Incidence of neural tube defects in the least-developed area of India: a population-based study

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Hospital-based records from major cities of India, where roughly a quarter of the population resides, identified the frequency of neural tube defects (NTDs) as ranging from 3·9 to 8·8 per 1000 births, but the incidence in rural areas is unknown. We did a population-based door-to-door survey of mothers living in remote clusters of villages in Balrampur District in Uttar Pradesh, a region ranked as the least-developed area in India. The data showed that the incidence of NTDs was 6·57–8·21 per 1000 livebirths, which is among the highest worldwide. India’s Ministry of Health needs to produce a strategy to reduce the incidence of such defects.

Although periconceptional folates prevent the first occurrence of neural tube defects (NTDs),1 a comprehensive strategy for public health has not been developed in India. Hospital-based records, mainly from large cities, documented an incidence ranging from 3·9 to 8·8 per 1000 births (stillbirths and livebirths).2,3 Such studies cannot show the incidence of NTDs in villages where more women than in cities give birth at home often under the supervision of Dais (nurse midwives), and where nearly three-quarters of all Indians reside. Accordingly, we estimated the incidence of NTD in a district that the Government of India National Commission on Population ranked lowest in the composite index,4 in relation to health, economic, and social indicators.

The study was done in Utraula and Gaindas Bujurg in Balrampur District, Uttar Pradesh, India, between October, 2002, and September, 2003. The study was based at Emmanuel Hospital Association-Prem Sewa Hospital in Utraula, a 30-bed mission hospital with only three full-time physicians. Because the hospital lacked the infrastructure for an institutional review board committee, the central office of the Emmanuel Hospital Association in New Delhi approved this study. The total population in Utraula and Gaindas Bujurg of 222 847 was distributed into 99 village clusters, from which 30 village clusters were selected (15 from each area), covering a population of 44 447. These clusters were selected by simple random sampling from two sample frames, consisting of lists of the village clusters in each area. As a preliminary step the population was counted and the cohort of all women who had delivered during the preceding year identified.

Four teams of female fieldworkers who were recruited from these villages were sent door-to-door to interview women in every household. They had a photo album consisting of seven pictures depicting occipital meningocele, open spina bifida/spinal meningo(myelo)cele, closed spina bifida/meningocele, spina bifida occulta (indicated by localised hypertrichosis over the lower spine), craniorachischisis, exencephaly, and anencephaly. Additional pictures were also used in case there was confusion in identification. Consent to participate in this study was obtained verbally because most women were illiterate. All mothers and a female relative were asked if any baby similar to those depicted in the pictures were born to them during the past year. Women’s statements that no child was born with NTD were validated through interviews with the neighbours in the community. Stillbirths were not included in the study because mothers were unable to provide descriptive information about physical characteristics of these babies.

There was a total of 1218 livebirths in the population during the study period. The estimated crude birth rate was 27·4 per 1000 population, which is similar to birth rates elsewhere in Uttar Pradesh. Ten babies were born with NTDs (table), of which all three with anencephaly died and the remaining seven were alive at the time of the survey. With one affected baby for every 121 livebirths, and a male to female ratio of 1 to 1·5, the incidence of NTD was 8·21 per 1000 livebirths (SD 0·09; 95% CI, 4·2–15·6). In two babies born with NTD, the precise date of birth was unknown. Although the birth was identified as being within the preceding 12 months, the child could have been a month older than the date of birth obtained. If these babies were removed from the calculation, the incidence would be 6·57 per 1000 livebirths (SD 0·08; CI 3·1–13·4).

Our population-based study was a work-intensive, door-to-door survey of mothers living in remote village clusters in the poorest region of India. This approach probably captured all the data for livebirths from the study population. The incidence of NTD of 6·57–8·21 per 1000 livebirths is higher (although not statistically different) than the 6 per 1000 births reported from the northern provinces of China which, until now, had had one of the highest incidences of NTD worldwide.5 The incidence of anencephaly is 35 times higher than in the USA,6 where such babies are often intentionally aborted after serum
There are specific limitations to our study that could serve as sources of error and underestimation of the incidence of NTDs. On the basis of the study design, the women were shown pictures of various NTDs; however, some of the defects are not externally visible (eg, forms of spina bifida occulta) and would thus be missed. Only female members of the family were interviewed about the birth of liveborn infants with NTD. We have no data for stillbirths, which, because the babies’ appearance might be upsetting, are often not shown to the mother (or close relatives). Of the ten cases of NTD recorded, there was an excess of spina bifida compared with anencephaly (most places have roughly equal numbers of these two NTDs), which might have arisen from not counting stillbirths that are more likely to be anencephalic. Thus, by contrast with most countries that count both live and stillbirths in reporting their rates of NTD, our data only relates to liveborn babies with NTDs and therefore are probably a substantial underestimation of the actual data.

Social taboos and mores about not revealing intimate confidences shared between mothers could have resulted in withholding such information from fieldworkers. For example, the absence of encephalocele could be attributable to the social taboo about the birth of such babies. The prevailing folk religious belief (noted after focus group discussions with village women) is that babies with encephalocele—who were referred to as Shaitan (an incarnation of the Devil)—were the curse that accompanied a punishment from God. So, if there were a reporting bias, it would probably stem from underreporting such births. However, an alternative explanation for an absence of encephaloceles—which are much less common than other NTDs—could be related to our small sample size which, by chance, might not have included any cases.

Several factors can render Indian babies especially vulnerable to NTD. Chief suspects are nutritional deficiency of vitamin B₁₂, vitamin B₅, and folate, (either singly or in combination) which results in hyperhomocysteinaemia that is linked to NTDs,¹ and has been documented in 75% of ambulatory Indians.² Vegetarianism and poverty can predispose to deficiency in these vitamins, which might have been a factor here.² Other factors, such as consanguinity,³ weather-related disaster, famine, or epidemic of dengue, did not seem to have a role.

Our study provides a snapshot of maternal and child health in the most poverty-stricken region of India; there are 168 other districts with similar low (health, social, and economic) composite index values in India.⁴ Moreover, the fact that our data correspond to the higher value of NTD incidence recorded in major cities in India⁵ somewhat validates the extrapolation of our data to a much wider area.

There are several policy implications of our findings. First, neither India’s Tenth Five Year Plan (2002–2007), nor any other public record addresses NTD prevention by periconceptional folate supplementation. Acknowledgment of this omission is a necessary first step.⁶ Second, the financial costs to ensure adequate periconceptional folates for Indian women probably pale in comparison with the economic burden of taking care of such children and the psychological toll on them and their parents.

Third, the bioavailability of folates in Indian cuisine needs to be investigated.⁷ Finally, the efficient delivery of periconceptional folates to women—by either dietary modification, folate supplements, or folate fortification of particular foods that are processed centrally and consumed by a majority of women in India—is urgently needed.

We therefore urge India’s Ministry of Health to develop a comprehensive strategy to reduce the incidence of NTD without delay.

Contributors
A Cherian, R K Bullock, and A C Antony conceived of the study and contributed to writing the manuscript. A Cherian also supervised the fieldworkers, data acquisition, and analysis. S Seena participated in supervision of the field-workers, data acquisition and analysis. As corresponding author, Professor Antony had full access to all the data in the study and takes final responsibility for the decision to submit for publication. The article was revised and approved by all contributors.

Conflict of interest statement
We declare that we have no conflict of interest.

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References