Micronutrient deficiency disorders among the rural children of West Bengal, India


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Background: Multiple micronutrient deficiencies continue to be a major nutritional problem of public health significance in India.
Aim: To assess the prevalence of micronutrient deficiencies among rural children of West Bengal, India.
Subjects and methods: A community-based cross-sectional study was carried out on 9228 and 437 pre-school children, respectively, for assessment of vitamin A deficiency (VAD) and anaemia. Iodine deficiency disorders (IDD) were assessed in 3490 children of 6–12 years.
Results: The prevalence of Bitot’s spots, an objective sign of clinical VAD, was 0.6% and was significantly (p < 0.01) higher among children of 3–5 years. Prevalence of blood vitamin A deficiency (<20 μg/dL) was 61% and ~ 81% of children were anaemic. About 25% children had both sub-clinical VAD and anaemia. The children of Scheduled Caste and Scheduled Tribe (OR = 2.3: 95% CI = 1.3–3.9) were at higher risk of anaemia, whereas children of Scheduled Tribe (OR = 4.5; 95% CI = 2.1–10.5) and 3–5 years (OR = 1.4; 95% CI = 1.0–2.0) were at risk for VAD. The prevalence of goitre was 9%.
Conclusions: Micronutrient deficiencies were found to be of public health significance among rural children of West Bengal. Therefore, there is a need to initiate sustainable long-term interventions for prevention and control of micronutrient deficiencies in children.

Keywords: Micronutrients, VAD, Bitot’s spots, anaemia, IDD

INTRODUCTION

Micronutrient deficiencies (MND) such as vitamin A deficiency (VAD), iron deficiency anaemia (IDA) and iodine deficiency disorders (IDD) have been major nutritional problems in developing countries, adversely affecting people’s health, performance and income and thereby becoming major impediments to economic development (Bowley 2008). The World Bank (1994) estimated the combined economic cost of IDA, VAD and IDD could be as much as 5% of gross domestic product (GDP). Murray and Lopez (1996) calculated the global burden of disease, in which IDA, VAD and IDD accounted for 2.4% of the overall disease burden of developing countries. These micronutrient deficiencies continue to be of public health significance in India (Vijayaraghavan 2002) and nearly half of the world’s micronutrient-deficient population is found in India (USAID 2005). Stein and Qaim (2007) reported that the estimated economic cost of micronutrient malnutrition is 0.8–2.4% of India’s GDP.

Vitamin A has a vital role in maintaining eye health and vision, growth, immune function and survival (Sommer and West 1996). Vitamin A deficiency is the most important cause of preventable blindness in young children (Vijayaraghavan 2006). Incidence of morbidities, especially episodes of respiratory infection, diarrhoea, measles and childhood mortality are closely associated with VAD (Sommer et al. 1984; Grotto et al. 2003; Gupta and Indrayan 2003; Thurnham et al. 2003; Villamor and Fawzi 2005).

Iron deficiency anaemia is the most widely prevalent nutritional problem across the world (Carlos Alberto et al. 2005) affecting almost all age/sex/physiological groups; pre-school children, pregnant women and lactating mothers being the most vulnerable (Agarwal 2001). About 60–70% of all children below 6 years of age suffer from various degrees of anaemia (Kapur et al. 2002), significantly contributing to childhood morbidity and mortality (Stoltzfus 2001).

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malformation, cretinism, mental retardation and hypothyroidism.

Data on the prevalence of IDA, VAD and IDD among the children at the State level are not readily available for many States in India, including West Bengal. These data are needed by State Governments for planning and development of health and nutrition policies and intervention programmes to combat micronutrient deficiencies among the at risk population, especially children. Keeping in view the magnitude of micronutrient malnutrition among children, the National Nutrition Monitoring Bureau (NNMB) carried out the present survey in 2003 in the State of West Bengal, India. The objective of the survey was to assess the prevalence of VAD, IDA and IDD among the rural children in the State of West Bengal.

Profile of West Bengal State
The State of West Bengal is located in the eastern part of India, stretching from the Himalayas in the north to the Bay of Bengal in the south. The State shares an international border with Bangladesh, Bhutan and Nepal. The State has 18 districts with a total population of 80.2 million (Rural: 57.7 million; Urban: 22.5 million) with a population density of 904 per square kilometre (Rural: 676/Km²; Urban: 6798/Km²).

METHODS
Sampling design
A population-based cross-sectional study adopting the multi-stage stratified random sampling procedure was carried out in rural areas of West Bengal. The villages covered by the National Sample Survey Organization (NSSO 1998) for its 54th round of consumer expenditure survey were taken as the sampling frame. The NSSO adopted a two-stage random sampling method. The villages formed the first stage-sampling units (FSUs), while the households formed the second stage-sampling units (SSUs). The State was divided into different strata based on agro-climatic variables and one district or part of a district with a population of 1.8 million was considered as one stratum. For the purpose of the present survey, a total of 16 strata were selected randomly from the State and a sub-sample of 80 villages (five villages per stratum) was selected randomly from 16 strata.

Sample size computations
The sample size to be covered for the estimation of haemoglobin levels among pre-school children was calculated by considering the prevalence of anaemia as 70% (Kapur et al. 2002). Thus, assuming the prevalence of anaemia as 70% and considering the 95% confidence interval (CI), 80% power and relative precision of 10%, a sample size of 336 pre-school children was arrived at.

Assuming prevalence of Bitot’s spots as 1% (NNMB 1999), considering the confidence interval (CI) of 95% and relative precision of 20%, a sample size of 9508 children (1–5 years old) was arrived at at the State level to cover for clinical VAD. Similarly, by assuming the prevalence of sub-clinical VAD, i.e. blood vitamin A levels of < 20 μg dL⁻¹, among pre-school children to be 50% (Gorstein et al. 2003a), the confidence interval (CI) of 95% and relative precision of 10%, a sample size of 400 pre-school children was arrived at.

In the case of IDD, the sample size of 3457 children of the 6–12 year age group for the State was arrived at by assuming the prevalence of total goitre in this age group as 10%, with a confidence interval (CI) of 95% and relative precision of 10%.

Selection of subjects
For the purpose of study, each selected village was divided into five geographical areas based on natural groups of houses or streets. Households (HHs) belonging to the Scheduled Caste/ Scheduled Tribe (SC/ST) community, who generally live as a group, constituted one of the five areas. All HHs, pre-school children and children of 6–12 years of age in each geographical area were enumerated. The children in the age group of 6–12 years of both genders were selected, because of their high vulnerability to goitre in the community (WHO/UNICEF/ICCIDD 1994).

The number of children required to be included for each investigation in a particular geographical area was determined based on (probability to proportion size) total number of samples to be covered from the village and the total number of children in a given area. The first HH with a target child in a given geographical area was selected randomly and the HHs were surveyed contiguously until the required number of children were covered for each investigation.

Ethical clearance and consent
The Scientific Advisory Committee of the Indian Council of Medical Research (ICMR) approved the study and ethical clearance was obtained from the Ethical Review Board of the National Institute of Nutrition. Written informed consent was obtained from the parents of all subjects.

Data collection
Information on household socio-demographic particulars were collected in all the selected HHs. Clinical examination was carried out on a total of 9228 pre-school children for the presence of signs and symptoms of vitamin A deficiency and a sub-sample of 590 children were covered for the estimation of blood vitamin A. Haemoglobin levels were estimated in ~ 437 pre-school children to assess anaemia. Similarly, 3490 children of 6–12 years were covered for IDD. Information was collected from 251 mothers of pre-school children on knowledge and practices regarding VAD, anaemia and IDD.
Collection of blood sample and estimation of blood vitamin A
Blood vitamin A levels were estimated by the dried blood spot (DBS) method (Craft et al. 2000a). A free falling drop of blood from a finger-prick was collected on pre-coded special chromatography filter paper (Whatman, Maidstone, Kent, England) and dried in a shade. Every third day, the filter papers (wrapped in thick black paper) were sent to the National Institute of Nutrition (NIN) by courier. The samples were protected from light and preserved in a deep freezer at −20°C at a DBS facility and retinol levels estimated from DBS by high-pressure liquid chromatography (Craft et al. 2000b).

Collection of blood sample and estimation of haemoglobin
A finger prick blood sample of 20 μL was collected using a fixed volume Finn pipette and transferred into a test tube containing 5 ml of Drabkin’s solution. The haemoglobin concentration of the blood sample was estimated by the cyanmethmoglobin method using a colourimeter (INACCG, Washington, DC, USA). The prevalence of anaemia was determined using the WHO (2001) cut-off level to diagnose prevalence of anaemia among pre-school children. (The cut-off value of <11 g dL⁻¹ of haemoglobin was considered as anaemia in children of 1–5 years).

Diagnosis of goitre
The children of the 6–12 year age group were clinically examined for enlargement of the thyroid (goitre) by a trained medical officer using the palpation method as recommended (Dunn and Van der Haar 1990). Grading of goitre was done as per the criteria recommended by WHO/UNICEF/ICCIDD (1994) (Grade 0: no goitre; Grade 1: thyroid palpable but not visible with neck in normal position; Grade 2: thyroid visible with neck in normal position).

Estimation of iodine content in cooking salt
The iodine content in cooking salt was estimated by spot testing kits (Pandav et al. 2000) in a sub-sample of 10 HHs per village.

Training and standardization
The investigators, comprising a medical officer, nutritionist and social worker, were trained and standardized for 3 weeks at the National Institute of Nutrition (NIN). They were trained in pipetting the 20 μL finger prick blood sample with a Finn pipette and estimation of haemoglobin by the cyanmethmoglobin method using a colourimeter. The investigators were also trained in identification of signs and symptoms of VAD and transferring the free falling drop of blood from a finger-prick onto a pre-coded special chromatography filter paper (Whatman). They were also given training in identification and grading of goitre and estimation of the iodine content in cooking salt by spot testing kits. After achieving maximum intra- and inter-individual agreement in all the investigations during the training, a mock survey was carried out in the community before initiation and/or execution of the actual survey in the State of West Bengal. In addition, to ensure the quality of the data, scientific and technical staff from NNMB Central Reference Laboratory, NIN, made periodical supervisory visits to the field and re-examined the data already collected by the investigators on a sub-sample basis.

Statistical analysis
The data was analysed using Statistical Package for Social Sciences (SPSS); version 15.0 for Windows (SPSS 2005). The percentage prevalence of micronutrient deficiencies was analysed as per age group and gender. Bivariate analysis was performed by the chi-square ($\chi^2$) test to study the association between the prevalence of micronutrient deficiency disorders and different socio-demographic variables. Multivariate analysis of step-wise logistic regression was performed to identify the best set of socio-demographic variables associated with the prevalence of anaemia and VAD. Independent variables such as community (Other community), occupation of the head of the household (Business/service), adult female literacy (literate), age group (1–3 for VAD and 4+ for anaemia), gender (Boys) and the sanitary latrine (present) at household level were included. The variables given in parentheses are the reference category.

Step-wise logistic regression analysis was also performed to assess the risk of micronutrient deficiencies with respect to different socio-demographic variables.

The variable ‘community’ mentioned in the text is defined as: Community (Caste): the Indian community is categorized into different castes that evolved historically based on their occupations. These were mainly divided into socially and economically under-developed poorer sections of the society like Scheduled Caste (SC) and Scheduled Tribes (ST), who are provided with certain social guarantees by the government of India. Other communities are socially developed and economically well off.

Nutritional programmes for control of micronutrient deficiencies in India
National nutritional anaemia prophylaxis programme (NNAP). The Ministry of Health and Family Welfare, Government of India initiated this programme in India in the year 1970, with the objective of prevention of nutritional anaemia in pregnant women, lactating mothers and pre-school children. Based on ICMR evaluation of the programme, the Government of India refined the programme and renamed it as National Nutritional Anaemia Control Programme (NNACP) in 1990 (Kapur et al. 2002). Under this programme iron and folic acid tablets are being supplemented to the beneficiaries. The children are supplemented with 20 mg of iron and 100 μg of folic acid, while adult beneficiaries get 100 mg of iron and 500 μg of folic acid daily for a period 100 days.
National programme for prophylaxis against blindness in children due to vitamin A deficiency. The Ministry of Health and Family Welfare, Government of India, initiated a vitamin A prophylaxis programme in 1970. Under this programme, children are supplemented with nine doses of vitamin A solution (Retinol Palmitate). The first dose of 100 000 IU is given at 9 months of age, followed by 200 000 IU biannually up to 5 years of age.

National iodine deficiency disorders control programme (NIDDCP). Government of India launched the National Goitre Control Programme (NGCP) in 1962. This NGCP was renamed as the National Iodine Deficiency Disorders Control Programme in 1992. The objectives are (i) To carry out surveys to assess the magnitude of IDD; (ii) Supply of iodized salt; (iii) Nationwide monitoring of IDD every 5 years; (iv) Laboratory monitoring of iodized salt and urinary iodine excretion; and (v) Health education and publicity.

RESULTS

Prevalence of VAD among pre-school children by age group and gender is presented in Table I. The results show that the overall prevalence of Bitot’s spots, an objective sign of VAD in pre-school children, was 0.6% (CI = 0.44–0.76) which is more than the WHO (1996) cut-off level (0.5%) of public health significance. Prevalence of other VAD manifestations such as night blindness and conjunctival xerosis was 0.2% and 3.7%, respectively. The proportion of children who exhibited one or more of these three VAD manifestations was 3.8%. The median blood vitamin A was 16.6 μg/dL⁻¹. The prevalence of sub-clinical vitamin A deficiency (< 20 μg/dL⁻¹) was ~61% (Table II). Clinical VAD was significantly (p < 0.01) higher among the 3–5 year age group and boys, while sub-clinical VAD was similar across age and gender groups.

The mean ± SD and 95% CI of haemoglobin values among pre-school children by gender and age are presented in Table III. The mean haemoglobin values among pre-school children was 10.1 ± 1.0 g/dL⁻¹ (CI = 10.0–10.2). The values were significantly (p < 0.01) lower (9.8 ± 0.9 g/dL⁻¹) in the 1–3 year age group compared to the 3–5 year age group (10.3 ± 1.0 g/dL⁻¹) and ranged from a low 9.8 ± 0.8 g/dL⁻¹ in 1+ year children to a high 10.4 ± 1.0 g/dL⁻¹ in 4+ year children.

The overall prevalence of anaemia was 81.2% (CI = 77.3–84.7), with a significantly (p < 0.01) higher (91.0%) proportion of 1–3 year children being anaemic as against 74.6% in 3–5 year age group. The prevalence of anaemia tended to decrease with increased age and ranged from a high (94.8%) in 1+ year to a low (71.9%) in 4+ year children. However, no gender differentials were reported in the prevalence of anaemia in 1–5 year old children (p > 0.05) (Table IV). The proportion of children with both blood vitamin A deficiency (<20 μg/dL⁻¹) and anaemia was 25%.

The overall prevalence of goitre in 6–12 year old children was 9%. The prevalence of deaf-mutism was 0.1%, while mental retardation was nil (Table V). Although a majority (85%) of the HHs were consuming iodized cooking salt, the salt was adequately iodized (≥15 ppm) in only ~55% of HHs.

Association between MNDs and different socio-demographic variables

The association between the prevalence of MNDs and different socio-demographic variables is presented in Table VI. In general, the prevalence of anaemia and VAD was significantly (p < 0.01) higher among the children of Scheduled Tribe and Scheduled Caste as compared to the children of other communities. Similarly, a higher proportion of children were anaemic in HHs where a sanitary latrine facility was absent (p < 0.05).

Step-wise logistic regression analysis revealed that age group and community were associated with prevalence of anaemia. Pre-school children belonging to the...
1 + (OR = 7.7; 95% CI = 2.6–22.4) and 2+ year age groups (OR = 3.0; 95% CI = 1.5–6.0) and Scheduled Caste and Scheduled Tribe communities (OR = 2.3; 95% CI = 1.3–3.9) were at higher risk of anaemia. In the case of VAD, pre-school children belonging to Scheduled Tribe (OR = 4.5; 95% CI = 2.1–10.5) and 3–5 year old children (OR = 1.4; 95% CI = 1.0–2.0) were at risk as compared to their counterparts.

Table III. Mean ± SD and 95% CI values of haemoglobin by age group and gender.

<table>
<thead>
<tr>
<th>Years</th>
<th>n</th>
<th>Mean ± SD</th>
<th>95% CI</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–3</td>
<td>177</td>
<td>9.8 ± 0.9</td>
<td>9.7–10.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3–5</td>
<td>260</td>
<td>10.3 ± 1.0</td>
<td>10.2–10.4</td>
<td></td>
</tr>
<tr>
<td>Pooled</td>
<td>437</td>
<td>10.1 ± 1.0</td>
<td>10.0–10.2</td>
<td></td>
</tr>
</tbody>
</table>

Gender

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean ± SD</th>
<th>95% CI</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>218</td>
<td>10.1 ± 1.0</td>
<td>10.0–10.2</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Girls</td>
<td>219</td>
<td>10.1 ± 1.0</td>
<td>10.0–10.2</td>
<td></td>
</tr>
</tbody>
</table>

*p < 0.05 indicates statistical significance.
SD: Standard Deviation; CI: Confidence Interval.

Table IV. Distribution (%) of anaemia among pre-school children by age group and gender.

<table>
<thead>
<tr>
<th>Years</th>
<th>n</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Total anaemia</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2</td>
<td>77</td>
<td>5.2</td>
<td>35.1</td>
<td>59.7</td>
<td>94.8</td>
<td>88.7–99.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2–3</td>
<td>100</td>
<td>12.0</td>
<td>31.0</td>
<td>57.0</td>
<td>88.0</td>
<td>81.6–94.4</td>
<td></td>
</tr>
<tr>
<td>3–4</td>
<td>100</td>
<td>21.0</td>
<td>34.0</td>
<td>45.0</td>
<td>79.0</td>
<td>71.0–87.0</td>
<td></td>
</tr>
<tr>
<td>4–5</td>
<td>160</td>
<td>28.1</td>
<td>35.6</td>
<td>36.3</td>
<td>71.9</td>
<td>65.0–79.0</td>
<td></td>
</tr>
<tr>
<td>Pooled</td>
<td>437</td>
<td>25.4</td>
<td>35.0</td>
<td>39.6</td>
<td>74.6</td>
<td>69.7–80.3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Gender

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Total anaemia</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>218</td>
<td>20.2</td>
<td>33.0</td>
<td>46.8</td>
<td>79.8</td>
<td>74.7–85.3</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Girls</td>
<td>219</td>
<td>17.4</td>
<td>35.2</td>
<td>47.5</td>
<td>82.6</td>
<td>78.0–88.0</td>
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</tr>
</tbody>
</table>

CI: Confidence Interval.

Grades of anaemia: Normal: ≥ 11 g dL⁻¹; Mild: 9–11 g dL⁻¹; Moderate: 7–9 g dL⁻¹.

Table V. Prevalence of IDD and consumption of iodized salt.

<table>
<thead>
<tr>
<th>IDD (n = 3490)</th>
<th>Iodine content</th>
<th>Goitre</th>
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</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>7.4</td>
<td>0 ppm</td>
</tr>
<tr>
<td>Grade II</td>
<td>1.6</td>
<td>&lt;15 ppm</td>
</tr>
<tr>
<td>Total goitre</td>
<td>9.0</td>
<td>≥15 ppm</td>
</tr>
<tr>
<td>Deaf-mutism</td>
<td>0.1</td>
<td></td>
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<tr>
<td>Mental retardation</td>
<td>0.0</td>
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</table>

Table VI. Association* between anaemia, blood vitamin A (< 20 μg/dL⁻¹) and different socio-economic variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Anaemia (%)</th>
<th>p-value*</th>
<th>n</th>
<th>&lt; 20 μg/dL⁻¹ (%)</th>
<th>p-value</th>
<th>n</th>
<th>Goitre</th>
<th>p-value</th>
</tr>
</thead>
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<td>Community</td>
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<td></td>
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<tr>
<td>ST</td>
<td>49</td>
<td>100.0</td>
<td>&lt;0.001e</td>
<td>54</td>
<td>87.0</td>
<td>&lt;0.01</td>
<td>407</td>
<td>10.8</td>
<td>&gt;0.05</td>
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<td>SC</td>
<td>134</td>
<td>82.8</td>
<td></td>
<td>123</td>
<td>56.9</td>
<td></td>
<td>1004</td>
<td>8.3</td>
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<tr>
<td>Others⁵</td>
<td>254</td>
<td>76.8</td>
<td></td>
<td>413</td>
<td>59.1</td>
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<td>2079</td>
<td>9.0</td>
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<td>Occupation</td>
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<tr>
<td>Labourers</td>
<td>265</td>
<td>81.9</td>
<td>&gt;0.05</td>
<td>323</td>
<td>56.7</td>
<td>&gt;0.05</td>
<td>1879</td>
<td>8.0</td>
<td>&lt;0.05</td>
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<td>Agriculture</td>
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<tr>
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<tr>
<td>&lt; 4</td>
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<td>&gt;0.05</td>
<td>1661</td>
<td>9.2</td>
<td>&gt;0.05</td>
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<td>5–7</td>
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<td>1667</td>
<td>9.2</td>
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<td>≥ 8</td>
<td>6</td>
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<td>61.5</td>
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<td>162</td>
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<td>Female literacy</td>
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<tr>
<td>Illiterate</td>
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<td>82.2</td>
<td>&gt;0.05</td>
<td>279</td>
<td>58.4</td>
<td>&gt;0.05</td>
<td>2017</td>
<td>8.5</td>
<td>&gt;0.05</td>
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<td>Literate</td>
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<td>80.1</td>
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<td>1473</td>
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<td>Sanitary latrine</td>
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</tr>
<tr>
<td>Absent</td>
<td>355</td>
<td>82.3</td>
<td>&lt;0.05</td>
<td>461</td>
<td>61.8</td>
<td>&gt;0.05</td>
<td>2757</td>
<td>9.0</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Present</td>
<td>82</td>
<td>76.8</td>
<td></td>
<td>129</td>
<td>58.9</td>
<td></td>
<td>733</td>
<td>9.0</td>
<td></td>
</tr>
</tbody>
</table>

*Chi-square; *p < 0.05 is statistically significant; *Significance levels are two-tailed; ⁵Other Backward Caste; ⁶Others = Forward caste; ⁷Blood vitamin A.

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Knowledge and practice (K&P) of mothers

About 52% of pre-school children had received one or two massive doses of vitamin A (200 000 IU of Retinol Palmitate) during the preceding 1 year, while only 4% received the stipulated two doses. The proportion of pre-school children receiving IFA tablets was nil. About 24% and 26% of mother’s of pre-school children, respectively, were aware of night blindness and anaemia, while only 2–3% of them were aware of the causes for the same. Only 1% of the mothers reportedly received health and nutrition education on VAD, anaemia and IDD.

DISCUSSION

Despite the fact that several national nutrition programmes are in operation, especially for the benefit of children, the prevalence of micronutrient deficiencies, particularly among rural children, continues to be of public health concern. This study has provided for the first time State representative data concurrently on the micronutrient status of rural children of West Bengal and has revealed that prevalence of multiple micronutrient malnutrition was higher than public health significance levels.

Prevalence of Bitot’s spots, the objective sign of clinical VAD, was higher than the WHO cut-off point of 0.5 (WHO 1996), indicating it to be a public health problem. However, the prevalence was lower compared to the figures reported for pre-school children of rural India (0.8%) by NNMB (2003), Maharashtra (1.3%) by Arlappa et al. (2008) and Ethiopia (2.2%) by Asrat et al. (2002). Blood vitamin A deficiency was very high (61%) compared to the prevalence of 8.2% in Sri Lanka (Mahawithanage et al. 2007), 30.8% in Bangladesh (West 2002), 32.3% in Nepal (Garstein et al. 2003b), 55% in the state of Maharashtra, India (Arlappa et al. 2008) and the global prevalence of 33.3% (WHO 2009).

In the case of anaemia, prevalence (81%) was more than double the cut-off level of ≥ 40% (WHO 2001), indicating the magnitude of the problem to be of ‘severe public health significance’. The prevalence was significantly (p < 0.01) higher when compared to 67% reported for children of rural India (NNMB 2003) and the figures reported by McLean et al. (2009) for pre-school children of Africa (64.6%), Asia (47.7%) and the world (47%). The prevalence was higher among the 1–3 years age group when compared to the figures reported by NFHS-2 (1998–1999), and NFHS-3 (2005–2006) for rural India, as well as the figures reported by the Indian Council of Medical Research (ICMR 1977) multicentric study. This study revealed a prevalence of both blood vitamin A deficiency and anaemia in 25% of pre-school children, indicating the association between VAD and iron deficiency. A similar observation was reported by Villalpando et al. (2007). The prevalence of total goitre (9%) in 6–12 year old children was more than the cut-off level of ≥ 5%, indicating the public health problem of IDD (WHO/UNICEF/ICCIDD 2001).

The major contributing factors for high prevalence of MNDs are low intake of micronutrient dense foods, poor purchasing power resulting from ever increasing food prices and ignorance of nutritional problems. As reported by NNMB (2002), rural pre-school children of West Bengal were subsisting on inadequate diets deficient in multiple micronutrients nutrients, where the median intakes of iron, vitamin A, riboflavin, free folic acid, vitamin C, thiamin and niacin were below recommended dietary allowances (RDA). Similarly, the median intakes of iron and vitamin A were grossly deficient, with 68–81% of pre-school children not consuming even 50% of their RDA (NNMB 2002; 2006). Due to cultural reasons and poverty, the majority of people in developing countries have a low dietary intake of animal products, which are rich in micronutrients such as Vitamin A, iron, etc. (Allen et al. 2006; Edem 2009), leading to high prevalence of anaemia in India and sub-Saharan Africa. De Pee et al. (1998) made a similar observation that vitamin A deficiency was mainly due to dietary intakes deficient in animal products.

Therefore, where deficiencies of multiple micronutrients are common, a more appropriate formulation of multiple micronutrients may be considered for supplementation (Yip 2000), as a short-term measure. However, as a long-term measure, consumption of all food groups in the right proportions is desirable to meet the nutritional needs of the community (Keding and Krawinkel 2008). An increasing reliance on basic staples also aggravates the risk of micronutrient deficiencies (Bowley 2008).

The coverage of pre-school children for iron and folic acid supplementation was nil, while that of massive dose vitamin A supplementation was also very poor, with coverage of biannual supplementation being only 4% as against corresponding figures of 85–90% in Nepal and Bangladesh (Richard and Martin 2008). Household consumption of adequately iodized salt (≥ 15 ppm of iodine) was 55% as against the WHO/UNICEF/ICCIDD (2001) recommendation of 90%. The corresponding figure for rural India was 41% (NFHS-3). Similarly, the knowledge and practices of mothers’ of pre-school children about MND was very poor.

As 81% children practice open defecation they are at risk of hookworm infestation, the most common cause of iron deficiency anaemia (Budhathoki et al. 2008). It is essential to subject them to periodic deworming, which improves the absorption of micronutrients and lowers the risk of micronutrient malnutrition (Allen 2008).

There is a need for the sensitization of health functionaries and the community through Health and Nutrition Education (HNE) and appropriate Behavioural Change Communication (BCC) activities. These interventions should be aimed at addressing the adverse effects of micro-nutrient malnutrition and ensuring better coverage of national nutritional programmes as well as increasing compliance of the community for the success and sustainability of the programmes. There is also a need to encourage the community to consume a variety of micronutrient rich foods through dietary diversification and horticulture intervention to ensure nutrition security. It should also be stressed that staple foods fortified with
multiple micronutrients must be made available to the
target population at an affordable price to improve their
micronutrient status, as well as to control and prevent the
adverse effects of micronutrient malnutrition. The Copen-
hagen Consensus 2008 has also given high priority to
supplementation and fortification of staples with micro-
nutrients as cost-effective interventions and the best
investments to create a positive impact on the health of
individuals and the economy of communities as well as of
countries.

The current scenario of vitamin A deficiency and the
relevance of vitamin A supplementation programme
in India
The current level of prevalence of clinical vitamin A
deficiency in terms of Bitot’s spots (the tip of the iceberg
of vitamin A deficiency) has declined considerably, as
compared to previous years. However, this decline was
not uniform throughout India. The prevalence of clinical
VAD, in terms of Bitot’s spots, an objective sign of VAD
among rural pre-school children, ranged from nil in Kerala
to 1.4% in the state of Madhya Pradesh. The national level
prevalence among rural pre-school children, ranged from nil in Kerala
to 1.4% in the state of Madhya Pradesh. The national level
prevalence (0.8%) was still higher than the figures
reported by the WHO (≥0.5%), indicating the public
health significance in rural pre-school children of India.
This prevalence would have been higher if data of the
ICMR multi-centre study from the states of Uttar Pradesh,
Bihar and Rajasthan were included (Toteja et al. 2002).
In the case of blood vitamin A deficiency (<20 µg dl⁻¹),
the prevalence (61%) was a public health problem
(prevalence of ≥20%; WHO 1996) in all NNMB states
of India, ranging from 52% in Maharashtra to 88% in
Madhya Pradesh.

The consumption of foods rich in vitamin A was very
poor among rural pre-school children in India. The mean
intake of leafy vegetables, a rich source of vitamin A, was
deficient by 80–85% as against the RDA. Intakes of fruits
and flesh foods were still worse among rural children
(NNMB 2006). Similarly, the diets of rural pre-school
children were grossly deficient in terms of vitamin A,
where the median intakes were deficient by 66–81% as
against the RDA of 400 µg (NNMB 2006). The median
vitamin A intake of 84% of pre-school children was not
even 50% of their RDA. The bi-annual massive dose
vitamin A supplementation coverage was also very poor,
with only 23% of rural pre-school children having received
the stipulated two massive doses of vitamin A during the
preceding year (NNMB 2003). Knowledge about VAD was
also very poor among mothers of rural pre-school
children, with only 12% of them being aware that VAD
is the cause of night blindness and only 4% reporting
Bitot’s spots as the sign of VAD. However, there was also a
paucity of the above information in urban and slum areas
of India.

Therefore, it’s very important to sensitize the
community towards VAD and its adverse effects on health and
to encourage them to consume vitamin A rich foods through
health and nutrition education (HNE) and behavioural
change communication (BCC). It is also essential to
undertake comprehensive and well-designed national
representative studies in rural, urban and slum settings
of India, to estimate both clinical and bio-chemical
vitamin A status as well as diet surveys to assess the
dietary pattern of vitamin A. In his article ‘The great
vitamin A fiasco’, Latham (2010) was not in favour of
continuing the vitamin A supplementation programme,
which was intended for short-term intervention, but he
strongly recommended sustainable food-based approaches,
particularly plant-based food systems and pertinent public
health measures for prevention and control of VAD. These
long-term measures have been known for decades;
however, not much progress has been achieved in this
regard. Therefore, until dietary intakes are satisfactory,
that blood vitamin A levels increased to optimal levels and
public health measures improved, supplementation of
vitamin A to pre-school children should be continued, as
the evidence shows that the prevalence of sub-clinical VAD
is much higher than the public health significance
accorded to it in India.

ACKNOWLEDGEMENTS
We would like to thank Dr Bandopadhyay, Medical Officer,
and Ms Sudeshna Maitra, Nutritionist, National Nutrition
Monitoring Bureau, West Bengal State Unit. We also thank
Dr Madhavan Nair, Scientist E, Dr P. Raghuv, Scientist B, and
Mr V. Vikas Rao, Technobical Officer, Micronutrient Research
and all staff members of the Division of Community Studies
who rendered their technical help and Miss Sarala,
Mr G. Hanumantha Rao and Mrs G. Prashanthi for
secretarial support.

Declaration of interest: The authors report no conflicts of
interest. The authors alone are responsible for the content
and writing of the paper.

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