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Declining Proportion of Girls at Birth at Cuddalore District, Tamil Nadu, India, 2001 to 2011 - Cause for Concern

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Abstract: ***Objectives: Cuddalore District of Tamil Nadu, India showed decline in sex ratio of children less than six years from 957 girls per 1000 boys (census 2001) to 895 (2011). Study objectives were to identify contributing vital statistics, describing it's time, place distribution and to generate hypothesis regarding etiology. Methods: We analyzed trend of female live birth proportion for total births and each birth order. We calculated ratio of female to male rates of infant, child mortalities and still birth. We mapped birth sex ratio of blocks from 2007 to 2011 and that of each birth order for 2011. We compared actual number of female and male live births with expected number for each birth order every year. Results: Female live birth proportion showed declining trend (P value<0.001). Female to male ratio of infant, child mortality rate and still birth rate were within normal range. Among 13 blocks, number of blocks with birth sex ratio more than 950 decreased from five to zero, from 2007 to 2011. During 2011, only four, one and zero blocks had ratio more than 950 for first order, 2nd order and higher order births respectively. Second and higher order births had significant declining trend for female proportion (P values <0.001). Though first order births had no significant trend, it showed less female live births in comparison to expected number during some years. Conclusion: Low child sex ratio was due to low birth sex ratio. Decline had spread to more geographical areas with time. Higher order births were more affected suggesting female sex selective abortion as hypothesis. Block as monitoring unit and monitoring of higher order pregnancies were recommended.***

Keywords: vital statistics, blocks, birth sex ratio, sex selective abortion

1. Introduction

In India, sex ratio among 0-6 year old children (child sex ratio) was 914 girls per 1000 boys during 2011 [1]. It had declined from 927(Census 2001) and it was 945 in 1991[2].Factors behind decline in child sex ratio could be declining sex ratio at birth, differential mortality of male & female children and differential undercounts of both [3]. Declining female to male sex ratio in the young population could be a fore runner of impending demographic imbalance with its social implications like compulsory bachelorhood for men, trafficking of girls, increasing sexual violence against women, increased and forced promiscuity and polyandry, social unrest and instability [4-6].

In Tamil Nadu, child sex ratio was 946 girls per 1000 boys according to Census 2011. Comparison of data from census 2001 and census 2011 shows that districts which had lowest child sex ratio in census 2001 had improved to various extent. But new districts had entered the list. They are Cuddalore (declined from 957 (2001) to 895 (2011)), Ariyalur (from 949 to 892), Perambalur (937 to 913), Villupuram (961 to 938) and Thiruvannamalai (948 to 932) [1].

Among the above mentioned districts, Cuddalore showed the greatest decline (62 points) [1]. Identification of involved parameter of vital statistics (low female to male sex ratio at birth or high mortality for females) & areas/ blocks affected and knowing the cause of this decline was vital to take appropriate action. We investigated the problem at Cuddalore district, Tamil Nadu with the following objectives. 1. To identify the parameter of vital statistics behind the low child sex ratio. 2. To describe the affected parameter in terms of time and place distribution. 3. To generate hypothesis regarding the etiology of decline.

2. Methods

Study Population

Our study population was children of age 0-6 years of Cuddalore District during the period April 2001- March 2012

Study Design

We did a cross sectional descriptive study based on secondary data

Operational Definitions

We adopted standard definitions: Male still birth rate is number of male stillbirths per 1000 male (total) births (live births + stillbirths) during the same period. Female still birth rate is number of female stillbirths per 1000 female (total) births (live births + stillbirths) during the same period. Female Infant Mortality Rate is female infant deaths per 1000 female live births during the same period. Male Infant Mortality Rate is male infant deaths per 1000 male live births during the same period. Male child mortality ratio is number of male child deaths of age 1-5 yrs per 1000 male live births of same period. Female child mortality ratio is number of female child deaths of age 1-5 yrs per 1000 female live births during the same period. Sex Ratio at Birth is number of female live births per 1000 male live births. We defined

expected number of female live births as actual number of male live births*952/1000.

Sample Size
We included all live births, stillbirths, infant deaths and child deaths (1-5 years) at Cuddalore district reported during April 2001 to March 2012 in the study.

Data Collection
We collected the data on still births (male, female), Live births (male, female), live births by order of birth (male, female), infant deaths(male, female) and child deaths(1-5 yrs) (male, female) for the period of 2001-2011 for the whole district. The same data with disaggregation at block level was available for the years 2007- 2011. These data were collected from Office of Director of Public Health & Preventive Medicine, Tamil Nadu and Office of Deputy Director of Health Services, Cuddalore district.

Analysis
We calculated ratio of male and female still birth rate, male and female infant mortality rate and male and female child mortality ratio for every year.We analyzed the trend of female live birth proportion with time (year as unit) for total and each order of births by applying chi square for linear trend. We calculated the child sex ratio for the year 2011 by using the actual number of births, infant deaths and child deaths in the data to comment about differential under counts of boys and girls. We plotted the graph of birth sex ratio for total and each order of birth against time. We mapped Sex Ratio at birth for the years 2007 to 2011.We also mapped sex ratio of each order of birthat block level for the year 2011. We compared the actual number of male &female live births with expected number of male &female live births employing the chi square test for each order of birth for every year. We used MS Excel, Epi Info and Open Epi software for analysis.

Human Subject Protection
As the secondary data from official records was aggregate in nature, there were no issues regarding individual human subject protection

3. Results

Female to male ratio of still birth rate was less than one except during 2005 and 2006. Female to male ratio of Infant Mortality rate was less than 0.9 except during 2001 & 2003. Female to male ratio of child mortality ratio was less than or equal to one except 2003 & 2004 (Table.1). Female birth proportion among live births showed a significant declining trend (P value<0.001). Since 2003, female to male sex ratio at birth was below 952 (expected birth sex ratio) for total, 2nd order and 3rd& above order births (Figure.1). Computed child sex ratio for 2011 from our data was 898 (Table.2 and 3).

Regarding place distribution of birth sex ratio, during 2007, eight out of 13 blocks had ratio less than 950 but all the blocks were below that level during 2011.During 2007 no block had ratio below 850 but during 2011, six blocks had ratio below 850 (Figure.2). Regarding first order births, during 2011, four out of 13 blocks had sex ratio more than 950, but one block showing that level for 2nd order births and no block crossed 950 for 3rd order births. For first order births all blocks had sex ratio more than 750, for 2nd order births all except one block had ratio more than 750, but for 3rd and above order births, except three blocks all had ratio below 750 and one block had ratio even below 550 (Figure. 3).

Female birth proportion among second order and 3rd& above order births showed significant declining trend with P values 0.001 and <0.001 respectively. For first order births, there was no significant trend, but actual number of female live births was significantly lower than the expected number during the years 2001, 2003, 2008 and 2011. Regarding second order births, observed number of female live births was lower than expected for all years except 2003, 2004, 2005 and 2006. For 3rd and above order births it was significantly lower than expected in every year since 2004 and during 2002 it was significantly higher than expected (Table 4).

4. Discussion

Girls' mortality statistics were within expected limits. Child sex ratio calculated from data set was close to the census result. Declining trend had been affecting sex ratio at birth especially for higher order births. More and more blocks joined the range of low sex ratio with passage of time. Even first order births had lesser number of female births than expected in some years.

Child sex ratio depends on the number of living boys and girls in the birth cohorts of previous six years. These numbers could be affected by differential mortality between both sexes in the age group of 0-6 years and by number of girls and boys at birth (Sex Ratio at Birth) [3]. The sex ratio at birth could be affected by differential mortality duringfetal life of both the sexes either due to natural causes or deliberate interventions by parents with the help of advanced techniques of pre conception and prenatal sex determination[7-9].It is said that female to male ratio of infant mortality rate in the gender neutral environment would be 0.77 to 0.83[8][10]. Female to male ratio of Child mortality ratio (1-4 years) would be 0.83 to 0.91[10]. In our study the ratios were within these ranges. Sex ratio at birth would be 943-962 in the absence of any external interference [11][12]. This range had been used in some of South Indian based studies also [7][8]. In our study this vital statistics showed deviation from this expected range; it was lower and had declining trend during the decade of 2001-10.

Block level analysis with time dimension (year) helped us to understand that more and more blocks had joined lower

Table 1: Comparison of female and male rates of stillbirths, infant deaths and child deaths at Cuddalore district, Tamil Nadu, India,2001-2011.

Year	Live births		Still Births		Infant deaths		Child (1-5 yrs) deaths		Female to Male Ratio of		
	Male	Female	Male	Female	Male	Female	Male	Female	Still Birth Rate	Infant Mortality Rate	Child Mortality Ratio
2001	21033	19077	284	242	459	409	45	32	0.94	0.98	0.78
2002	19973	19377	297	234	500	411	59	57	0.81	0.85	1.00
2003	19966	18730	288	247	423	398	77	77	0.92	1.00	1.07
2004	17820	16442	281	199	422	352	80	81	0.77	0.90	1.10
2005	18373	17100	219	198	437	331	62	52	0.97	0.81	0.90
2006	18687	16725	245	233	419	291	44	31	1.06	0.78	0.79
2007	18863	17272	262	195	389	289	48	37	0.81	0.81	0.84
2008	18995	16761	294	196	352	240	45	36	0.76	0.77	0.91
2009	19897	18096	207	172	346	290	52	30	0.91	0.92	0.63
2010	22345	20164	187	146	258	201	31	29	0.87	0.86	1.04
2011	20687	17922	206	151	304	187	43	32	0.85	0.71	0.86

Table 2: Calculation of No. of children in the age group of 0-6 years for the year 2011 from the data set , Cuddalore district, Tamil Nadu

Year	Male Livebirths	Female Livebirths	Male Infant deaths	Female Infant deaths	Male (1-5 yrs) deaths	Female (1-5 yrs) deaths	No of male children in the age group of 0-6 years during 2011	No of female children in the age group of 0-6 years during 2011
2006	18687	16725	419	291				
2007	18863	17272	389	289				
2008	18995	16761	352	240	45	36		
2009	19897	18096	346	290	52	30		
2010	22345	20164	258	201	31	29		
2011	20687	17922	304	187	43	32		
Total	119474	106940	2068	1498	171	127	117235	105315

Table 3: Comparison of female children proportion indata set with census 2011 enumeration (to checkdata quality and to comment about differential under counting of girls as a cause)

	Data set	Census 2011
No of male children 0-6 years	117235	137513
No of female children 0-6 years	105315	123071
Child sex ratio	898	895
Proportion of females with Confidence Interval	47.3 (47.1 to 47.5)	47.2 (47.0 to 47.4)

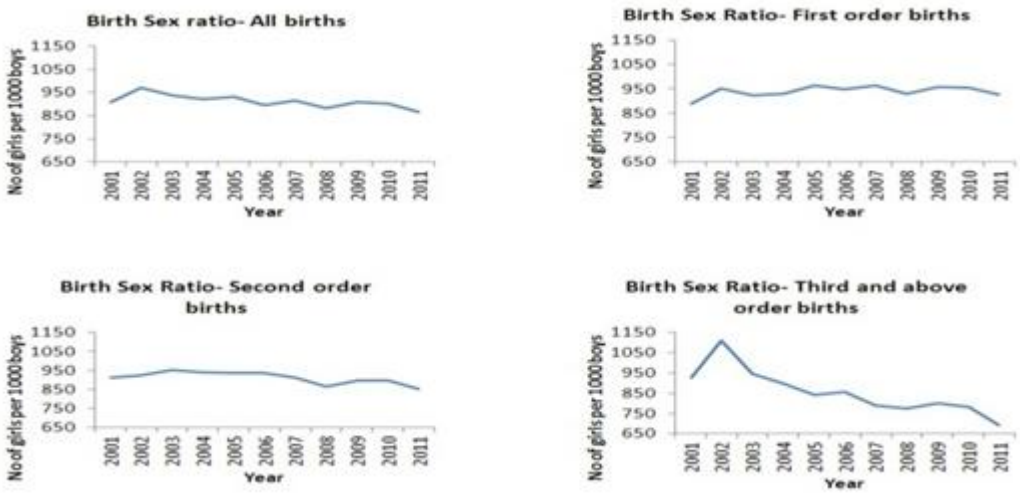

Figure 1: Trend of birth sex ratio, by order of birth at Cuddalore district, Tamil Nadu, India, 2001-2011.

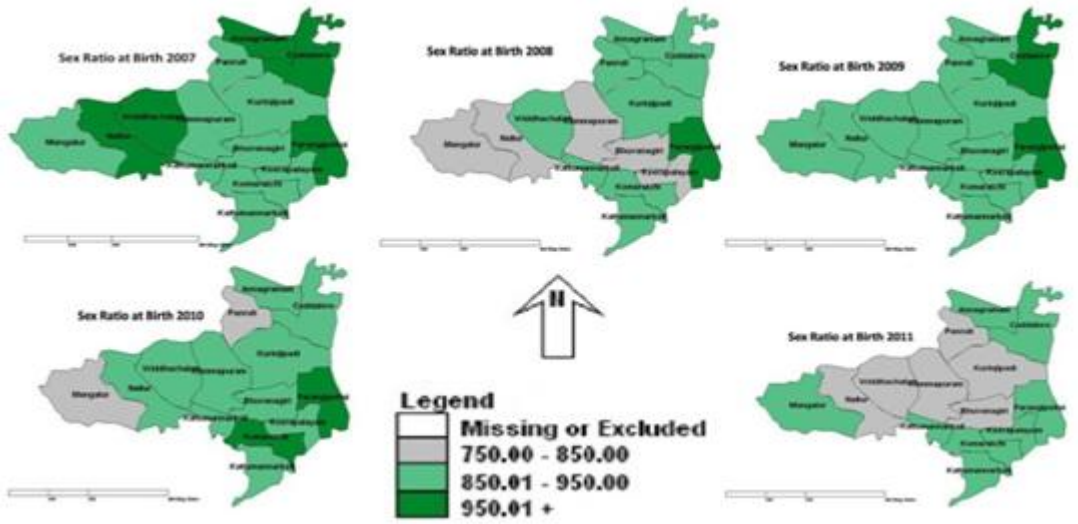

Figure 2: Distribution of Sex Ratio at Birth by block atCuddalore district, Tamil Nadu, India, 2007-2011.

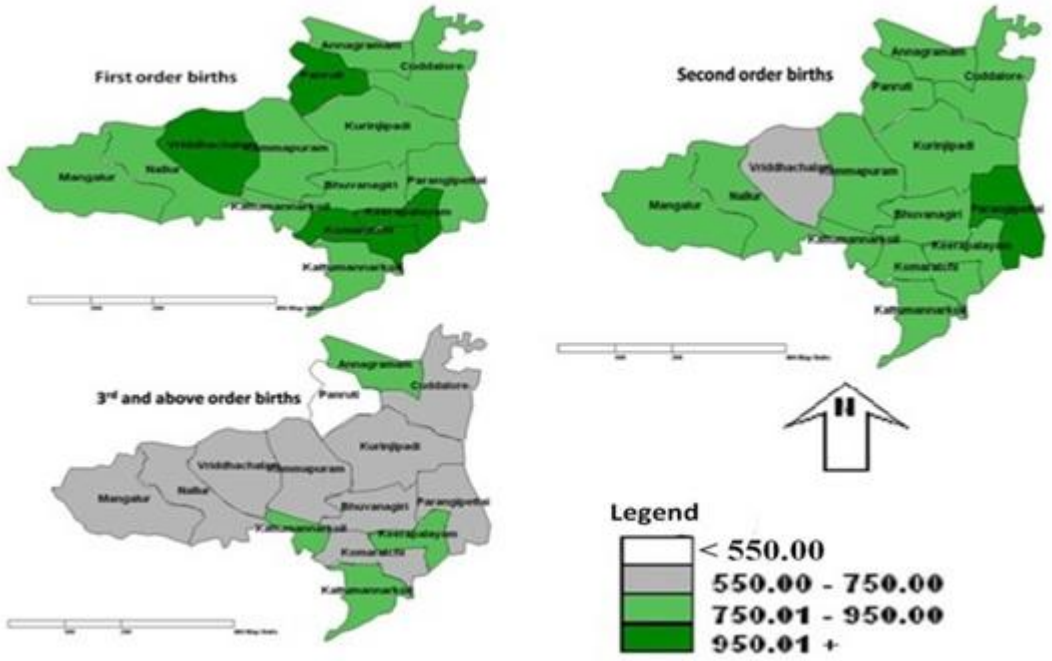

Figure 3: Distribution of Birth Sex Ratio by order of birth,by block at Cuddalore District, Tamil Nadu,India,2011.

Table 4: Comparison of observed and expected number offemale live births for each order of birth by Chi square technique at Cuddalore district, Tamil Nadu, India, 2001-2011

	First order births				Second order births				Third order birth			
Year	Total Live births	Female to Male Birth Sex Ratio	Chi Square value	P value	Total Live births	Female to Male Birth Sex Ratio	Chi Square value	P value	Total Live births	Female to Male Birth Sex Ratio	Chi square value	P value
2001	16579	0.890	24.06	<0.01	14520	0.914	9.01	<0.01	9011	0.927	2.87	>0.05
2002	20649	0.951	0.52	>0.05	11664	0.926	3.95	<0.05	7037	1.111	36.94	<0.01
2003	16773	0.922	7.04	<0.01	13584	0.953	0.23	>0.05	8339	0.947	0.46	>0.05
2004	14436	0.931	3.64	>0.05	12901	0.940	1.5	>0.05	7005	0.896	8.43	<0.01
2005	16126	0.963	0.01	>0.05	13206	0.936	2.29	>0.05	6141	0.842	26.61	<0.01
2006	16420	0.947	0.84	>0.05	13740	0.935	2.5	>0.05	5844	0.858	18.77	<0.01
2007	16784	0.963	0.03	>0.05	14061	0.912	9.62	<0.01	5290	0.788	51.57	<0.01
2008	16694	0.931	4.12	<0.05	13938	0.867	36.31	<0.01	5124	0.775	58.1	<0.01
2009	17539	0.957	0.07	>0.05	14828	0.898	16.96	<0.01	5626	0.802	45.43	<0.01
2010	19389	0.953	0.31	>0.05	16402	0.897	19.12	<0.01	6718	0.781	71.65	<0.01
2011	18675	0.927	5.96	<0.05	15164	0.855	51.41	<0.01	4770	0.691	126.49	<0.01

Note: Expected sex ratio of '952 girls per 1000 boys' used
for calculating expected numbers

Range with the time. Literature review suggests that unit of analysis was at least district in most of the studies [3][7][8][13][14].Our observation suggests that block level monitoring of data would help to pick up the trend and affected areas early. It may be helpful to take early and targeted action. As many blocks had low sex ratio for higher order births, monitoring of higher order births by early registration of pregnancy and follow up could help in understanding the cause for this phenomenon.

Though the decrease in the proportion of girls in the first order births was lower in magnitude than higher order births, the high proportion of first order births among total births could make it a significant factor. Literature review suggests that low sex ratio has been documented with higher order births by some authors in Tamil Nadu. It was conditional upon sex of previous births and was attributed to sex selective abortion of females. But low sex ratio for the first order birth had not been documented in Tamil Nadu [7][15].Though the lower sex ratio of higher order births support the hypothesis of sex selective abortion, our finding of low sex ratio for first order births was contradicting that. So searching for alternative cause and knowing the level of acceptance of girl children including first born in the study area could help testing the hypothesis.

We could not rule out the possibility of differential enumeration of boys and girls as a cause of low child sex ratio. It could overestimate/ underestimate the contribution of lower proportion of girls at birth as the cause of low child sex ratio. However the calculated child sex ratio from our data was closer to child sex ratio reported by census 2011. So it might not greatly affect our interpretation regarding the cause of low child sex ratio.

We conclude that low child sex ratio at Cuddalore district was due to low sex ratio at birth. Higher order births was predominantly affected. Block level monitoring of sex disaggregated birth data could be useful in identifying the trend and affected localities early.

We recommend that block should be the unit for monitoring the child sex ratio related statistics. Close monitoring of higher order births would be useful to identify or exclude sex selective abortion as the cause of low sex ratio at birth. We proposed evaluation of scan centre audit component of RCH II programme which was meant for checking sex selective abortions. We also suggested further studies to assess the level of preference for boys including that of first order births and to identify or exclude the other factors (example: environmental factors).

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