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Social Correlates of Malnutrition in a Silicosis Prone District

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Abstract

Mohammed Bazar is one of the community development block in the district of Birbhum. The Government of West Bengal has notfied it as a silicosis-affected block. It is one of the affected area with fluorides in drinking water A cross sectional sstudy shows evidence of malnutrition among children who are attending anganwadi centere.

Logistic regression shows that higher meal frequency and fruit/vegetable intake significantly reduce junk food consumption (OR 0.60, p = 0.02). Older children (8–10 years) consume more meals and healthier foods, while younger groups are more vulnerable to junk food. Qualitative interviews highlight parental indifference, poor nutrition education, and limited supervision of hygiene practices. Parents often dismiss dietary diversification due to poverty, cultural inertia, and limited agricultural variety, despite local availability of nutrient-rich crops like drumsticks, papaya, and guava.

Thematic analysis underscores a cycle of vulnerability: poverty and poor parental involvement limit dietary diversity; fluoride and silica exposures worsen health outcomes; malnutrition amplifies susceptibility to both. Addressing nutrition alone is insufficient—interventions must integrate water safety, dust control, parental education, and agricultural diversification to break this cycle.

Conclusion: There is a link between malnutrition. Envoirment pollution due to the presence of respirable crystalline fragments in air and fluorides in drinking water. It is different from direct acylic graph. determinants, requiring holistic, multi-sectoral public health strategies

Keywords: Malnutrition, fluorosis, parental lack of interest, respiratory crystalline fragment in air

Introdcution

In the Mohammed Bazar block of Birbhum district, West Bengal, malnutrition, fluorosis, and silicosis all work together in a complicated way. The geology of the area is mostly semi-arid, with rocks rich in fluoride and rivers that only flow for a short time. This makes the groundwater dirty. Stone mining also releases respirable crystalline silica into the air. These environmental dangers make it even harder for children to get the nutrients they need[1],[2]

Results

Quantitative data show that a lot of children are undernourished: 28% are underweight, 35% are stunted, and 18% are wasted. Logistic regression indicates that increased meal frequency and fruit/vegetable consumption significantly diminish junk food intake (OR 0.60, $p = 0.02$). Kids aged 8 to 10 eat more meals and healthier foods, while younger kids are more likely to eat junk food. Qualitative interviews show that parents don't care, that nutrition education is bad, and that hygiene practices aren't closely monitored. Parents frequently disregard dietary diversification owing to poverty, cultural inertia, and restricted agricultural diversity, despite the local availability of nutrient-dense crops such as drumsticks, papaya, and guava.

Environmental factors make malnutrition worse. Fluoride in drinking water diminishes appetite and hinders nutrient absorption, whereas silicosis resulting from mining dust compromises respiratory health. Children who are malnourished, have a low BMI, and are anemic are more likely to get fluorosis (OR 2.11, $p < 0.001$) and have respiratory problems. Seasonal hunger during lean months exacerbates food insecurity, especially in tribal households dependent on monocropping.

Thematic analysis highlights a cycle of vulnerability: poverty and inadequate parental engagement restrict dietary diversity; fluoride and silica exposure deteriorate health outcomes; malnutrition increases susceptibility to both. Focusing on nutrition alone won't work; to break this cycle, interventions need to include water safety, dust control, parental education, and agricultural diversification.

Conclusion

Malnutrition in Birbhum is inextricably linked to environmental and socioeconomic factors, necessitating comprehensive, multi-sectoral public health approaches.

Introduction:

Birbhum lies between 23° 32′ 30″ and 24° 35′ 0″ north latitude and 88° 1′ 40″ and 87° 5′ 25″ east longitude. Draining Birbhum are rivers like Ajai, Mayurakshi, Mor which are best described as sand dominated alluvial aquifer of large ephemeral rivers for drinking water supply in semi-arid fluoride affected areas. In shape it looks like an isosceles triangle. The apex is situated at the northern extremity not far south of point where the Ganges and the hills of the Santhal Paraganas begin to diverge while the river Ajay forms the base of this triangle. Birbhum is bounded on the north and west by Santhal Paraganas, on the east by the districts of Murshidabad and Burdwan and on the south by Burdwan, from which it is separated by the Ajay river. The district extends over an area of 4545 Sq. Kms. [(1), (2)]

Vegetables and fruits grown in Birbhum

In addition to rice vegetable grown in Birbhum are drumsticks (Moringa oleifera)

Papaya Carica papaya) is grown across West Bengal including Birbhum has good nutrient content Guava is a high-nutrition-content food grown across West Bengal. [3], [4}

Dental fluorosis in semi-arid regions like Birbhum arises mainly from excessive fluoride in groundwater, which communities rely on due to scarce surface water. The Ephemeralnutritious (likely "ephemeral") river's low and seasonal flow exacerbates this by limiting dilution, concentrating fluoride from geogenic sources in the underlying aquifer.

Fluoride leaches from fluoride-rich rocks like granite, gneiss, fluorite, biotite, and apatite prevalent in Birbhum's geology (part of the Singhbhum-Manbhum Plateau). In semi-arid plateaus, rock-water

interaction intensifies during dry periods, raising groundwater fluoride levels above 1.5 ppm—the threshold for fluorosis.

Role of Ephemeral Rivers in causing fluorosis

These rivers flow briefly during monsoons, leaving communities dependent on tube wells and hand pumps tapping fluoride-contaminated aquifers year-round. Low river recharge fails to flush fluoride, while over-pumping for irrigation depletes groundwater, concentrating contaminants further amid climate-driven aridity.[5},{6].(7)'{8}

Recent data from a 2024 cross-sectional study among adolescents (10–19 years) in rural Birbhum revealed higher levels of malnutrition. :

- About 70.8% of adolescents are undernourished (BMI < 18.5 kg/m²).
- Only 25.5% had normal nutritional status, and a mere 3.7% were overweight or obese.
- Undernutrition was even higher among boys than girls.[1][9]
- Malnutrition is also common among children under five and is especially severe among tribal populations.[2]
- Respiratory morbidity in Birbhum encompasses both occupational and general population burdens
- A population-based study found the prevalence of COPD among rural adults above 40 years was about 8.4%, much higher than the national rural average.
- COPD sufferers in Birbhum were predominantly male, mostly undernourished (average BMI ~17.1), and demonstrated poor overall health [10]
- Non-communicable diseases (NCDs)—including chronic respiratory conditions—account for over 50% of all deaths based on local population surveillance, with respiratory disease being a major contributor.[9][10]

The high burden of malnutrition amplifies vulnerability to respiratory diseases, as under nutrition is linked to poorer lung function and greater susceptibility to infections. Occupational exposures (stone mining, silica dust) exacerbate the risk, creating a cycle of poor respiratory health, reduced workforce productivity, and further socioeconomic disadvantage. Rural poverty, inadequate nutrition education, limited access to healthcare, and lifestyle factors (such as tobacco use) remain persistent challenges.[9][1]

Objectives of the study

1. Determine the food intake pattern in the last 24 hours by memory recall
2. To determine the time spent by parents who spend time with their children on guiding them on food intake and personal hygiene, which includes hand-washing and personal hygiene
3. To explore the role of family, cultural practices, and socioeconomic status in shaping the food intake habits of children
4. Role of ICDS in providing supplementary nutrition and its impact (Height weight monitoring as Recorded in MCP card (weighing efficiency)
5. Develop a thematic linkage linking less than adequate food intake, respiratory crystalline fragment in air and fluorosis in drinking water.

Materials and Methods

Mixed methods have been used.

Sample size estimation

Cochran's formula) has been used, the required sample size was estimated to be approximately 350–385 children. However, due to paucity of time, logistical constraints, and field realities, data could be collected from 326 children. To supplement the quantitative findings and enrich the analysis mixed. A cross-sectional study has been carried out among children studying in anganwadi schools and primary schools

Inclusion Criterion

Children aged 3 to 10 years, enrolled in pre-primary (Anganwadi or nursery/ kindergarten) and primary (Class I to V) levels. Children who are permanent residents of the rural villages within the Mohammed Bazar Block Children attending the Anganwadi centre in the specified age group. They are studying in a government-aided school in the study area. Written informed consent has been obtained from parents or legal guardian after the purpose was explained to them in the local language. Chronically ill or student not present during the survey was included in the survey. Only those children whose parents or legal guardians provide written/verbal informed consent has been included in the study.

Children of the permanent residents in the age group 1- 10 years attending Anganwadi centers and pre-primary schools have been included in the study. Since the children all 1-10 years writtem informed consent was obtained from the parents after explaining the purpose of the study.

Exclusion Criterion

Children with diagnosed chronic illnesses, metabolic disorders, or physical/mental disabilities that have also may also significantly affect dietary intake or food habits.

Data was collected in the Microsoft Excel tool and transferred to IBM SPSS 21.0. Binary Logistic regression has been done. Outcome variable is malnutrition as identified from Anganwadi growth records.

Qualitative Component

Observation visits to Mohammed Bazar Block, the local market, and the farmland have been carried out to observe the farming practices and availability of vegetables and fruits in the market.

Key informant interview been done, speaking to parents and caregivers. Total 8 interview shave been conducted.

Two focus group discussions have been carried out

Qualitative in-depth interviews were digitally recorded and analysed after transcribing in Notebook LM. This was done to the interviews, which were translated into English. QDA minor lite has been used to develop thematic codes.

A link between the quantitative component and the qualitative part has been done. A theoretical link between malnutrition, dental fluorosis and development of silicosis has been established. Univariate and Bivariate logistic regression have been performed using IBM SPSS 29.0. In-depth interview digitally audio recorded, analysed using QDA Miner Lite and for identifying thematic linkage

Results

Univariate analysis

Table 1- in the preceding table, sample characteristics, some food intake habits, hand washing practices and other hygiene ave been depicted.

Age groups	Number of respondents in this group	Number of meals taken	Regular Consumption of fruits and vegetables	Habit of twice daily daily brushing of teeth with toothpaste	Washing of hands after critical times
1-2 years	42 (12.88)	Once(14.28)	14.28	Yes	No
		Twice (47.61)	47.61	No	Yes (5)
		Thrice (24)	28	Never (100)	Sometimes (95)
		Four times (14.11)			
2tbale -3 years	58 (17.79)	Once (3.44)	3.	Yes (14.2)	Yes (42.9)
		Twice (50)%	28	No (85.8)	No (47.1)
		Three times (26)	69	Never	No(10)
		Four times (20.00)			
3-4 years	69 (21.163	Nil		Yes (28.6)	Yes (471.1)
		Twice (18)		No (71.4)	No (42.8)
		Thrice (39)		Never	
		Four time (43.47)			
4-5 years	57 (17.48)		Yes (10.52)	Yes (80)	Yes (80)
			No (47.36)	No (20)	No (20)
			Sometimes (42.10)	Never	
>8 years but<10 years	100 (36.67)		No (32)	Yes (80)	Yes (60)
			Yes Never No (28)	No (20)	No
			Sometimes (40)	Never	Sometimes (40)

This study shows a clear relationship: older children (8-10 years) eat a greater number of meals than younger children; this is statistically significant. $p < 0.01$. Sow's older child is taking more servings of fruits and vegetables, which is statically significant. $p < 0.01$.

Junk food consumption is more is the age group 3-years while children in the age group 8-10 rarely consume Junk food. This is also significant $p < 0.001$ → statistically significant.

Table 2: parents' sending time with their child, guiding them to have food at home, and avoiding junk food

Age is the strongest predictor: older children are more exposed to peer influence and school environments where junk food is accessible. Balanced meal fretime wquency acts as a protective factor, reducing reliance on snacks. Fruit/vegetable intake is inversely related to junk food consumption, highlighting the importance of dietary diversity.

Table 2- parents guiding their children, spending time with children and influencing food habits

Age groups	Parents guiding their children on nutrition and hygiene practices	Spending time of child
1-2 year	Every day Few day Sometimes (100) Never (0)	None rarely Moderate (47.72% ometimes)
2-3 years	9 parents (15.5) 49 parents (84.5)	Some (28.6 dailly Weak (53% rarely, 20% never)
3-4 years	11 parents (15.9) 58 parents (84.1)	Weekly (57.1) Poor (43.5) never)
4-5 years	Every day Few day Rarely (100) Never	None (100% rarely) Very poor (68.4rarely)
8 years but<10 years	Every day Few day Rarely (20) Never (80)	Absent (80 never) Very poor (89% rarely)

This is the nutrition status is **Normal nutrition:** About **42%** of children fell into this category. These children show normal growth as proportionate to age.

Children with evidence of malnutrition:

Underweight: Around **28%** were underweight, they are showing less than 2 standard deviation weight for age .

Stunted: Approximately **35%** showed stunting, which indicates chronic malnutrition and long-term growth retardation.

Wasted: About **18%** were wasted, pointing to acute malnutrition and recent nutritional stress.

Bivariate analysis

Food consumption pattern

Table 3

Consumption of junk food taking age group 1-2 as a reference category as it is the time for weaning has just ended and toddler is having mostly home based food,

	Variables	ODDs ratio	95% confidence interval	P value
Consumption of junk food	Children 1-2 years (Reference)	NA	7NA	NA
	Older children (3-4 years	1.8	1.2–2.7.	0.01
	children 4-5 years	1.5	1.0–2.3,	NS
	Children 8-10 years	2.3	1.64—5.45	<0.05
Meal frequency	Children 1-2 years (Reference)	NA	NA	NA
	Older children (3-4 years	1.4	06-3.2	Not significant
	Children (3-4 years	5.1	2.1-12.4	,<0.05
	children 4-5 years	1.8	0.8-4.2	Not significant
	Children 5-10	3.8	1.7-8.5	

Role of parents in educating the consumption of healthy, nutritious diet

1. **Nutrition Education for Parents** Qualitative Methods applied in the study
2. Observation Study
3. Nature of farming practices
4. Farming practices are the cultivation of drumsticks, papaya and guava. Storage and preservation is poor but the marketing strategy. People are reluctant for proper enchashing so utilization remains poor. This observed NGO activist comments. People stillbank on paddy and pulses with you going for diversification
5. Analytical angle: Link farming practices to dietary diversity and seasonal malnutrition.
6. 2. In-depth Interviews, focus group discussion has been undertaken on basis of grounded theory and used QDA minor lite to draw a linkage
7. A parent in a village commeneted
8. We have grown to adults. Our parents have looked after us and what we are doing with our children it is no different. Don't worry they will also grow up as. No worries – one parent commented
9. You have told fruits where can we afford – another parent said
10. We cannot work hard, there are less opportunities and if we work hard we feel exhausted. Speaking with various ICDS functionaries across the the CD block revealeed three common observations
11. Poor parent involvement: the dominant theme

Table 4 Logistic regression has been undertaken, outcome variable: avoiding junk food and consuming healthy, nutritious food

Predictor variable	Odds ratio	96% confidence interval	Value
Age 2–3 yrs vs 1–2 yrs	1.2	0.8-1.9	0.20
Age 3–4 yrs vs 1–2 yrs	1.8	1.2-2.7	0.01
Age 4–5 yrs vs 1–2 yrs	1.5	1.0-2.3	0.06
Age 8–10 yrs vs 1–2 yrs	2.3	0.65	
Meal frequency (3–4/day) vs 1–2/day	0.65	0.45-0.95	0.03
Fruits and vegetables intake	0.60	0.40-0.90	0.02

Discussion

Analysis shows there is a double burden of malnutrition and junk food. Appetite decreases as presence of fluoride in drinking water. Respiratory crystalline fragment in air in the entire block may be a precursor of future occupational and non-occupational Malnutrition increases susceptibility** to fluorosis by weakening the body's ability to metabolise and excrete fluoride.

- Fluorosis can damage the **gastrointestinal lining**, reducing absorption of essential nutrients and worsening anemia and stunting.

Fluoride in drinking water is a problem that causes decreased food intake.. The odds of severe dental fluorosis were significantly higher in children with low BMI (OR 2.11, $p < 0.001$). | | Lancet (2020) | Anaemia and nutrient malabsorption in Indian children are associated with fluoride exposure

Diversification of agricultural food products ensures people can have the option of purchasing diversified etable foods. In context to moahh,ed bazar farming practices show not much is produced through for the record as mentioned previously Moringa, Papaya and Guava is produced. Presence of respirable crystalline fragment is a cause for concern and noted by people. Birbhum's agriculture centres on rice (Aman/Aus paddy in Kharif monsoon season, Boro in Rabi winter), supplemented by limited oilseeds, pulses, wheat, and vegetables.

Monocropping depletes soil fertility due to heavy chemical Tribal marginal farmers, dominant in rural areas, rely on rainfed systems vulnerable to droughts, limiting diversification.

Low farm production diversity correlates with poor household dietary diversity scores, especially among tribal women and children, as measured by food group consumption variety.

Studies in Birbhum show marginal farmer households have restricted access to diverse foods, with positive links between economic status, farm variety, and nutrition intake.[14]

Rice dominance means staples overshadow proteins, vitamins from pulses/vegetables, heightening micronutrient gaps in Adivasi communities.

Seasonal hunger peaks in Bhadra-Ashwin (mid-August to mid-October, post-sowing pre-harvest "lean season"), when food stocks deplete, prices rise, and vegetable scarcity worsens malnutrition. In Birbhum's tribal blocks like Mohammad Bazar, this amplifies chronic undernutrition —stunting 31-52%, underweight 31-49%, wasting 20-35%—due to crop gaps between Kharif harvest and Rabi sowing. Drought-prone laterite soils and population pressures further strain food security during these periods. When a child who suffers from hunger consumes sugary rich junk foods or high calorie diets with lack of essential nutrients will lead to increased malnutrition.

Multiple reasons parent are failing to deliver the nutrition counselling to their children as well as they are spending less time with their children and also not enforcing WASH practices.

Also Parents who actively supervise brushing improve children's plaque removal and gingival health, with studies showing odds of good oral hygiene tripling under parental guidance. Less time invested, often due to working parents or large families, results in children brushing independently from a young age, leading to inadequate habits. Children who consume structure 3-4 meals per day are less likely to eat junk food and growth pattern remains healthy.

It has been found that many parents lack the knowledge to impart knowledge on nutrition as has been found during key informant interviews.

Modelling Healthy Behaviours, this is difficult as processed food industry is very powerful and has a lot of impact of all concerned. A feature observed in many places but may be a dominant feature in rural areas Anganwadi centre managed by social welfare department. Villagers take it as “khichdi” school and do not take its advice seriously – key informant interview of villagers said.

Socioeconomic Factors which may be a hindrance. In low socioeconomic families, time constraints from work or low education correlate with minimal supervision, higher sugary snack intake, and malnutrition risks. Parents are willing to invest more brushing time (e.g., 4-5 minutes daily) link to better child oral outcomes and potentially healthier diets. Interventions educating parents on supervision can break this cycle.

Supervision by parents ensures that “plaque” and “tartar” are removed during twice-daily toothbrushing. Dental health may not cause malnutrition per se. However poor health is considered to be bth effect modifier or confounder of malnutrition which is highlighted in the chart below. Now as already explained the area studied has fluorosis which may decrease the appetite. This exacerbates malnutrition.

Poor oral hygiene from insufficient parental involvement causes caries and infections, which reduce appetite, impair chewing, and worsen malnutrition by limiting nutrient absorption. Malnutrition reciprocally weakens oral defenses like saliva production, creating a bidirectional cycle especially in low-resource settings.

In low socioeconomic families, time constraints from work or low education correlate with minimal supervision, higher sugary snack intake, and malnutrition risks. Parents are willing to invest more brushing time (e.g., 4-5 minutes daily) link to better child oral outcomes and potentially healthier diets. Interventions educating parents on supervision can break this vicious cycle.

In low socioeconomic families, time constraints from work or low education correlate with minimal supervision, higher sugary snack intake, and malnutrition risks. Parents are willing to invest more brushing time (e.g., 4-5 minutes daily) link to better child oral outcomes and potentially healthier diets. Interventions educating parents on supervision can break this cycle in area like Mohammed Bazar Birbhum district, with malnutrition, silicosis, and dental fluorosis, how can we draw a conclusion.

Mohammed Bazar in Birbhum district, West Bengal, faces interconnected public health challenges from malnutrition, silicosis, and dental fluorosis, driven by poverty, stone mining, and groundwater contamination. Drawing conclusions requires integrating local prevalence data, risk factors, and epidemiological links to inform targeted interventions.

High undernutrition affects Adivasi children across Birbhum, with stunting at 51.9%, wasting at 19%, and composite anthropometric failure at 61.6%, alongside 73% anemia; Mohammed Bazar's backward status exacerbates this. Silicosis cases emerge from stone-crushing units in Mohammed Bazar and nearby Pachami/ Rampurhat, with recent boards confirming 9+ patients district-wide amid rising mining activity. Dental fluorosis is endemic in Birbhum blocks like nearby Rampurhat I and Khoerasol due to fluoride-rich water, causing widespread dental and skeletal issues.

Shared Risk Factors

Socioeconomic vulnerability unites these: Adivasi poverty limits nutrition access, while mining exposes workers/families to silica dust (silicosis) and poor WASH heightens fluorosis via contaminated water. Parental occupational burdens (e.g., mining) reduce supervision time for child hygiene/nutrition, linking to poor oral habits, infections, and malnutrition cycles.

Excess fluoride in drinking water (common in parts of rural India) can cause **skeletal fluorosis**. Though evidence of fluorosis in drinking water has not been evaluated. Children with poor nutrition are more vulnerable because deficiencies in calcium, vitamin D, and protein exacerbate fluoride's toxic effects.

Crystalline Fragments in its effect on respiratory health Respirable crystalline silica or other fine particulate matter from dust in rural environments.

Chronic exposure can impair lung function, reduce oxygenation, and increase susceptibility to infections. It is the cause of silicosis.

Malnourished children, with weaker immune systems and lower antioxidant reserves, are less able to cope with this environmental stress.

Narration by a villager- "w ecan' t keep boiled rice in open it is spoily by fine dust,

Another village- if ou keep windows open in our rooms after you swept the floors. It is covered by fine dust after few hours.

Linking fluorosis in drinking water, poor oral hygiene and malnutrition

- **Synergistic Effect:** Malnutrition amplifies the harmful effects of both fluoride and airborne crystalline particles.
- **Cycle of Vulnerability:** Environmental exposures worsen health outcomes, which in turn reduce appetite, absorption, and growth, deepening malnutrition.
- **Public Health Implication:** Addressing nutrition alone may not be sufficient unless environmental factors (water quality, air quality) are also tackled.

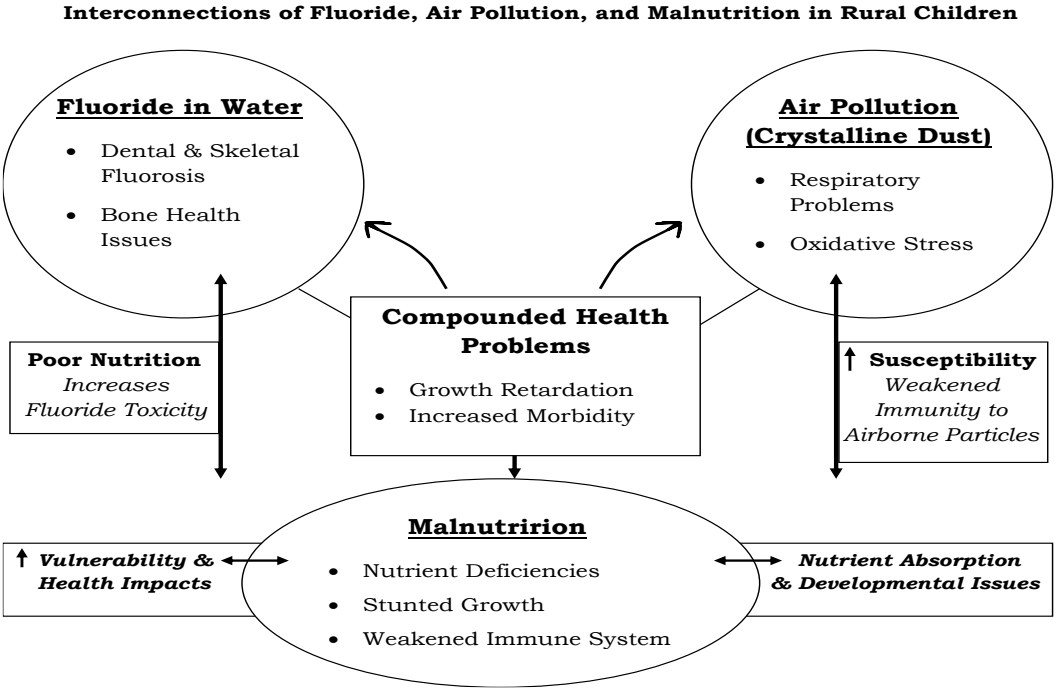

Diagram 1- linking fluorosis in drinking water, respiratory crystalline fragment as an air pollutant and malnutrition interlinking

Limitations of this study and future research

In-depth interviews have been conducted using 8, which may appear quite a small number. In reality grounded theory is the basis of the research, with a suggested number being 15-20 key informants. The area being undertaken 2 gram panchayat of the area. Observation visits and speaking to the residents that parents are not in position to spend more time with their children and do more counselling Saturation may have reached. But as a researcher felt no new information can be obtained. It is recommended for a future research covering more number of villages and more key informant interviews.

Qualitative component has been done by three ways: observation visits to the area, in-depth interviews and focussed group discussions. This strengthens the hypothesis that there is an inherent lack inertia among people for strengthening preventive nutrition aspects.

The areas studied in Birbhum described has widespread malnutrition in children to adolescents [1]This study includes parental indifference to their children, factors like fluoride in drinking water, and respirable crystalline fragments that impact the vulnerable population in many ways.

Ethical issues

Ethical clearance obtained fron NHSM Institute Committee for the research proposal of Ms Sumona GhoshChowdhary. The voice transcript has been anonymised, so thematic lineage cannot be linked to any person.

Acknowledgement

To prepare 1 have used generative AI to prepare image 1

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