Original article

Estimation of the total fertility rates and proximate determinants of fertility in North and South Gondar zones, Northwest Ethiopia: An application of the Bongaarts' model

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Abstract

Background: Evidence shows that nearly two million people are added to the population of Ethiopia each year. It has become clear that uncontrolled fertility has adversely influenced the socio-economic, demographic and environmental situations of the country.

Objectives: To estimate the total fertility rates and look into the relative contribution of the intermediate determinant variables in bringing fertility below its biological maximum in North and South Gondar zones of Northwest Ethiopia.

Methods: A cross-sectional study which included a sample size of 3512 women of reproductive age was performed. Multi-stage cluster sampling was used to select the required study subjects. The Bongaarts model was employed to estimate fertility rates and quantify the contribution of each of the proximate determinants of fertility.

Results: The overall total fertility rate of the two Gondar zones was computed as 5.3. Among the three major proximate determinants in reducing fertility in the two zones, postpartum infecundability (C_i=0.55) stood first followed by contraceptive use (C_c=0.75) and non- marriage (C_m=0.83).

Conclusion: The fertility-inhibiting effect of postpartum infecundability resulting from prolonged breastfeeding is by far the most important proximate determinant in the entire study areas. A substantial role (particularly in urban areas) is played by contraceptive use. The promotion of breastfeeding should continue by all concerned bodies and the region should continue exerting its maximum effort to make the majority of the rural population users of modern contraceptive methods. [*Ethiop.J.Health Dev.* 2009;23(1):19-27]

Introduction

Ethiopia is one of the most densely populated countries in Africa with a projected population of 77.1 million in mid-2007 and an annual population growth rate of 2.7% (1,2). Evidence shows that nearly two million people are added to the country's population each year (3, 4). The country is characterized by a very high fertility, low life expectancy, high maternal and child mortality, poor nutritional status, high infant mortality, low per capita income, etc. (1,2,5, 6).

The total fertility rate (TFR) calculated from the 2005 Ethiopian demographic and health survey (EDHS) shows little difference from the one obtained in 2000 EDHS (5.4 versus 5.5). Fertility rates in the rural areas (TFR=6.0) are much higher than in the urban areas (TFR=2.4) and have not changed much since the adoption of the national population policy (6). The population below 15 years of age at present is about 43% and this youthful age structure generated by high fertility levels guarantees a continuing future rapid population growth (6, 7). This warns us that a lot has to be done to fully comprehend and tackle problems related to uncontrolled population growth in this country.

The two zones (North Gondar and South Gondar) of Amhara region where this particular study was undertaken constitute about 40% of the area of Amhara region. Nearly 28% of the population of the region lives in these two zones (8). These zones have similar socio-demographic experiences to other zones of Amhara region. A few studies undertaken in these zones have indicated that the carrying capacity of the land in rural areas is deteriorating thereby increasing the level of poverty among those living in these zones. This is partly explained by excessive population pressure which has affected the available resources (land, water, etc.) and is widening its dimensions to areas which were once known for their surplus production (*9*). Measures, such as moving the people from the drought affected areas to resettlement development areas are being taken by the regional government as part of the rural poverty alleviation programme. However, resettling people from the highland areas to the lowland fertile areas by itself may not bring a lasting solution unless the root causes of such excessive population pressure are properly dealt with and solved (10, 11).

A range of approaches including the Bongaarts model, have been used to assess rapid population growth and its negative consequences in poor countries like Ethiopia. Bongaarts (1978) developed a simple mathematical model to quantify the effects of the proximate determinants on fertility (12). Accordingly, in this paper, the Bongaarts model is applied to estimate the various total fertility rates (TFRs) and look into the relative contribution of the above proximate variables in bringing fertility below its biological maximum in North and South Gondar zones of Northwest Ethiopia.

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Methods

A cross-sectional survey aimed at estimating the TFRs and the associated determinant proximate variables was undertaken in North and South Gondar zones from mid October to mid December, 2007. The study population was women in the age group 15 to 49 who were permanent dwellers of the selected areas. A woman aged 15 to 49 years was considered as a permanent dweller if she had been living in the area for at least six months.

Multi-stage cluster sampling stratified by place of residence (rural vs. urban) was done to select the required study subjects. From a total of 30 rural districts (w*oredas*) 8 were randomly drawn. That is, 5 of the 20 rural *woredas* in North Gondar and 3 of the 10 rural *woredas* in South Gondar were randomly selected. The towns of Gondar and Debre Tabour (labeled as big towns in this study) which have the status of *woreda* administration were also included. In total, there were 10 *woredas* involved in the study. Following the selection of *woredas*, different sampling methods were employed in the rural areas and urban centers to identify the actual study units. Accordingly, from each rural *woreda*, 2 clusters (*Gotes*) and the center of the woreda (called small town in this study) were selected. Similarly, 5 and 3 urban kebeles were randomly taken from the towns of Gondar and Debre Tabour, respectively. Consequently, a total of 16 clusters and 16 urban kebeles (8 from the big towns and another 8 from the small towns) were included in the study.

The randomly selected rural *woredas* were divided into clusters depending on the size of the population (households) of the given *woreda*. The number of households included in a cluster was between 120 and 170. This was adapted from the census that took place some four months prior to conducting the present study. All women aged 15 to 49 years residing in the selected clusters were registered (fresh listing) and interviewed. On the other hand, random samples of women (aged 15 to 49 years) were drawn from the selected urban *kebeles*. The selection of the study subjects in urban areas was done on the basis of the list of households obtained from the respective *kebele* administration. In this regard, *woredas* and *Gotes* (clusters) were the primary and secondary sampling units, respectively, in rural areas. By the same token, urban kebeles and households (households with women aged 15 to 49 years) were the primary and secondary sampling units, respectively, in towns.

In this study, about two-thirds of the study women (n=2277) were from the typical rural areas while the remaining one-third (n=1235) was drawn from the urban centers (big and small towns). The overall sample size (n=3512) was computed by taking account of the other component of this particular investigation. That part of the study which was devoted to examine the knowledge, attitude and practice of modern family planning methods gave rise to this sample size. All variables required to apply the Bongaarts model were listed at the design stage and data were collected accordingly.

Data collection was carried out by twenty health professionals (health officers, nurses and environmental health technicians) who were provided with a three-day intensive training with practical exercises. Five health officers/sanitarians were assigned to supervise the data collection process and the overall coordination was handled by the investigators of the research project. A standardized structured questionnaire with closed and open ended questions was used to collect the required data. Pre-testing of the questionnaire was carried out before undertaking the collection of the main data and some adjustments were made accordingly. Variables useful for the application of the Bongaarts model were incorporated in the questionnaire. These variables which are usually called proximate determinants of fertility are: marriage, contraception, induced abortion and postpartum infecundability.

The Bongaarts model summarizes the effect of each of the proximate determinants of fertility using individual indices that range from 0 to 1, with 0 indicating the greatest possible inhibiting effect on fertility and 1 indicating no inhibiting effect. The indices measuring the effect of marriage, contraception, postpartum infecundability and abortion are denoted by *Cm, Cc, Ci and Ca* respectively. An estimate of the observed total fertility rate (TFR) is produced by multiplying the indices together with the total fecundity rate (TF) that one would expect in the absence of the inhibiting effects of the proximate determinants. The Bongaarts model is given by the following equation:

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

When all indices equal one, fertility is at its biological maximum and the predicted TFR equals TF. Based on studies of historical populations with the highest recorded fertility, Bongaarts recommends using 15.3 as an estimate of TF, or the maximum number of births (12, 13).

These indices were estimated using the following equations:

i) $C_m = \dfrac{\sum m(a)g(a)}{\sum g(a)}$

Where m(a) = age-specific proportions of women currently married; g(a) = age-specific marital fertility rate

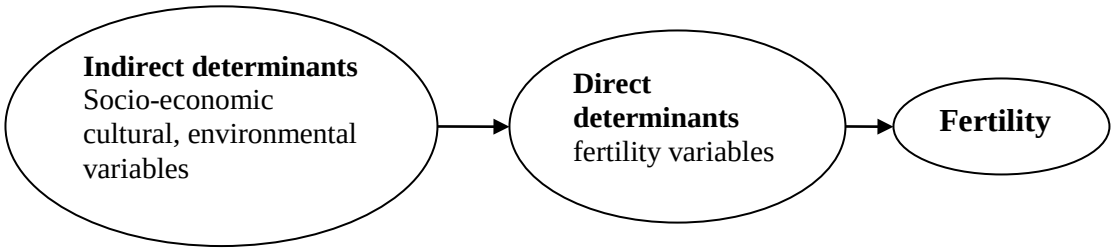
ii) $C_c = 1 - 1.08ue$

Where, u = the average proportion of married women currently using contraception; e = the average contraceptive effectiveness; and 1.08 is the sterility correction factor. In this study, 0.85 was used as the average contraceptive effectiveness as recommended by Bongaarts for developing nations (12, 14).

iii) C_i = 20 / (18.5+i), where, i = the mean duration of postpartum infecundability measured in months. According to Bongaarts, without lactation, a typical average birth interval is estimated at 20 months, and with lactation it equals the average total duration of the infecund period plus 18.5 months (12)

Because of lack of reliable data for induced abortion, no attempt was made to estimate the index of abortion. The difficulty of getting such data was reported by Bongaarts himself and many other researchers (13-15). As deliberate abortion is uncommon in the rural areas of the two Gondar zones, the absence of this index from the model could not substantially affect the overall estimates.

According to the Bongaarts model, fertility differences among populations and trends in fertility over time can always be traced to variations in one or more of the intermediate fertility variables. The following simple diagram summarizes the relationships among the determinants of fertility (12):



Ethical clearance was obtained from the School of Public Health and the Faculty of Medicine of Addis Ababa University. Written consent was obtained from the responsible Zone and *Woreda* government organizations by explaining the objectives of the study. Verbal consent was obtained from each study subject included in the study.

Results

A total of 3512 women (response rate, 99%) aged 15 to 49 years in the selected households were interviewed. There were 3178 households with an average of 4.8 people living in each household. The total population living in the selected households was 15308. There were 7659 males and 7649 females giving a sex ratio (male to female) of 100%. The proportion of females aged 15-49 years was 23% of the entire population of the study areas registered by the data collectors.

Among the 2097 rural households included in this study, about 7% reported that they did not have any farmland at all. When the households who reported some land were further examined, the majority of them (nearly 70%) had less than or equal to a hectare. It could be noted here that the farmland possession per head among these families would be much less than one-fourth of a hectare (Table 1). About 79% of the urban and 26% of rural households reported that they had functional radios.

Among the 2277 rural women who participated in this study, about 86% had no modern education. Similarly, 36% (that is, 450 out of 1235) of the women in the urban centers reported that they had no modern education. As shown in Table 2, it is surprising that only 3% of respondents (most of them from urban areas) were civil servants. Nearly 70% of the women were housewives. The distribution of study subjects by religion shows enormous differences between the urban and rural dwellers. In the big towns (Gondar and Debre Tabour) the Orthodox Christians were 89.6% while the Muslims constituted 9.5% of the responding women. In the small towns (Centers of *Woreda* Administrations), the Orthodox Christians and Muslims constituted 80.4% and 19.4%, respectively. In the rural areas, the figures for the Orthodox Christians and Muslims were reported to be 97.4% and 2.5%, respectively. Overall, the great majority were Orthodox Christians (93.4%) followed by Muslims (6.3%). The contribution of the other religions was only 0.3%. The details of the socio-demographic characteristics of the study subjects are presented in Table 2.

The mean age of first marriage in the rural areas of the two Gondar zones was 13 years while it was 16.5 years in the big urban centers. A similar pattern was also noted among the women of the different dwelling areas regarding the mean age of first sexual intercourse. On the other hand, marital disruption was reported to be highest in rural areas. This study showed the breakage of first marriages among 46.6% and 42.6% of rural and urban (big towns) areas, respectively (Table 3).

Measures of current fertility are presented in Table 4 and Figure 1 for the 3-year period preceding the survey. Table 4 shows the overall ASFRs of the study areas leading to a total fertility rate of 5.3. Fertility begins at early age and increases to a peak of 241 births per 1,000 among women aged 25 to 29 years and declines thereafter. Figure 1 also shows the ASFRs by place of residence. Although the pattern of fertility across each age group in all urban and rural areas is similar, one could easily notice that the ASFRs are much higher in the rural areas than the urban dwelling centers. The total fertility rate of the rural areas was computed as 6.3 while that of the zonal towns (Gondar and Debre Tabour) was 2.9. When all towns were combined irrespective of their

status (either zonal or woreda centers), a TFR of 3.5 was obtained.

The mean number of children ever born to older women reaching the end of their reproductive period (women aged 45 to 49 years) which is indicator of average completed fertility was computed as 6.5. When this average completed fertility is compared to the current fertility, it could be noted that fertility has fallen by more than one child during the past three decades, from 6.5 to 5.3 children per woman in the two Gondar zones. A similar comparison among the urban dwellers showed a greater reduction in fertility from 5 to 3.5 children per woman during the same period. On the other hand, the comparison made among women of rural areas indicated a relatively small reduction in fertility from 7 to 6.3 children per woman.

In North and South Gondar zones the index of marriage (Cm) equals 0.83, which means delayed marriage and being single reduce fertility by 17% below what it would otherwise be if marriage were universal among all women aged 15 to 49 years. In urban areas of these zones the indices were even lower at 0.72 (for Gondar and Debre Tabour towns) and 0.75 (for all towns) compared to 0.88 in rural areas.

With respect to contraceptive use, the index of contraception (Cc) of the two zones was 0.75 indicating that contraceptive use played a greater role than delayed marriage and non-marriage in bringing fertility below its biological maximum. In urban areas, contraceptive use was observed to be the most important contributing factor in reducing fertility (Table 4).

The contraceptive prevalence rate was found to be 22% among all women and 27.3% of married women during the time of the survey. Nearly two-thirds of the married women reported their intention to use contraceptives in the future. Rural-urban differences in contraceptive use were striking. About 48% of the married women in urban areas of the two zones were using contraceptive, compared to only 18.8% of married women in rural areas.

The determinants of the duration of postpartum infecundability are postpartum amenorrhea prolonged by breastfeeding and postpartum abstinence. Whichever is the longest decides the infecundability duration. In the study areas, abstinence was much shorter than postpartum amenorrhea and breastfeeding. Among the Orthodox Christians of the study areas it was reported that abstinence lasted until the child was baptized (40 days for a male birth and 80 days for a female one). Among Muslims, postpartum abstinence was very much alike to the Christians (about 40 days).

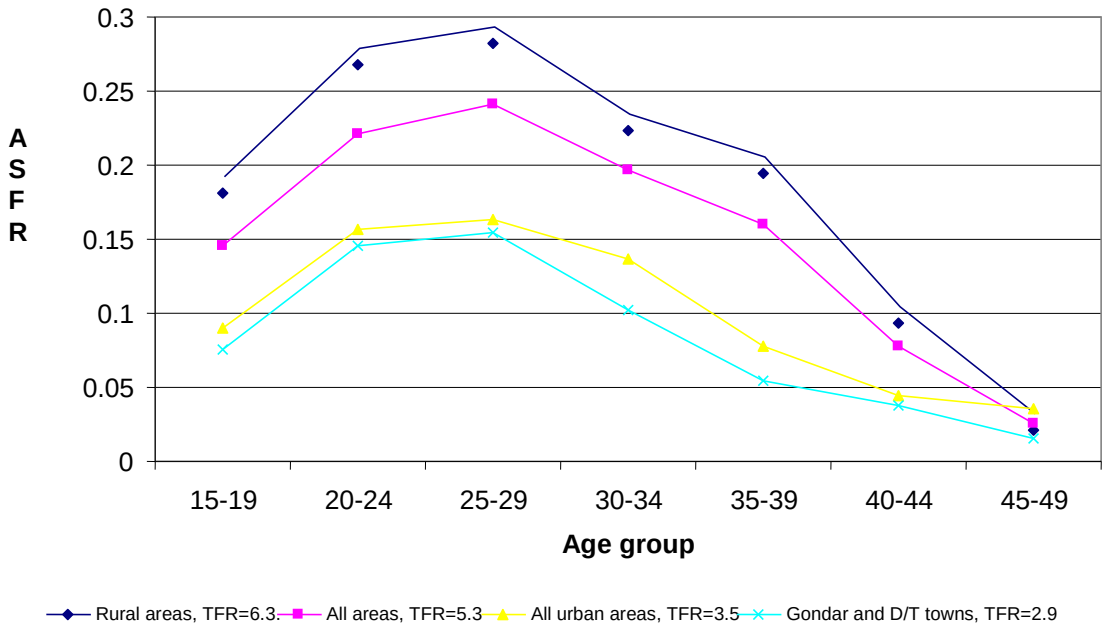


Figure 1: **Age specific fertility rates by rural-urban residence, North and South Gondar zones, 2007**

Table 1: **The socio-economic characteristics of the households from which the study subjects had come from distributed by type of living place (big towns/small towns/rural villages), North and South Gondar zones, Northwest Ethiopia, 2007**

Characteristics	Big towns (n=659)		Small towns (n=422)		Rural areas (n=2097)		Total (n=3178)	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Monthly expenditure of the household								
≤320	189	28.7	122	28.9	901	43.0	1212	38.1
321-500	209	31.7	156	37.0	663	31.6	1028	32.3
501-999	182	27.6	110	26.1	425	20.3	717	22.6
≥1000	79	12.0	34	8.0	108	5.1	221	7.0
Type of roof								
Grass/bamboo	8	1.2	28	6.6	1072	51.1	1108	34.9
Corrugated iron	646	98.0	393	93.1	1020	48.7	2059	64.8
Other	5	0.8	1	0.2	5	0.2	11	0.3
Source of drinking water								
Pipe	609	92.4	394	93.4	527	25.1	1530	48.1
Protected spring/ well	43	6.5	23	5.4	459	21.9	525	16.5
unprotected spring/well	7	1.1	3	0.7	514	24.5	524	16.5
River water	0	0.0	2	0.5	597	28.5	599	18.9
Time taken to fetch water in hours (round trip)								
Less than 15 minutes	543	82.4	295	69.9	355	16.9	1193	37.5
15<30 minutes	59	8.9	73	17.3	370	17.6	502	15.8
30-59 minutes	38	5.8	42	10.0	675	32.2	755	23.8
60+ minutes	19	2.9	12	2.8	697	33.2	728	22.9
Availability of toilet facilities								
Yes and use it	584	88.6	289	68.5	602	28.7	1475	46.4
Yes, but don't use it	0	0.0	6	1.4	170	8.1	176	5.5
No	75	11.4	127	30.1	1325	63.2	1527	48.1
Availability of radio in the HH								
Yes, functional	536	81.3	315	74.6	543	25.9	1394	43.9
Yes, but non-functional	40	6.1	24	5.7	265	12.6	329	10.3
No	83	12.6	83	19.7	1289	61.5	1455	45.8
Availability farm land								
Yes	17	2.6	52	12.3	1960	93.5	2029	63.8
No	642	97.4	370	87.7	137	6.5	1149	36.2

Women of the study areas on the average breastfeed their babies for about two years with a relatively small difference between urban and rural areas. In this study, the mean duration of postpartum amenorrhea which was prolonged by breastfeeding was found to be 18 months. Accordingly, the mean durations of postpartum amenorrhea in urban (Gondar and Debre Tabour towns) and rural areas were 15.2 and 18.9 months, respectively. The mean duration for all urban areas was 15.7 months.

As shown in Table 4, the predicted TFRs are generally very close to the observed TFRs estimated from information on births in the last three years preceding the present survey. However, there appeared a relatively greater predicted value than the observed TFR in the urban population of Gondar and Debre Tabour towns (3.44 compared to 2.93). It is also noticeable from Table 4 that the fertility inhibiting effect of postpartum infecundability (C_i =0.54) is by far the most significant proximate determinant in rural areas. On the other hand, contraceptive use is taking the lead in urban centers. The inhibiting effect of postpartum infecundability is also very substantial in urban areas of the two Gondar zones. Overall, among the three major proximate determinants in reducing fertility in the two zones, postpartum infecundability (C_i=0.55) stands first followed by contraceptive use (C_c=0.75) and delayed marriage (C_m=0.83).

Table 2: **The socio-economic characteristics of the study subjects North and South Gondar zones, Northwest Ethiopia, 2007**

Characteristics	Big towns		Small towns		Rural areas		Total	
	Frequency (n=756)	%	Frequency (n=479)	%	Frequency (n=2277)	%	Frequency (n=3512)	%
Age (years)								
15-19	115	15.2	87	18.2	285	12.5	487	13.9
20-24	168	22.2	83	17.3	350	15.4	601	17.1
25-29	189	25.0	94	19.6	475	20.9	758	21.6
30-34	99	13.1	72	15.0	435	19.1	606	17.2
35-39	95	12.6	75	15.7	381	16.7	551	15.7
40-44	51	6.7	41	8.6	217	9.5	309	8.8
45-49	39	5.2	27	5.6	134	5.9	200	5.7
Educational status								
No education	259	34.3	191	39.9	1950	85.6	2400	68.3
Primary	207	27.4	145	30.3	279	12.3	631	18.0
Secondary and above	290	38.3	143	29.8	48	2.1	481	13.7
Occupation								
Farmer (subsistence)	0	0.0	4	0.8	257	11.3	261	7.4
Trade (sales - service)	64	8.5	36	7.5	17	0.8	117	3.3
Civil servant	74	9.8	24	5.0	6	0.3	104	3.0
Housewife	380	50.3	261	54.5	1776	78.0	2417	68.8
Student	90	11.9	70	14.6	117	5.1	277	7.9
Daily laborer	63	8.3	17	3.6	20	0.9	100	2.8
Commercial sex worker	13	1.7	23	4.8	26	1.1	62	1.8
Jobless	61	8.1	29	6.1	46	2.0	136	3.9
Others	11	1.4	15	3.1	12	0.5	38	1.1
Marital Status								
Never married	136	18.0	76	15.9	146	6.4	358	10.2
Married	461	61.0	310	64.7	1875	82.4	2646	75.3
Divorced	108	14.3	60	12.5	162	7.1	330	9.4
Widowed	41	5.4	30	6.3	82	3.6	153	4.4
Separated	10	1.3	3	0.6	12	0.5	25	0.7
Religion								
Orthodox Christian	677	89.6	385	80.4	2217	97.4	3279	93.4
Muslim	72	9.5	93	19.4	57	2.5	222	6.3
Protestant	4	0.5	1	0.2	1	0.0	6	0.2
Others	3	0.4	0	0.0	2	0.0	5	0.1
Ethnic group								
Amhara	722	95.5	462	96.5	2216	97.3	3400	96.8
Tigrai	27	3.6	15	3.1	7	0.3	49	1.4
Oromo	5	0.6	0	0.0	2	0.1	7	0.2
Agaw	0	0.0	2	0.4	34	1.5	36	1.0
Gumuz	0	0.0	0	0.0	18	0.8	18	0.5
Others	2	0.3	0	0.0	0	0.0	2	0.1

Table 3: **Patterns of marriage in North and South Gondar zones classified by place of residence, Northwest Ethiopia, 2007**

Marriage patterns	Place of residence			
	Gondar and D/T town	All urban centers	Rural	Total
Mean age at first marriage	16.5	15.9	13.0	13.9
Mean age at first sexual intercourse	16.9	16.5	14.4	15.1
Marital status*				
Ever married	620 (82.0%)	1023 (82.8%)	2131 (93.6%)	3154 (89.8%)
Never Married	136 (18.0%)	212 (17.2%)	146 (6.4%)	358 (10.2%)
Marital disruption among the ever married ones*				
Currently living with 1st husband	356 (57.4%)	562 (55.0%)	1138 (53.4%)	1700 (53.9%)
Currently living with 2nd/3rd, etc. husband	105 (16.9%)	209 (20.4%)	737 (34.6%)	946 (30.0%)
divorced/ widowed/ separated	159 (25.7%)	252 (24.6%)	256 (12.0%)	508 (16.1%)

* Shows the number (percentage) of women in each place of residence

Table 4: **Indices for proximate determinants of fertility, North and South Gondar zones, Northwest Ethiopia, 2007**

Index/Measure	North and South Gondar zones	Gondar and Debre Tabour towns	All towns	rural areas
C_m	0.83	0.72	0.75	0.88
C_c	0.75	0.53	0.56	0.83
C_i	0.55	0.59	0.58	0.54
Predicted TFR_1	5.24	3.44	3.73	6.03
Observed TFR_2	5.34	2.93	3.52	6.31

[1]Predicted by Bongaarts formula
[2]Estimated using births in the last 3 years preceding the survey

Discussion

Uncontrolled population growth has been repeatedly reported by many scholars as one of the most serious problems that Ethiopia is currently facing (15-19). The emergence of households devoid of farmland in the typical rural areas of the two Gondar zones has clearly demonstrated this undesirable fact (Table 1). However, the country seems to refrain from taking strong measures, such as the ones taken by other developing countries (20-21).

As can be noted from Table 4, three proximate determinants of fertility have played important roles in reducing fertility from the potential level to the actual level. Based on the present assessment, the strongest reduction in the fertility level of the two Gondar zones has been achieved by postpartum infecundability. Given the relatively short duration of postpartum abstinence in the two Gondar zones, it is prolonged breastfeeding which played the greatest role in reducing fertility below its biological maximum in the above zones. This finding is in agreement with the results of previous analyses carried out by different researchers from Addis Ababa (Ethiopia) and Brown (USA) Universities based on the 1990 National Family and Fertility Survey and the 2000 Demographic and Health Survey data of Ethiopia (14, 15, 22).

However, unlike the earlier reports which presented non-marriage (due either to delayed marriage or the exit from marriage) as the second factor responsible for the fertility decline in the Amhara and Oromia regions (15, 22), this study has shown that contraceptive use is becoming the second important factor in the present study areas. In fact, as indicated in Table 4, the use of contraceptive has become the most important factor affecting fertility in urban areas, surpassing postpartum infecundability and non-marriage. On the other hand, although the rise in contraceptive use showed a substantial impact on the fertility level of rural areas, postpartum infecundability has remained the most important factor in bringing fertility below its biological maximum.

Because the CPR among married women (18.8%) in the rural areas was much less than that in the urban centers, the cumulative effect of contraceptive use in the entire population of the two zones was far below the fertility-inhibiting effect of postpartum infecundability. It is also important to note that over 85% of the Amhara population lives in rural areas (1) and hence the leading position of contraceptive use in reducing fertility among the urban dwellers could not be maintained in the entire women population of the two zones. In this respect, if the current intention of women regarding their future contraceptive use holds true, the role of the index of contraception will increase thereby contributing substantially to the reduction of fertility in the years to come. On the other hand, although the effort of the Amhara National Regional State to increase the prevalence of contraceptive use in the region is appreciable, it has to go a long way to achieve the desired results among the broad masses of the rural people.

The indices of marriage and contraception were close to one in rural areas, reflecting weak fertility-inhibiting effects. Marriage is universal among the rural dwellers and starts early in life. As can be seen in Table 3, mean age of first marriage is 13 years for girls. This is contrary to the family code of the Amhara region which has set the minimum age for marriage as 18 years for both males and females (23, 24). Unless this tradition of early marriage in the rural areas of the Amhara region is changed, in addition to exposing young girls to various health problems, would continue its fertility-enhancing effect on the overwhelming majority the rural population. While marital dissolution is a fairly common phenomenon in the study areas (Table 3), women do not remain out of unions for long. Therefore, marital instability does not seem to have played a substantial role in the fertility decline especially in the rural areas (18).

The closeness of the predicted and observed TFRs increases our confidence in the quality of the data upon which the present analysis was performed. This suggests that the proximate determinants included in the model are the principal mechanisms by which fertility is reduced below its biological maximum. However, the predicted TFR for the urban population is substantially above the observed (3.44 compared to 2.93). This difference between the model estimate and the observed value is consistent with the omission of an important proximate determinant from the model. The absence of induced abortion from the model is a likely explanation for such overestimate of fertility (13,15). Non-reporting of the occurrences of abortions in the Amhara region is a common problem. For example, only 260 safe and 74

unsafe abortions were reported in the entire Amhara region in 2007 (25).

If the present indices of marriage and postpartum infecundability remain constant, in the years to come, the contraceptive prevalence rate among married women of the two Gondar zones should reach 76% to bring fertility down to its replacement level of 2.1 children per woman. Accordingly, there appears a need to increase the present CPR among married women about 3 fold to acquire the above estimate. However, such estimates may not work for the very reason that postpartum infecundability prolonged by breastfeeding could not remain constant for a very long time as was the case in the urban areas.

In conclusion, the fertility-inhibiting effect of postpartum infecundability resulting from prolonged breastfeeding is by far the most important proximate determinant in the entire study areas. A substantial effect on fertility decline (particularly in urban areas) is played by contraceptive use. On the other hand, early marriage and a relatively low prevalence of contraceptive use keep fertility at high levels in rural areas.

The promotion of breastfeeding should continue by all concerned bodies and the implementation of the family law of the region which asserts the minimum age of marriage as 18 years should be ensured particularly in rural areas. The region should continue exerting its maximum effort in order to make the majority of the rural population users of modern contraceptive methods.

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