IOSR Journal Of Humanities and Social Science (IOSR-JHSS)
Volume 31, Issue 1, Series 4 (January, 2026) 39-48
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Sex Ratio In India: Introspecting The Changing Scenario

Dr. Manas Ghose
Assistant Professor, Department Of Economics, Bagnan College, Howrah, West Bengal, India

Abstract
Sex Ratio (SR) in India is adverse and alarming. Census data reveals that SR of India drastically increases from 102.9 in 1901 to 107.9 in 1991 and exhibits a slightly falling tendency in the Twenty First century. World Population Prospect-2022 data also show the almost same trend. In such a situation the present paper tries to explain the factors responsible for such an adverse SR of Indian population. Using Indian Population Census data and World Population Prospect-2022 data of United Nations this paper finds that Natural SR in India is unfavourable. Nature produces a SR at the time of birth which is significantly greater than 100. Use of sex selective abortions using modern technology adds some fuel to the fire of unfavourable SR and makes it more unfavourable. Enactment of Pre-Natal Diagnostic Techniques Act, 1994 in India only reduces some extent of the adverse effect of modern technology on SR but not eliminate it completely.

Keywords: *Sex Ratio, Gender Discrimination, Son Preference, Natural Sex Ratio, Sex Selective Abortions*

Date of Submission: 10-01-2026 Date of Acceptance: 20-01-2026

I. Introduction

The United Nations (UN) recognizes that gender equality is essential for a peaceful, prosperous, and sustainable world. However, gender inequality persists in all over the world, though dimensions and extent of inequality varies across nation. Gender inequality is decreasing in developed countries but it remains wide in poor and developing countries. A favourable Sex Ratio (SR) is socially desirable in every nation. If number of male and female is more or less equal in the population then sex ratio of the country is called favourable. SR of a country is called unfavourable if in the population relatively higher number of people belong to any one gender compare to another. A favourable SR helps to reduce gender related crimes, gender related injustice, domestic violence and create a safe, tension free and peaceful environment to peoples of both the genders.

Unfavourable SR is of two types- i) more male compare to female and ii) more female compare to male in a given population. Only few countries, in the globe, have been suffering from second type of unfavourable SR and most of the countries, including India, have been suffering from the first type of unfavourable SR as a result the world as a whole has been suffering from the first type of unfavourable SR. So, the causes and consequences of first type of unfavourable SR is a research topic for researchers. SR is generally measured as the number of males per 100 females in a given population. According to United Nations' World Population Statistics-2024, the global SR at birth was estimated as 105.4 boys per 100 girls. However, at the same time India's estimated SR at birth was 107.1 boys per 100 girls, higher than the global SR. India has been suffering from adverse SR since starting of the twentieth century. One point should be noted here that 'Natural Sex Ratio' for human is 105 i.e., 105 males for 100 females (Brain & Jaisson 2007). It is the SR that nature produces without any interventions. Thus, natural SR is also unfavourable. Various researchers conducted their research to search for reasons behind such unfavourable SR. This paper identifies the factors responsible for unfavourable SR from the existing literature and classified, broadly, into two groups- **A) Biological Factors and B) Social Factors.**

A. Biological Factors: The factors like time of insemination, finger length ratio, chemical exposure, infections and disease conditions and child bearing activity are included under the biological factors. Except child bearing activity of human all these factors under these group determine human SR at the time of birth so they may be called *ex-ante* factors affecting SR. All these factors work by changing hormone levels so all these may be included under the broad head 'Endocrinological factor'. The last one i.e., child bearing activity of human affects only adult SR, through death of some adult mother at the time of child bearing so it may be called an *ex-post* factor.

Sex ratio at the time of birth of any mammals including human related with hormone levels of both parent around the time of conception (James 2008). SR of the offspring, SR $= f(\frac{T+E}{G+P})$, such that f'> 0 where SR is sex ratio, T, E, G and P are the sex-standardized concentrations of testosterone, oestrogen, gonadotrophins and progesterone of both parents (James 2008). High parental concentration of testosterone and oestrogen are

associated with male birth and high parental concentration of gonadotrophins and progesterone are associated with female birth. Some other factors are also associated with sex ratio at the time of birth but all these factors affect SR through changing hormone level of the parents.

Time of insemination within the menstrual cycle: The time of insemination within the menstrual cycle plays an important role in determining sex ratio of new born babies. For human, the length of the fertile window (the time within the cycle in which insemination may result in conception) is of the order of 5 days or more (Schiphorst et al. 1985, Keulers et al. 2007). The relation between SR and time of insemination within the menstrual cycle is 'U' shaped. That implies more male offspring will be expected if insemination leads to conception at the first and last part of the fertile window and more female offspring will be expected if it occurs at middle of the fertile window (James 2000a). In this case also sex of the foetus will be determined through variation of hormone levels of both parents prevailing during the fertile window.

Finger Length Ratios: The finger length ratio $R = \frac{2D}{4D}$ plays an important role in determining SR of the offspring (via testosterone hormone level) where 2D is the length of the second finger and 4D is the length of the fourth finger of the male parent. A high value of R leads to lower SR (James 2001b, Manning et al, 2002).

Exposure of Some Chemicals: Exposure of some chemicals sometimes determine SR of the offspring through changing hormone level (endocrine disruption) of the parents. Parental exposure to chemicals like Dibromo Chloropropane (DBCP) (Potashnik & Yanai-Inbar 1987), Dichlorodiphenyltrichloroethane DDT, (Cocco et al. 2005, Perry et al. 2006), 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (Mandal 2005), Boron (James 1999, Chang et al. 2006) affect SR of the offspring by changing the hormone level. Exposure of some fungicide also determine offspring SR by changing hormone level (Garry et al. 2002a,b, 2003). Similarly professional drivers, pilot, astronauts who are exposed by lead that lowers male testosterone levels and reduces SR of the offspring (Rockert 1977, Lyster 1982, James 1992, Dickinson & Parker 1994, Simonsen et al. 2006).

Infections and some disease conditions: Some virus infections and disease conditions like pre-menopausal breast cancer (James 2006c), Toxoplasma gondii infection (Flegr et al. 2005, Kankova et al. 2007a, Kankova et al. 2007b). Hepatitis B virus (HBV) (Chahnazarian et al. 1988, Oster 2005, Blumberg 2006, Yuan et al. 1995), Cytomegalovirus (CMV) (Piazze et al. 1999, Shields et al. 2002), Placenta praevia (James 2001d, Jansen 1984, Paltieli et al. 2000) and HLA-B15 gene (rheumatoid arthritis) (Cutolo & Accardo 1991, Ollier et al. 1989, Astolfi et al. 2001) significantly influence SR of the offspring by changing hormone level of the parents.

Child Bearing Activity: The child bearing activity is the most dangerous activity of the women. Since conception to post birth period every woman has to bear many sufferings and even few mothers lose their lives either at the time of giving birth or due to different health hazards in the post birth period (WHO 2023). Development in the field of Medical Sciences has reduced some extent of such type of death in recent times but not completely. According to World Health Organisation (WHO) in the world about 2,60,000 women died during and following pregnancy and childbirth in 2023. So, this activity directly reduces SR of the population.

B. Social Factors: There are many social factors like dowry system, continuous negligence on female health, malnutrition, domestic violence, murder after rape, suicide due to rape, sexual assault, sexual deception etc. those affect SR of the population. They are generally *ex-post* type. Social factors directly reduce SR of the population after birth as a significant number of females die due to these reasons. Use of modern technology to determine sex of the foetus and abortion of the female foetus is also one of the important factors, relevant during last four decades, in determining SR at the time of birth. So, this factor may be called an *ex-ante* factor.

All the social factors are originated, mainly, from social system prevails in the society (which determine cultural norms and values of male and female in the society), constitutional provisions, legal sanction, extent of punishment for illegal activities etc. It is evidenced that in the matrilineal society SR is favourable whereas it is unfavourable in the patriarchal society (Kaur & Singh 2023). Kour and Singh (2023) found a favourable SR in most of the Tribal society in India, where society gives equal value on both male and female. In most of the social system females are considered as liability and male are considered as assets. In all the society male dominate in economic, political, religious, social, cultural and educational spheres of the society (Pandhe, 1989). According to Ghose (2011) if parental 'capitalistic attitude' dominates their 'altruistic attitude' then we have two outcomes- 'son preference' (*ex-ante* outcome) and 'gender discrimination against female child' (*ex-post* outcome). Parental son preference attitude was hidden since very long periods ago as they think a male child is an asset vis-à-vis a female child as the liability of the family. However, it flourished after the invention of ultrasound/ ultrasonography as foetus sex determining tool. Many researchers conducted their research to find the evidence of whether sex selective abortion after determining foetus sex using modern technology affects SR at birth.

On the other hand, gender discrimination against female child leads to malnutrition, higher mortality rate and lesser human capital formation within the female which again make the female as liability to the family. Child bearing and breast-feeding activities of the adult female placed them in a disadvantageous position compare to an adult male in case of outside work for family earning. A dowry system directly makes the female as a liability and at the same time it makes the male an asset to the family. All these factors make the female as liability to the family and society. These types of attitudes of the parent as well as society increases the SR at birth as well as SR of the population.

Under this scenario, the present paper tries to examine whether India's Natural SR at birth is unfavourable or it is unfavourable due to man-made reason (abortion of female foetus after detecting sex of the foetus using technology).

The paper is divided as follows. A brief introduction is given in this section, data and methodology is given in section-II, data analysis and results are given in section-II and finally we conclude in section-IV.

II. Data And Methodology

This paper utilises data on Sex Ratio of India from World Population Prospect-2022 data published by Department of Economics and Social Affairs, Population Division of United Nations and Population Census of India data, Ministry of Home Affairs, Government of India. World Population Prospect-2022 data provides country wise SR for different age groups of the population since 1950. In this paper I have used percentages, charts and graphs and different types of t-tests where required to establish the desired results.

III. Data Analysis And Results

SR in India has been continuously rising during the twentieth century and taking a slightly downturn in the early twenty first century. However, researchers and policy makers in India were not much concerned about the fact at least until 1980's. After that and with the introduction of ultrasonography as a foetus sex determining tool in India, researchers and policy makers started to focus on this matter. Now this paper wants to highlight India's scenario on SR during twentieth century to the present time from the two sets of data.

Table-I: Comparison of SR in India by Two Sets of Data

Year	Total SR in India (from Census of India)	Total SR in India (from World Population Prospect-2022)
1901	102.9	
1911	103.7	
1921	104.7	
1931	105.3	
1941	105.8	
1951	105.7	100.4
1961	106.3	111.7
1971	107.5	117.0
1981	107.1	118.6
1991	107.9	115.9
2001	107.2	112.0
2011	106.4	108.9
2021	N.A.	107.5

Source: Census of India and World Population Prospect-2022 by Population Division of United Nations.

Table-I shows SR in India starting from 1901 to 2011 with a ten years interval provided by census of India. It also shows the same from 1951 to 2021 with a ten years interval provided by World Population Prospect-2022. Thus, this table helps to make a comparison of SR in India from two different data sets. Census data reveals that total SR was 102.9 in 1901 i.e., in India, on an average, there were 102.9 males per 100 females. This was continuously rising up to 1991 with a slight downward turn in 1951 and 1981. In 1991 gender ratio reached to 107.9 which was highest for ever. Thus, from first to last censuses of twentieth century show that SR of India drastically increases from 102.9 to 107.9. In twenty first century we have the data on only two censuses i.e., in 2001 and in 2011 but these two censuses show that a downturn is starting and SR is reached to 106.4 in 2011 from 107.9 in 1991. If we see the same from World Population Prospect-2022 data then we have found almost similar type of trend. It was initially rising and reached a maximum in 1981 and after that it was decreasing up to 2021. However, there are some differences in two series of data. In 1951, SR of India was 105.7 from one source of data and 100.4 from another source of data. From the census data it is found that during 1951 to 1961 SR of India rose from 105.7 to 106.3 but World Population Prospect-2022 data shows that it rose from 100.4 to 111.7. The

census of India data shows that a downturn in SR was started during 1991 to 2001 but World Population Prospect-2022 data shows that the downturn started during 1981 to 1991.

Figure-I also shows the same fact graphically. The census of India data shows that SR increased smoothly from 1901 to 1991 then took a downturn and decreased thereafter slowly. However, World Population Prospect-2022 data shows that a havoc increase in gender ratio happened in between 1951 to 1981. A downturn started in 1981 and thereafter it decreased continuously up to 2021. Though, in 1951 figures of gender ratio from these two data sets have much difference.

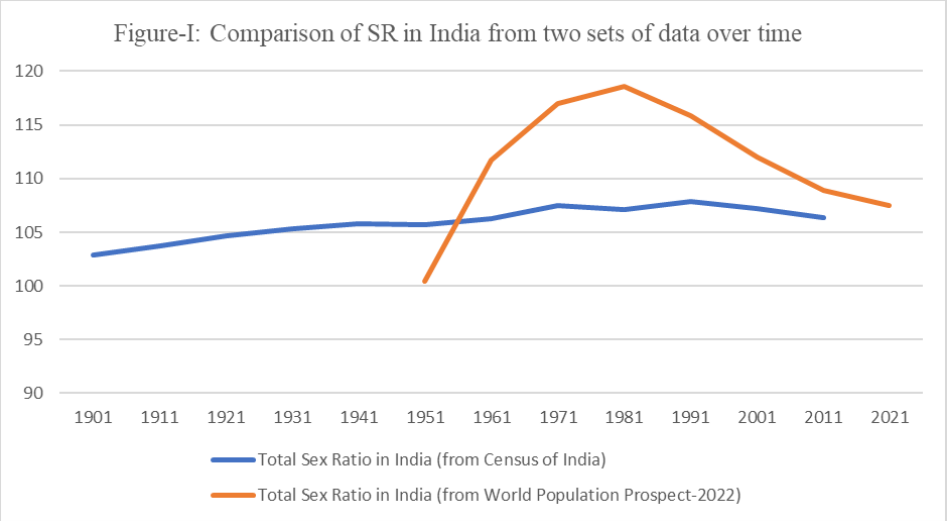


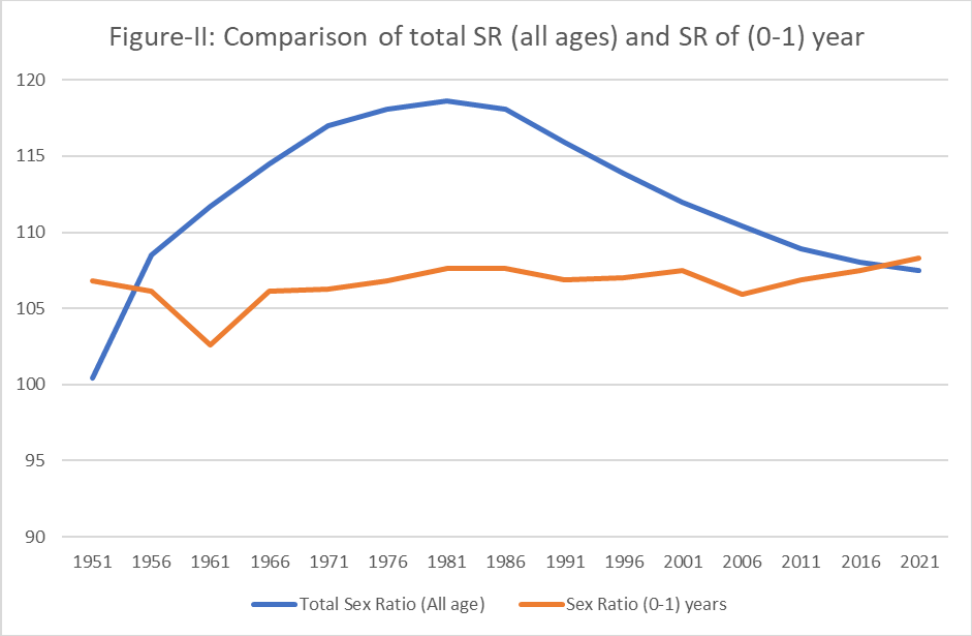
Table-II: Comparison of Total SR and SR of (0-1 years) Age

Year	Total SR (All age)	SR (0-1 years)
1951	100.4	106.8
1956	108.5	106.1
1961	111.7	102.6
1966	114.5	106.1
1971	117.0	106.3
1976	118.1	106.8
1981	118.6	107.6
1986	118.1	107.6
1991	115.9	106.9
1996	113.9	107.0
2001	112.0	107.5
2006	110.4	105.9
2011	108.9	106.9
2016	108.0	107.5
2021	107.5	108.3

Source: World Population Prospect-2022 by Population Division of United Nations.

Table-II makes a comparison of total SR, considering all ages, with SR of new born babies i.e., 0 to 1 years of age. World Population Prospect-2022, actually, provided these two data on each year since 1951 to 2021 but to make the table a reasonable size, here, data is provided at five years interval starting from 1951. The main objective of comparison of these two SR is that whether newly added population adds population of respective gender in a balancing way or not. It also helps to understand whether newly added population has a favourable impact on total SR or not. From these table it is seen that newly added population adds more male members than female members in the total population during last 70 years and as a result unfavourable SR is prevalent throughout the period. SR for new born baby is lower than total SR in all the years except in 1951 and in 2021. Though newly added population adds more male member than female member in the population but it helps to correct, some extent, favourably the unfavourable total SR, except in 1951 and in 2021. In otherwards it can be said that total SR excluding new born babies (0 to 1 years) was more unfavourable.

From figure-II it is seen that SR within the new born babies slowly increased during this period with little fluctuation. On the other hand, total SR sharply increased up to mid eighty's and after that it started to fall.



SR of a country will be called favourable if within the population almost half will be male and rest will be female. Neither more male compare to female nor more female compare to male are good for the country. SR of a country is unfavourable mainly due to three reasons. These are- 1) Unfavourable Natural SR at the time of birth- Natural Reason, 2) Sex selective abortion at pre-natal stage- Man made Reasons, 3) Continuous neglect of population of a particular sex by the parent, family and society- Man made Reasons. Out of these three reasons the first reason is not man-made or society made. We know that sex of the new born babies are determined by some Endocrinological factors of the parents which again determined naturally and environmentally. In absence of second and third reasons if 'Nature' biasedly determine sex of the new born babies then SR will be unfavourable. In presence of second and third reasons if 'Nature' biasedly determine sex of the new born babies then unfavourable SR caused by the first may be corrected by some extent or may make more unfavourable. Thus, there are actually seven different combinations. **Combination-1**: Nature is biased and gifted more male children and parent as well as society prefer more male children compare to female children then SR will be seriously unfavourable and, in that case, SR will be increasing . **Combination-2**: Nature is biased and gifted more male children and parent as well as society prefer more female children compare to male children then unfavourable SR will be corrected by some extent. **Combination-3**: Nature is unbiased and gifted more or less half male children, half female children but parent as well as society prefer more male children compare to female children then SR will be unfavourable mainly due to man-made or society made reasons and, in that case, SR will be increasing. **Combination-4**: Nature is unbiased and gifted more or less half male children but parent as well as society prefer more female children compare to male children then also SR will be unfavourable mainly due to man-made or society made causes and, in that case, SR will be decreasing. **Combination-5**: Nature is biased and gifted more female children and parent as well as society prefer more female children compare to male children then SR will be seriously unfavourable and, in that case, SR will be decreasing. **Combination-6:** Nature is biased and gifted more female children and parent as well as society prefer more male children compare to female children then unfavourable SR will be corrected by some extent. **Combination-7**: Nature and parent as well as society all are unbiased about the sex of the children then SR of the country will be favourable. Out of these seven combinations, in reality, we may find only combination-1 and 2 because in the literature it is already established that Natural SR is 105 (Brain & Jaisson 2007) i.e., Nature produces a biased SR towards male. In such a situation if parent and society prefer male child compare to female child then SR will be increasing (Combination-1) and if parental and societal preference alter then only, we may have a favourable SR (Combination-2).

Now this paper tries to examine whether SR in the Indian population is favourable or not for some specific age groups (0-4, 0-14, 0-17, 0-19, 0-24 years), at the time of birth (0-1 years) and for 'all ages'.

Table-III: Descriptive Statistics and t- test Results of Sex Ratio of Different Age Groups

Age Groups	Total (all age)	(0-1) years	(0-4) years	(0-14) years	(0-17) years	(0-19) years	(0-24) years
Descriptive Statistics							
No. of Years	72	72	72	72	72	72	72
Minimum	100.4	102.6	102.4	104.0	103.9	103.9	104.4
Maximum	118.8	109.8	108.9	108.5	109.4	110.2	112.6
Mean	112.589	106.721	106.583	106.919	107.338	107.693	108.739
S.D	4.66	1.274	1.374	1.135	1.215	1.381	2.023
t-Test Results							
t (Observed value)	22.923	44.759	40.665	51.722	51.234	47.269	36.663
DF	71	71	71	71	71	71	71
p-value (one-tailed)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
alpha	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Decision	H0 Rejected	H0 Rejected	H0 Rejected	H0 Rejected	H0 Rejected	H0 Rejected	H0 Rejected

Table- III has two sections. Upper section of the table shows descriptive statistics of the SR of eight different age groups and lower section shows the t-test results for the SR of the corresponding age groups. From the upper section of the table, it is seen that average SR of all these age groups are higher than 100 i.e., SR of Indian population is not favourable i.e., number of males are higher than the number of females in the total population. Average SR for the lower age groups, like (0-1) years and (0-4) years, are relatively better compare to the age groups that include older peoples. This indicates female mortality rate is higher than mortality rate of the male. This may be due to parental as well as societal gender discrimination against female.

In the lower part of the table results of t- test are shown for all these age groups. For t- test our null hypothesis is- H0: SR is 100 i.e. males and females in total population are equal in numbers. Alternative hypothesis is H1: SR is greater than 100 i.e. number of males are higher than the number of females in total population. The t-test results show that H0 rejected at 1% level of significance for SR of all the age groups. These imply the fact that SR of all these age groups are significantly higher than 100 i.e., unfavourable. SR for the age group 0-1 years can be considered as SR at the time of birth. So, we can say that during the period 1950 to 2021, Nature produces larger number of male children than the number of female children in India.

Table-IV: Result of t-Test for SR of Different Age Groups

	15+	25+	50+	60+	70+	80+	90+
Descriptive Statistics							
No. of Years	72	72	72	72	72	72	72
Minimum	98.4	96.6	87.9	80.9	69.1	55.6	30.0
Maximum	128.6	133.0	131.1	119.0	108.4	95.5	85.3
Mean	116.875	119.25	113.886	104.336	95.478	84.91	65.603
S.D	8.126	10.166	12.554	10.895	9.014	7.897	12.932
t-test Results							
t (Observed value)	17.621	16.067	9.386	3.377	-4.257	-16.213	-22.57
DF	71	71	71	71	71	71	71
p-value (one-tailed)	<0.001	<0.001	<0.001	0.007	1.000	1.000	1.000
alpha	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Decision	H0 Rejected	H0 Rejected	H0 Rejected	H0 Rejected	H0 Can't be Rejected	H0 Can't be Rejected	H0 Can't be Rejected

Like table-III, table-IV shows the descriptive statistics and t-test result of SR for the different age groups. This table shows that average SR is highest for 25+ age group peoples but it is falling as we move towards higher age groups. Thus, female mortality rate is higher than mortality rate of the male in the age groups 15 to below 50 years but female mortality rate is lower than the mortality rate of male for the age groups 50 years and above. A. R. Chaurasia (2023) found exactly the same results. Due to the lower mortality rate of the female, SR improves for the higher age groups. This nature of female mortality rate may be due to the fact that, normally mortality rate of the female is lower than the male but as child birth is a dangerous activity by the female and a good number of females die during the child bearing period so female mortality rate for the age group of 15 to below 50 years is higher than the mortality rate of the male. Apart from the childbirth there are two more factors which increase the

female mortality rate in this age group. Females are sexually active in this age group and marriage also takes place during this age. These two factors increase the female mortality rate via dowry system, domestic violence, rape, sexual harassment, suicide, murder etc.

For t-test, same null and alternative hypothesis are used as in table-III. t-test results show that null hypothesis is rejected at 1% level for the age groups 15+, 25+, 50+ and 60+ i.e., SR is unfavourable. But null hypothesis is accepted (not rejected) for the age groups 70+, 80+ and 90+ i.e., SR is favourable (in the sense more female compare to male in the population).

In the 1970s, pre-natal diagnostic technology was first introduced in India in the form of amniocentesis, though that service was highly expensive. Only few affluent families could afford it. Around the early 1980s, ultrasound- a cheaper alternative was introduced in India as a method of detecting foetal anomalies. Within a very short span of time this technology was being used for pre-natal sex detection in the wealthier parts of the country, though it did not become widely available and affordable outside major cities until the 1990s and even the 2000s. After 2000 this technology was widely available all over India. However, pre-natal sex determination was banned in India in 1994, under the Pre-Conception and Pre-Natal Diagnostic Techniques Act, 1994. Even after enactment of this law some dishonest doctors and private diagnostics centres continues sex selective abortion using this technology. So, this technology has some adverse effect on SR of India. Social scientists, politicians and even common peoples also often claim that sex selective abortions using this modern technology adversely affects SR of India. Table-V can't prove this claim rather it proves that before the introduction and use of this modern technology SR of India at the time of birth (0-1 years) was unfavourable. Thus, in India Nature was not unbiased in determining sex of the new born babies.

Table-V: Descriptive Statistics and t-test Results of SR in Five Different Time Periods

Time Periods	1950-1979	1980-2021	1990-2021	2000-2021	1950-2021
Age Group (year)	0-1	0-1	0-1	0-1	0-1
No. of Years	30	42	32	22	72
Minimum	102.6	105.2	105.2	105.2	102.6
Maximum	108.8	109.8	108.3	108.3	109.7
Mean	105.98	107.25	107.08	107.14	106.7
S.D	1.3997	0.862	0.68297	0.81681	1.268
t (Observed value)	23.543123	54.882748	58.897957	41.189386	44.967171
DF	29	41	31	21	71
p-value (one-tailed)	1.43954E-35	3.461E-60	2.55988E-62	1.319E-51	3.25881E-54
alpha	0.01	0.01	0.01	0.01	0.01
Decision	H0 Rejected	H0 Rejected	H0 Rejected	H0 Rejected	H0 Rejected

Table-V shows descriptive statistics and t-test results of SR at the time of birth in five different time periods 1950-1979, 1980-2021, 1990-2021, 2000-2021 and 1951-2021 respectively. From the descriptive statistics it is seen that average SR at the time of birth slightly increases after 1980 onwards that may be due to the adverse effect of introduction and use of sex selective abortion applying modern technology.

Lower part of this table shows t-test results. For t- test our null hypothesis is- H0: SR is 100. Alternative hypothesis is H1: SR is greater than 100. From t-test results it is seen that in all these five time periods null hypothesis is rejected at one percent level of significance and alternative hypothesis is accepted. Thus, it can be concluded that SR at the time of birth was greater than 100 for both before (1950-1979) and after (1980-2021) introduction of sex selective abortion using modern technology. It, again, established that 'Nature' produces an unfavourable SR at birth in India.

Table-VI: Descriptive Statistics for Three Different Pair of Time Periods

	Variable	Observations	Minimum	Maximum	Mean	Std. deviation
1950-1979	0-1	30	102.6	108.8	106.0	1.3997
1980-2021	0-1	42	105.2	109.8	107.2	0.862
1950-1989	0-1	40	102.6	109.8	106.4	1.5416
1990-2021	0-1	32	105.2	108.3	107.1	0.6796
1950-1999	0-1	50	102.6	109.8	106.5	1.3912
2000-2021	0-1	22	105.2	108.3	107.1	0.8129

Table-VI shows descriptive statistics of SR at the time of birth. This table shows descriptive statistics by dividing entire data set at three different points to make three different pair of time periods viz 1950-1979 and 1980-2021, 1950-1989 and 1990-2021 and finally, 1950-1999 and 2000-2021. From this table it is seen that average SR is higher for the first period compared to second period of all these three pairs of time periods. That

implies SR was lower during the period when sex selective abortions using modern technology was not introduced.

Table-VII: Two Independent Sample Mean Test Results for SR at the Time of Birth

Period	1950-1979 and 1980-2021	1950-1979 and 1990-2021	1950-1979 and 2000-2021
Age	0-1	0-1	0-1
Difference	-1.289	-1.092	-1.155
t (Observed value)	-4.886	-3.962	-3.475
t (Critical value)	-2.380	-2.390	-2.403
DF	71	60	50
p-value (one-tailed)	**<0.0001**	**0.000**	**0.001**
alpha	0.01	0.01	0.01
Decision	H0 Rejected	H0 Rejected	H0 Rejected

Table-6 shows the two-sample t-test results for the SR at the time of birth. Here entire data is divided in three pair of periods. Period 1950-1979 where there was no sex selective abortion using modern technology and period 1980-2021 where this technology was introduced and used. Period 1990-2021 where sex selective abortion using modern technology was introduced and used by relatively more peoples. Period 2000-2021 where relatively larger number of peoples used this technology. For t-test our null hypothesis is H0: mean of first sample – mean of second sample = 0 or mean of two samples are equal. Alternative hypothesis is H1: mean of first sample – mean of second sample < 0. In all these three cases our null hypothesis is rejected at one percent level of significance and alternative hypothesis is accepted. That implies average SR during 1950-1979 is lower than average SR during either1980-2021 or 1990-2021 or 2000-2021. In otherwards, it can be said that sex ratio increased after introduction and use of sex selective abortion applying modern technology compare to the period when no such technology was available.

IV. Conclusion

After analysing data this paper concludes that SR in India is adverse and alarming. Census data reveals that total SR was 102.9 in 1901 and it was continuously rising up to 1991 with a slight downward turn in 1951 and 1981. In 1991 SR reached to 107.9 which was highest for ever. Thus, from first to last censuses of twentieth century show that SR of India drastically increases from 102.9 to 107.9. In twenty first century we have the data on only two censuses i.e., in 2001 and in 2011 but these two censuses show that a downturn is starting and SR is reached to 106.4 in 2011 from 107.9 in 1991. We have found almost similar type of trend from World Population Prospect-2022 data. It was initially rising and reached a maximum in 1981 and after that it was decreasing up to 2021. However, there are some differences in two series of data. In 1951, SR of India was 105.7 from census data and 100.4 from World Population Prospect-2022 data. The census of India data shows that a downturn in SR was started during 1991 to 2001 but World Population Prospect-2022 data shows that the downturn started after 1981.

World Population Prospect-2022 data helps to make a comparison between total SR (considering all age group peoples together) with SR of new born babies (0-1 years). From this comparison it is found that newly added population adds more male members than female members in the total population during last 70 years and as a result unfavourable SR prevailed throughout the period. SR for new born baby is higher than total SR in all the years except in 1951 and in 2021. Though newly added population adds more male members than female members in the population but it helps to correct, some extent, favourably the unfavourable total SR, except in 1951 and in 2021. In otherwards it can be said that total SR excluding new born babies (0 to 1 years) was more unfavourable during this period.

Average SR is highest for 25+ age group peoples but it is falling as we move towards higher age groups. Thus, female mortality rate is higher than mortality rate of the male in the age groups 15 to below 50 years but female mortality rate is lower than the mortality rate of male for the age groups 50 years and above. Normally mortality rate of the female is lower than the male but as child birth is a dangerous activity by the female and a good number of females die during the child bearing period so female mortality rate for the age group of 15 to below 50 years is higher than the mortality rate of the male. During this age group females are sexually active and marriage also takes place. These two factors increase the female mortality rate via dowry system, domestic violence, rape, sexual harassment, suicide, murder etc. This fact established the existence of intense gender discrimination against female by the parent as well as society in India. SR is unfavourable for the age groups 15+, 25+, 50+ and 60+ but favourable (means more female than male in the population) for the age groups 70+, 80+ and 90+.

SR at the time of birth was significantly greater than 100 for both before(1950-1979) and after (1980-2021) the introduction of sex selective abortion using modern technology. 'Nature' produces an unfavourable SR at birth in India but sex selective abortions using modern technology increases the SR by some extent and makes it more unfavourable. SR at the time of birth was lower in the period when modern technology was not available. Modern technology significantly increases the SR. Enactment of Pre-Natal Diagnostic Techniques Act, 1994 only reduces some extent of the adverse effect of modern technology on SR but not eliminate completely.

References

[1]. Astolfi, P., Cuccia, M., & Martinetti, M., (2001), Paternal HLA Genotype And Offspring Sex Ratio. Human Biology 73 315–319.
[2]. Blumberg, B.S., (2006), The Curiosities Of Hepatitis B Virus: Prevention, Sex Ratio And Demography. Proceedings Of The American Thoracic Society 3 14–20.
[3]. Brian, É., And Jaisson, M., (2007), The Descent Of Human Sex Ratio At Birth: A Dialogue Between Mathematics, Biology And Sociology. Springer.
[4]. Census Of India; Ministry Of Home Affairs, Government Of India.
[5]. Chahnazarian, A., Blumberg, B.S., & London, W.T., (1988), Hepatitis B And The Sex Ratio At Birth: A Comparative Analysis Of Four Populations. Journal Of Biosocial Science 20 357–370.
[6]. Chang, B.L., Robbins, W.A., Wei, F., Xun, L., Wu, G., & Elashoff, D.A., (2006), Boron Workers In China: Exploring Work And Lifestyle Factors Related To Boron Exposure. American Association Of Occupational Health Nurses Journal 54 435–443
[7]. Chaurasia, R.A., (2023c). Seventy Years Of Mortality Transition In India: 1950-2021 Doi: Https://Doi.Org/10.1101/2023.03.24.23287189.
[8]. Cocco, P., Fadda, D., Ibba, A., Melis, M., Tocca, M.G., Atzeri, S., Avataneo, G., Meloni, M., Monni, F., & Flore, C., (2005), Reproductive Outcome In DDT Applicators. Environmental Research 98 120–126.
[9]. Cutolo, M., & Accardo, S., (1991), Sex Hormones, HLA And Rheumatoid Arthritis. Clinical And Experimental Rheumatology 9 641–646.
[10]. Dickinson, H., & Parker, L., (1994), Do Alcohol And Lead Change The Sex Ratio? Journal Of Theoretical Biology 169 313.
[11]. Flegr, J., Hruskova, M., Hodny, Z., Novotna, M., & Hanusova, J., (2005), Body Height, Body Mass Index, Waist-Hip Ratio, Fluctuating Asymmetry And Second To Fourth Digit Ratio In Subjects With Latent Toxoplasmosis. Parasitology 130 621–628.
[12]. Garry, V.F., Harkins, M.E., Erickson, L.L., Long-Simpson, L.K., Holland, S.E. & Burroughs, B.L. (2002a), Birth Defects, Season Of Conception And Sex Of Children Born To Pesticide Applicators Living In The Red River Valley Of Minnesota, USA. Environmental Health Perspectives 110(Suppl 3) 441–449.
[13]. Garry, V.F., Harkins, M., Lyubimov, A., Erickson, L., & Long, L., (2002b), Reproductive Outcomes In The Women Of Red River Valley Of The North. 1. The Spouses Of Pesticide Applicators: Pregnancy Loss, Age At Menarche And Exposure To Pesticides. Journal Of Toxicology And Environmental Health 65 769–786.
[14]. Garry, V.F., Holland, S.E., Erickson, L.L., & Burroughs, B.L., (2003), Male Reproductive Hormones And Thyroid Function In Pesticide Applicators In The Red River Valley Of Minnesota. Journal Of Toxicology And Environmental Health. Part A 66 965–986.
[15]. Ghose, M., (2011), Gender Bias In Education In India, Journal Of Economic And Social Development, Vol. VII, No. 2.
[16]. James, W.H., (1992), The Hypothesized Hormonal Control Of Mammalian Sex Ratio At Birth – A Second Update. Journal Of Theoretical Biology 155 121–128.
[17]. James, W.H., (1999), Is Transposition Of The Great Arteries A Consequence Of Maternal Hormone Imbalance? Evidence From The Sex Ratios Of The Relatives Of Probands. Journal Of Theoretical Biology 198 301–303.
[18]. James, W.H., (2000a), Analysing Data On The Sex Ratio Of Human Births By Cycle Day Of Conception. Human Reproduction 15 1206–1207.
[19]. James, W.H., (2001b), Finger Length Ratios, Sexual Orientation And Offspring Sex Ratios. Journal Of Theoretical Biology 212 273–274.
[20]. James, W.H. (2001d), The Sex Ratio Of Births Associated With Placenta Praevia. Journal Of Obstetrics And Gynaecology 21 160–161.
[21]. James, W.H., (2006c), Sex Ratios Of Offspring Of Patients With Breast Cancer And Other Endocrine Related Cancers. International Journal Of Cancer 119 2710–2711.
[22]. James, W.H., (2008), Evidence That Mammalian Sex Ratios At Birth Are Partially Controlled By Parental Hormone Levels Around The Time Of Conception, Journal Of Endocrinology 198, 3–15.
[23]. Jansen, R.P.S., (1984), Endocrine Response In The Fallopian Tube. Endocrine Reviews 5 525–551.
[24]. Kankova, S., Sulc, J., Nouzova, K., Fajfrlik, K., Frynta, D., & Flegr, J., (2007a), Women Infected With Parasite Toxoplasma Have More Sons. Naturwissenschaften 94 122–127.
[25]. Kankova, S., Kodym, P., Frynta, D., Vavrinova, R., Kubena, A., & Flegr, J., (2007b), Influence Of Latent Toxoplasmosis On The Secondary Sex Ratio In Mice. Parasitology (In Press).
[26]. Kaur, B., & Singh, H., (2023), Profile Of Child Sex Ratio In India: A Geographical
[27]. Analysis, International Journal Of Geography, Geology And Environment 5(2): 23-31 DOI: Https://Doi.Org/10.22271/27067483.2023.V5.I2a.169
[28]. Keulers, M.J., Hamilton, C.J.C.M., Franx, A., Evers, J.L.H., & Bots, R.S.G.M., (2007), The Length Of The Fertile Window Is Associated With The Chance Of Spontaneously Conceiving An Ongoing Pregnancy In Sub-Fertile Couples. Human Reproduction 22 1652–1656.
[29]. Lyster, W.R., (1982), Altered Sex Ratio In Children Of Divers. Lancet Ii 152.
[30]. Mandal, P.K., (2005), Dioxin: A Review Of Its Environmental Effects And Its Aryl Hydrocarbon Receptor Biology. Journal Of Comparative Physiology 'B' - Biochemical, Systematic And Environmental Physiology 175 221–230.
[31]. Manning, J.T., Martin, S., Trivers, R.L., & Soler, M., (2002), 2nd To 4th Digit Ratio And Offspring Sex Ratio. Journal Of Theoretical Biology 217 93–96.
[32]. Ollier, W., Spector, T., Silman, A., Perry, L., Ord, J., Thomson, W., & Festenstein, H., (1989), Are Certain HLA Haplotypes Responsible For Low Testosterone Levels In Males? Disease Markers 7 139–143.
[33]. Oster, E., (2005), Hepatitis B And The Case Of The Missing Women. Journal Of Political Economy 113 1163–1216.
[34]. Paltieli, Y., Eibschitz, I., Ziskind, G., Ohel, G., Silbermann, M., & Weichselbaum, A., (2000), High Progesterone Levels And Ciliary Dysfunction – A Possible Cause Of Ectopic Pregnancy. Journal Of Assisted Reproduction And Genetics 17 103–106.
[35]. Pandhe, S., (1989), Women's Subordination (Its Origins), New Delhi, Kanak Publications.

[36]. Perry, M.J., Ouyang, F., Korrick, S.A., Venners, S.A, Chen, C., Xu, X., Lasley, B.L., & Wang, X., (2006), A Prospective Study Of Serum DDT And Progesterone And Oestrogen Levels Across The Menstrual Cycle In Nulliparous Women Of Reproductive Age. American Journal Of Epidemiology 164 1056–1064.
[37]. Piazze, J., Nigro, G., Mazzocco, M., Marchiani, E., Brancato, V., Anceschi, M.M., & Cosmi, E.V., (1999), The Effect Of Primary Cytomegalovirus Infection On Fetal Lung Maturity Indices. Early Human Development 54 137–144.
[38]. Potashnik, G., & Yanai-Inbar, I., (1987), Dibromochloropropane (DBCP): An 8-Year Re-Evaluation Of Testicular Function And Reproductive Performance. Fertility And Sterility 47 317–323
[39]. "Pre-Conception And Prenatal Diagnostic Techniques (Prohibition Of Sex Selection) Act" (1994); Retrieved On 27.08.2024.
[40]. Rockert, H.O.E., (1977), Changes In The Vascular Bed In Testes Of Rats Exposed To Air At 6 Atmospheres Absolute Pressure. IRCS Journal Of Medical Science 5 107.
[41]. Schiphorst, L.E.M., Collins, W.P., & Royston, J.P., (1985), An Oestrogen Test To Determine The Times Of Potential Fertility In Women. Fertility And Sterility 44, 328–334.
[42]. Shields, M.D., O'Hare, B., Nelson, J., Stewart, M.C., & Coyle, P., (2002), Maternal Cytomegalovirus Seropositivity. BMJ 325 335.
[43]. Simonsen, C.R., Roge, R., Christiansen, V., Larsen, T. & Bonde, J.P. (2006), Effects Of Paternal Blood Lead Levels On Offspring Sex Ratio. Reproductive Toxicology 22 3–4.
[44]. World Health Organisation: Https://Www.Who.Int/News-Room/Factsheets/Detail/Maternal-Mortality
[45]. World Population Prospects-2022, Department Of Economic And Social Affair, Population Division Of United Nations: Https://Population.Un.Org/Wpp/ ; Retrieved On 10.08.2023.
[46]. Yuan, J.M., Ross, R.K., Stanczyk, F.Z., Govindarajan, S., Gao, Y.T., Henderson, B.E. & Yu, M.C., (1995) A Cohort Study Of Serum Testosterone And Hepatocellular Carcinoma In Shanghai, China. International Journal Of Cancer 63 491–493.