The Role of Proximate Determinants and Distal Variables On Recent Fertility in Dabat Health and Demographic Surveillance System Site, Northwest Ethiopia: A Mediation Analysis

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Research

Abstract

Background

In Ethiopia, previous studies have explored the role of the proximate determinants for recent fertility decline at national and regional levels. However, none of these studies have examined the role of socioeconomic factors on the observed fertility decline through these proximate variables. This study aimed to estimate the effects of proximate determinants of fertility and the contribution of distal variables in recent fertility in Dabat Health and Demographic Surveillance Site, northwest Ethiopia.

Methods

A community based cross-sectional survey was carried out in 2020 among 1649 women of reproductive age group. Data were collected using structured and interviewer administered questionnaire. Generalized structural equation model was employed for the mediation analysis to estimate the relationships among distal and mediating variables with outcome variable, children ever born, simultaneously. A difference approach was used to test whether the effects of predictor variables were mediated.

Results

The Total Fertility Rate (TFR) for the three years preceding the survey was estimated at 3.4 children per woman. The Age Specific Fertility Rate (ASFR) in the study area reached its peak in the age group of 25–29 with 191 children per 1000 women. Among the proximate determinants, only marriage was a significant proximate determinant of recent fertility. The probability of having birth was more than fivefold higher among currently married women (IRR = 5.6 with a P-value = 0.000) than their unmarried counterparts. Age of women, occupation of women, household wealth status, ideal number of children, and experiencing child death had a significant total effect on recent fertility that were decomposed to direct and indirect or mediated effects of variables.

Conclusion

Marriage was the only proximate determinant that stood out as a significant mediated variable through which the distal variables affected fertility. Findings also clearly indicated that female participation in non-agricultural occupation affected the recent fertility. Hence, women's level of employment should be raised to increase their economic independence that will reduce the desirability of early marriage which in turn lower the number of children. In addition, the prevailing strategies on family planning programs should be improved to enhance the prevalence of contraceptive use among married women that will accelerate the current fertility transition.

Plain English Summary

Davis and Blake (1956) suggested two types of factors mainly affect fertility: the direct or proximate determinants (Marriage, Contraception, Abortion, and Postpartum In-fecundability) and indirect determinants or demographic and socioeconomic factors. The indirect factors such as demographic and socioeconomic factors influence fertility through these proximate determinants but indirectly. In Ethiopia, previous studies have explored the role of the proximate determinants for recent fertility decline at national and regional levels. However, none of these studies have examined the role of demographic and socioeconomic factors on the observed fertility decline through these proximate variables. Hence, this study aimed to estimate the effects of both direct and indirect factors of the recent fertility simultaneously using generalized structural equation model. A total of 1649 were the study participants.

The Total Fertility Rate (TFR) for the three years preceding the survey was estimated at 3.4 children per woman. Among the proximate determinants, only marriage was a significant proximate determinant of recent fertility. The probability of having birth was more than fivefold higher among currently married women than their unmarried counterparts. Age of women, occupation of women, household wealth status, ideal number of children, and experiencing child death had a significant effect on recent fertility.

In conclusion: Women's level of employment should be raised to increase their economic independence that will reduce the desirability of early marriage which in turn lower the number of children. In addition, the prevailing strategies on family planning programs should be improved to enhance the prevalence of contraceptive use among married women that will accelerate the current fertility transition.

Background

Ethiopia is the second most populous country in Africa next to Nigeria and 12th in the world with an estimated population of 98.7 million in 2019 which is also projected to be 136.7 million in 2037 (1–3). About 40% of the population of Ethiopia is below 15 years of age while only 3.1% is above 64 years in 2019 (2). In terms of urbanization, the same source stated that Ethiopia is among the least urbanized country in the world with only 17% of its population living in urban areas.

The demographic pattern of Ethiopia is characterized by fertility and mortality rates which constitute the major dynamics of the population (4). However, in recent times, with a relatively low level of mortality, fertility is the most important component of population dynamics and plays a major role in changing the size and structure of the population of the country (5, 6) Total Fertility Rate (TFR) is the measurement most used to assess the level and trends of fertility. TFR is the average number of children women would bear, if they survive to the end of reproductive life and have the same probability of child-bearing in each age interval as currently prevails across the population (7).

Ethiopia is one of the countries in Sub-Saharan Africa reported to be experiencing incipient fertility decline over the past few decades (1, 8). The fertility trend shows that it has been at its highest levels at the end of the twentieth century and started declining since 1990. Between 1990 and 2016, TFR in the country declined moderately from 6.4 to 4.6 children per woman of reproductive age; there has been almost a two children drop in less than three decades (9, 10). Fertility decline is now widespread and virtually universal in the country. Over the last couple of decades, fertility has declined in a majority of the regions except Somali and Afar

regions of the country. The decline has been the highest in Amhara National Regional State (ANRS). TFR of this regional state had dropped from 5.9 in 2000 to 3.7 births per woman in 2016 (9, 10). The steady decline in TFR in the study area, Dabat Health and Demographic Surveillance System site (HDSSs) was also observed decreasing from 4.4 in 2009 to 3.6 births per woman in 2011 which was below regional averages (11, 12).

Observed level of fertility is much lower than its theoretical maximum (7). The effects of proximate and background determinants are responsible for the difference between the theoretical maximum and observed fertility levels (13–17). The proximate determinant of fertility refers to the behavioral and biological factors that act to reduce the rate of childbearing in a population. The principal characteristics of proximate determinants are their direct influence on fertility whereas background or distal determinants are economic and socio-cultural factors which affect fertility only indirectly by modifying the proximate determinants (18–20) These relationships were first recognized by Davis and Blake who defined a large set of "intermediate fertility variables"(17). In the late 1970s, Bongaarts identified a smaller set of proximate determinants and developed a relatively simple model to quantify their fertility effects (21). Bongaarts identified four proximate determinants such as marriage, contraception, induced abortion, and postpartum in-fecundability that accounted for the majority of variation in fertility levels observed across populations.

Several studies have investigated the role of the proximate determinants for recent fertility decline at national and regional levels in Ethiopia (22–25). However, none of these studies have examined the role of socioeconomic factors that can have positive or negative influence on the observed fertility decline through these proximate variables. Understanding the factors contributing to the fertility decline and their level of fertility inhibiting effect have a paramount policy implication in the country. Therefore, the main purpose of this study was to estimate the relative strengths of proximate determinants of fertility and the contribution of distal variables in recent fertility decline in Dabat Health and Demographic Surveillance Site, Northwest Ethiopia.

Methods

Study setting and design

A community based cross-sectional survey was conducted from January 10 to February 29, 2020 in Dabat Health and Demographic Surveillance System site (HDSSs) which has been hosted by the University of Gondar, Ethiopia. The site is located in the Dabat District in the northwest part of Ethiopia, 75 Kms north of Gondar and 804 Kms northwest of Addis Ababa. Dabat district has a total of 26 rural and 4 urban kebeles (the smallest administration unit in Ethiopia). According to the 2007 census report, the district had an estimated total population of 145,458. The size of the population was projected to be 172, 836 in 2015. Of these, 50.4% were female and 13% were urban inhabitants (26,27). Dabat district was initially selected purposively as a surveillance site for its unique three agro-climatic zones (lowland, midland and highland) with altitude ranging from about 1000 to 2500 meters above sea level (28). Currently, Dabat HDSSs incorporates 13 kebeles. Three of these kebeles were included in the surveillance site in 2014 and these were not included in this study. Out of the remaining 10, seven were from rural and three from urban kebeles, among which seven were from highland, one from midland and two from lowland areas.

Sample size and sampling techniques

The study population included women of reproductive age who have been living in the surveillance site at the time of the interview. The sample size was determined using a single population proportion formula considering the following assumptions: the proportion of women of reproductive age who had a first birth by age greater than 20 (47%) (10); the age at which childbearing commences is an important determinant of the overall level of fertility, with 95% level of confidence, 2.5 % margin of error, and 10% non-response rate. Accordingly, the required sample size was computed as 1683. The sample size was proportionally allocated to each of the Kebele administrations based on their number of women of reproductive age population. To select the study subjects, first, the list of women of reproductive age with Kebele, household, and individual identifier was extracted from the database. Then after, the allocated sizes of women of reproductive age were selected using a simple random sampling technique using a random number generator. The Kebele, household, and individual identifiers were used to locate the selected women for an interview. When two or more women were found in a household, one of them were selected for an interview using a lottery method.

Data collection tools and procedures

Data were collected using structured, pretested, and interviewer administered questionnaire. The questionnaire was adopted from Ethiopian demographic and health survey and other literature (9,10,12). It consists of socio-economic and demographic, and reproductive health characteristics of the respondents. To maintain consistency, the questionnaire was first translated from English to Amharic, the native language of the study area, and was retranslated back to English by professional translators and demographers. The tool was pretested on 100 (6% of the sample size) women with reproductive age out of the study area. During the pretest, the acceptability and applicability of the procedures and tools were evaluated. Twenty data collectors, two in each Kebele, and five field supervisors, both working in Dabat HDSSs, were recruited for the study. Two days training on the objective of the study, content of the questionnaire, confidentiality of information, how to use open data kit (ODK) software suites and techniques to conduct interview was given to the data collectors and supervisors. Data were collected using ODK software suites which is one of the most well-known mobile data collection frameworks. It is capable of controlling data entry error with its skip rules, internal consistency checks and facilities such as supporting multiple languages and making calculations (29). Data completeness was checked by supervisors, a data manager, and the principal investigator during data collection.

Study variables; The outcome variable of the study is the number of births in the last three years preceding the survey which is a count variable. The independent variables were the socioeconomic and demographic characteristics of women with reproductive age. The variables were categorized for analysis as shown in Tables 1, 2, 3 and 4.

Data processing and analysis

The collected data were exported to STATA version 14 for cleaning and analysis. Descriptive statistics including frequencies and proportions were used to summarize the variables of interest. Fertility differentials using Age Specific Fertility Rate (ASFR) and Total Fertility Rate (TFR) were also carried out along with the respondents' characteristics. Negative binomial regression analysis was used and a goodness of fit test

showed that the model fits the data well. In our analysis, abortion, contraceptive use and current marital status were considered as a binary mediating variable. Duration of postpartum infecundability, in the present analysis, was taken as an input for exposure variable than proximate variable and its mediating effect has not been evaluated.

Generalized structural equation model (GSEM) was employed for the mediation analysis to estimate the relationships among distal, mediating, and outcome variables simultaneously. A difference approach was used to test whether the effects of predictor variables were mediated. Initially, the mediator variables were checked if they had a mediating effect and the analysis indicated that abortion and current contraceptive use had no mediating effect. As such, abortion was dropped from further analysis for the number of cases were small and did not meet the criteria for mediating variable. However, contraceptive use was kept in further analysis due to its relevance in explaining fertility regardless of its statistical insignificance. After the test of mediation, first, the total effect of variables was evaluated in a model that did not include the mediator variables. In a follow up, the direct effect of variables on fertility was estimated in the presence of a mediating variables in the model. Finally, the difference in coefficients between the two models, the total effect and the direct effect models, was produced to estimate the mediated effect of a variable (30). Variables whose total effects were statistically significant or variables that have at least a partially mediated effect were included in the final model. STATA's *nlcom* command was used to produce the mediated effect. A 5.0% level of significance was used to declare statistical significance.

Results

Socio- economic and demographic characteristics

A total of 1649 women with reproductive age were successfully interviewed, with 98% response rate. The study showed that the mean age of women was 27.2 ± 10 years. Women whose age less than 20 constituted 30.8%. The study revealed that 587 (35.6%) respondents were from urban areas, 18% were born in urban areas, 35.4% had no formal education, 56% were ever married and 49.2% were currently married, and 97.5% were Orthodox religion followers. Two hundred fifteen 215 (23.3%) participants had divorce experience at least once in their life.

The median age at first marriage of the participants was 15 (urban 18 and rural 15) years. Women, who got married before the age of 18 years, legal age of marriage, accounted for 71.7%. About 25% and 66% of participants had their first menstrual period at age less than 15 and between 15 and 17 years, respectively. The median age of the participants at first birth was 18 years (urban 20 and rural 18). About 40 percent of them gave birth to their first child below age 18 years.

Majority (47.1%) of the participants was housewives and only 10% were civil servants. More than two-third of husbands (68.6%) were farmers while 24.4% of them were civil servants. Majority (58%) of husbands did not attend any formal education whereas 24% of them had secondary and above level of education. Majority (72.2%) of the respondents had no media exposure. More than half (51.1%) of the participants empowered to decide the households' monthly expense (alone = 6.9% and with husband = 44.2%). Participants also reported that 13.3% of them had food shortage experience in the last five years (Table 1).

Table 1
Socio-economic and demographic characteristics of the study participants in Dabat HDSSs, Northwest Ethiopia, 2020

Characteristics	Categories	Number (%)
Age group (n = 1649)	15−19	508 (30.8)
	20−24	267 (16.2)
	25−29	205 (12.4)
	30−34	195 (11.8)
	35−39	198 (12.0)
	40−44	146 (8.9)
	45−49	130 (7.9)
	Mean (± SD)	27.2 (10.0)
Residence (n = 1649)	Urban	587 (35.6)
	Rural	1062 (64.4)
Religion (n = 1649)	Orthodox	1607 (97.5)
	Muslim	42 (2.5)
Age at first marriage (n = 924)	< 18	662 (71.6)
	≥ 18	262 (28.4)
	Median- rural (urban)	15−15 (18.0)
Age at first menstruation (n = 1466)	< 15	364 (24.8)
	15−17	971 (66.2)
	>17	131 (9)
Age at first birth (n = 877)	< 18	352 (40.1)
	≥ 18	525 (59.9)
	Median- rural (urban)	18−18 (20.0)
Place of birth (n = 1649)	Urban	294 (17.8)
	Rural	1355 (82.2)
Educational Level (n = 1649)	No formal education	584 (35.4)
	Primary	435 (26.4)
	Secondary+	630 (38.2)
Occupation(n = 1649)	Housewife	776 (47.1)

Characteristics	Categories	Number (%)
	Student	576 (34.9)
	Civil servant	168 (10.2)
	Job seeker	129 (7.8)
Current marital status (n = 1649)	Single	725 (44.0)
	Married	812 (49.2)
	Widowed	29 (1.8)
	Divorced	71 (4.3)
	Separated	12 (0.7)
Husband educational level (n = 924)	No formal education	536 (58.0)
	Primary	166 (18.0)
	Secondary+	222 (24.0)
Husband Occupation (n = 924)	Farmer	634 (68.6)
	Employed	226 (24.4)
	Job seeker	64 (7.0)
Divorce experience (n = 924)	Yes	215 (23.3)
	No	709 (76.7)
Media exposure (n = 1649)	Yes	459 (27.8)
	No	1190 (72.2)
Food shortage experience in the last 5 years(n = 1649)	Yes	220 (13.3)
	No	1429 (86.7)
Who decide household expenses (n = 1649)	Husband	443 (26.9)
	Herself	114 (6.9)
	Together (with husband)	729 (44.2)
	Elderly kin	27 (1.6)
	Parents	336 (20.4)
Wealth index (n = 1649)	Lowest	351 (21.3)
	Lower	327 (19.8)
	Middle	325 (19.7)
	Higher	313 (19.0)

Characteristics	Categories	Number (%)
	Highest	333 (20.2)

Reproductive Health Characteristics Of The Study Participants

The study revealed that 53.2% of the study participants gave birth to a child in their life, and only 2.4% of the study participants had abortion experience. The mean ideal number of children, ever born children and children alive were 4.13 ± 2.3, 3.99 ± 0.5 and 3.83 ± 2.3, respectively and those whose ideal, ever born and number of children alive were four or lower accounted 64%, 60.6% and 61.5%, respectively. One hundred two (11.6%) participants had the experience of child death. Among women who had children, 51% of them wanted more children in the future. About 38% of women have used at least one contraceptive method at any time. At the time of the survey, among all women who used contraceptive methods were 283 (17.2%) of which, 258 (31.8%) were married women (Table 2).

Table 2

Reproductive health characteristics of the study participants in Dabat HDSSs, Northwest Ethiopia, 2020

Characteristics	Categories	Number (%)
Ever give birth to a child (n = 1649)	Yes	878 (53.2)
	No	771 (46.8)
Abortion experience (n = 1649)	Yes	39 (2.4)
	No	1610 (97.6)
Ideal number of children (n = 1649)	<=4	1056 (64.0)
	5+	593 (36.0)
	Average (± SD)	4.13 (2.3)
Number of ever born children (n = 877)	<=4	532 (60.6)
	5+	346 (39.4)
	Average (± SD)	3.99 (0.5)
Number of children alive (n = 877)	None	11 (1.3)
	<=4	539 (61.5)
	5+	327 (37.2)
	Average (± SD)	3.83 (2.3)
Experience of child death (n = 877)	No	776 (88.4)
	yes	102 (11.6)
Want more children (n = 877)	Yes	447 (51.0)
	No	431 (49.0)
Ever use of contraceptive methods (n = 1649)	Yes	623 (37.8)
	No	1026 (62.2)
Current contraceptive use (all women) (n = 1649)	Yes	283 (17.2)
	No	1366 (82.8)
Current contraceptive use (currently married women) (n = 812)	Yes	258 (31.8)
	No	554 (68.2)

Fertility Differentials By Background Characteristics Of The Study Participants

Substantial demographic and socio-economic differentials in fertility are identified in the study area. The study indicated that the Total Fertility Rate (TFR) for the three years preceding the survey was 3.4 children per woman. The Age Specific Fertility Rate (ASFR) in the study area reached its peak in the age interval of 25–29 years with 191 children per 1000 women. The TFR of the urban areas was 2.5 while the rural areas had a TFR of 3.9. The TFR of women with urban birth place was about 2.3 whereas of women with rural birth place was 3.6 children per woman.

The level of fertility decreased sharply from 4.9 children among women with no formal education to 2 children among women with secondary and above education. TFR was higher among women who did not have any media exposure (3.8 children per woman) than those who had media exposure (2.3 children per woman). The TFR of housewives was higher (5.2 children per woman) than employed women (4.5 children per woman). TFR of women who were students and job seekers at the time of the survey was 0.45 and 1.6 children per woman, respectively. Currently married women had a TFR of 6.0, more than twice as high as those whose marriage was dissolved (divorced, widowed and separated), at 2.9. The TFR of never married women equal to 0.78 child per woman.

The TFR of women whose ideal number of children was greater than four was 4.7, whereas women whose ideal number of children were four and lower were 2.5 children per women. The TFR among women who wanted additional children were 2.7 whereas those who did not want had a TFR of 7.6 children per women. Women who have used at least one contraceptive method had higher TFR (5.1 children per women) than those who did not use at all (2.8 children per women).

Among women who had food shortage experience in the last 5 years had higher TFR (4.0 children per woman) and those who did not have the experience had a TFR of 3.4 children per woman. The TFR of women who were empowered to decide (alone or together with husband) on the households' monthly expense was 3.3 children per women while of those who were not empowered was 4.5 children per women and women with lowest and highest wealth status had lower TFR, 2.88 and 2.82 children per woman respectively (Table 3).

Table 3
Fertility Differentials, Age Specific Fertility and Total Fertility Rates, in Dabat HDSS, Ethiopia, 2020

Characteristics	Categories	Fertility by the age of women at birth							
		15–19	20–24	25–29	30–34	35–39	40–44	45–49	TFR
Residence	Urban	0.019	0.10	0.161	0.139	0.058	0.021	0.008	**2.53**
	Rural	0.023	0.126	0.220	0.189	0.148	0.064	0.014	**3.92**
Age at first marriage	< 18	0.212	0.259	0.280	0.192	0.131	0.060	0.013	**5.74**
	≥ 18	0.333	0.301	0.219	0.132	0.114	0.025	0.019	**5.71**
Age at first birth	< 18	0.485	0.278	0.236	0.219	0.111	0.043	0.007	**6.89**
	≥ 18	0.667	0.395	0.293	0.163	0.143	0.059	0.017	**8.67**
Place of birth	Urban	0.012	0.089	0.181	0.098	0.072	-	-	**2.26**
	Rural	0.024	0.124	0.194	0.184	0.125	0.056	0.014	**3.60**
Educational Level	No formal edu.	0.077	0.222	0.281	0.196	0.148	0.055	0.016	**4.97**
	Primary	0.017	0.204	0.150	0.172	0.062	0.062	-	**3.33**
	Secondary+	0.020	0.059	0.151	0.120	0.046	0.015	-	**2.05**
Media exposure	Yes	0.011	0.085	0.161	0.140	0.047	0.025	-	**2.34**
	No	0.027	0.131	0.206	0.181	0.143	0.055	0.015	**3.79**
Occupation	Student	0.005	0.011	0.074	-	-	-	-	**0.45**
	Housewife	0.122	0.288	0.233	0.190	0.144	0.059	0.012	**5.24**
	Employed	0.333	0.140	0.211	0.159	0.032	-	0.033	**4.54**
	Job seekers	0.083	0.076	0.068	0.047	-	0.041	-	**1.57**
Current marital status	Single	0.004	0.016	0.018	0.119	-	-	-	**0.78**
	Married	0.264	0.285	0.256	0.183	0.138	0.06	0.016	**6.00**
	Dissolved	0.095	0.142	0.214	0.095	0.017	0.015	-	**2.90**
Divorce experience	Yes	0.166	0.222	0.333	0.141	0.109	0.028	0.023	**5.11**
	No	0.252	0.284	0.237	0.182	0.133	0.062	0.008	**5.79**
Husband's education level	No formal edu.	0.153	0.302	0.248	0.157	0.138	0.062	0.014	**5.37**
	Primary	0.281	0.262	0.264	0.289	0.160	0.027	0.021	**6.52**
	Secondary+	0.285	0.264	0.25	0.153	0.057	0.039	-	**5.24**

Characteristics	Categories	Fertility by the age of women at birth							
		15–19	20–24	25–29	30–34	35–39	40–44	45–49	TFR
Husband's occupation	Farmer	0.234	0.311	0.258	0.191	0.149	0.061	0.014	**6.10**
	Employed	0.416	0.275	0.251	0.137	0.073	0.023	0.014	**5.94**
	Job seeker	0.166	0.157	0.20	0.111	-	0.055	-	**3.44**
Ideal number of children	<=4	0.025	0.101	0.151	0.133	0.071	0.024	-	**2.52**
	5+	0.010	0.178	0.303	0.207	0.159	0.065	0.018	**4.70**
Want more children	Yes	0.017	0.096	0.148	0.156	0.078	0.036	0.007	**2.69**
	No	0.296	0.318	0.323	0.194	0.181	0.061	0.156	**7.64**
Contraceptive ever use	Yes	0.200	0.246	0.225	0.168	0.107	0.076	0.007	**5.14**
	No	0.009	0.049	0.147	0.172	0.139	0.026	0.016	**2.79**
Food shortage in the last 5 years	Yes	0.005	0.128	0.375	0.145	0.111	0.037	-	**4.01**
	No	0.024	0.116	0.176	0.173	0.121	0.053	0.015	**3.39**
Decision making power	Unempowered	0.018	0.102	0.205	0.149	0.166	0.043	0.009	**4.46**
	Empowered	0.027	0.130	0.182	0.184	0.075	0.055	0.016	**3.34**
Wealth index	Lowest	0.011	0.071	0.137	0.175	0.135	0.032	0.016	**2.88**
	Lower	0.034	0.103	0.144	0.171	0.155	0.075	0.015	**3.48**
	Middle	0.022	0.185	0.342	0.225	0.138	0.075	0.012	**4.99**
	Higher	0.035	0.117	0.156	0.172	0.129	0.041	-	**4.25**
	Highest	0.010	0.108	0.181	0.121	0.034	0.015	0.015	**2.42**
Total		**0.022**	**0.117**	**0.191**	**0.169**	**0.119**	**0.050**	**0.012**	**3.40**

Multivariate Mediation Analysis

Among the proximate determinants, it was only marriage that stood out as a significant proximate determinant of recent fertility. The level of recent fertility was more than fivefold higher among currently married women (IRR = 5.6 with a P-value = 0.000) than their unmarried counterpart. Thus, it was only marriage in the population that had a relatively higher influence over recent fertility in the area. Both contraception and

abortion did not show any statistically verifiable evidence of influence over fertility. In this study, it was apparent that the indirect effects of the distal variables operated through marriage in the population.

Current age of women, occupation of women, household wealth, ideal number of children, and child death experience had a significant total effect that were decomposed to direct and indirect or mediated effects of variables. Fertility peaked in the age group of 25–34 years (IRR = 1.3 with P-value = 0.042) and the risk of fertility of older women (age 35+) has fallen below women of age group 15–24 (IRR = 0.6 with P-value = 0.000). The study revealed that the direct influence for women of age group 25–34 was insignificant but fully mediated by marriage, that is, the indirect effect contributed 100% to the total effect. For women of age 35 + years, the direct influence (IRR = 0.4 with P-value = 0.000) was larger than the total impact such that the indirect contribution through marriage became positive (IRR = 1.3 with P-value = 0.000). That is, by virtue of higher prevalence of marriage among the elderly women, their fertility was likely to increase as opposed to younger women. However, this increase did not offset the decrease caused by the direct effect resulting in a negative total effect.

Urban resident women had a lower risk of fertility (IRR = 0.6 with P-value = 0.031) as opposed to their rural counterpart. The influence of urban residence on recent fertility is fully mediated by marriage. Educational achievement of women did not play a role in influencing their fertility. The types of occupations women were engaged in highly shaped the recent fertility of the study area. The study showed that students had a rather lowest level of fertility (IRR = 0.05 with P-value = 0.000), followed by job seekers (IRR = 0.3 with P-value = 0.000) and employed women (IRR = 0.7 with P-value = 0.046). The effect for the students was partially mediated (35.4%) while for employed and job seekers, the effects on fertility was fully mediated by marriage.

Wealth was another factor that had a statistically significant influence over fertility of women. The risk of fertility progressively increases with the level of household wealth; however, the mediated effect of wealth of middle (29.0%) and richer (25.6%) category was partially mediated. For the rest of the groups, their direct effect on fertility was nil and their influence was perceived through marriage. On the other hand, women that had a larger ideal number of children had a higher risk of fertility (IRR = 1.4 with P-value = 0.001) than women that had fewer ideal number of children. The result also suggested that the relationship was direct and no effect mediation was observed. Similarly, women that had a child death experience had an increased risk of fertility ((IRR = 1.4 with P-value = 0.020) than women that did not have child death experience. However, unlike the effect of ideal number of children, the influence was fully mediated and its influence was carried through its effect on marriage.

Table 4
The direct, indirect, and total effects of socio-economic and demographic determinants on fertility among childbearing age women in Dabat HDSS, derived from Generalized Structural Equation Model, 2020

Characteristics	Categories	Total Effect IRR (P-Value)	Direct effect IRR (P-Value)	Indirect Effect IRR (P-Value)	% of Indirect effect to Total effect
Age group	15–24 (*Ref*)	1.0	1.0	1.0	
	25–34	1.3 (0.042)	1.0 (0.880)	1.3 (0.042)	100.0
	35+	0.6 (0.001)	0.4 (0.000)	1.3 (0.000)	-48.4
Current Place of Residence	Urban	0.6 (0.031)	0.8 (0.207)	0.6 (0.031)	100.0
	Rural (*Ref*)	1.0	1.0	1.0	
Place of birth	Urban	1.2 (0.458)	1.4 (0.076)		
	Rural (*Ref*)	1.0	1.0		
Educational Level	Illiterate	1.0 (0.806)	0.9 (0.703)		
	Primary	1.0 (0.872)	1.0 (0.722)		
	Secondary+ (*Ref*)	1.0	1.0		
Occupation	Housewife (*Ref*)	1.0	1.0	1.0	
	Student	0.05 (0.000)	0.1 (0.000)	0.4 (0.000)	35.4
	Employed	0.7 (0.046)	0.9 (0.572)	0.7 (0.046)	100.0
	Job seeker	0.3 (0.000)	0.6 (0.096)	0.3 (0.000)	100.0
Media exposure	No (*Ref*)	1.0	1.0		
	Yes	0.9 (0.708)	0.9 (0.472)		
Food shortage experience in the last 5 years	No (*Ref*)	1.0	1.0		
	Yes	0.9 (0.302)	0.9 (0.679)		

Characteristics	Categories	Total Effect IRR (P-Value)	Direct effect IRR (P-Value)	Indirect Effect IRR (P-Value)	% of Indirect effect to Total effect
Women who decide household expenses	Unempowered (*Ref*)	1.0	1.0		
	Empowered	1.0 (0.984)	1.1 (0.329)		
Wealth index	Poorest (*Ref*)	1.0	1.0	1.0	
	Poorer	1.6 (0.010)	1.3 (0.147)	1.6 (0.010)	100.0
	Middle	2.1 (0.000)	1.7 (0.000)	1.2 (0.000)	29.0
	Richer	2.6 (0.000)	2.0 (0.000)	1.3 (0.000)	25.6
	Richest	2.5 (0.002)	1.5 (0.113)	2.5 (0.002)	100.0
Ideal number of children	<=4 (*Ref*)	1.0	1.0	1.0	
	>=5	1.4 (0.001)	1.4 (0.004)	1.1 (0.115)	14.3
Child death experience	No (*Ref*)	1.0	1.0	1.0	
	Yes	1.4 (0.020)	1.3 (0.057)	1.4 (0.020)	100.0
Current contraceptive use	No (*Ref*)		1.0		
	Yes		0.8 (0.078)		
Marriage	No (*Ref*)		1.0		
	Yes		5.6 (0.000)		

Discussion

The TFR for the three years preceding the survey was estimated at 3.4 children per woman which was below the national and regional average (10). TFR in the study area showed a continues declining from 3.9 children per woman in 2012 (28). Thus, the trend shows that the total-fertility rate target stipulated in the Ethiopian population policy achieved before the expected period which couldn't be achieved at national level (10, 31). The result also depicted Age Specific Fertility Rate in the study area reached its peak in the age group of 25–29 and falls slowly with advancing age. However, studies conducted in Ethiopia in 1990s and before showed

that women in age group with the highest fertility level was 20–24 (15, 31, 32) which shows the shifting of the peak ages in ASFR or the postponement of births to the later ages that may be attributed to the increasing of age at first marriage and birth.

The multivariate results showed that the residence, age, occupation of women, child death experience, marriage and wealth index could have been responsible for the current fertility in the study area. According to the result, marriage had a positive and strong association with fertility. The level of recent fertility was more than fivefold higher among currently married women than their unmarried, consistent with a study from Addis Ababa city (33). This indicates that premarital fertility is very minimal in the study area in which birth is highly attached with marital union as birth out of wedlock is socially unacceptable in Ethiopia (10, 34). The prevailing decline in the proportion of currently married women may contribute to the reduction of the recent fertility (9, 10).

The other predictor of fertility is current age of women. In this study fertility was significantly higher among women of age group 25–34 but significantly declining after age 34 compared to women of 15–24 age group which was fully mediated by marriage. This result was confirmed by previous studies that suggested the causes related to behavioral and biological reasons. Regarding the behavioral reasons, it was suggested that fertility decline occurred among women in the later reproductive ages because of the fact that women took deliberate steps to limit subsequent childbearing once they had borne the desired number of children. Women will begin to have all of the children they desire immediately after marriage and will continue to have births until they achieve their target family size and then will actively prevent the birth of additional children (35). It would be because of these individual decisions that produced the fertility decline in old age groups. On the other hand, in biological reasons, the ability of older women to get pregnant is naturally becoming low, the embryo implanting ability and survival start declining gradually after 30 years of age, but by more than two thirds after 40 years (36, 37).

Residence was one of the variables that significantly associated with fertility. The study depicted those urban women had a lower chance of having children compared to their rural counterparts. The influence of urban residence on recent fertility was fully mediated by marriage. This difference may be due to the fact that women in urban areas enter into unions at relatively older ages and an increasing proportion of single women with very low premarital fertility (38). This shift in union formation to later age is commonly attributed to women's increasing levels of education, greater participation in wage employment and the development of alternative roles for women outside marriage and motherhood (39).

The types of occupations in which women were engaged also affected the fertility in the study area. Employed women and those who looked for job had lower level of fertility compared to housewives in that the effect on fertility was fully mediated by marriage. Employed women were possibly educated and were likely to marry at later ages. Employment influences on women's marital decisions as it tends to lead women to appreciating singlehood and cohabitation over marriage (40). Nowadays, studies reported that women's rising employment levels have increased their economic independence and hence have greatly reduced the desirability of marriage and consequently have fewer children (41). On the other hand, job seekers usually postpone their marriage which in turn influence the level of fertility. Studies indicated that there has been a growing sentiment that women's involvement in and attachment to the paid labor force before marriage has

become part of their gender freedom (42, 43). The result also revealed that students had lower level of fertility compared to housewives. Girls who stay in school longer have a direct influence to lower their probability of having child (44). The effect for the students was also partially mediated by marriage in that the chance of girls to marry is low until they completed their education. Studies mentioned that it was to avoid the challenges of getting involved in their own relationship such as to dedicate time to marriage and household responsibilities that may distract from their studies which in turn reduce the level of fertility (45).

Women who had large ideal number of children had a positive association with fertility which has a direct effect with absence of influence through marriage. This is similar to other studies where the desire to have lower children usually tending for decline in fertility (46). History of child death among the married women in this study was found to have a positive association with fertility but fully mediated through marriage. Women who had a child-death experience were likely to have a higher number of children than those who had no such experience. Similar studies indicated that high child mortality causes high fertility through the insurance and replacement effect, married women were exposed to a higher risk of uncontrolled fertility as number of children who died increased (6, 46, 47).

Household wealth status was found to have an important influence on women's fertility. Contrary to the findings of many studies (48, 49), fertility in this study was significantly higher among women with better wealth quintile compared to women with the poorest wealth status, the risk of fertility progressively increases with the level of household wealth. Nowadays, in low-income countries, poor people have the same desired fertility and even they tended to have lower number of births as compared to their wealthy compatriots, consistent with a study from Tanzania (50) and Ethiopia (38, 51). This might be attributed to the increasing severe economic difficulties that may initiate women not to give birth. The effect of wealth of poorer and richest category was full mediated through marriage. For the middle and richer wealth quintile, their effect on fertility was partially mediated through marriage.

Contrary to most studies on fertility determinants (47, 48, 52), the result of this study revealed that education and media exposure did not show any association with fertility. It could be supposed that differences among individuals in different categories in fertility behavior may be diminishing due to improved communication links among educated and uneducated, and the entire societies that may help to have similar information about the benefit of having desired number of children in a household. This may be due to the deployment of health extension workers since 2003 in each Kebele (53).

The results of many studies (20, 23, 25) revealed that the prevailing contraceptive use has showed a significant and negative association with fertility. However, in the present study, current contraceptive use was only marginally significant (P = 0.078). There was no evidence that current contraceptive use has an effect for the recent fertility decline. Similar findings were documented in Amhara and other regions of the country (6, 33, 54). It could be supposed that the absence of the effect of contraception may be due to low level of contraceptive prevalence rate (CPR) that might not be at the level (CPR = 17%) of influencing the current fertility and might be due to high discontinuation rate in the study area.

Women were asked whether they can decide on major household expenses that might indicate whether they can be able to pass a decision on the number of children they wish to have and the use of contraceptive

methods they prefer at any time. However, the result showed that the variable had no any association with fertility. Respondents were also asked whether household experienced food shortage in five years preceding the survey that may indirectly showed the household economic status and risk to susceptibility. However, the result showed that the variable had no any association with fertility.

The use of Dabat HDSSs database to recruit study participants and administration of the questionnaire by the surveillance site supervisors and data collectors could be mentioned as strengths for the current study. The surveillance staffs knew study participants for a long time and this also built trust on the participants side to provide reliable information. As a limitation, this study did not interview men, in cultures where males tend to dominate decisions, about their fertility preferences and behavior assuming detailed information was more readily and accurately obtained from females, and males and females have similar attitudes toward a number of key issues that may affect fertility behavior.

Conclusion

Marriage was the only proximate determinant that stood out as a significant mediated variable through which the distal variables affected fertility. Findings also clearly indicated that female participation in non-agricultural occupation affected the recent fertility. Hence, women's level of employment should be raised to increase their economic independence that will reduce the desirability of early marriage which in turn lower the number of children. In addition, strategies on family planning programs should be improved to enhance the prevalence of contraceptive use among married women that will accelerate the current fertility transition in the study area.

Abbreviations

HDSSs	Health and Demographic Surveillance Site
TFR:	Total Fertility Rate
ASFR	Age Specific Fertility Rate
EDHS:	Ethiopia's Demographic and Health Survey
ANRS:	Amhara National Regional State
CEB:	Children Ever Born
GSEM	Generalized Structural Equation Model

Declarations

Ethics approval and consent to participate

The Authors have obtained ethical clearance from the Health Research Ethics Review Committee (HRERC) of the University of Gondar. A formal letter was written to the local district administrative and health offices. Written informed consent was also obtained from the head of the family or other eligible adult in the family when relevant. The right of the respondent to withdraw from the interview or not to participate at all was

informed and respected. Each piece of information that was given by every responding subject was made strictly confidential.

Consent for publication

Not applicable, no individual detail is presented.

Availability of data and materials

The raw data used in this analysis is available from the corresponding author on reasonable request using mihretn21@gmail.com

Competing interests

The authors declare that they have no competing interest.

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Authors' contributions

NM participated from conception to the final approval of the final version of the article. AH, MY and KA supervised the whole exercise and made critical comments at each step in the research. They also approved the final version of the article.

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