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SEX RATIOS AND SEX SEQUENCES OF BIRTHS IN INDIA

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Summary. 101,220 births in urban areas and 147,331 in rural areas in India, recorded by interview from a 10% sample of households in 3888 villages and 2357 urban blocks, have been analysed. The overall sex ratio was similar to that found in Europe; the only obvious effect of birth order was an apparent high masculinity of first births in both urban and rural areas (probably artifactual); the distribution of the sexes in families in both areas differed somewhat from the binomial expectation; and there was no association between the sexes of pairs of children from adjacent births, but some in the case of pairs separated by one other birth in urban areas or by two other births in rural areas.

Introduction

The decennial census reports of India since 1881 show that the number of males has regularly exceeded that of females. This general biological feature is true for almost all provinces of the country. Three explanations have been offered for this difference in the numbers of the sexes: (a) a more complete enumeration of the male population, (b) a larger number of male births, and (c) a heavier mortality amongst females. The assumption of under-enumeration of females has been contested on factual grounds by the authorities. On the other hand, there is undoubtedly an excess of males at birth, the number of males per 100 females ranging from 109 in 1891 to 108 in 1895 and again to 107 in 1900. Contextually, it is interesting that this general demographic feature has its counterpart in contemporary Europe where the proportion of males at birth varies from about 103 to 108 per 100 females. In 1931, it was stated further that the population of India has shown a continued steady fall in the proportion of females to males since 1901 (Census of India, 1931).

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In a critical review of the question of sex ratio in India during 1901–61 (Visaria, 1967), it was pointed out that (i) the population of India exhibited a continuing and slightly increasing excess of males, and (ii) the masculinity at birth continued to be higher than in the past. On the other hand, variations in sex ratios of registered births in most of the different Provinces of India between 1891 and 1939 are within the usual range of 104–107. The high sex ratio is also emphasized in a recent National Sample Survey of India in 1963–64; the sex ratio of the population of the country was shown to be 113·9 and 104·5 for urban and rural sectors respectively (NSS Report, 1967).

The sex ratio at birth in different populations of the world centres approximately around 106 boys to 100 girls, varying only within narrow limits (Russell, 1936; Ciocco, 1938; Lazos, 1959; Parkes, 1963; Pollard, 1969). In this respect, the sex ratio at birth in India shows no discordance.

But it has concurrently been observed that 'in nearly all populations, the ratio of males is highest for the first births and decreases with successive births . . . It may directly relate to birth order itself. . . .' (Stern, 1960). Thus, certain questions crop up at once about this effect: (a) how far variations in the secondary sex ratio are correlated with order of birth in India? (b) to what extent does the often reported higher ratio of males to females for rural, as compared with urban, populations exist in India? (c) what are the sequences of the sexes in Indian families living in either rural or urban society of today? Of these three important biological issues only the first has been considered to a useful extent a few years back (Ajit Das Gupta *et al.*, 1955). Further examination of the three questions, especially the last, is attempted here.

As the census data fail in general to provide the requisite qualitative information, we utilized the relevant data collected in the National Sample Survey (NSS), 1961–62, by the Indian Statistical Institute which dealt directly with the fertility of Indian couples residing in villages, towns and cities of the country.

Material

In the NSS of 1961–62 an all-India inquiry on fertility history and mortality was carried out on a 10% sample of households in 3888 villages and 2357 urban blocks, according to a schedule on 'Population, Births and Deaths'. The couples were interviewed to elicit information on socio-demographic attributes such as marital status, age at formal and at effective marriage, present age, marriage duration, number of offspring according to birth order and sex, interval (in months) since previous birth, etc.

As in the other rounds of NSS, the sample design was fairly comprehensive but complicated—stratified, multistage—for both rural and urban sectors. The details are available elsewhere (NSS Report, 1967). The figures marshalled here have been derived from straightforward (unweighted) sample counts. It is presumed that this procedure will not essentially affect our findings.

All tabulations were computed with the help of an IBM 1401 computer, after a thorough scrutiny of the raw data which led to rectification of nearly 2% of the cards. The inquiry on fertility history initially covered 52,284 rural couples and 35,108 urban couples. In the present study the relevant fertility histories of only 43,325 rural couples and 29,477 urban couples were found eligible for our analysis.

Method and its limitations

The requisite data were recorded on punched cards, from which were built up the basic tables relating to (a) sex distribution among the first five children in the sample families—rural and urban separately, and (b) the frequency of each combination of the sexes; order being taken into immediate consideration, for the first five children only. Exclusion of the sixth and subsequent child-births caused the omission of 18% of the urban data and 16% of the rural data under examination.

It should be noted that since the data have been extracted from the sample census they obviously relate to many incomplete families (Gini, 1951). Accordingly, nothing can be directly inferred from the present analysis about the sex distributions in completed families of exactly N children. This limitation clearly makes our study not strictly comparable with other recent studies (e.g. Edwards & Fraccaro, 1960), but it is in line with previous studies on incomplete families (Rife & Snyder, 1937; Slater, 1944; Meyers, 1949). Families with one or more multiple births have been excluded from this study.

First, we have tested whether the sex ratio varies significantly between births of different parities (birth orders) within rural or urban families of India.

Second, a test for binomial distribution of the sex combinations in families has been made following the method employed by Edwards & Fraccaro (1960). The data recorded in Appendix A have been arranged in the form of binomial sex distributions for the first N children of families of N or more children, irrespective of birth order, and then we have compared the variances of the distributions with those expected on the simple binomial hypothesis.

Third, we have analysed, again according to the method of Edwards & Fraccaro, the association between the sexes of various pairs of births in a family, the rural and urban families being considered separately. The results are presented after testing the significance of the association by means of contingency χ^2. In employing this particular test we have excluded the children belonging definitely to the first birth order. The reasons for such exclusion are discussed below.

It should be emphasized that this study, though including data from many incomplete families, deals with a huge number of births (248,551) and thus gives scope for the necessary quantitative work. Moreover, no study has so far been made to examine the distributions of the sexes in Indian families, and we have been able to analyse the distributions in both rural and urban India.

Results

(1) Table 1 shows sex ratios according to parity for rural and urban births separately. Calculations of contingency χ^2 for testing homogeneity give very large values, highly significant at the 1% level. Such high values may indicate some inconsistency in the enumerated data, and here our attention is naturally drawn to the excessive masculinity of first births in both rural and urban families. On excluding the sex ratios obtained for the first parities, recalculation yields a very

Table 1. The sex ratio for births of different parity

Area		Birth order 1	2	3	4	5	Total	Including first births χ^2 (4 d.f.)	Excluding first births χ^2 (3 d.f.)
Urban	Males	16265	12621	10031	7907	6051	52875	147·08	2·91
	Females	13212	12126	9757	7593	5657	48345		
	Total	29477	24747	19788	15500	11708	101220		
	Sex ratio	123	104	103	104	107	109		
Rural	Males	24202	18192	14888	11359	8335	76976	330·49	9·10
	Females	19123	17733	14050	11165	8284	70355		
	Total	43325	35925	28938	22524	16619	147331		
	Sex ratio	127	103	106	102	101	109		

Note: Sex ratio = males per 100 females.

sharp fall in the values of χ^2. This indicates, no doubt, that some element of bias has crept into the enumeration of the sex of first-born children. The new χ^2 values (excluding first parity) are non-significant at 1% level for both rural and urban sectors.

(2) From Table 1, also, it is interesting to note that in spite of the fact that the sex ratio varies between births of different parities in both urban and rural families, the overall sex ratios among the children do not differ between urban and rural sectors of the country; we may ask whether this result has any 'geographical significance' (Russell, 1936). The question of possible differences between rural and urban sex ratios has already been considered by many authors (Ciocco, 1938; Strandskov & Roth, 1949) and in this connection our present finding may be of interest.

(3) Table 2 summarizes the Appendix and Table 3 shows the observed values of the ratio and the 99% fiducial limits of the expected values on the simple binomial hypothesis. The distributions are significantly different from the binomial

Table 2. The sex distribution of the first *N* children of families with *N* or more children

Area	Males	*N*				
		1	2	3	4	5
Urban	5					427
	4				1029	1920
	3			2630	3458	3922
	2		6776	8034	6119	3618
	1	16265	12700	7134	4118	1529
	0	13212	5271	1990	776	292
	Total	29477	24747	19788	15500	11708
Rural	5					560
	4				1572	2758
	3			3920	5982	5578
	2		9826	10394	8849	5054
	1	24202	18587	11776	5006	2252
	0	19123	7512	2848	1115	417
	Total	43325	35925	28938	22524	16619

Table 3. Variance test of the distributions in Table 2, values of the variance ratio and fiducial limits of the expected value

Area	*N*	Variance ratio	99% fiducial limits	
			Upper	Lower
Urban	2	0·9666	1·0237	0·9763
	3	0·9493	1·0263	0·9737
	4	0·9549	1·0289	0·9711
	5	0·9604	1·0342	0·9658
Rural	2	0·9571	1·0197	0·9803
	3	0·9565	1·0210	0·9790
	4	0·9580	1·0237	0·9763
	5	0·9590	1·0289	0·9711

expectation for all N children ($N = 2, 3, 4$ and 5) and for both the rural and urban sectors of the country. From this analysis we are forced to conclude that the biased recording of the sex of the first-born child has influenced in one way or other the exact nature of the distribution of couples by number of male births.

(4) Table 4 shows for urban children (excluding first births) the degree of association between adjacent births, births separated by one other birth and births separated by two other births, respectively, together with the values of χ^2. The association between the sexes of pairs of adjacent births is negative (at the 1% level of significance). But, χ^2-values for the association between the sexes of births separated by one or two other births appear to be higher than was found by Edwards & Fraccaro in their study of Swedish families. In fact, the χ^2-values for pairs separated by one other birth is significant at the 1% level.

(5) Table 4 also gives the comparable data for rural children. Association between the sexes of pairs of adjacent births in rural families, as in urban families, is negative at the 1% level of significance. Here, also, the χ^2-values for association between the sexes of pairs of births separated by one or two other births are higher than those found by Edwards & Fraccaro. The χ^2-value for pairs separated by two other births is significant at the 1% level.

Table 4. The sexes of pairs of births (excluding first parity)

	Urban			Rural		
	Sex of the first birth of the pair	Sex of the second birth of the pair		Sex of the first birth of the pair	Sex of the second birth of the pair	
		m	f		m	f
Pairs of adjacent births	m	12132	11699	m	17498	17031
	f	11857	11308	f	17084	16468
	$\chi^2 = 0{\cdot}348$ on 1 d.f.			$\chi^2 = 0{\cdot}388$ on 1 d.f.		
Pairs separated by one other birth	m	6916	6805	m	9938	10009
	f	7042	6445	f	9756	9440
	$\chi^2 = 8{\cdot}834$ on 1 d.f.*			$\chi^2 = 3{\cdot}881$ on 1 d.f.		
Pairs separated by two births	m	2954	2892	m	4121	4265
	f	3097	2765	f	4214	4019
	$\chi^2 = 6{\cdot}117$ on 1 d.f.			$\chi^2 = 6{\cdot}853$ on 1 d.f.*		

* Significant at 1% level.

Discussion

The relevant findings on the distribution and sequences of the two sexes in Indian families of urban and rural areas conform generally with the results derived from a similar study on Swedish families by Edwards & Fraccaro (1960). This important demographic point must be stressed in the overall context of current biosocial researches in India. Previously, no attempt has been made to highlight the nature of the association, if any, between the sexes of births separated by none, one and two other births in the Indian situation. In spite of its limitations, our study does bear upon the crucial question: 'Does the sex of one child influence the sex of the next' in rural or urban families in India, but it would be unwise to draw any general biological inferences.

Among the first-born children we have found in our sample a high masculinity at birth in both urban and rural families. This phenomenon is not new: it has been known and debated for decades (Jastrzebski, 1919; Census of India, 1921). This problem merits further discussion. In the present sample, the sex ratio among first-born children comes to 127 males/100 females and this figure does not differ from that given for rural children of the first parity in Indian families in 1951 (Ajit Das Gupta *et al.*, 1955). It was then pointed out that a serious 'sex selective recall lapse' might be responsible for such apparent high masculinity.

The problem of 'recall lapse' has meanwhile been discussed in a recent study of the strength and weakness of the data under examination (Halder & Bhattacharya, 1970). Without going further into the issue, we must admit that inconsistent sex recording of the births of first parity in particular, or of any other parity in general, continues to be unavoidable under the varying sociopsychological conditions prevailing in this country; any survey on births and deaths can hardly avoid the consequences of 'recall lapse' and other fluctuating attitudinal factors. More precisely, (a) non-reporting of a dead first child which was female, and (b) a tendency to report the first son as older than the first daughter are not infrequently distorting factors. The problem of 'notoriously inaccurate' enumeration of vital statistics in India has, in fact, been well known to population researchers for many years (Chandrasekhar, 1946). Nevertheless, many workers have tried to reach reasonable conclusions about sex ratio problems in India (Davis, 1951; Visaria, 1967; Desai, 1967).

In contrast to the observed large excess of males at first parity, the sex ratios at successive parities (second to fifth) are within the usual range, though the scatter is relatively less in urban families (1961–62). On examining the sex ratio at birth from fifth to eighth parities among 3330 rural mothers of India (1952) an irregular pattern was found previously (Ajit Das Gupta *et al.*, 1955). Such irregularity is also discernible in our findings for successive parities from first to fifth among 147,331 rural mothers and, again, of 101,220 urban mothers of India (1961–62). Irregularity has also been found in a recent study of the sex ratio at

birth among 34,518 live-births, irrespective of parity, which were registered in a Calcutta hospital during 1956 and 1964.

In this connection, it may be noted that among all single live-births (4493) of Bengali mothers registered at a Calcutta hospital in 1964, the sex ratio was 110·0, while the sex ratio was only 103·5 among 1508 first-born babies (Banerjee, 1969). On the other hand, sex ratio at first parity was found to be 108·8 among 5477 first-born children in the Swedish families studied by Edwards & Fraccaro (1960). Under the circumstances, we did not think it proper to include first-born children in examining the association between the sexes in pairs of births. This exclusion causes a slight departure in our analytical procedure from that of Edwards & Fraccaro. Nevertheless, our general findings for this association, or lack of it, do not run counter to those of Edwards & Fraccaro in their study on Swedish families.

In this country, fertility is still largely uncontrolled, particularly in the rural sector, and, currently, extensive family planning measures are being taken at the insistence of the Government to limit the number of births per couple to only two or three. We may thus ask: could such efforts, sooner or later, influence the nature of the sex ratio at birth. What would happen in secondary sex ratio if all births beyond the second and third could be prevented. An answer to this question may perhaps be formulated on the basis of our present findings on the sex ratio according to parity among the 248,551 children considered.

Additionally, the information we have obtained for the first time on the sequence of the sexes in rural and urban families of India (Table 2 and Appendix) does offer interesting base material for future researches on population biology and control in the country. We may here refer to a recent study which examined, on the basis of a portion of the data utilized by us, the influence of the sex of the first two children on the incidence of a third child birth within 3 years of the birth of the second child, in rural or urban families in India (Halder & Bhattacharya, 1970). This study concluded 'a larger proportion of couples with two female children (FF) had a third child within 3 years of the second child's birth than did the couples having other sex-combinations of the first two children—male–male (MM), male–female (MF) or female–male (FM) in the families.

The distribution of the sexes over first to fifth parities of Indian mothers is clearly seen in detail from the Appendix and such distribution needs further examination, according to region and state, to deal with the questions of size of family and preference for children of each sex for India as a whole.

The findings of the present study, together with those of a previous study (Ajit Das Gupta *et al.*, 1955) on the sex ratio at different parities in Indian families, add to our scanty knowledge about this vital aspect of population biology of the country, but a specialized investigation yielding a bigger volume of reliable data on all births in Indian families is imperative to reach more satisfactory conclusions.

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Appendix

Sequences of sexes amongst the first N children in families of N or more children

$N = 1$

Sequence	No. urban	No. rural
m	16265	24202
f	13212	19123
Total	29477	43325

$N = 2$

Sequence	No. urban	No. rural
m m	6776	9826
m f	6855	10221
f m	5845	8366
f f	5271	7512
Total	24747	35925

$N = 3$

Sequence	No. urban	No. rural
mm m	2630	3920
mm f	2810	4015
mf m	2845	4239
mf f	2738	4004
fm m	2379	3522
fm f	2219	3183
ff m	2177	3207
ff f	1990	2848
Total	19788	28938

$N = 4$

Sequence	No. urban	No. rural
mmm m	1029	1572
mmm f	1025	1496
mmf m	1035	1465
mmf f	1149	1661
mfm m	1147	1648
mfm f	1120	1693
mff m	1145	1636
mff f	1009	1486
fmm m	911	1373
fmm f	879	1313
fmf m	869	1267
fmf f	890	1210
ffm m	957	1279
ffm f	745	1191
fff m	814	1119
fff f	776	1115
Total	15500	22524

$N = 5$

Sequence	No. urban	No. rural
mmm mm	427	560
mmm mf	366	621
mmm fm	346	499
mmm ff	424	604
mmf mm	362	537
mmf mf	407	545
mmf fm	469	623
mmf ff	370	602
mfm mm	507	584
mfm mf	400	644
mfm fm	434	644
mfm ff	416	597
mff mm	425	608
mff mf	414	538
mff fm	408	545
mff ff	360	540
fmm mm	339	517
fmm mf	346	474
fmm fm	332	496
fmm ff	326	487
fmf mm	304	437
fmf mf	338	480
fmf fm	375	452
fmf ff	315	452
ffm mm	381	503
ffm mf	331	457
ffm fm	306	458
ffm ff	253	445
fff mm	334	438
fff mf	299	381
fff fm	302	434
fff ff	292	417
Total	11708	16619