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Variation in Fecundability among Indian Females

K. K. Singh[1], Shilpi Tanti[2,*]

[1]Department of Statistics, Faculty of Science, Banaras Hindu University, Varanasi-221005, India
[2]DST-CIMS, Department of Statistics, Faculty of Science, Banaras Hindu University, Varanasi-221005, India

Abstract Several studies have assumed that fecundability of female is constant over time except the early reproductive ages i.e., <=15 years. In this paper, an attempt has been made to test this hypothesis since in spite of being a biological factor, fecundability is also governed by a large number of socio-demographic and cultural factors associated with it. In the present study, fecundability is estimated for India as well as different major states of the country in different age-groups of the females using the data of their last closed birth interval. The relevant data are compiled from the National Family Health Survey III. Life table technique is used to estimate age specific fecundability to statistically grip the problem of censoring and selectivity. The results show that fecundability decreases with increasing age of the females. But, from this it cannot be inferred that age is the only factor responsible for variation in fecundability. This may be due to some socio-cultural factors which influence the behavioural factor, coital frequency. This study suggests that the variation in fecundability among the Indian females is due to the confounded effect of age and some socio-cultural factors associated with coital frequency and the effect of these two cannot be separated.

Keywords Censoring, Selectivity, Fecundability, Life Expectancy, Parity, Closed Birth Interval, Coital Frequency

1. Introduction

Fecundability is defined as the probability of conception in one menstrual cycle of a fecund female. Usually, the measure, fecundability is obtained indirectly from the data of waiting time to conception between two consecutive births. This duration variable is not only governed by biological factors but also various socio-cultural and behavioural factors associated with it. Many studies have assumed that fecundability of female is constant over time except the early reproductive ages i.e., ≤ 15 years. Is this hypothesis true? If this is not true then how fecundability varies over time in a female's reproductive span and what will be the plausible reason for its variation? These questions are of great interest to demographers as well as to couples concerned about their infertility and about how long they can wait in postponing childbearing[4].

Keeping in view the above questions, an attempt has been made here to study how fecundability varies w.r.t age of the females using their age at last birth and their corresponding last closed birth interval (LCBI). LCBI is defined as the interval between last and last but one birth prior to the survey date. The structure of LCBI is examined by [5] irrespective of parity, after subtracting the actual length of post-partum amenorrhea (PPA) in the traditional Indian society.

Fecundability is frequently estimated from the probability distribution of waiting times to conception. It has been observed that for a homogeneous group of females, the reciprocal of mean waiting time to conception gives the arithmetic mean of fecundability, whereas for a heterogeneous group of females, it gives the harmonic mean of fecundability[3]. The data on waiting time to conception is generally not available in any survey data; it can be obtained from the data on birth intervals.

It is well known that the collection of birth interval data in developing countries suffers from non-sampling errors arising out of recall lapse on the part of respondents. These errors, which are sometimes serious, often vitiate the data if the duration of time elapsed since the occurrence of the event is large[1,2]. Due to these errors, more caution has to be exercised to arrive at any valid conclusions about fertility levels[6, 8, 9, 11, 12]. In this context, the data of LCBI will be more reliable for the analysis of fertility changes among married females compared to other CBI[7,10] as it seems to be less affected by memory biases.

A CBI is generally composed of three mutually exclusive random components in the absence of defective terminations of pregnancy (foetal losses), viz.;

i) a period of temporary sterility caused by PPA following the previous birth during which no conception is possible;

ii) the menstruating period, i.e., the waiting time to conception (X); and

iii) the period of gestation leading to the next birth.

Except for the last component, which is generally taken to be constant equal to nine months, the other two components vary considerably with the age of the married female and

* Corresponding author:
shilpi.tanti@gmail.com (Shilpi Tanti)
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with their parity. Hence to study the distribution of CBI, one has to study the distributions of PPA and the waiting time to conception. Naturally, this distribution will involve the parameter fecundability which can be estimated using appropriate methods.

Here to estimate fecundability, life table technique is being used under some steady state conditions. Life table is constructed for the females of different age-groups for estimating the age specific fecundability. The relevant technique is described in Section *2*. The data used for the study have been taken from National Family Health Survey III (NFHS III).

2. Data and Methodology

As mentioned earlier, the analysis of data on birth interval generally suffers from selectivity and censoring. The problem of selectivity arises due to the fact that highly fecund females may reach the i^{th} parity first and hence low fertility females get excluded from the analysis. The censoring refers to the period of exposure, i.e.; for some females, the period of exposure is only partially known. Hence, problem of censoring arises because some of the females who have reached parity i do not reach parity $(i+1)$ as they will not get adequate time due to the short exposure period by the reference date of the survey. The problem of censoring as well as selectivity can be statistically handled through the application of life table technique.

The life table is largely a product of actuarial science; its application is not limited to the computation of insurance premiums. Advances in theoretical statistics and stochastic processes have made it possible to study length of life from a purely statistical point of view, making the life table a valuable analytical tool for demographers, epidemiologists, physicians, zoologists, manufacturers and investigators in other fields.

Here, the distribution of LCBI is analysed to arrive at any valid conclusion about fecundability by life table technique.

In the present paper, the life tables are constructed for the cohort of different age groups of the females based on the following assumptions:

i) The duration of PPA is same for each and every female during the study period.

ii) Each conception results in a live birth.

In the present analysis, the females who have at least one child are considered. The females having at least two children are considered as event of the study and the rest are considered as censored cases. It is mentioned earlier that the study variable is composed of three components viz., the non susceptible PPA period associated with the previous birth, the waiting time for conception and the gestation period. The duration of PPA is here taken as *6* months (median duration of PPA) for each female and the period of gestation is taken as *9* months. Here, the duration of PPA is computed from the data of last birth occurred five years prior to the survey date using life table technique. The present analysis is restricted for the females whose last closed birth intervals are less than *135* months. The females are being followed for *135* months in the sense that they will get *135-15=120* months full exposure period to conceive, where *15* months is the rest period, i.e., the sum of non susceptible PPA and gestation period. In the analysis, the censored females who are widowed/divorced/not living together with husband are excluded as they are not exposed to the risk of conception. The sterile censored females are also excluded from the study since they are also not exposed to the risk of conception in the near future. The censored females who have reported that they don't have desire for more children are also excluded from the study. The censored females whose age at last birth are greater than or equal to *40* years and open birth intervals are greater than or equal to *120* months are not included in the study.

The desired life tables are then constructed for different age groups of the females by treating the total females of that age group as a cohort which is exposed to the risk of conception in the successive *10* months interval.

Analogous to the usual abridged life table where x column depicts the person's age in interval i.e.; x to $x+n$, here x column has also been introduced which represents the duration of waiting time to last conception of concerned females in units of *10* months i.e.; x to $x+10$. Since, waiting time to conceptions up to *129* (in the sense that the censored females will not have the gestation period, they will have only the PPA period and the menstruating period during the study period, i.e.; *135-6=129* months) have only been considered hence x takes thirteen values ranging from *0* to *129*. For example, the interval *0-9* months is denoted as $x=0$, the interval *10-19* months is denoted as $x=1$ and so on.

The d_x column in the present case denotes the number of females conceive between $(x, x+10)$, in contrast to the abridged life table where it stands for number of persons dying between ages $(x, x+n)$.

The two columns q_x and e_x^0 are the columns of main interest in any life table analysis. In the usual life table, q_x gives the conditional probability of death during $(x, x+n)$ for the persons who have not died up to x and e_x^0 gives an estimate of the average future life time after attainment of age x and consequently e_0^0 gives an estimate of average life in the population. In the present study, q_x represents the conditional probability of conception during $(x, x+n)$ for the females who have not conceived up to x, whereas, e_0^0 represents the average waiting time to conception for the specific cohort. Since, in the present case, one unit of time is taken as *10* months, the product of e_0^0 and unit of time i.e.; *10* will give the average waiting time to conception. The mean fecundability can be obtained from the average waiting time to conception through the inverse relationship between them. Thus, from the value of e_0^0, the mean fecundability can be estimated for specific age groups.

The technique is then applied to the data of India as well as its twelve major states viz., Assam, Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh, Orissa, Maharashtra, Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and West Bengal situated in different regions of the country obtained from

National Family Health Survey III (NFHS III) to find the mean fecundability for specific age groups.

3. Results and Discussion

An inverse relationship is observed between the age of the females and the mean waiting time to conception. *Table 1* presents the life table estimates of mean waiting time to conception and mean fecundability of females for the specific age groups in India. In this study, the main emphasis is given on the two columns of life table viz., q_x (probability of conception) and e_x (expected waiting time to conception). It is observed from the table that the value of q_x, probability of conception is low in the first cell i.e., when X (waiting time to conception) is *0-9* months and then its value has risen in the next cell i.e., when X is *10-19* months in all the age-groups viz., *14-20*, *21-24*, *25-28*, *29-32*, *33+*. The possible reasons for observing low probability of conception when the exposure period is *0-9* months may be (i) a proportion of females is not exposed to the risk of conception due to short exposure period, they may have longer PPA duration but here duration of PPA is considered as *6* months for each female, and (ii) after having a birth, couples don't want the next child for some time, and (iii) again, just after a birth, the socio-cultural factors also play a dominant role on the behavioural factor viz., coital frequency and without intercourse, conception is not possible. The reason of rise in the value of q_x in the second cell may be that the socio-cultural norms and taboos associated with coital frequency start to decrease with the passage of time. Another reason may be that having an appropriate interval after a birth, the possibility of avoiding conception becomes less. *Table 1* also shows that the probability of conception is decreasing with time in the younger age groups *14-20* and *21-24* and in the age group *14-20*, it is declining more rapidly. The reason of declining probability of conception with time may be due to heterogeneity in the population. Heterogeneity has physiological sources; particularly important sources are the differences in level of intra-uterine mortality, differences in the incidence of anovulatory cycles and total cycle lengths[14]. Prolonged breastfeeding may be one plausible reason of it. Another possible reason for it may be that the females of younger age groups may be more concerned about their ideal family size although they have high fecundability. They may be practicing various contraceptive methods to prevent the next birth. In age group *25-28*, the probability of conception fluctuates with time. It may be due to the heterogeneity in the population regarding the desire of next child as well as due to some unwanted pregnancies. Again in the age group *29-32* and *33+*, the probability of conception increases with time. Normally, the probability of conception increases with time due to the mentioned fact that socio-cultural norms and taboos decrease with the passage of time. *Table 2* presents mean last closed birth intervals and mean fecundability of the females corresponding to their age at last birth for the considered states of the country in the study. From the results, it is quite clear that the females in the age groups ≤ 20 have the maximum fecundability. However, after this age group, there is a steady decline in the estimates of fecundability. In the age-group ≤ 20 females are taking on an average *32* months to have a birth. The highest fecundability is observed in Karnataka whereas the lowest is observed in Assam. The variation is observed in the level of fecundability in the different states of the country whereas the trend of fecundability is observed to be similar in the different states. The level of fecundability gradually decreases with increasing age of the females. After attaining the age-group *25-28*, fecundability starts to decline more rapidly specifically in the states viz., Assam ($\leq$ 0.0311), Maharashtra ($\leq$ 0.0384), Orissa ($\leq$ 0.0386), West Bengal ($\leq$ 0.0300), Andhra Pradesh ($\leq$ 0.0393), Karnataka ($\leq$ 0.0383), Kerala ($\leq$ 0.0337), Tamil Nadu ($\leq$ 0.0385), as compared to the Northern states Bihar ($\leq$ 0.0435), Uttar Pradesh ($\leq$ 0.0436), Madhya Pradesh ($\leq$ 0.0433)and Rajasthan ($\leq$ 0.0436). This may be due to the variation in different socio-economic, cultural and socio-demographic characteristics among the states. The possible reason for declining fecundability with increasing age may be ascribed largely to biological factors such as foetal losses and other health related or sub fertility problems[13]. It may also be due to socio-cultural, behavioural and personal factors associated with the desire of children and the extent of these factors varies from individual to individual. Overall, it is observed that the mean fecundability is decreasing with increasing age of the females. But, from this it cannot be inferred that age is the only factor responsible for variation in fecundability. The variation in fecundability may be due to the parity of the females and it is a known fact that age and parity are highly correlated. Females of older age will have higher parity and as soon as females reach to their desired parity, they don't want children any more. This may also be one of the reasons for observed declining fecundability with increasing age of the females. Demographers have frequently suggested that a woman's fecundability reaches a maximum some time in her *20*'s and thereafter remains at a plateau for some years. This theory is incorrect as the major cause of the decline in fecundability across ages *20-40* is a decline in coital rates and a smaller part of the decline in fecundability is caused by a rise in the risk of unrecognized spontaneous abortion. The biological capacity to conceive does not vary significantly between ages *20-40*[15]. This study suggests that the variation in fecundability among the Indian females is due to the confounded effect of age and some socio-cultural factors associated with the behavioural factor. Because in the traditional society like India, as the age increases, the frequency of intercourse decreases due to various norms and taboos and the effect of these two cannot be separated.

Table 1. Life table estimates of mean waiting time to conception and mean fecundability of Indian females of specific age-groups

X in months[1]	N_e[2]	N_w[3]	l_x	d_x	q_x	L_x	T_x	e_x	$\bar{X}$[4]	λ[5]
Age group 14-20										
0-9	10195	1056	9667	3141	0.3249	8096.5	17377.5	1.7976	17.976	0.0556
10-19	5998	750	5623	2395	0.4259	4425.5	9281	1.6505	16.501	
20-29	2853	417	2644.5	1081	0.4088	2104	4855.5	1.8361	18.361	
30-39	1355	256	1227	362	0.2950	1046	2751.5	2.2425	22.425	
40-49	738	168	653	133	0.2037	586.5	1705.5	2.6118	26.118	
50-59	436	96	388	54	0.1391	361	1119	2.8840	28.840	
60-69	286	69	251.5	6	0.0239	248.5	758	3.0139	30.139	
70-79	211	55	183.5	5	0.0272	181	509.5	2.7766	27.766	
80-89	151	39	131.5	1	0.0076	131	328.5	2.4981	24.981	
90-99	111	33	94.5	0	0	94.5	197.5	2.0899	20.899	
100-109	78	32	62	0	0	62	103	1.6613	16.613	
110-119	46	28	32	0	0	32	41	1.2813	12.813	
120-129	18	18	9	0	0	9				
Age group 21-24										
0-9	21663	687	21319.5	6345	0.2976	18147	41509.5	1.9470	19.470	0.0514
10-19	14631	501	14380.5	6345	0.4412	11208	23362.5	1.6246	16.246	
20-29	7785	327	7621.5	3494	0.4584	5874.5	12154.5	1.5948	15.948	
30-39	3964	186	3871	1735	0.4482	3003.5	6280	1.6223	16.223	
40-49	2043	141	1972.5	881	0.4466	1532	3276.5	1.6611	16.611	
50-59	1021	99	971.5	388	0.3994	777.5	1744.5	1.7957	17.957	
60-69	534	62	503	168	0.3340	419	967	1.9225	19.225	
70-79	304	59	274.5	73	0.2659	238	548	1.9964	19.964	
80-89	172	33	155.5	31	0.1994	140	310	1.9936	19.936	
90-99	108	33	91.5	12	0.1311	85.5	170	1.8579	18.579	
100-109	63	24	51	3	0.0588	49.5	84.5	1.6569	16.569	
110-119	36	17	27.5	2	0.0727	26.5	35	1.2727	12.727	
120-129	17	17	8.5	0	0	8.5				
Age group 25-28										
0-9	20069	253	19942.5	4474	0.2243	17705.5	50351.5	2.5248	25.248	0.0396
10-19	15342	207	15238.5	5092	0.3342	12692.5	32646	2.1423	21.423	
20-29	10043	153	9966.5	3581	0.3593	8176	19953.5	2.0021	20.021	
30-39	6309	98	6260	2460	0.3930	5030	11777.5	1.8814	18.814	
40-49	3751	72	3715	1519	0.4089	2955.5	6747.5	1.8163	18.163	
50-59	2160	49	2135.5	885	0.4144	1693	3792	1.7757	17.757	
60-69	1226	45	1203.5	502	0.4171	952.5	2099	1.7441	17.441	
70-79	679	25	666.5	251	0.3766	541	1146.5	1.7202	17.202	
80-89	403	24	391	155	0.3964	313.5	605.5	1.5486	15.486	
90-99	224	18	215	79	0.3674	175.5	292	1.3581	13.581	
100-109	127	11	121.5	71	0.5844	86	116.5	0.9588	9.588	
110-119	45	12	39	25	0.6410	26.5	30.5	0.7821	7.821	
120-129	8	7	4.5	1	0.2222	4				
Age group 29-32										
0-9	11415	83	11373.5	2125	0.1868	10311	34958.5	3.0737	30.737	0.0325
10-19	9207	64	9175	2483	0.2706	7933.5	24647.5	2.6864	26.864	
20-29	6660	37	6641.5	2005	0.3019	5639	16714	2.5166	25.166	
30-39	4618	32	4602	1440	0.3129	3882	11075	2.4066	24.066	
40-49	3146	26	3133	980	0.3128	2643	7193	2.2959	22.959	
50-59	2140	21	2129.5	730	0.3428	1764.5	4550	2.1367	21.367	
60-69	1389	18	1380	482	0.3493	1139	2785.5	2.0185	20.185	
70-79	889	9	884.5	318	0.3595	725.5	1646.5	1.8615	18.615	
80-89	562	11	556.5	210	0.3774	451.5	921	1.6550	16.550	
90-99	341	4	339	135	0.3982	271.5	469.5	1.3850	13.850	
100-109	202	7	198.5	115	0.5793	141	198	0.9975	9.975	
110-119	80	5	77.5	58	0.7484	48.5	57	0.7355	7.355	
120-129	17	6	14	11	0.7857	8.5				
Age group 33+										
0-9	6948	19	6938.5	1135	0.1636	6371	23978	3.4558	34.558	0.0289
10-19	5794	16	5786	1420	0.2454	5076	17607	3.0430	30.430	
20-29	4358	12	4352	1213	0.2787	3745.5	12531	2.8794	28.794	
30-39	3133	8	3129	835	0.2669	2711.5	8785.5	2.8078	28.078	
40-49	2290	7	2286.5	629	0.2751	1972	6074	2.6565	26.565	

50-59	1654	5	1651.5	463	0.2804	1420	4102	2.4838	24.838
60-69	1186	3	1184.5	350	0.2955	1009.5	2682	2.2642	22.642
70-79	833	4	831	260	0.3129	701	1672.5	2.0126	20.126
80-89	569	2	568	204	0.3592	466	971.5	1.7104	17.104
90-99	363	2	362	139	0.3840	292.5	505.5	1.3964	13.964
100-109	222	1	221.5	125	0.5643	159	213	0.9616	9.616
110-119	96	1	95.5	89	0.9319	51	54	0.5654	5.654
120-129	6	1	5.5	5	0.0900	3			

Note: [1]Waiting time to conception in months, [2]Number of females entering in the interval, [3]Number of females withdrawing during the interval, [4]Mean waiting time to conception, [5]Mean fecundability

Table 2. Average last closed birth intervals (LCBI) and mean age-specific fecundability estimates of the females of the different states of the country

Age groups	States							
	Bihar				Uttar Pradesh			
	No. of females	*LEB* $(e_0^0)^a$	*Av. LCBI*	λ	*No. of females*	*LEB* (e_0^0)	*Av. LCBI*	λ
≤ 20	368	1.827	33.27	0.0547	833	1.878	33.78	0.0533
20-24	625	1.960	34.60	0.0510	1833	1.823	33.23	0.0549
24-28	613	2.301	38.01	0.0435	2037	1.501	37.96	0.0436
28-32	419	2.454	39.54	0.0407	1420	2.296	43.15	0.0355
>32	350	2.808	43.04	0.0356	1151	2.815	45.93	0.0323
Age groups	**Madhya Pradesh**				**Rajasthan**			
≤ 20	525	1.776	32.76	0.0563	348	1.782	32.82	0.0561
20-24	1332	1.824	33.24	0.0548	749	1.836	33.36	0.0545
24-28	1129	2.312	38.12	0.0433	653	2.131	36.31	0.0469
28-32	595	2.948	44.48	0.0339	424	2.470	39.70	0.0405
>32	364	3.040	45.40	0.0329	299	2.826	43.26	0.0354
Age groups	**Assam**				**Maharashtra**			
≤ 20	327	2.263	37.63	0.0442	762	1.679	31.79	0.0595
20-24	602	2.326	38.26	0.0430	1906	1.798	32.98	0.0556
24-28	556	3.217	47.17	0.0311	1530	2.606	41.06	0.0384
28-32	356	3.495	49.95	0.0286	665	3.373	48.73	0.0296
>32	254	3.744	52.44	0.0267	239	4.140	56.40	0.0242
Age groups	**Orissa**				**West Bengal**			
≤ 20	370	1.738	32.38	0.0576	787	1.932	34.32	0.0518
20-24	870	2.014	35.14	0.0497	1220	2.475	39.75	0.0404
24-28	728	2.590	40.90	0.0386	979	3.327	48.25	0.0300
28-32	398	3.280	47.80	0.0305	447	3.779	52.79	0.0265
>32	214	4.023	55.23	0.0249	223	4.137	56.37	0.0212
Age groups	**Andhra Pradesh**				**Karnataka**			
≤ 20	1077	1.756	32.56	0.0569	839	1.601	31.01	0.0625
20-24	1515	2.056	35.56	0.0486	1231	1.843	33.43	0.0543
24-28	925	2.541	40.41	0.0393	863	2.614	41.14	0.0383
28-32	400	3.339	48.39	0.0299	379	3.046	45.46	0.0328
>32	181	3.819	53.19	0.0262	150	4.313	58.13	0.0232
Age groups	**Kerala**				**Tamil Nadu**			
≤ 20	192	1.994	34.94	0.0501	591	1.649	31.49	0.006
20-24	674	2.208	37.08	0.0453	1276	1.986	34.86	0.0204
24-28	721	2.964	44.64	0.0337	1020	2.600	41.00	0.0385
28-32	384	3.895	53.95	0.0257	388	3.475	49.75	0.0288
>32	114	4.658	61.48	0.0215	158	4.025	55.25	0.0248

Note: [a]LEB: Life Expectancy at birth

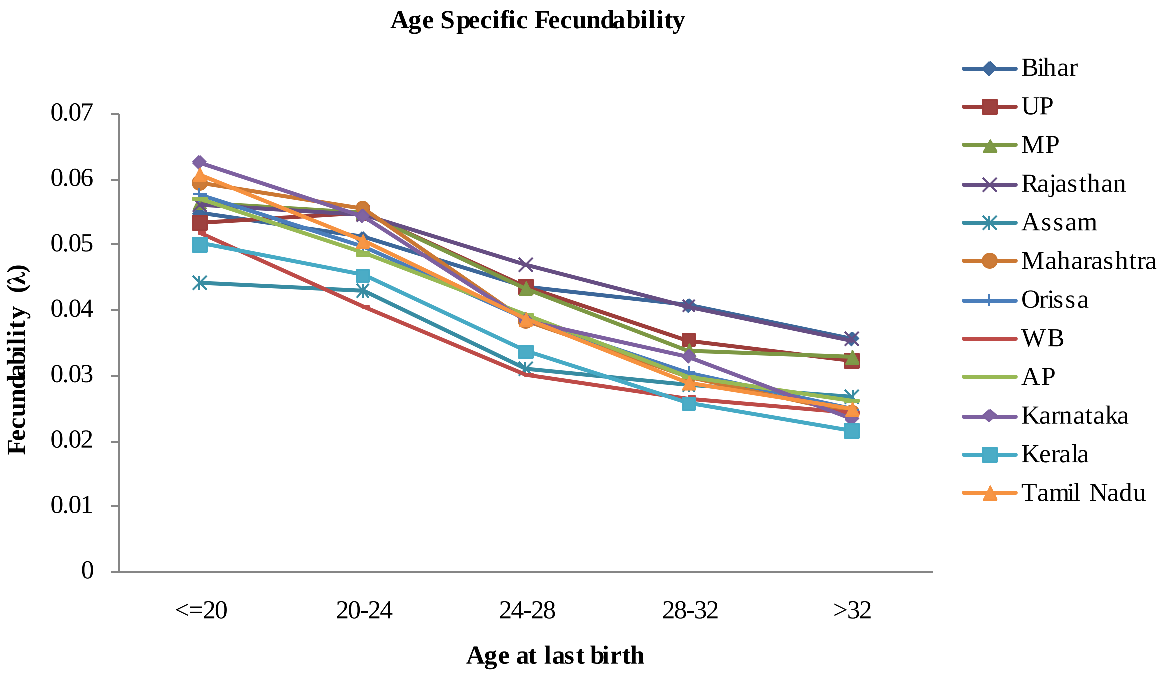

Figure 1. shows the trend of fecundability of females in the the different considered states of the country

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REFERENCES

[1] Cleland, J. & Hobcraft, J. (1986); Reproductive changes in developing countries: Insights from World Fertility Surveys, Population and Development Review, 12(2):341-349.

[2] Gupta, A. D., Som, R. K., Majumdar, M., & Mitra, S. N. (1955); Couple fertility, The National Sample Survey No. 7. Department of Economic Affairs, New Delhi, India.

[3] Henry, L. (1956); Anciennes families genevoises: Etude demographique xvi-xx e siecles, Paris, France: Presses Universitaires de France, Cahier No: 26:227-229.

[4] Larrsen, U & Vaupel, J.W. (1993); Hutterite fecundability by age and parity: Strategies for frailty modeling of event histories, Demography, 30(1):81-102.

[5] Nath, D. C., Land, K. C., Singh, K. K. & Talukdar, P. K. (1994); Most recent birth intervals in a traditional society: A life table and hazards regression analysis, Canadian Studies in Population, 21(2):149-164.

[6] Sheps, M. C., Menken, J. A., Ridley, J. C., & Lingner, J. W. (1970); Truncation effect in closed and open birth interval data, Journal of the American Statistical Association, 65:678-693.

[7] Srinivasan, K. (1967); A probability model applicable to the study of interlive birth intervals and random segments of the same, Population Studies, 21:63-70.

[8] Srinivasan, K. (1980); Birth interval analysis in fertility surveys, W. F. S. Scientific Report Series No. 7.

[9] Srinivasan, K. (1982); Birth intervals, in Workshop on Recent advances in the Techniques for Demographic Analysis, IIPS, Bombay.

[10] Srinivasan, K., Pathak, K. B., & Pandey, A. (1987); On estimating age specific fecundability and secondary sterility from the data on open and last closed birth intervals, Sankhy$\bar{a}$: The Indian Journal of Statistics, Series B, 49:176-185.

[11] Venkatacharya, K. (1969a); Certain implications of short marital durations in the analysis of live birth intervals, Sankhy$\bar{a}$, 31B:53-69.

[12] Venkatacharya, K. (1969b); An examination of a certain bias due to truncation in the context of simulation models of human reproduction, Sankhy$\bar{a}$, 31B:397-412.

[13] Weinstein, M., Wood, J. W., Stoto, M. A., & Greenfield, D. D. (1990); Components of age-specific fecundability, Population Studies, 44(3):447-467.

[14] Weinstein, M., Wood, J., & Chang, M. (1993); Age patterns of fecundability, Biomedical and demographic determinants of reproduction, edited by Ronald Gray, Henri Leridon, and Alfred Spira. Oxford, England, Clarendon Press, 209-27.

[15] W.H. James (1979); The causes of the decline in fecundability with age, Social Biology, 26(4):330-4.