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RESEARCH ARTICLE

PATTERN OF FIRST BIRTH INTERVAL: EVIDENCES FROM NFHS DATA

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ABSTRACT

A women's age at marriage is considered to be one of the most important variables accounting for variation in fertility levels among different societies of the world. The objective of the present paper is to study the fertility behavior of females near the time of marriage using the approach of first birth interval. The study is done in two sections. Section-1 deals with the study of spatial variation in first birth interval across different states of the country (India) for females classified according to age at marriage. It also deals with the investigation of transition of first birth interval from NFHS-2 to NFHS-3. Section-2 is concerned with the application of a simple model to investigate whether the assumption of constant fecundability after marriage till the occurrence of first conception is suitable or not. If so, the estimates of fecundability have also been obtained using simple technique of estimation.

INTRODUCTION

The variation in fertility behavior of human beings is a complex phenomenon. In general, although fertility is more and more a social phenomenon, it is first a physiological process. It is always difficult to analyze separate components by studying the aggregate product. However, this analysis is not impossible, and out of many components of fertility, if few are fixed then the estimates of other components can be obtained.

In our country, by and large cohabitation and child bearing are socially sanctioned only after marriage. The appropriate age at marriage sociologically contributes to the family welfare, better education and improvement on the quality of life of girls and women particularly in the sphere of pregnancy, safe childbirth and child rearing. Higher age of marriage reduces the reproductive span and to some extent checks the maternal mortality. Hence, age at marriage plays a significant role in shaping the fertility behavior of females. The duration of time from marriage to first birth is termed as first birth interval and is very much influenced by age at marriage. It is a bit different from other birth intervals as it does not contain the component of postpartum amennoherea (PPA) period and consequently it is generally studied separately from birth intervals of higher order. It is related to women's first sexual experiences and consequently to the risk of pregnancy and child bearing at the beginning of marital life. In this paper an attempt has been made to study the variations in fertility behavior of females near the time of marriage utilizing data on first birth interval collected in National Family Health Surveys (NFHS-2 and NFHS-3). Since age at marriage significantly affect the duration variable under study, hence pattern of FBI is analysed according to different age at marriage group discussed in the next section.

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Data and Methodology

It is significant to point out that most of the results associated to the problems of analysis of birth interval data are mostly of theoretical nature or simulated. Fortunately the NFHS has found extensive data on birth histories of all eligible females included in the survey. Such huge data provide sufficient opportunities to calculate observed birth interval distributions under varying sampling frames. The first round of NFHS was conducted in 1992-1993 (NFHS-1), second in 1998-99 (NFHS-2) and third in 2005-06 (NFHS-3), initiated by the Ministry of Health and Family Welfare, Government of India, and coordinated by the International Institute for Population Sciences, Mumbai. A detailed description of the NFHS can be found in NFHS reports.

The data utilized for the purpose of present study have been taken from NFHS-2 and NFHS-3 for different states of India. In NFHS, data relating to first birth interval are given as a variable named as marriage to first birth interval (in months). The date on age at marriage (in years) and marital duration in grouped form are also available. For studying the variation in the time of first birth, intervals of only those females have been considered in the study who have completed at least ten years of marital duration. This has been done to account the fact that marital duration of each female should be large

enough such that every fertile female has approximately probability one for having at least one birth in that marital duration. In Indian society normally cohabitation takes place only after marriage, so we have excluded those first birth intervals which are less than nine months. The ages at marriage are grouped as <=12, 13-15, 16-18, 19-21, 22-24 and 25+ years for the analysis purpose. The study is done in two sections. Section-1 deals with the study of spatial variation in FBI across different states of the country (India) for females classified according to age at marriage. It also deals with the investigation of transition of FBI from NFHS-2 to NFHS-3. Section-2 is concerned with the analysis of conception rate (?) under different sets of assumption. Further with the application of a simple model for higher age at marriage group, it was investigated that whether the assumption of constant hazard rate for first conception is suitable or not.

Section 1

This section mainly deals with the study of investigation of spatial variation (if any) in the time of first birth interval. Since age at marriage, especially lower age at marriage plays very significant role in determining the length of first birth interval, we have analysed the data on first birth interval keeping age at marriage fixed. The measure used for comparison is the mean of first birth interval. Table 1 presents the values of mean of first birth interval for 15 major states of India as well as India as a whole.

As expected, the means are significantly higher for lower age at marriage groups in comparison to means for higher age at marriage groups for all states, though the variations for higher ages at marriage (above 18 years) are minor. Significantly enough, even for fixed age at marriage groups, there seems enough variation over states. The so called BIMARU states (Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and Orissa) by and large, show higher mean first birth interval in comparison to other states for each age at marriage group. For more clear picture, Table -2 presents mean FBI for combined states groups viz. BIMARU states, Southern states (Andhra Pradesh, Karnataka, Tamil Nadu, Kerala), Northern states (Punjab, Haryana), Eastern states (West Bengal, Assam) Western states (Maharashtra, Gujarat). Apart from other things, the Table- 2 clearly indicates that there is large gap (6-7 months) between means of BIMARU and southern states at least for ages at marriage up to 18 years. The lower mean values for southern states may be perhaps due to lesser effects of deterrent social factors such as social taboos for restrictive intercourse frequency, frequent visits to parental home by females, etc. The reasons for larger mean values for lower age at marriages are well discussed in literature (Agarwala, 1962; Altekar, 1956; Kapadia, 1966; Mukherjee, 1973). The other reasons may be that many of the females might not have attained menarche or might be in the stage of adolescent sterility at the time of marriage (Talwar, 1965; Parker et al, 1978; Saxena, 1969; Yadava, 1971; Basu, 1993). These factors play important role in delaying the first birth. A detailed account of various socio cultural factors affecting human fertility is given in Potts and (Selmen, 1979) and (Mendelbaum, 1970). The change in mean FBI over time for fixed age at marriage is also provided in table -3.This table presents the values of mean first birth interval (for the country as a whole) for NFHS-2 and NFHS-3. The last row of table presents the difference in the mean FBI from NFHS-2 to NFHS-3.

There is decrement in the mean FBI for every age at marriage group. This is about one month for age at marriage group ≤ 12 years, five months for ≥ 25 years and 2.5-3.0 months for all other age at marriage groups. It can be concluded that the mean FBI is slowly decreasing from NFHS-2 to NFHS-3.This decrement in the mean first birth interval may be due to weakening of social factors. The improved educational status might also be playing a passive role in the decrement of mean of first birth interval over time. Further, it is also pertinent to mention that in the analysis only those females have been included who had completed at least ten years of marital duration. Thus the difference in the means shown in Table 3 from NFHS-2 to NFHS-3 must be seen in this perspective.

Section 2

In the previous section, we have dealt with the study of differentials in mean FBI among different states at fixed age at marriage groups. In this section an attempt has been made to analyse the distribution of time from marriage to first conception. In the absence of direct observations on the biological determinants of fecundability, estimates of its value are derived from data on waiting time to first conception. In literature there are many crucial operating assumptions in this indirect estimation. These assumptions are broadly classified in three categories:

(a) The fecundability of each woman is constant.
(b) Fecundability of each woman is constant till occurrence of first conception but population is heterogeneous with respect to fecundability.
(c) The fecundability is time dependent (time being measured from the age at marriage).

Under the assumption (a), the time of first conception from marriage is assumed to be distributed as geometric or exponential depending upon whether time is considered to be discrete or continuous. In case of geometric distribution unit of time is taken as a menstrual cycle or roughly a month. In this case the number of females conceiving in consecutive months shows a declining trend but conditional probability of conception in consecutive months remains constant. Similar results are true for continuous case also. Under assumption (b), the number of females conceiving in consecutive months shows a declining trend but at the same time conditional probability of conception in a month also shows a declining trend. Under assumption (c), the number of females conceiving in a month is dependent upon the assumed pattern of time dependency. It may show an increasing trend or decreasing trend or curve of another nature depending upon the assumptions. Various models have been proposed by various authors dealing with different situations (Sheps and Perrin, 1966; George, 1967; Chakraborty, 1976; Yadava, 2009; Sharma *et al.,* 2007). It is expected that for females having relatively higher age at marriage and having similar bio-socio-cultured characteristics, the assumption (a) may be more appropriate while for females with lower age at marriage, say less than 15-16 years, the assumption (c) may be more appropriate. Under this situation fecundability may be assumed to have an increasing trend over time or increasing up

Table 1. The values of mean of first birth interval (in months) for (NFHS-3) for various major states of the country (India) for different age at marriage groups viz. ≤ 12 years, 13-15 years, 16-18 years, 19-21 years, 22-24 years and 25+ years

Age at Marriage / States	<=12	13-15	16-18	19-21	22-24	25+
Haryana	42.95 (95)	35.87 (412)	31.51 (508)	26.07 (236)	24.07 (72)	26.92 (28)
Punjab	40.33 (54)	31.68 (307)	25.69 (512)	22.75 (472)	21.43 (199)	21.66 (62)
Rajasthan	49.53 (146)	39.07 (743)	34.33 (645)	30.93 (242)	31.06 (45)	24.25 (16)
Madhya Pradesh	46.12 (242)	35.32 (1127)	31.09 (1088)	27.77 (438)	25.73 (149)	23.5 (47)
Uttar Pradesh	48.40 (207)	37.45 (1467)	32.32 (1859)	27.68 (692)	24.07 (170)	20.40 (62)
Bihar	48.61 (71)	40.58 (694)	34.35 (535)	26.14 (122)	31.37 (28)	26.5 (8)
Orissa	41.72 (60)	31.61 (521)	29.48 (742)	27.69 (301)	21.11 (73)	29.07 (35)
West Bengal	43.79 (191)	31.77 (794)	26.02 (868)	26.60 (391)	26.32 (167)	27.81 (95)
Assam	41.53 (78)	29.48 (368)	24.92 (395)	24.77 (244)	24.53 (120)	23.08 (79)
Gujarat	49.39 (50)	32.36 (422)	27.80 (698)	25.99 (413)	27.19 (106)	39.51 (28)
Maharashtra	46.68 (174)	31.16 (918)	27.50 (1269)	24.57 (706)	20.75 (338)	21.16 (128)
Andhra Pradesh	42.31 (564)	34.68 (1125)	28.35 (868)	25.59 (409)	26.98 (152)	22.96 (62)
Karnataka	38.92 (182)	30.33 (749)	26.72 (680)	23.08 (362)	21.65 (148)	24.62 (105)
Kerala	44.87 (44)	29.46 (187)	23.32 (442)	21.40 (421)	19.17 (272)	19.79 (165)
Tamil Nadu	32.20 (124)	25.81 (537)	23.07 (936)	23.08 (653)	20.92 (246)	21.60 (107)
INDIA	43.99 (3037)	33.47 (13664)	28.17 (16775)	24.57 (9184)	22.43 (3797)	21.94 (1972)

Table 2. The values of mean of first birth interval (in months) for (NFHS-3) for various Regions of the country (India) for different age at marriage groups viz. ≤ 12 years, 13-15 years, 16-18 years, 19-21 years, 22-24 years and 25+ years

Age at Marriage / States	<=12	13-15	16-18	19-21	22-24	25+
Southern	40.39	31.22	25.52	23.25	21.59	21.84
	(914)	(2598)	(2926)	(1845)	(818)	(439)
BIMARU	47.34	37.00	32.10	28.04	25.25	23.73
	(726)	(4552)	(4869)	(1795)	(465)	(168)
Northern	42.00	34.08	28.59	23.86	22.28	23.3
	(149)	(719)	(1020)	(708)	(271)	(90)
Eastern	43.13	31.04	25.68	25.90	25.57	25.66
	(269)	(1162)	(1263)	(635)	(287)	(174)
Western	47.29	31.54	27.61	25.09	22.29	24.46
	(224)	(1340)	(1967)	(1119)	(444)	(156)
INDIA	43.99	33.47	28.17	24.57	22.43	21.94
	(3037)	(13664)	(16775)	(9184)	(3797)	(1972)

Table 3. The difference in the mean first birth interval from NFHS-2 to NFHS-3 for different age at marriage groups viz. ≤ 12 years, 13-15 years, 16-18 years, 19-21 years, 22-24 years and 25+ years

Age at marriage	<=12	13-15	16-18	19-21	22-24	25+
NFHS -2	44.95	35.93	30.65	27.78	25.27	27.69
NFHS -3	43.99	33.47	28.17	24.57	22.43	21.94
DIFFERENCE	0.96	2.46	2.48	3.21	2.84	5.75

to some level and then remaining constant. In the previous section we have mentioned that data on FBI are available for females with different ages at marriage. Theoretically it is quite difficult to get data on time of first conception from marriage from data on first birth interval because in few cases there may be many foetal losses before the first birth. However, if we make an assumption of one to one correspondence between conception and birth, then data on time of first conception can be easily obtained from data on first birth interval (i.e. subtracting nine months from first birth interval). On the basis of above assumption we have determined the distribution of time of first conception for females with different age at marriage groups.

Keeping in view the above discussion, we have classified the females with lower and higher age at marriage groups. For latter case, i.e. ages at marriage 19 years and above, we use a stochastic model fulfilling assumption (a). Let X denotes the time between marriage and the first conception. Then the assumption (a) implies that the chance of conception between time t and $t + \Delta t$ is $\lambda . \Delta t + 0 (\Delta t)$ with probability density function (p.d.f) of X as -

$$f(x,\lambda) = \begin{cases} \lambda e^{-\lambda x} & \lambda > 0 \; x > 0 \\ 0, & \text{otherwise} \end{cases}$$

Here λ represents the conception rate per unit of time (hazard rate). If unit of time is one month then conception rate may be interpreted as similar to fecundability. If the unit of time is taken as one year then it is known as yearly conception rate.

In exponential model, the maximum likelihood estimator as well as moment estimator of λ is $\frac{1}{\overline{X}}$ where $\overline{X}$ is sample mean corresponding to a random sample from the population. The data set (as described in introduction) provides us the duration of first birth interval (Y), which is sum of waiting time for conception and gestation period. Generally, there is little variation in the gestation period 'g' associated with a live birth, however, for all practical purposes this interval 'g' is

Table: 4.1. Estimates of fecund ability in NFHS-2 & NFHS-3 for Southern States

Age at marriage (in years)	Frequency	Fecund ability	Chi sq (cal)	Chi sq (tab)
		NFHS-2		
<=12	345	0.031	13.571	11.070 (5)
13-15	2533	0.039	6.883	11.070 (5)
16-18	2221	0.050	32.790	11.070 (5)
19-21	1102	0.056	19.999	11.070 (5)
22-24	434	0.056	13.311	11.070 (5)
25+	202	0.050	6.899	11.070 (5)
Total (19 above)	1738	0.055	35.58	11.070 (5)
		NFHS-3		
<=12	914	0.031	45.662	11.070 (5)
13-15	2598	0.043	17.202	11.070 (5)
16-18	2926	0.058	48.883	11.070 (5)
19-21	1845	0.065	105.56	11.070 (5)
22-24	818	0.073	98.967	11.070 (5)
25+	399	0.070	24.606	9.488 (4)
Total (19 above)	3102	0.068	225.56	11.070 (5)

Table 4.2. Estimates of fecund ability in NFHS-2 & NFHS-3 for BIMARU States

Age at marriage (in years)	Frequency	Fecund ability	Chi sq (cal)	Chi sq (tab)
		NFHS-2		
<=12	1027	0.026	110.737	11.070 (5)
13-15	7415	0.033	231.833	11.070 (5)
16-18	5862	0.038	98.041	11.070 (5)
19-21	1519	0.041	7.39	11.070 (5)
22-24	253	0.050	4.653	11.070 (5)
25+	73	0.047	0.410	7.815 (3)
Total(19 above)	1845	0.042	9.13	11.070 (5)
		NFHS-3		
<=12	726	0.026	101.370	11.070 (5)
13-15	4552	0.035	147.406	11.070 (5)
16-18	4869	0.042	63.020	11.070 (5)
19-21	1795	0.051	8.961	11.070 (5)
22-24	465	0.059	2.822	11.070 (5)
25+	168	0.065	0.969	7.815 (3)
Total (19 above)	2428	0.053	7.38	11.070 (5)

Table 4.3. Estimates of fecund ability in NFHS-2 & NFHS-3 for Northern States

Age at marriage (in years)	Frequency	Fecund ability	Chi sq (cal)	Chi sq (tab)
		NFHS-2		
<=12	5	0.036	*	*
13-15	424	0.039	14.881	11.070 (5)
16-18	1194	0.049	11.482	11.070 (5)
19-21	665	0.058	2.13	11.070 (5)
22-24	219	0.063	5.47	7.815 (3)
25+	77	0.052	13.52	7.815 (3)
Total (19 above)	961	0.059	17.83	11.070 (5)
		NFHS-3		
	149	0.030	11.063	11.070 (5)
	719	0.039	11.785	11.070 (5)
	1020	0.049	5.086	11.070 (5)
19-21	708	0.064	6.533	11.070 (5)
22-24	271	0.070	18.491	9.488 (4)
25+	90	0.065	0.069	5.991 (2)
Total (19 above)	1069	0.066	14.89	11.070 (5)

Table 4.4. Estimates of fecund ability in NFHS-2 & NFHS-3 for Eastern States

Age at marriage (in years)	Frequency	Fecund ability	Chi sq (cal)	Chi sq (tab)
		NFHS-2		
<=12	164	0.029	19.168	11.070 (5)
13-15	1147	0.042	12.744	11.070 (5)
16-18	1286	0.054	12.629	11.070 (5)
19-21	475	0.057	16.098	11.070 (5)
22-24	186	0.061	5.088	9.488 (4)
25+	95	0.053	5.258	5.991 (2)
Total (19 above)	756	0.057	24.37	11.070 (5)
		NFHS-3		
<=12	269	0.029	27.814	11.070 (5)
13-15	1162	0.044	4.473	11.070 (5)
16-18	1263	0.058	2.805	11.070 (5)
19-21	635	0.057	15.885	11.070 (5)
22-24	287	0.058	17.341	9.488 (4)
25+	174	0.057	1.501	9.488 (4)
Total (19 above)	1096	0.057	28.01	11.070 (5)

Table 4.5. Estimates of fecund ability in NFHS-2 & NFHS-3 for Western States

Age at marriage (in years)	Frequency	Fecund ability	Chi sq (cal)	Chi sq (tab)
		NFHS-2		
<=12	140	0.030	14.254	11.070 (5)
13-15	1059	0.040	8.187	11.070 (5)
16-18	1558	0.049	11.602	11.070 (5)
19-21	732	0.050	13.695	11.070 (5)
22-24	226	0.055	22.271	9.488 (4)
25+	89	0.050	2.816	7.815 (3)
Total (19 above)	1047	0.051	22.66	11.070 (5)
		NFHS-3		
<=12	2244	0.026	13.637	11.070 (5)
13-15	1340	0.044	26.243	11.070 (5)
16-18	1967	0.052	19.671	11.070 (5)
19-21	1119	0.059	28.435	11.070 (5)
22-24	444	0.070	21.557	9.488 (4)
25+	156	0.061	35.830	7.815 (3)
Total(19 above)	1719	0.062	75.77	11.070 (5)

Table 5.1 Conditional probability (CP) with different age at marriage (NFHS -2)

Age at marriage Class interval	<=12	CP	13-15	CP	16-18	CP	19-21	CP	22-24	CP	25+	CP
0-11	344	0.1900	4550	0.3153	5997	0.4037	2888	0.4747	1064	0.5267	435	0.4938
12-23	373	0.2543	3514	0.3557	3878	0.4378	1584	0.4956	524	0.5481	227	0.5090
24-35	325	0.2971	2264	0.3557	2066	0.4149	719	0.4460	201	0.4653	87	0.3973
36-47	238	0.3095	1534	0.3741	1253	0.4300	345	0.3863	102	0.4416	52	0.3939
48-59	192	0.3616	1054	0.4106	687	0.4136	225	0.4106	56	0.4341	27	0.3375
60-71	127	0.3746	620	0.4098	395	0.4055	118	0.3653	25	0.3425	16	0.3019
≥72	212	1.0000	893	1.0000	579	1.0000	205	1.0000	48	1.0000	37	1.0000
	1811		14429		14855		6084		2020		881	

Table 5.2. Conditional probability (CP) with different age at marriage (NFHS-3)

Age at marriage Class interval	<=12	CP	13-15	CP	16-18	CP	19-21	CP	22-24	CP	25+	CP
0-11	613	0.2018	4778	0.3497	7645	0.4557	5072	0.5523	2330	0.6136	1255	0.6364
12-23	674	0.2781	3575	0.4023	4361	0.4777	2210	0.5375	873	0.5951	406	0.5662
24-35	494	0.2823	2056	0.3871	2140	0.4487	903	0.4748	278	0.4680	158	0.5080
36-47	384	0.3057	1264	0.3883	1148	0.4367	441	0.4414	131	0.4146	66	0.4314
48-59	297	0.3406	817	0.4103	643	0.4342	243	0.4355	71	0.3838	28	0.3218
60-71	236	0.4104	476	0.4055	345	0.4117	121	0.3841	44	0.3860	22	0.3729
≥72	339	1.0000	698	1.0000	493	1.0000	194	1.0000	70	1.0000	37	1.0000
	3037		13664		16775		9184		3797		1972	

taken as nine months. If we assume that there is one to one correspondence between conception and birth there exist a linear relationship between Y and X is Y=X+g.

As in previous section major states of India are broadly classified in five groups: Southern, BIMARU, Eastern, Western and Northern states. For all these five region higher age at marriages is classified in four groups as 19-21, 22-24, 25+ and 19 and above. Analysis of variations, if any, for all four groups in the pattern of bearing first birth over time by considering the patterns in NFHS-2 and NFHS-3 is also done. In this context the distribution of time of first conception has been considered as class intervals 0-11, 12-23, 24-34, 36-47, 48-59, 60-71, and 72 above. The estimate of λ has been obtained for each group by the method described above. Further to investigate the goodness of fit, chi square test is applied. To avoid huge tables we have given the observed mean first conceptive delays corresponding estimates of λ and value of chi-square along with degree of freedom are given in Table (4.1to 4.5). The assumption of constant fecundability is somewhat robust for all age at marriage, but for comparison i.e. for analysis of the changing pattern of first birth interval over time, this approach is mathematically simple and suitable. The results in the tables (4.1 to 4.5) show that, the conception rate has increased more or less in almost every regions of India. But in the Eastern region there is no change in the pattern of bearing first child from NFHS-2 to NFHS-3 (Table 4.4). The females involve in our study belong to many background characteristics such as place of residence, educational level, economic status and others. Certainly, these characteristics have been improving over time. For lower ages at marriage the assumption (a) is not suitable due to some biological and social factors. To analyze the behavior of fecundability under different ages at marriages group, conditional probability of conception rate for given time (in class interval) is calculated. The results are presented in table 5.1 and 5.2 for NFHS -2 and NFHS -3 respectively. At lower age at marriage the conditional probability increases over time. This is due to the relation of various social restrictions and attainment of puberty over time for younger married female. But at little higher age at marriage (16-18) the values of conditional probability increases up to second cell, then decreases further with time. This indicates that, various social factors restricting a women's exposure to sexual intercourse during early period of her married life. Hence the assumption (c) i.e. fecund ability is time dependent is true for lower age at marriage group. For higher age at marriage group the values of conditional probability is decreasing over time. There results

indicate that the assumption (b) is true for higher age at marriage. Hence it may be concluded that the female of higher age at marriage is heterogeneous with respect to fecund ability. A critical review of table reveals that the model fits well for only higher age at marriage groups for BIMARU States only. In other states, the fit was not good for any group. This clearly indicates that the assumed model may be considered to be appropriate only for BIMARU States for higher age at marriage groups. There can be many reasons for not getting satisfactory fits for other groups of Sates. Among them the heterogeneity with respect to conception rate in the population may be a major reason. However, the value in the table 5.1 and 5.2 clearly shows the declining trend for almost all cases considered here. This clearly gives an evidence to assume the population of females of these states to be quite heterogeneous with respect to conception rate. The variations in the place of residence, education level and other socio-cultural environmental factors may be responsible for such variation even for higher age at marriage. For BIMARU States the females for higher age at marriage may be perhaps of more or less similar characteristic resulting in almost homogeneous structure of population under consideration. The other plausible reason for getting a satisfactory fit for BIMARU states may be that here also there might be heterogeneity in the population of females which show declining trend in conditional probabilities but due to minor increase over age in fecundability near the age of marriage may be responsible for increase in conditional probabilities and the net effect might be balancing which ends in good fit for the model.

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