Original Article

Women's Literacy a Major Predictor of Population Size: Findings from National Family Health Survey-5

Pallavi Lohani[1], Arshad Ayub[2], Nitika[3], Neeraj Agarwal[4*]

[1]Department of Community Medicine, Madhubani Medical College, Madhubani, Bihar, India.
[2]Department of Community and Family Medicine, All India Institute Of Medical Science, Deoghar, Jharkhand, India
[3]Independent Researcher, Department Community Medicine.
[4]Department Community and Family Medicine, All India Institute Of Medical Science, Deoghar, Bibinagar, Hyderabad, Telangana, India

Abstract

Background: The global population continues to rise at different rates in different parts of the world. While some countries are seeing a fast population increase, others are experiencing population loss. Significant ramifications of such changes in the global population distribution would be felt, as they are critical for meeting the sustainable development goals (SDGs), or we might say that rapid population expansion poses obstacles to sustainable development.

Estimating the population size and composition by age, sex, and other demographic parameters is crucial for analyzing the country's future influence on poverty, sustainability, and development. This study tries to look at these parameters covered by the National Family Health Survey- 5 (NFHS 5) to see how accurate and trustworthy the predictors of district population size are.

Methodology: The study assessed the predictors of the population size of any district. It was conducted using the secondary data of phase 1 of NFHS-5. The outcome variable is the population of each district. Household profiles, literacy among women, their marriage and fertility, contraceptive usage, and unmet need for family planning were considered to assess their potential as a predictor of the district's population size. Principal component analysis (PCA) was conducted to identify the predictors.

Result: PCA was conducted on 18 variables, resulting in 7 principal components. Cumulatively, these components explained 77.6% of the total variation in data. On multiple linear regression, four principal components were found significant and these were related to women's literacy, contraceptive usage, early pregnancy, the marriage of fewer than 18 years, and those using health insurance.

Conclusion: Thus, women's literacy plays a pivotal role in determining a region's population size.

Keywords: Principal component analysis, Women's literacy, Population control, Social Security.

Introduction

There are likely to be around 8.5 billion people on earth within little more than a decade and almost 10 billion by 2050, compared to 7.75 billion today.[1] The world's population continues to increase, but growth rates vary greatly across regions. While some countries are facing rapid growth, some are seeing their populations decline. Nine countries will make up more than half the projected population growth between now and 2050.[1] At the same time, the planet's inhabitants are growing older as global life expectancy continues to increase and fertility continues to fall. Important consequences of such changes in the distribution of the world's population would be felt as these are important for achieving the sustainable development goals (SDGs) or we can say that rapid population growth presents challenges for sustainable development.

Most of the poorest countries have the fastest-growing populations. This brings additional challenges in the effort to

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Address for correspondence: Neeraj Agarwal, Community and Family Medicine, AIIMS Bibinagar, Hyderabad, Telangana, India
E-mail: neeraj.cfm@aiimsbibinagar.edu.in

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end poverty (SDG 1), achieve greater equality (SDGs 5 and 10), fight hunger and malnutrition (SDG 2), and strengthen the coverage and quality of health and education systems (SDGs 3 and 4).

At the global level, population growth is determined by the number of births and deaths. One needs to look at how births and deaths are changing to determine the population growth trajectory. And, at a deeper level, what is happening to the elements that influence them. Every country's population is naturally growing as life expectancy rises and child mortality falls. The offsetting tendency is declining fertility rates - the trend of couples having fewer children is what has already brought fast population expansion to a halt in many nations and will do so globally. Estimating the accurate population size and its composition by age and sex and other demographic factors is critical for assessing its future impact on poverty, sustainability and the nation's development. The current total population of India is 1,399,531,786 as of saturday, December 11, 2021, based on Worldometer elaboration of the latest United Nations data. It is equivalent to 17.7% of the total world population and ranks 2 in the list of countries (and dependencies) by population. It will reach a whopping 1.5 billion in 2030 and 1.63 Billion in 2060.[2] The principal data source for any population estimation is the population census which follows the UN Principles and Recommendations on Population and Housing Censuses (United Nations, 2017b).[3] Most countries conduct a census about once per decade.[4] Altogether, almost 1,600 censuses have been conducted worldwide since the 1950s, providing a data treasure for analyzing and monitoring population change.

In some countries, including India, population registers based on administrative data systems are sufficiently well developed to serve as a basis for population estimates (e.g. NFHS, SRS) The National Family Health Survey (NFHS) is a large-scale, multi-round survey which is conducted on a representative sample of households throughout India. The NFHS is a collaborative project of the International Institute for Population Sciences (IIPS), Mumbai, ICF, Calverton, Maryland, USA and the East-West Center, Honolulu, Hawaii, USA.[5]

This survey provides state and national information for India on fertility, infant and child mortality, family planning practices, maternal and child health, reproductive health, nutrition, anaemia and utilization and quality of health and family planning services. We're taking a look at these factors used in the National Family Health Survey- 5 (NFHS 5) in a quest to assess the predictors of population size of the districts, as this will reflect how accurate and reliable the predictors are.

Methodology

This study was undertaken to assess the predictors of the population size of any district. It was conducted using the secondary data of NFHS-5.

NFHS 5, the fifth in the series was conducted in the reference period of 2019- 20. Phase 1 of NFHS-5 was conducted in 22 states/UT while phase-2 in 14 states is currently in progress. This survey provides information on national, state and district-level estimates on population, health and nutrition. International Institute for Population Sciences, Mumbai is the nodal agency to conduct NFHS-5. The survey includes four schedules: households, women, men, and biomarkers using computer assisted personal interviewing (CAPI).

The household schedule collects data on the socio-economic characteristics of the household; water, sanitation, and hygiene; health insurance coverage; the number of deaths in the household in the three years preceding the survey; and the ownership and use of mosquito nets. The woman's schedule covered a wide variety of topics, including the woman's characteristics, marriage, fertility, contraception, menstrual hygiene etc.

NFHS- 5 phase 1 covered 342 districts of Andaman and Nicobar Island, Andhra Pradesh, Assam, Bihar, Dadra Nagar Haveli, Daman and Diu, Goa, Gujarat, Himachal Pradesh, Jammu Kashmir, Ladakh, Kerala, Karnataka, Lakshadweep, Maharashtra, Manipur, Meghalaya, Mizoram, Sikkim, Nagaland, Tripura, Telangana and West Bengal.

Study Variables

The outcome or dependent variable was the population of each district. The 2021 census is still in process, therefore the census data of 2011 was used to calculate the projected population of 2021 district-wise. For calculating the projected population, a mathematical formula was used, which is based on the assumption of no fluctuation in growth rate and fairly unchanging mortality, fertility and migration rates over the projection period.[6,7] District wise population and growth rates were used for the calculation of the projected population using the following formula.[8]

The projected population for the year 2020: Population of the year 2011 * exp RT

Where R = annual growth rate and T = 9 years

Independent Variables

The variables about the household profile, literacy among women, their marriage and fertility along with contraceptive usage and unmet need for family planning, were taken into consideration to assess their potential as predictors of the population size of any district. The variables under these broad headings were as described.

Population and household profile

The indicators to characterise household profile included: Female population age 6 years and above who ever attended school, sex ratio of the total population, children under age 5 years whose birth was registered with the civil authority, deaths in the last 3 years registered with the civil authority, population living in households with electricity, population living in households with an improved drinking-water source (Piped water into dwelling/yard/plot, piped to neighbour, public tap/standpipe, tube well or borehole, protected dug well, protected spring, rainwater, tanker truck, cart with small tank, bottled water, community RO plant), population living

in households that use an improved sanitation facility (Flush to piped sewer system, flush to septic tank, flush to pit latrine, flush to don't know where, ventilated improved pit (VIP)/ biogas latrine, pit latrine with slab, twin pit/composting toilet, which is not shared with any other household), households using clean fuel for cooking (Electricity, LPG/natural gas, biogas), households using iodized salt, households with any usual member covered under a health insurance/financing scheme, children age 5 years who attended pre-primary school during the school year 2019-20.

Characteristics of Women, marriage and fertility, current use of family planning methods and unmet need of family planning: This heading included: women who are literate. It refers to women who completed standard 9 or higher and women who can read a whole sentence or part of a sentence, women aged 20 to 24 years married before age 18 years, births in the 5 years preceding the survey that are third or higher-order, women age 15 to 24 years who use hygienic methods of protection during their menstrual period. Locally prepared napkins, sanitary napkins, tampons, and menstrual cups are considered hygienic methods of protection, contraceptive usage, contraceptive usage, and any modern method and total unmet need. Total unmet needs comprise unmet needs of spacing and unmet needs of limiting. Unmet need for family planning refers to fecund women who do not use contraception but wish to postpone the next birth (spacing) or stop childbearing altogether (limiting).

Data Management and Statistical Analysis

The NFHS-5 survey information was obtained on the excel sheets. All the independent variables were expressed as percentages except for the sex- ratio, expressed as females per 1000 males. To retain the comparability of the dataset the variables were standardized by calculating z- score. For the calculation of z- score, the following formula was used.

$Z_i = (x - mean_i)/Standard\ deviation_i$

Where Zi = computed value of z- score of individual variables

X= district- wise value of the variable

$Mean_i$= mean of the variable

Standard $deviation_i$= standard deviation of the variable.

As mentioned earlier, we aim to identify predictors of the population size of any district. We have a large set of variables with multiple dimensions. Thus, to reduce the dimensionality of the data and yet retain the information of the larger data set, Principal Component Analysis was used. It is a statistical method to reduce the dimensionality of the dataset. This analysis creates new variables using linear combinations of available variables. These new variables are called Principal Components (PCs). The first PC thus generated accounts for the maximum variance of the dataset. The PCs are uncorrelated to each other so that maximum information of the dataset is captured.

The PCs with a value of more than 1 are taken into consideration and these are used to run multiple linear regression to assess the predictors of the population size of any district. All the analysis was done on STATA.12.

Result

Various indicators about the household profile, literacy among women, their marriage and fertility contraceptive usage and unmet need for family planning were taken into consideration to assess their potential as a predictor of the population size of any district. Principal component analysis was conducted on these 18 variables. Multi-dimensional variables boiled down to 7 principal components. The Eigenvalue for these 7 principal components was more than 1, thus these were taken into consideration for further analysis. It could also be noted from Table 1; that 77.6% of the total variation in data was explained by these seven components cumulatively. A similar finding is corroborated by the scree plot. The first component contributed 25% variation with an Eigenvalue of 4.5 [Table 1 and Figure 1].

Table 2 depicts the loadings of Principal components (PC) of the various variables taken for the prediction of population size. The table shows only values more than 0.3 for clarity in result depiction. The first PC is positively correlated with the proportion of birth and death registration, the proportion of the population living with sanitary facilities and the proportion of women literate. The second component was negatively correlated with contraceptive usage and unmet needs of family planning while positively correlated with women's literacy. The third component pertained to the proportion of the

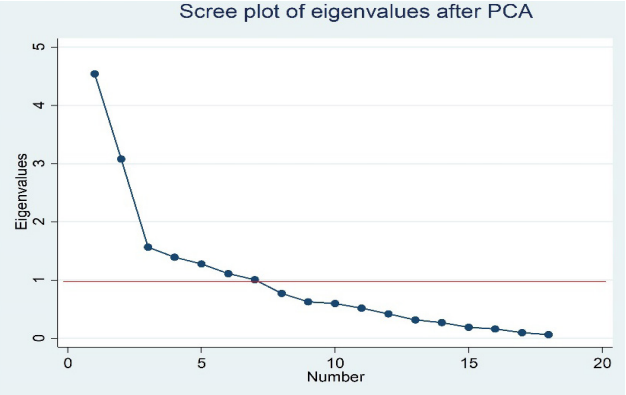

Figure 1: Scree plot of eigenvalues after principal component analysis.

Table1: Eigenvalue and Proportion of variation explained by the principal components individually and cumulatively using Principal Component Analysis

Principal component (pc)	*Eigenvalue*	*Proportion of variation*	*Cumulative proportion*
pC1	4.53706	0.2521	0.2521
PC2	3.07993	0.1711	0.4232
PC3	1.56632	0.087	0.5102
PC4	1.39349	0.0774	0.5876
PC5	1.27908	0.0711	0.6587
PC6	1.10952	0.0616	0.7203
PC7	1.00774	0.056	0.7763

population using electricity, improved- drinking water sources and clean fuel. The fourth PC was negatively correlated with sex- ratio and proportion of females using hygienic methods of protection during menstrual periods. The PC was positively correlated with the proportion of birth and death registration and the proportion of women married before 18 years of age. The fifth PC was positively correlated with the proportion of households using iodized salt and negatively with the proportion of households covered under the health insurance scheme. Sex-ratio, the proportion of children attending pre-primary school and the proportion of women married before 18 years determined PC6. The seventh PC was positively correlated with the proportion of households using iodized salt and improved- drinking water sources and negatively with the proportion of children attending pre-primary school. The principal components were used as predictor variables in multiple linear regression. Table 3 shows the result of multiple linear regression ($F(7, 334) = 10.91$, $p < 0.000$ $R^2 = 18.6$). The model explained the 18.6% variation in the population size. PC1(p 0.001), PC2 ($p < 0.00$), PC4($p < 0.00$) and PC7 ($p < 0.00$) were found significant. The loadings of various components have already been described in Table 2. Furthermore, it can be deduced from the analysis that PC1 pertains to factors related to the socio-economic development of the household, while PC2 correlates with contraceptive usage and the unmet needs of family planning. However, both components have a positive correlation with women's literacy. PC3 pertains to diverse factors like sex ratio, birth and death registration, early marriage, and hygienic menstrual practices. Like PC1, PC7 also correlates with the proportion of iodized salt intake, improved water source and children in pre-primary schools.

Discussion

The current study observes that the factors which significantly affect the population size are those based mainly on women's literacy, contraceptive usage, early pregnancy, marriage of less than 18 years, and those using health insurance.

A systematic review conducted to explore the association between female education and fertility choices in South Asia concluded that a negative relationship exists between improved female literacy and a decline in fertility and population growth.[9] Similar findings were reported from a study conducted to assess the correlation between crude birth rate and male and female literacy. The study reports an inverse relationship between male literacy rates, female literacy rates and overall literacy rates with that of the crude birth rates and infant mortality rates of the respective states and UTs. However, only female literacy rates were found significantly correlate to crude birth rates and infant mortality rates.[10]

Education empowers a woman and provides financial

Table 2: Loadings of the principal component 1- 7 of various variables for predicting the population size of a district.

Variable	*PC1*	*PC2*	*PC3*	*PC4*	*PC5*	*PC6*	*PC7*
Female population age 6 years and above who ever attended school		0.3567					
Sex ratio of the total population				-0.4087		0.58	
Children under the age of 5 years whose birth was registered with the civil authority	0.3173			0.4624			
Deaths in the last 3 years registered with the civil authority	0.352			0.3576			
Population living in households with electricity			0.4125				
Population living in households with an improved drinking-water source			0.4869				0.3071
Population living in households that use an improved sanitation facility	0.3226						
Households using clean fuel for cooking			0.4487				
Households using iodized salt					0.3468		0.6131
Households with any usual member covered under a health insurance/financing scheme					-0.7227		
Children age 5 years who attended pre-primary school during the school year 2019-20						0.4083	-0.6229
Literate women	0.3361	0.3198					
Women aged 20-24 years married before the age of 18 years				0.3643		0.4091	
Births in the 5 years preceding the survey that are third or higher-order							
Women aged 15-24 years who use hygienic methods of protection during their menstrual period				-0.3782			
Contraceptive usage: any method		-0.4145					
Contraceptive usage: any modern method		-0.4369					
Total unmet need		0.4298					

Table 3: Predictors of population size of any district (p <0.000)

Predictor Variables	*Coefficient*	*t- value*	*P-Value*	*95% CI*	
PC1	0.10	3.24	0.001	0.0394	0.1614
PC2	0.17	4.42	0.000	0.0933	0.2430
PC3	0.03	0.76	0.445	-0.0483	0.1096
PC4	0.14	3.57	0.000	0.0613	0.2117
PC5	-0.05	-1.25	0.213	-0.1355	0.0303
PC6	-0.07	-1.67	0.095	-0.1545	0.0125
PC7	0.26	5.65	0.000	0.1682	0.3478

independence for them. With this, the decision-making roles of women further improve. Thus, women's literacy rates positively improve the health, economic and social benefits to families, communities and the country at large. Evidence suggests that a rise in female literacy will improve maternal and child health. The empowered women are more likely to utilize the provisions made for them through government-run national programmes and services. Among various factors associated with the non-utilization of health care services, poor women's education was reported as one of the most significant factors.[11]

The impact of education on the fertility of tribal women in three districts of Assam among mising tribes was assessed and the study established that the critical years of education of the wives required to have a depressing impact on fertility is 5.3. Additionally, the odds of using contraceptives among tribal women increased by 24% with each year's increase in schooling.[11]

The other most common factor affecting population size is contraceptive usage, which is again directly or indirectly related to women's education. An educated woman is more likely to discuss family planning methods with her husband and would be able to regulate her family size. She is more likely to attain family planning services than an illiterate woman.[12]

Family planning methods allow the couple to regulate their fertility. It has been found that those females who were consistent in their fertility desire were consistent in contraceptive usage.[13] Additionally, it has been reported that providing contraceptives to 215 million women would reduce the number of unwanted pregnancies by two-thirds.[14] A multi-stage comparative cross-sectional study conducted in the Amhara region of Northwest Ethiopia found that fertility risks were reduced by 20% among contraceptive users compared to non-users.[15] Likewise, a study conducted to assess the effect of the Family Planning and Health Services Project started in rural districts of Bangladesh reported a decline of 1.5 births per woman with rising contraceptive prevalence in intervention areas than in the control areas.[16]

Women's literacy, age at marriage and contraceptive utilization are all interlinked together. It's a well-known fact that how stringent the rules to regulate the marriage age is mainly determined by social belief and norms. A study from Africa suggests that a negative pattern exists between the level of educational attainment and the chances of child marriage. The study utilized the pooled data from the latest demographic and health survey conducted across 34 sub-Saharan African countries between 2008–2017. It establishes the fact that females undergoing child marriage are 17 times more likely to have more than equal to 3 children than their counterparts who married at the legal age of marriage.[17]

Evidence from Indian Human Development Survey conducted in 28 states and 5 union territories in 2005 suggests that age at marriage strongly affects school enrolment and attendance. It also quantifies that – a year delay in age at marriage reduces the number of desired children by 0.5 in the full sample.[18]

Evidence suggests that children provide a sense of security to old and disabled parents. If such security is provided by social security schemes, a reduction in fertility is noted. Studies suggest that pension insurance has contributed to the childlessness of the Germans.[19] Similar findings were suggested by New Rural Pension Scheme (NRPS) implemented in rural China and its negative impact on fertility. It was also reported that the fertility-reducing effect of the scheme was larger among those females who were well-educated, younger and from high-income backgrounds.[20]

The strength of the study lies in the fact that it utilizes the NFHS-5 data, a large representative sample. However, only the phase 1 data of NFHS- 5 is being utilized, which is the study's major limitation.

Conclusion and recommendations

In a nutshell, the current study emphasizes that women's literacy plays a pivotal role in determining a region's population size. It is already a fact that women's literacy is a deciding factor for marital age and pregnancy thereafter. The second most important and independent factor that emerged as a population size predictor is insurance scheme utilization. Thus, improving educational availability and accessibility to women will play a pivotal role in reducing population growth. Additionally, measures are to be taken to strengthen the social security schemes and their utilization by those who need the most.

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