Demographic and Socio-economic Factors Affecting Fertility in Madhesh Province

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Abstract

This study used secondary data from the 2022 Nepal Demographic and Health Survey (NDHS) to explore factors affecting fertility among 2,499 women in Madhesh province. The mean number of children ever born (CEB) in Madhesh was 2.21, higher than the national average of 1.86. The findings revealed higher fertility rates, larger household sizes, and younger age profiles in Madhesh compared to national averages. Education levels were lower, and the ages at first cohabitation and childbirth were earlier. Significant positive relationships were found between fertility and factors such as age, breastfeeding, child mortality, ideal number of children, and household size. In contrast, fertility was negatively associated with wealth, desired number of children, household head age, and pregnancy status. Furthermore, female household headship, the husband's age, and the husband's occupation positively affected fertility, while the husband's education level had a strong negative effect. The study suggests that targeted programs addressing these factors are needed to reduce fertility rates and meet Sustainable Development Goals (SDGs) in Madhesh province. Factors such as religion, ethnicity, place of residence, age at first cohabitation, age at first birth, contraceptive use, abortion, respondents' education and occupation, amenorrhoeic status, marriage-to-first-birth interval, and employment in the last twelve months were found to be non-influential.

Keywords: Fertility, Children Ever Born (CEB), Demographic factors, Socioeconomic factors, Madhesh province, Nepal

1. Introduction

Fertility rates are fundamental to shaping the demographic structure of societies worldwide, impacting economic, social, and health dynamics at both local and global levels. High fertility rates often lead to rapid population growth, particularly in developing regions, where larger family sizes are more common due to cultural practices, economic factors, and access limitations to family planning. On the other hand, low fertility rates, typically seen in developed nations, contribute to population aging and a shrinking working-age demographic, posing challenges for long-term economic sustainability and healthcare systems (UNDESA, 2013). This complex interrelation between fertility and demographic trends highlights the need to examine factors affecting fertility, access to healthcare, and government policies across regions to foster balanced population growth.

Fertility Trends and Socioeconomic Implications

Global fertility rates have decreased in recent decades, a trend linked to improvements in socioeconomic conditions, greater access to family planning, and heightened educational and employment opportunities for women. Countries transitioning from high to lower fertility rates generally experience declining mortality rates, leading to shifts in population age structures and the so-called demographic transition. This phenomenon is particularly notable in regions where fertility and mortality rates have fallen significantly, bringing the average number of children born per woman down to near replacement levels (Bongaarts, 2009).

Despite these shifts, global population growth continues due to factors such as longer lifespans, increased numbers of people reaching reproductive age, and urbanization. Projections indicate that the world population will grow from approximately 8 billion, today to 9.7 billion by 2050, with a potential peak of 10.4 billion by 2100 (UNDESA, 2017). However, this growth is not uniform across regions. Fertility rates in parts of Africa, for example, remain high, with countries like Niger reporting an average of 6.7 children per woman, while other areas, such as East Asia, are witnessing historic lows. This demographic divergence has significant implications for healthcare, education, and sustainable development initiatives, with governments often facing distinct challenges based on their region's fertility trends.

Fertility Disparities by Region and Country

The average global Total Fertility Rate (TFR) currently sits around 2.3 children per woman, a figure masking wide regional and national disparities. Regions such as Asia and the Pacific have relatively low TFRs (around 1.9), while parts of Africa, particularly West and Central Africa, have among the highest TFRs globally, averaging around 4.8 (UNFPA, 2023). Countries like Niger lead in fertility rates, while regions like Hong Kong and South Korea exhibit some of the world's lowest TFRs at 0.7 and 0.8, respectively (World Bank Group, 2022).

Fertility declines are evident even in historically high-fertility regions. Africa, for example, saw its TFR decrease from 5.1 in 2000-2005 to 4.7 in 2010-2015, although the high growth rate in some African nations poses challenges to achieving sustainable development goals (SDGs) by 2030. In contrast, Europe, with historically low fertility, has seen a slight increase, with TFRs rising from 1.4 to 1.6 over the same period (UNDESA, 2017). This contrast between regional trends highlights the complex, multifaceted influences on fertility and emphasizes the importance of tailored policies and initiatives.

Case Study: Fertility in Nepal and the Provincial Disparities

Nepal's fertility trends exemplify how socioeconomic and cultural factors drive demographic differences within a country. The national TFR has declined significantly, from 4.6 in 1996 to 2.1 in 2022, aligning with Nepal's SDG goal of a replacement-level TFR (National Planning Fertility Commission, 2020a). Despite this achievement, variations exist across Nepal's provinces, notably in Madhesh Province, where the TFR remains high at 2.7, contrasting with the national average.

The disparities in fertility between provinces like Madhesh and Bagmati reveal how socioeconomic, educational, and healthcare access disparities shape demographic outcomes. Madhesh's high fertility rate correlates with early marriage, low literacy levels, high maternal mortality rate and limited access to reproductive health services (MoHP, 2023). The province's higher population growth rate (1.19%) compared to the national rate (0.92%) reflects these challenges, with specific districts such as Rautahat exhibiting rapid growth (NSO, 2023).

Factors Influencing Fertility in Nepal

Various factors influence fertility across Nepal's provinces, including education, marriage age, and socioeconomic status. Madhesh Province demonstrates the effect of early marriage on fertility rates. The median age at first marriage in Madhesh is 19.3 years, lower than Nepal's national median of 20.6 years (MoHP, 2023). Early marriage typically leads to earlier and more frequent childbearing, contributing to higher lifetime fertility. Moreover, lower educational attainment in Madhesh, particularly among women, limits awareness and access to family planning, further elevating fertility rates (MoHP, 2023).

Healthcare access disparities also play a crucial role. In Madhesh, many births occur at home (32%), and only 67% of births take place in health facilities, both the lowest rates among Nepal's provinces. Immunization rates are similarly low, with only 68% of children aged 12-23 months fully immunized, underscoring health service access challenges that contribute to higher fertility and child mortality rates (MoHP, 2023).

The Role of Policy and Health Initiatives

To address high fertility and its implications for sustainable development, Nepal has implemented policies and programs focused on family planning, maternal health, and education. Family planning services, often delivered through health facilities and Female Community Health Volunteers (FCHVs), provide free contraceptives and counselling to help reduce fertility rates. The Adolescent and Sexual Reproductive Health Program further educates youth on reproductive health, aiming to delay marriage and reduce teenage pregnancies (MoHP, n.d.).

Legalization of abortion in 2002 marked a turning point for Nepal's fertility rates, as it allowed for safe and accessible abortion services, reducing maternal mortality associated with unsafe abortions (Wu et al., 2017). Additionally, Nepal's commitment to promoting exclusive breastfeeding and increasing the breastfeeding rate to over 90% by 2030 further supports child health and contributes to better family planning outcomes (Kathmandu Post, 2023). The promotion of late marriages, which is legal at 20 years of age (Chintan Law Associate, 2023), aims to increase the median age at first marriage, thereby delaying the age of first childbirth.

2. **Research Objective**

To assess and compare the mean number of children ever born (CEB) in Madhesh Province with those in other provinces and Nepal, and to examine the causal relationship between the number of children ever born (CEB) and various independent variables in Madhesh Province, with a comparison to Nepal.

3. Research Methodology

Research design and source of data

This study employed both descriptive and explanatory research designs to comprehensively explore the objective, relying on secondary data from the 2022 Nepal Demographic and Health Survey (NDHS).

Dependent and independent variable

Children ever born (CEB) serves as the specific measure of fertility, representing the average number of live births to women within a particular age group. It reflects their lifetime fertility experience up to the point of data collection. (UNDESA, 2013; World Fertility Report, 2012). Children ever born" (CEB) is a preferred measure of fertility as it provides a cumulative and stable reflection of a woman's reproductive history, capturing both past and present fertility behavior.

In this study, CEB was used as the dependent variable, while independent variables included demographic, socioeconomic, and cultural factors such as age, marital status, age at marriage, age at first birth, insusceptibility to pregnancy, breastfeeding, contraceptive use, induced abortion, marital duration, etc.

Methods of data analysis

Initially, the data were extracted from the publicly available fertility dataset of Nepal from the 2022 DHS program in STATA software. The criterion and predictor variables for the study were identified and key identifiers such as caseid, v000, v001, v002, v003, and v004 were retained. Thereafter, the fertility-related outcome and explanatory variables were inspected using the DHS dataset codebook to understand their labels and values. A summary of the dataset was generated, focusing on key statistics: observations, mean, standard deviation, minimum, and maximum. New variables were then examined and recoded or generated from the original NDHS variables, converting ratio-level data into appropriate ratio, nominal, ordinal, and interval data to align with the study's objective. These newly created variables were compared to ensure accuracy.

The data analysis for Madhesh province and Nepal involved multiple detailed steps. These steps included generating frequency tables to examine the characteristics of the data through univariate analysis, cross-tabulations were used for bivariate analysis to assess associations between the number of children ever born (CEB) and other independent variables, mean tables over provinces were constructed to calculate and compare averages across different provinces, and correlation matrices were employed to evaluate the relationships between variables, where each cell contains a correlation coefficient indicating the strength and direction of the relationship which ranging from -1 to +1.

Additionally, the study used both a simple linear regression model (unadjusted) and a multiple linear regression (adjusted) model. Initially, a simple linear regression model was conducted with CEB and each variable separately for Madhesh and Nepal analysis. This step helped in understanding the individual effect of each predictor on fertility. Following this, multiple linear

regression analysis (adjusted) was performed twice based on Davis & Blake and Bongaarts' model; and other empirical models using the Ordinary Least Squares (OLS) technique. The multivariate analysis explored relationships between CEB and multiple predictors simultaneously. Weighting factors provided by NDHS were applied in the multiple linear regression analysis to ensure an accurate representation of the Nepalese and Madhesh populations. Dummy variables were created for multinomial variables such as religion, ethnicity, and province to facilitate the regression analysis. The net effect of each predictor on the dependent variable was measured by controlling for the effect of other predictors. STATA has a default system of handling multicollinearity by omitting problematic variables (Current marital status and number of living children). A few variables, such as months of abstinence and religion, were excluded due to low observations and with about 85.5% of the population being Hindu respectively.

4.   Results and Discussion

4.1 **Demographic and socio-economic characteristics of women respondents in Madhesh province**

Table 1 presents the demographic and socio-economic characteristics of women respondents in Madhesh province and Nepal from the NDHS 2022 data. The analysis indicated a trend towards smaller family sizes in Madhesh province. Approximately 24.7 percent of respondents had no children, 11.9 percent had one child, and 20.1 percent had two children. The population was relatively young, with 20.89 percent of respondents aged 15-19 and 19.21 percent aged 20-24. Most respondents (80.43%) were married, while single, widowed, separated, and divorced individuals comprised the remaining 19.57 percent.

Early cohabitation was prevalent, with 68.8 percent of respondents starting cohabitation between 13-17 years. The mean age at first cohabitation was 16.48 years. The majority of first births occurred between ages 16-20 (66.0%). A majority of respondents (56.9%) resided in urban areas. The wealth distribution showed a concentration in the middle (31.9%), poorer (27.6%), and richer (23.7%) categories, indicating a relatively balanced economic landscape compared to national data.

Madhesh province was predominantly Hindu (85.5%), with significant Muslim (12.9%) and small Buddhist (1.4%) communities. Ethnic diversity was notable, with the largest groups being other terai castes (49.3%) and terai Dalits (21.2%). Education levels revealed a high illiteracy rate (44.9%), with 30.2 percent having primary education and 23.1 percent secondary education. Employment was dominated by self-employment in agriculture (51.1%) and a substantial non-working population (36.3%). Contraceptive use showed that 58.5 percent of respondents did not use any method, with female sterilization being the most common among users (24.3%).

Most respondents had not experienced the death of a child, indicating high child survival rates. The majority of respondents (93.7%) were not pregnant, and 21.0 percent were currently breastfeeding. The majority of respondents' husbands fell within the 35-39 age group (17.2%). In terms of education, 33.8 percent of husbands had completed basic education, while 31.0 percent

had secondary education. A very small percentage of husbands (5.7%) had completed higher secondary education. Additionally, the occupational distribution showed that a significant number of husbands were engaged in skilled (27.5%) and unskilled manual labour (25.0%), followed by agriculture (17.6%), with others working in sales and service, and professional roles.Household sizes were generally moderate, with 51.7 percent having 1-5 members. The majority of household heads were male (70.5%) and aged 40-44 years (19%).

Table 1. Percent and frequency distribution of women respondents by selected demographic characteristics

Background Characteristics	Madhesh			Nepal		
	Mean	Number	Percent	Mean	Number	Percent
CEB	2.21			1.86		
0		618	24.7		4,110	27.7
1		297	11.9		2,564	17.3
2		501	20.1		3,610	24.3
3		510	20.4		2,249	15.2
4		335	13.4		1,262	8.5
5		137	5.5		580	3.9
6		69	2.8		290	2.0
7		15	0.6		100	0.7
8		12	0.5		44	0.3
9		1	0.0		22	0.2
10		3	0.1		11	0.1
11		0	0.0		2	0.0
12		1	0.0		1	0.0
Total		**2499**	**100.0**		**14,845**	**100.0**
Age group	29.03			29.69		
15-19		522	20.9		2,777	18.7
20-24		480	19.2		2,623	17.7
25-29		372	14.9		2,361	15.9
30-34		312	12.5		2,065	13.9
35-39		329	13.2		2,002	13.5
40-44		293	11.7		1,650	11.1
45-49		191	7.6		1,367	9.2
Total		**2499**	**100.0**		**14,845**	**100.0**

Background Characteristics	Madhesh			Nepal		
	Mean	Number	Percent	Mean	Number	Percent
Current marital status						
Single		436	17.5		3,123	21.0
Married		2,010	80.4		11,232	75.7
Living with partner		0	0.0		26	0.2
Widowed		45	1.8		309	2.1
Divorced		2	0.1		30	0.2
Separated		6	0.2		125	0.8
Total		**2,499**	**100.0**		**14,845**	**100.0**
Age at first cohabitation	16.48			17.91		
8-12		64	3.1		236	2.0
13-17		1,419	68.8		5,848	49.9
18-22		538	26.1		4,565	38.9
22-27		36	1.8		867	7.4
28-32		5	0.2		168	1.4
33-37		1	0.1		32	0.3
38-43		0	0.0		6	0.1
Total		**2,063**	**100.0**		**11,722**	**100.0**
Age at first birth	18.88			19.93		
11-15		163	8.7		594	5.5
16-20		1,241	66.0		6,253	58.3
21-25		441	23.4		3,171	29.5
26-30		30	1.6		594	5.5
31-35		5	0.3		106	1.0
36-40		1	0.1		15	0.1
41-43		0	0.0		2	0.0
Total		**1,881**	**100.0**		**10,735**	**100.0**
Contraceptive use and intention						
Using modern method		873	34.9		4,998	33.7
Using traditional method		164	6.6		1,491	10.0
Non user- intends to use later		911	36.5		5,534	37.3

Background Characteristics	Madhesh			Nepal		
	Mean	Number	Percent	Mean	Number	Percent
Does not intend to use		551	22.1		2,822	19.0
Total		**2499**	**100.0**		**14,845**	**100.0**
Abortion						
No abortion		2,068	82.8		11,857	79.9
Abortion		431	17.3		2,988	20.1
Total		**2,499**	**100.0**		**14,845**	**100.0**
Breastfeeding						
No breastfeeding		1,974	79.0		12,167	82.0
Currently breastfeeding		525	21.0		2,678	18.0
Total		**2,499**	**100.0**		**14,845**	**100.0**
Amenorrheic						
No amenorrheic		2,384	95.4		14,133	95.2
Currently amenorrheic		115	4.6		712	4.8
Total		**2,499**	**100.0**		**14,845**	**100.0**
Currently Pregnant						
No or unsure		2,341	93.7		14,250	96.0
Yes		158	6.3		595	4.0
Total		**2,499**	**100.0**		**14,845**	**100.0**
Sons who have died						
No death of son		2,339	93.6		13,968	94.1
1 son died		149	6.0		751	5.1
2 son died		10	0.4		102	0.7
3 son died		0	0.0		20	0.1
4 son died		0	0.0		3	0.0
5 son died		1	0.0		1	0.0
Total		**2,499**	**100.0**		**14,845**	**100.0**
Daughter who have died						
No death of daughter		2,337	93.5		14,099	95.0
1 daughter died		144	5.8		672	4.5
2 daughter died		18	0.7		65	0.4

| Background Characteristics | Madhesh | | | Nepal | | |
	Mean	Number	Percent	Mean	Number	Percent
3 daughter died		0	0.0		7	0.1
4 daughter died		0	0.0		1	0.0
5 daughter died		0	0.0		1	0.0
Total		**2,499**	**100.0**		**14,845**	**100.0**
Number of household members	5.93			5.09		
1-5		1,291	51.7		9,752	65.7
6-10		1,059	42.4		4,673	31.5
11-15		133	5.3		373	2.5
16-20		13	0.5		31	0.2
21-26		3	0.1		16	0.1
Total		**2,499**	**100.0**		**14,845**	**100.0**
Husband's age	36.22			36.30		
15-19		17	0.9		152	1.4
20-24		211	10.5		1,094	9.7
25-29		335	16.7		1,849	16.4
30-34		316	15.7		2,003	17.8
35-39		345	17.2		1,899	16.9
40-44		312	15.5		1,753	15.6
45-49		249	12.4		1,329	11.8
50-54		171	8.5		831	7.4
55-59		39	1.9		236	2.1
60-64		9	0.5		71	0.6
65-69		5	0.3		23	0.2
70-74		1	0.1		7	0.1
75-95		0	0.0		11	0.1
Total		**2010**	**100.0**		**11,258**	**100.0**
Age of household head						
15-19		3	0.1		117	0.8
20-24		66	2.6		568	3.8

Background Characteristics	Madhesh			Nepal		
	Mean	Number	Percent	Mean	Number	Percent
25-29		137	5.5		1,068	7.2
30-34		197	7.9		1,459	9.8
35-39		335	13.4		2,065	13.9
40-44		474	19.0		2,353	15.9
45-49		355	14.2		2,114	14.2
50-54		310	12.4		1,696	11.4
55-59		192	7.7		1,110	7.5
60-64		166	6.6		883	6.0
65-69		123	4.9		589	4.0
70-74		89	3.6		430	2.9
75-95		52	2.1		393	2.7
Total		**2,499**	**100.0**		**14,845**	**100.0**
Sex of household head						
Male		1,761	70.5		9,650	65.0
Female		738	29.5		5,195	35.0
Total		**2,499**	**100.0**		**14,845**	**100.0**
Education	4.11			6.09		
No education		1,123	44.9		4,005	27.0
Basic		754	30.2		4,751	32.0
Secondary		578	23.1		5,603	37.7
Higher		44	1.8		486	3.3
Total		**2,499**	**100.0**		**14,845**	**100.0**
Religion						
Hindu		2,136	85.5		12,618	85.0
Buddhist		34	1.4		848	5.7
Muslim		322	12.9		523	3.5
Kirat		3	0.1		371	2.5
Christian		4	0.2		477	3.0
Other		0	0.0		8	0.1

| Background Characteristics | Madhesh | | | Nepal | | |
	Mean	Number	Percent	Mean	Number	Percent
Total		**2,499**	**100.0**		**14,845**	**100.0**
Ethnicity						
Hill Brahmin		27	1.1		1,350	9.1
Hill Chhetri		16	0.6		3,493	23.5
Terai Brahmin/Chhetri		69	2.8		139	0.9
Other terai caste		1,233	49.3		1,753	11.8
Hill Dalit		10	0.4		1,700	11.5
Terai Dalit		530	21.2		788	5.3
Newar		40	1.6		393	2.7
Hill Janajati		57	2.3		3,265	22.0
Terai Janajati		193	7.7		1,433	9.7
Muslim		322	12.9		518	3.5
Other		2	0.1		13	0.1
Total		**2,499**	**100.0**		**14,845**	**100.0**
Husband's education	6.04			7.10		
No education		512	25.5		1,481	13.2
Basic		680	33.8		4,688	41.6
Secondary		622	31.0		4,239	37.7
Higher		115	5.7		718	6.4
Don't know		81	4.0		132	1.2
Total		**2010**	**100.0**		11,258	**100.0**
Wealth index (combined)						
Poorest		190	7.6		3,997	26.9
Poorer		690	27.6		3,029	20.4
Middle		796	31.9		2,965	20.0
Richer		591	23.7		2,733	18.4
Richest		232	9.3		2,121	14.3
Total		2499	100.0		14,845	100.0
Occupation						

		Madhesh		Nepal		
Background Characteristics	**Mean**	**Number**	**Percent**	**Mean**	**Number**	**Percent**
Not working		907	36.3		3,595	24.2
Professional/Technical/Managerial		71	2.8		749	5.1
Clerical		15	0.6		170	1.2
Sales		97	3.9		1,033	7.0
Agricultural-self employed		1,276	51.1		8,138	54.8
Skilled manual		84	3.4		474	3.2
Unskilled manual		48	1.9		676	4.6
Other		1	0.0		10	0.1
Total		**2499**	**100.0**		**14,845**	**100.0**
Husband's occupation						
Not working and didn't work in last 12		40	2.0		287	2.6
Professional/technical/managerial		195	9.7		1,129	10.0
Clerical		74	3.7		252	2.2
Sales and service		284	14.1		2,154	19.1
Skilled manual		552	27.5		2,554	22.7
Unskilled manual		502	25.0		2,447	21.7
Agriculture		347	17.3		2,356	20.9
Other		1	0.1		8	0.1
Don't know		15	0.8		71	0.6
Total		**2010**	**100.0**		**11,258**	**100.0**
Urban-rural residence						
Urban		1,422	56.9		8,019	54.0
Rural		1,077	43.1		6,826	46.0
Total		**2,499**	**100.0**		**14,845**	**100.0**

Source: NDHS, 2022

4.2 Mean Estimations of continuous variables across Provinces and Nepal

Table 2 highlights significant provincial discrepancies in key variables compared to national averages. In Madhesh province, the mean number of children ever born (2.21), ideal number of children (2.35), living children (2.07), and household size (5.93) are the highest among provinces and above national averages. The mean age of household heads (46.30 years) is slightly higher

than the national average, while the respondents' mean age (29.03 years) is the lowest. Respondents' mean years of schooling (4.11), age at first cohabitation (16.48), and age at first birth (18.88) are all below national averages, as are husbands' mean years of schooling (6.04) and mean age (36.22).

Table 2. Mean estimations of continuous variables over province and Nepal

Background Characteristics	n	Mean	Std. Err.	[95% Conf. Interval]
Children Ever Born (CEB)				
Nepal	14485	1.86	0.01381	1.83303-1.88715
Koshi	2,209	1.68	0.03172	1.61505-1.73941
Madhesh	2449	2.21	0.03579	2.13874-2.27903
Bagmati	2,106	1.56	0.03354	1.49171-1.62320
Gandaki	1,682	1.64	0.03556	1.57180-1.71120
Lumbini	2,266	1.73	0.03225	1.66804-1.79445
Karnali	1,978	2.18	0.04428	2.09268-2.26627
Sudurpaschim	2,105	1.95	0.03866	1.87815-2.02969
Current age of respondent				
Nepal	14845	29.69	0.08022	29.53498-29.84946
Koshi		30.04	0.20673	29.63552-30.44597
Madhesh	2499	29.03	0.19543	28.64214-29.40828
Bagmati		30.41	0.21184	29.99360-30.82406
Gandaki		30.74	0.24087	30.26866-31.21291
Lumbini		29.85	0.19748	29.46684-30.24101
Karnali		28.74	0.22320	28.30213-29.17714
Sudurpaschim		29.28	0.21604	28.86110-29.70802
Completed years of schooling				
Nepal	14845	6.09	0.03765	6.01843-6.16601
Koshi		6.72	0.08859	6.54524-6.89252
Madhesh	2499	4.11	0.08968	3.93626-4.28783
Bagmati		7.11	0.10265	6.90942-7.31185
Gandaki		7.23	0.10216	7.02923-7.42974
Lumbini		6.31	0.09238	6.12607-6.48823

Background Characteristics	n	Mean	Std. Err.	[95% Conf. Interval]
Karnali		5.91	0.10364	5.71141-6.11771
Sudurpaschim		5.79	0.10233	5.59276-5.99394
Age at first cohabitation				
Nepal	11722	17.91	0.03186	17.84602-17.97091
Koshi		18.95	0.08801	18.77818-19.12320
Madhesh	2063	16.48	0.05422	16.36876-16.58131
Bagmati		19.24	0.10663	19.02902-19.44705
Gandaki		18.32	0.09662	18.12818-18.50696
Lumbini		18.04	0.07737	17.88831-18.19160
Karnali		17.12	0.07265	16.97625-17.26106
Sudurpaschim		17.61	0.07754	17.46278-17.76677
Age at first birth				
Nepal	10735	19.93	0.03324	19.86367-19.99399
Koshi		20.78	0.09186	20.60320-20.96332
Madhesh	1881	18.88	0.06441	18.75201-19.00450
Bagmati		20.87	0.10916	20.65741-21.08535
Gandaki		20.23	0.10320	20.02360-20.42817
Lumbini		20.05	0.08275	19.88628-20.21069
Karnali		19.19	0.07838	19.04060-19.34787
Sudurpaschim		19.79	0.07917	19.63334-19.94373
Husband's age				
Nepal	11258	36.30	0.09168	36.12522-36.48465
Koshi		37.06	0.23944	36.59159-37.53027
Madhesh	1929	36.22	0.21418	35.80156-36.64123
Bagmati		37.54	0.24420	37.05893-38.01626
Gandaki		37.75	0.26858	37.22608-38.27903
Lumbini		35.63	0.21673	35.20594-36.05561
Karnali		34.54	0.25981	34.03322-35.05177
Sudurpaschim		35.68	0.25742	35.17702-36.18621
Husband's education				

Background Characteristics	n	Mean	Std. Err.	[95% Conf. Interval]
Nepal	11126	7.10	0.03855	6.99223-7.35131
Koshi		7.17	0.09159	7.29512-8.02507
Madhesh	1929	6.04	0.10242	5.84123-6.24275
Bagmati		7.47	0.10875	7.25907-7.68542
Gandaki		7.64	0.10066	7.43991-7.83454
Lumbini		7.10	0.09312	6.91569-7.28076
Karnali		7.20	0.10629	6.98860-7.40528
Sudurpaschim		7.45	0.10188	7.25207-7.65148
Age of household head				
Nepal	14845	45.15	0.11040	44.93799-45.37080
Koshi		45.81	0.28676	45.24462-46.36878
Madhesh	2499	46.30	0.25396	45.80313-46.79871
Bagmati		45.25	0.30668	44.64531-45.84757
Gandaki		45.91	0.33633	45.24920-46.56768
Lumbini		45.96	0.28620	45.40371-46.52568
Karnali		42.12	0.28458	41.56251-42.67814
Sudurpaschim		44.39	0.29377	43.81705-44.96869
Number of household member				
Nepal	14845	5.09	0.01928	5.05456-5.13015
Koshi		4.89	0.04255	4.80296-4.96979
Madhesh	2499	5.93	0.05424	5.81966-6.03228
Bagmati		4.48	0.04031	4.40343-4.56144
Gandaki		4.43	0.04720	4.33971-4.52474
Lumbini		5.15	0.05251	5.04800-5.25386
Karnali		5.10	0.05200	5.00223-5.20607
Sudurpaschim		5.38	0.05412	5.27634-5.48851

Source: NDHS, 2022

4.3 Linear regression model

The two regression models, simple linear and subsequently multiple linear regression model was employed in the study to show the gross and net effect of independent variable on CEB in

Madhesh province. In the analysis using a simple linear regression model (unadjusted), almost all variables were highly or to some extent significant for Nepal, indicating meaningful relationships at the national level. For Madhesh Province, the variables breastfeeding, amenorrheic, and month of abstinence did not show any significant associations, while all other variables were more or less significant.

Table 3 presents the adjusted multiple linear regression model based on Davis & Blake and Bongaart's proximate determinants of fertility framework. Key factors influencing fertility in Madhesh province included the respondent's age, marital status, age at first cohabitation, age at first birth, and contraceptive use. Age of respondent, marital status and breastfeeding showed a positive association with children ever born (CEB). Age at cohabitation and first birth negatively affected fertility, while contraceptive use showed a complex positive association with fertility. Abortion history and amenorrheic status positively affected fertility in Nepal, but not in Madhesh.

Table 3. Davis and Blake; Bongaarts fertility model

	Multiple Regression Model (OLS)-(Adjusted)				
	Background characteristics	**Madhesh province**		**Nepal**	
	Children ever born	**Coefficient**	**P-value**	**Coefficient**	**P-value**
1	Respondent current age	0.11970	0.000	0.10871	0.000
2	Current marital status (ref:no)	0.57429	0.000	0.37170	0.000
3	Age at first cohabitation	-0.06063	0.000	-0.06637	0.000
4	Age at first birth	-0.12159	0.000	-0.10030	0.000
5	Contraceptive use (ref:no)	0.11164	0.001	0.07328	0.001
6	Abortion (ref:no)	-0.02459	0.668	0.56559	0.000
7	Breastfeeding (ref:no)	0.42879	0.000	-0.00135	0.954
8	Amenorrheic (ref:no)	0.17980	0.091	0.14604	0.002
	Constant value	1.62457		1.49270	
	R2 value	0.4294		0.4186	
	Probability of F	0.0000		0.0000	
	N	2257		10592	

Source: NDHS, 2022 (Note. *=p<0.10, **=p<0.05, ***=p<0.001)

Table 4. shows the empirical fertility model in which additional variables were incorporated to the previously established Davis and Blake and Bongaarts fertility models for a more comprehensive analysis. The adjusted multiple regression model incorporating demographic, socio-economic, and cultural variables significantly improved the explanatory power of fertility factors.

The empirical fertility model using selective demographic, socio-cultural and economic variables also outlined that the older respondents, breastfeeding status, sons who have died, daughters who have died, ideal number of children, household sex (female household head) and number of household members were positively and significantly associated with the number of children ever born both in Nepal and Madhesh province, indicating these factors tend to increase fertility.

However, wealth index, desired number of children, age of household head, currently pregnant status, husband's education and ethnicity (terai and hill Janajati with reference to hill/terai Brahmin/Chhetri) tend to have few children, indication a negatively and significant association with CEB. Further, current marital status, age at first cohabitation, amenorrhoeic status, respondent worked in last 12 months, place of residence and marriage to first birth interval were not significant in both Madhesh province and Nepal.

In Nepal, contraceptive user, abortion, province (Madhesh and Bagmati with reference to Gandaki), ethnicity (other terai caste, Dalit and Muslim with reference to hill/terai Brahmin/Chhetri) were positively associated with CEB while age at first birth, education and occupation of the respondent, education of the husbands were negatively associated with CEB. Likewise, the age and occupation of the husband were positively associated with CEB in Madhesh province excluding Nepal. Overall, this model clarified the importance of demographic, socio-economic, and cultural factors in influencing fertility, with some spatial variations for Nepal and Madhesh province. The findings highlighted the common and unique factors responsible for fertility change.

Table 4. Empirical fertility model including demographic, socio-cultural and economic variables

	Multiple Regression Model (OLS) (Adjusted)				
	Background Characteristic		**Madhesh province**		**Nepal**	
	Children ever born		**Coefficient**	**P-value**	**Coefficient**	**P-value**
1	Current age of respondent		0.08060	0.000	0.08148	0.000
2	Current marital status (ref: no)		0 (omitted)		-0.17225	0.367
3	Age at first cohabitation		-0.05001	0.295	-0.03282	0.100
4	Age at first birth		-0.04226	0.375	-0.05047	0.011
5	Contraceptive user (ref: no)		0.04005	0.373	0.04975	0.006
6	Abortion (ref: no)		-0.00263	0.956	0.03485	0.056
7	Breastfeeding (ref: no)		0.25348	0.000	0.30537	0.000
8	Amenorrheic (ref: no)		-0.00607	0.946	0.04619	0.203
9	Son who have died (ref: no)		0.74677	0.000	0.83889	0.000
10	Daughter who have died (ref: no)		0.74414	0.000	0.88868	0.000
11	Education (ref:no)		-0.00590	0.379	-0.01311	0.000
12	Occupation (ref: agriculture/not working)		-0.07269	0.251	-0.05151	0.017
13	Respondent worked in last 12 months (ref: no)		0.03172	0.479	0.02758	0.140
14	Wealth Index (ref. 1=Poorest)	2=Poorer	-0.27411	0.000	-0.28899	0.000
		3=Middle	-0.30479	0.000	-0.37271	0.000
		4=Richer	-0.44678	0.000	-0.46464	0.000
		5=Richest	-0.50846	0.000	-0.61799	0.000
15	Desire number of children (ref: no)		-0.64504	0.000	-0.47328	0.000
16	Ideal number of children		0.30896	0.000	0.26576	0.000
17	Household head age		-0.00925	0.000	-0.00901	0.000
18	Household head sex (ref: male)		0.14901	0.002	0.09704	0.000
19	Husband age		0.01147	0.030	0.00220	0.235
20	Husband occupation (ref: agriculture/not working)		0.15951	0.003	0.02202	0.287
21	Province (ref. 4=Gandaki)	1=Koshi			0.02818	0.381
		2=Madhesh			0.17411	0.000

Multiple Regression Model (OLS) (Adjusted)					
Background Characteristic		Madhesh province		Nepal	
Children ever born		Coefficient	P-value	Coefficient	P-value
	3=Bagmati			0.08346	0.009
	5=Lumbini			-0.02240	0.481
	6=Karnali			0.07718	0.071
	7=Sudurpaschim	NA		0.06307	0.098
22 Urban/Rural residence (ref: urban)		0.04133	0.363	0.02862	0.115
23 Number of household member		0.12533	0.000	0.12694	0.000
24 Currently pregnant (ref: no)		-0.35347	0.000	-0.34696	0.000
25 Husband education		-0.01456	0.010	-0.01377	0.000
26 Ethnicity (ref.1= Hill & terai Brahmin/Chhetri)	2=other terai caste, Dalit & Muslim 3=terai and hill Janajati	0.11654	0.221	0.12985	0.000
		-0.32539	0.003	-0.18372	0.000
27 Marriage to first birth interval		-0.00482	0.227	-0.00235	0.164
Constant value		0.48883	0.083	0.83121	0.000
R2 value		0.6419		0.6784	
Probability of F		0.0000		0.0000	
N		2069		9871	

Source: NDHS, 2022 (Note. *=p<0.10, **=p<0.05, ***=p<0.001; NA=Not Applicable

5. Conclusion

The empirical fertility adjusted model highlights the importance of spousal characteristics, such as husband's age and occupation other than agriculture, which are positively and significantly associated with CEB in Madhesh province. The findings also suggest that while age, marital status, and reproductive behaviours are critical in Davis & Blake model and Bongaart's model, factors like education, occupation, wealth, and spousal characteristics also play a more significant role in shaping fertility in the empirical model.

Further research is needed to gain deeper insights into the factors influencing fertility in Madhesh province. The study found no significant association between CEB and factors such as age at marriage, age at first birth, contraceptive use, abortion, education or occupation of respondents in Madhesh province, as these did not align with established theories and models, suggesting the need for more specific studies. Additionally, the respondent's current age, female-headed households, and breastfeeding showed a significant positive effect on CEB, contrary to the expected negative effect. This discrepancy warrants further investigation.

6. Future Implications and the Need for Targeted Interventions

While Nepal has made strides in achieving a national replacement-level (TFR 2.1), provinces like Madhesh (TFR 2.7) highlight the need for tailored interventions to address province-specific barriers, as the regression analysis revealed that some factors were significant for Nepal but not for Madhesh province. Provincial disparities in education, occupation, healthcare access, and cultural practices impact fertility rates, underscoring the importance of province-focused initiatives. Data analysis from NDHS 2022 emphasizes that factors such as the husband's age and

occupations outside agriculture are positively associated with CEB in Madhesh province, contributing to higher fertility rates in Madhesh compared to the national average and suggesting areas where policy interventions could be most effective.

Improving education access to husbands and delaying marriage are among the key strategies for reducing fertility rates in province like Madhesh. Policies promoting girls' education and community health services can help address both the causes and effects of high fertility, fostering sustainable development. Increased healthcare access, particularly in rural areas, is crucial to ensuring that family planning and reproductive health services reach all populations, helping to create equitable fertility outcomes across province.

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