Full text open access online (Since 1997)

J Soc Sci, 74(1-3): 1-7 (2023)
PRINT: ISSN 0971-8923 ONLINE: ISSN 2456-6756
DOI: 10.31901/24566756.2023/74.1-3.2303

Expected Effects of the Indian Decision in 2021 to Increase the Legal Age of Marriage for Girls: A Demographic Projection

Jasneet Kaur Wadhwa[a] and P. Arun[b]

[a]Department of Economics, [b]Department of Electronics,
Sri Guru Teg Bahadur Khalsa College, University of Delhi, Delhi 110007 (INDIA)

KEYWORDS Political Intervention. Computer Simulation. Age Specific Fertility Rate

ABSTRACT The Government of India has recently increased the legal marriageable age of girls from eighteen to twenty-one years. While the Government has made justifications for its decision, the same is expected to affect the growth in India's population. To test this, the researchers have computer simulated the population growth of India until the year 2111 with and without this change in the legal marriageable age of girls. There is a substantial difference, showing the effect this decision will play on India's population growth. According to the researchers' simulation, raising the legal marriage age for girls would result in a decrease in net population with little or no effect on the total population dependency ratio. Thus, the researchers conclude that the decision of the Government of India, in the next century, will result in growth of per capita income, resulting from a fall in population, with no loss in productivity due to the constant total population dependency ratio.

INTRODUCTION

Malthus's (Malthus 1888) basic argument was that human population growth will outpace the rate at which agricultural output increases, thus leading to starvation and poverty. However, Bloom et al. (2000; 2003) explained the rate of economic growth in East Asian countries, despite a large population in the 1990s due to the favourable rise in the working-age population. Thus, from the initial years where a large population was seen as a bane (Malthus 1888), to the current situation where it is now considered a resource (Bloom et al. 2000; Bloom et al. 2003), the subject of demography makes for an interesting topic for study. Demography is defined as the "study of the human population in relation to the changes brought about by the interplay of births, deaths and migrations" (Pressat 1985). Today, it is well acknowledged that if a country's total population dependency ratio (TDR, the ratio of the population under the age of 14 and above 65 to the population between the ages of 15 and 65) is low, the country will have an adequate work force to produce and provide for the whole population. Thus, based on demographic studies, the government and political parties have started to make decisions to engineer the TDR of the country for social and economic changes.

India is a large country that ranks seventh in terms of land area and has the second largest population in the world. Even a census exercise takes over a year or more to complete. Since 1952, India has tried to control its population numbers by implementing family planning programs. Initially, the program advocated sterilisation, but gradually it changed to encouraging the use of contraceptives along with educational programs. Hence, the basic attack was on the birth rate. These measures have succeeded after three to four decades of efforts, and India is now at a point where it can reap the benefits of its investments.

India has had a custom of child marriage since early days and the British took steps to stop this by passing the Child Marriage Restraint Act (1929). The Act made it necessary for a boy to be of 18 years and a girl to be of 14 years before they could marry. In 1949, the age limit for girls was raised to 15 years. In 1978, the Child Marriage Restraint Act (1929) was amended making the minimum age of marriage 21 and 18 for men and women, respectively. The Government introduced the Prohibition of Child Marriage (Amendment) Bill in 2021, to raise the minimum legal age of marriage for girls from 18

Address for correspondence:
Dr P. Arun
Department of Electronics,
Sri Guru Tegh Bahadur Khalsa College, University of Delhi, Delhi 110007
Mobile: 9810586482
E-mail: arunp92@sgtbkhalsa.du.ac.in

to 21 years. Interestingly, only China, another populous country, matches this new marriageable age (in China the legal marriageable age is 20). Publicly, the government justifies its move by reasoning that, by doing so, girls will no longer be subjected to malnutrition or undernourishment and will be able to complete graduation, and hence, be in a position to get better jobs. Comparative studies based on states of India, which are considered developed and have high literacy rate, low infant mortality and maternal mortality rate during child-birth and whose GDPs are better-off than the poor states, show that the average age at which girls are married is higher (Bhatt et al. 2022). Dhamija and Roychowdhury (2020) however, have shown that delaying the marriageable age of girls does not guarantee pay parity or better jobs to girls. However, this increase in marriage age is implemented in the hope that it will also help to accelerate population reduction and achieve a favourable TDR. The population size and its distribution with age depend on three main factors, namely the birth rate, the death rate, and the influx or out-flow of population (migrations). The infant mortality rate, life expectancy, education and employment opportunities, and health care facilities are all inextricably linked to the birth rate. While a human female has the potential for reproduction between the ages of 13 and 50, social and legal norms push up the average age at which a girl has her first child, thus affecting the Age Specific Fertility Rate (ASFR).

Post the 2021 legislation, some studies (Bhatt 2022; Yasmeen 2022; Suresh 2022) have based on interviews recorded public opinion across different states of the country. Most respondents welcomed the decision, however, they do point out the limitations of laws to curb social problems. Some even felt this law would encourage live-in relationships in urban areas, which would lead to new social problems. These studies however, do not tangibly test the hypothesis of the Government of India while enacting the law.

The Government of India hopes to improve the ASFR by raising the legal marriage age for girls to 21. The government's assumption's correctness or validity will only be revealed over time. However, one can investigate the likely outcome scenario using computer simulation. Barreto (2018) showed that such simulations can be conducted easily, even with common spreadsheet softwares like Microsoft Excel. He used just two inputs, the birth rate and the death rate, to project population demography in the future. The present study improves on the work by Barreto (2018) by including the ASFR. Simulation, of course, not only affords the possibility of investigating the effect of the birth rate and the death rate, but also the overall fertility rate (ASFR) on the country's population size. It is important to investigate in the coming years, whether the legal intervention of raising the marriage age of females will achieve the objective of increasing ASFR, decreasing the net population and TDR since it affects the per capita income and indicates the general prosperity of the population.

Objectives of the Study

The initial objective would be to simulate the well-established projections and trends of India's population over the next couple of decades, after which the researchers investigate the variation in population projections by tweaking the ASFR. The simulations were done using Scilab, and they also report the possible change in TDR due to the increase in the legal marriageable age of girls in India by three years (and, in turn, tweak the ASFR).

Simulation

In this paper, the researchers have simulated the population demography of India from the year 2011 to 2111 (basically a period of hundred years) using the birth rate, infant mortality rate, fertility rate, and death rate as reported by the Government of India (GOI) census of 2011, as given in Government of India's *Ministry of Statistics and Programme Implementation Report (2016)* (the 2020-2021 Census has been delayed due to the COVID-19 pandemic). The detailed census reports clearly show that these quantities strongly vary from state to state in India, however, to keep the initial simulations simple, the researchers have considered the country as a whole. Also, though these quantities are dynamically evolving with time, the researchers have, for the present study, considered them constant over the period of study. The researchers chose Scilab (rather than Microsoft Excel) because it is freeware and easily downloadable and installable in popular operating systems such as Windows and Ubuntu. It would also afford more control over the configuration of parameters for future calculations.

Table 1: The population profile shows a "young" population in India for the year 2011

Age (in years)	2	7	12	17	22	27	32	37	42	47	52	62	67	72	77
Population (in %)	9.3	10.5	11	10	9.2	8.4	7.3	7	6	5.1	4.1	3.2	2.2	1.6	0.8

Source: Government of India's Ministry of Statistics and Programme Implementation Report 2016

The simulation involves defining an initial population profile. The population distribution with age given by the Government of India's *Ministry of Statistics and Programme Implementation Report (2016)* based on Census 2011 is given in Table 1. The data fits the equation:

$$N_y(x) = N_o e^{\frac{-(x-b)^2}{2c^2}} \quad (1)$$

The subscript 'y' signifies the year for which the distribution is being defined. A good fit was obtained for N_o=10.20%, b=8.35 years, and c=32.53 years. This reflects the young population of India in the year 2011 (y=2011), with the largest percentage of the population having an age around 10 years old (the median age). The total population is given as:

$$N_{Total} = \sum_{x=a}^{100} N_y(x) \quad (2)$$

The second parameter required for the simulation is the death rate. On an average, the population perishing due to deaths, increases with increasing age (Comfort 1964). This is explained due to the "accumulation of damages" over the years to the physical body organs, more popularly called degeneracy with time. The variation in death rate with age was given as as the following equation (Olshansky and Carnes 1997):

$$\gamma(x) = pe^{qx} \quad (3)$$

Where, 'p' and 'q' are fitting parameters and have values greater than zero. Modelling has recently revealed that this empirical relationship of death rate with age holds regardless of how damages accumulate (Ledberg 2020). The statistical data published by the Government of India's *Ministry of Statistics and Programme Implementation Report* 2016 follows the exponential trend for ages above sixty, with fitting parameters p and q equal to 0.00934 and 0.116, respectively.

The third parameter required for the simulation is the infant mortality rate. While most of the developed countries have been able to arrest infant mortality, for a country as large as India, the process is still on, and unfortunately, death during birth and during infancy is still prevalent due to the large population without access to proper health care and nutrition. According to data from the *National Institute of Public Cooperation and Child Development Handbook* (2018), infant mortality has an exponential decreasing trend relationship with increasing age.

$$\eta(x) = 2.0e^{-029x} + 0.44 \quad (4)$$

These two terms (in equations 3 and 4) together are technically called the Age Specific Death Rate (ASDR). Combining the two equations, the remaining population (at age 'x', N_1) after a year (that is, for 'y+1') is evaluated (each iteration of the program is an elapse of one year, and it records changes in population demography), in the simulation, using the equation:

$$N_{y+1} = \left[1 - \left(\frac{\gamma - \eta}{1000}\right)\right] N_y(x) \quad (5)$$

The new population added to the existing population by birth (immigration has not been factored in the present work) is given as:

$$N_{Birth} = \frac{1}{2}\sum_{x=1}^{100} N_y(x) \times ASFR(x) \quad (6)$$

Wherein, ASFR(x) is the Age Specific Fertility Rate. In equation (6), the multiple factor of half is an idealisation based on the assumption of a sex-ratio of 1:1. In general, the expression should be written as:

$$N_{Birth} = \left(\frac{1}{SexRatio + 1}\right)\sum_{x=1}^{100} N_y(x) \times ASFR(x) \quad (7)$$

As per the data of 2011, the multiplication factor for India would be 0.47, however, since the study is more based on trend rather than absolute population values, the researchers carried out the simulation with equation (6). The ASFR is again age dependent and usually decreases with increasing age. However, this is a more complex parameter to determine since it depends upon local culture and customs (fluctuations in infant mortality rate, recession, etc. affects ASFR). There are many models used to explain the nature of the variation of ASFR

with age. Here the researchers have not gone into the complexities of the parameters affecting ASFR and hence have not explained which model best explains India's data. For a more detailed discussion on this, the work of Srivastava et al. (2021) is of significance. To further the discussion, the researchers have done a curve fit to the *National Institute of Public Cooperation and Child Development Handbook* (2018) data. The best curve fit performed on the data reveals the following trend, with coefficients as follows:

$$ASFR(x) = 174e^{\frac{-(x-26)^2}{50}} \quad (8)$$

The ASFR peaks at 25-26 years of age, followed by a rapid fall, reflecting the Indian society's trend of marrying off female offspring before the age of thirty. The lower ASFR in the late 1990s, implying a lower fertility rate, manifested as a decelerator in India's population growth, as shown in the simulation results below.

Migration is also a factor that affects the population of a country. However, since the 1980s, after the liberation of Bangladesh, the influx of migratory populations has dropped drastically from that region. The 1990s did see some migrations taking place in the state of Tamil Nadu from Sri Lanka due to the civil war in that country. These numbers, however, would have been reflected in the census data of 2011, which the researchers have used as initial parameters for the simulations. The political dispensation of 2018 prevented any major influx of Rohingya refugees from Myanmar. Thus, the researchers have not taken this parameter into consideration for the simulations.

RESULTS AND DISCUSSION

The logic of the simulation program is fairly simple. It basically uses the initial data of 2011 from literature and evaluates the projected population for the year 2012 using equation (5) and equation (7). The program runs in iteration, updating the initial conditions with the new computed data. That is, for the second iteration, the population distribution of 2012 is updated as the initial condition to compute the project population of 2013 (that is, before restarting the loop, the program does). ASFR was changed from 2022 to reflect the Government's December 2021 legislation. Table 2 lists the results of the simulation

Table 2: Population distribution with age of India as simulated for the years 2036, 2061, 2086 and 2111 using 2011 census data as input

Age group	*Projected population in 10^8*			
	2036	*2061*	*2086*	*2111*
0-10	2.303	2.129	1.973	1.834
10-20	2.268	2.103	1.973	1.852
20-30	2.283	2.177	2.048	1.916
30-40	2.492	2.286	2.098	1.944
40-50	2.305	2.100	2.045	1.940
50-60	1.894	2.336	2.126	1.966
60-70	1.312	2.031	1.859	1.722
70-80	0.651	1.242	1.253	1.205
80-90	0.143	0.320	0.428	0.393
90-100	0.003	0.008	0.013	0.012

Source: Authors

and shows the population distribution with age at the end of the years 2036, 2061, 2086, and 2111. These years were chosen randomly (however with a time interval of 25-30 years). The data clearly show that the population for those under 50 would steadily decrease while that for those 60 and older would increase. This would suggest that the Indian population would grow older. In fact the number of senior citizens would be larger than the simulation projects since the researchers have not changed the death rate as the simulation proceeded.

Another notable inference one can make is that the net population of India is projected to decrease after 2062. Table 3 shows the evolution of India's projected net population over time. It is clear from this Table, that the population is set to maximise around 2058-2062 at a net value a shade below 1.7 billion. This is in agreement with the projections released by the United Nations Population Division (UNPD) in 2011 (UNPD 2011). In addition, to decrease the death rate, life expectancy is expected to rise by ten years by the 2080s, from seventy in the 2030s. This along with the increased population of senior citizens projected by the simulation is going to reflect on the Total Dependency Ratio (TDR) which the researchers shall discuss subsequently.

The success the researchers had in confirming the projections of the United Nations Population Division (UNPD) in 2011 (UNPD 2011) with the simulation gives the researchers confidence in investigating the possible effect of increasing the legal age of marriage in India. Again, for the first principle investigation, the researchers assume that this decision will initially affect the ASFR only, without affecting its variation with age (that

Table 3: The population simulation suggests stabilisation in population around 2058-2062, after which India's population is expected to decrease

Year	*Projected population of India ($x10^9$)*
2030	1.496
2032	1.522
2034	1.545
2036	1.566
2038	1.584
2040	1.600
2042	1.614
2044	1.627
2046	1.637
2048	1.647
2050	1.655
2052	1.662
2054	1.668
2056	1.672
2058	1.674
2060	1.674
2062	1.673
2064	1.669
2066	1.665
2068	1.658
2070	1.651
2072	1.643
2074	1.635
2076	1.626
2078	1.618
2080	1.609

Source: Author

is, the trend described in Table 2 will still hold). This decision is expected to push the peak from 25-26 to 28-29 (especially with compliance being readily adopted in urban and semi-urban areas). However, the statistical behaviour of the population (including those in rural areas) would ensure that the "spread" (Full-Width at Half Maximum) would either remain the same or increase (see Table 4). The extent of the spread will depend on how readily this legislation is accepted, not enforced. Unlike in the earlier decades after independence, the spread of television and the social media posts 1990s has resulted in an easier spread of social messages. Hence, if effectively this legislation results in ASFR peak to narrow around 28-29 years, the fall in population would be faster.

The change in ASFR is expected to result in a decrease in the birth rate, and hence, a decrease in the net population of the country. The trend in population with the passing of years surprisingly seems to follow the same trend as before the increase in legal marriage age, with the population expected

Table 4: The data compares the ASFR trend used for simulation on passing the new legal age for marriage

Age (in years)	*India's Age Specific Fertility Rate (ASFR)*	
	Before change in marriage age	*After change in marriage age*
17	10.7	18.1
22	135.4	67.8
27	166	126.7
32	91.7	118.2
37	32.7	55
42	11.3	12.8
47	4.1	1.4

Source: Authors

to reach a maximum around the year 2058-2060 (the value of course is lower). However, after 2060, the simulation suggests that the population will fall more rapidly (see Table 5).

The researchers have further compared the expected TDR of India based on the simulations. TDR of India has been decreasing linearly over the last eight decades, from 0.812 to 0.484 between the years 1965 to 2020 (Chakravarty 2014), and is expected to decrease further till 2030-2040. This argues well for India. The young population of 2011 (peak between ages 8-14, Table 1) is expected to mature and reach their productive age (30-40) by 2036. The peak in population distribution between the ages 30-40, with a sharp fall in population contribution from the age group above 60 years (see Table 3) will result in a TDR of less than 0.5 (see Table 7). However, subsequently though the birth rate decreases, the increasing life expectancy pushes TDR up (to around 0.5).

Interestingly, Table 6 shows that the TDR variation is not affected by the increase in the legal age of marriage. That is, the trend of TDR is not strongly dependent on the initial nature of ASFR. The TDR curve changes only if the coefficient of the exponential is large (see equation 8). This would in turn imply a larger birth rate, explaining the increase in population and TDR. A decrease in net population with stabilisation of TDR (hovering

Table 5: Simulation results projecting India's population variation before and after change in legal age for marriage

Year	*Population ($x10^9$)*	
	Before change in marriage age	*After change in marriage age*
2036	1.566	1.530
2061	1.673	1.592
2086	1.582	1.451
2111	1.478	1.314

Source: Authors

Table 6: Simulation results projecting India's TDR variation before and after change in legal age for marriage

TDR	*Year*			
	2036	*2061*	*2086*	*2111*
No change in age	0.434	0.517	0.534	0.538
After change	0.427	0.513	0.525	0.537

Source: Authors

around 0.52-0.53) post-2060 argues well for the government planning. The decreased population will ensure ease of pressure on the employment generation requirements and the delaying of the girl's marriage would elongate the education period of children (especially girl child) and encourage the employment of females in non-labour/ organised sector (Canning et al. 2015).

The rich information that can be generated and analysed with simple programming is surprising, and the flexibility to expand and include more realistic variables is astonishing. However, for the present, the results of the simulation suggest the Government of India would be partially successful in managing and controlling the country's population by tweeting the ASFR with the recent legislation.

CONCLUSION

The manuscript uses simulation to investigate the effect of increasing the legal marriage age of girls in India from 18 to 21 years, on population demography. The results of the simulation shows that the Indian population will shrink after 2060, and that this shrinking would be faster after the legal marriage age has been raised. The simulation also suggests that the AFSR would change with the average age at which girls would start a family would go up, but this does not seem to affect the TDR profile very strongly and that there would be no major change in the TDR profile with this government legislation. This would suggest that there will be a growth in the county's per capita income, due to the fall in population, with no loss in productivity due to the constant total population dependency ratio. It would be interesting to extend this study by taking the death rate as a variable that changes with time.

RECOMMENDATIONS

Fairly interesting results have been obtained from the simple simulations. However, these simulations were done with an unrealistic assumption that the birth rate, infant mortality rate, fertility rate, and death rate of 2011 will remain constant during the next century. Even then the country's ASFR is expected to increase with the increase in legal marriageable age of girls. The Government would do well to also make it socially and economically advantageous for girls to marry and start families in their early to mid thirties. Also, the urban-rural divide in marriageable age needs to be broken.

The study now needs to be extended by considering how population would vary with dynamically changing birth rate, infant mortality rate, fertility rate and death rate. Effects of COVID-19-like pandemics and migrations would also be useful study for future policymakers.

REFERENCES

Barreto H 2018. Let's put demography back into economics: Population pyramids in Excel. *The Journal of Economic Education,* 49: 91-102.

Bloom DE, Canning D, Malaney P 2000. Demographic change and economic growth in Asia. *Population and Development Review,* 26: 257–290.

Bloom DE, Canning D, Sevilla J 2003. *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change.* Santa Monica, CA (USA): RAND Corporation.

Bhatt S, Rohra A, Singh VA et al. 2022. Increasing the marriage age of girls from 18 to 21: Effects on health and nutrition, maternal mortality and education. *World Journal of Pharmaceutical and Medical Research,* 8: 153-157.

Canning D, Raja S, Yazbeck AS 2015. *Africa's Demographic Transition: Dividend or Disaster? World Bank Publications.* Washington, DC (USA): World Bank and Agence Française de Développement.

Chakravarty Manas 2014. Making India's Demography Its Destiny. *Mint,* 10 October.

Comfort A 1964. *Time, Cells, and Aging*. New York: Holt, Rinehart, and Winston.

Dhamija G, Roychowdhury P 2020. Age at marriage and women's labour market outcomes in India. *Journal of International Development,* 32: 342-374.

Government of India Ministry of Statistics and Programme Implementation 2016. *Report of Ministry of Statistics and Programme Implementation: Elderly in India-Profile and Programmes 2016.* Delhi: Government of India.

Ledberg A 2020. Exponential increase in mortality with age is a generic property of a simple model system of damage accumulation and death. *PLoS ONE,* 15: 1-17. https://doi.org/10.1371/journal.pone.0233384

Malthus TR 1888. *An Essay on the Principle of Population: Or, a View of Its Past and Present Effects on Human Happiness.* London: Reeves and Turner.

National Institute of Public Cooperation and Child Development Handbook 2018. New Delhi: Ministry of Women & Child Development.

Olshansky S, Carnes B 1997. Ever since Gompertz. *Demography,* 34: 1–15.

Pressat R 1985. *Dictionnaire de Démographie*. US: Published in English by Blackwell Publishers.

Srivastava U, Singh KK, Pandey A, Narayan N 2021. Experiments in modeling recent Indian fertility pattern. *Science Reports,* 11: 6592.

United Nations 2011. Report of United Nations Population Division, Department of Economics and Social Affairs. World Population Prospects: The 2010 Revision. New York: United Nations. From <http://population.un.org/wpp/> (Retrieved on 4 January 2022).

Suresh K 2022. Raising legal age of marriage for women: The law, the reasons and the criticism. *Acta Scientific Women's Health,* 4: 45-51.

Yasmeen S 2022. Increasing legal age of marriage of women in India-Socio-legal issues and concerns- A case study of Aurangabad City. *International Journal of Creative Research Thoughts,* 10: 737-742.

Paper received for publication in March, 2023
Paper accepted for publication in May, 2023