables: life expectancy, educational attainment, and per capita income. The negative sign of the coefficient implies that as the index increases the value of the discriminant score decreases, and the likelihood of the country to belong to group 2 or group 3 increases which is in consonance with our expectation. The three component variables are very important dimensions of human development, and with developments in these dimensions people perceive smaller families beneficial to them, and hence tend to limit births with consequent greater use of contraceptives.

Child mortality also contributes positively to the discriminant score (large positive structure coefficient). This lends support to the well known child survival hypothesis – the greater the child mortality the lower the contraceptive use.

The percentage of the total population living in urban areas contributes negatively to the discriminant score, as expected. People living in urban areas enjoy relatively more opportunities of modern life which is conducive to having smaller families and as such, the higher the percentage of people living in urban areas the greater the likelihood of the country to belong to group 2 or group 3. Population growth rate is also an important contributor to the discriminant score but its negative sign is counter to our expectation.

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