

Original Research Article

Clinical assessment of micronutrient deficiencies in 2-6 years old children: a survey with pediatricians

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Received: 02 November 2020

Accepted: 11 December 2020

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ABSTRACT

Background: Worldwide, at least fifty percent of children, younger than 5 years of age, suffer from micronutrient, protein and calorie deficiencies causing negative impact on health. Our study aims to understand the pediatricians' perspectives on diagnosis and management of these micronutrient deficiencies (MND).

Methods: A cross sectional questionnaire-based survey of 490 pediatricians, wherein the questionnaire focused on prevalence, causes, diagnosis, management and long-term impact of micronutrient deficiencies in children aged 2 to 6 years.

Results: Majority of pediatricians (94%) commonly see MNDs in their clinical practice; with 94% pediatricians seeing MNDs in stunted children, 93% in wasted and 89.0% in obese children. About 50–90% pediatricians reported calorie, protein, vitamins and mineral deficiencies. Not eating a balanced diet was the cause of nutrient deficiency as per 97% pediatricians, while about 93-97% opined MNDs also cause frequent illness, lack of energy/weakness, loss of weight or causes thinness. All pediatricians believe that minerals, vitamins and proteins are important for immunity and bone development. Also, 88% pediatricians believe multiple MNDs can be evaluated by physical examination and clinical history; and about 40% pediatricians suggest intervention to 25-50% children. Also, they believe that MNDs impact long-term health outcomes like growth, cognitive development, metabolic development and social development.

Conclusions: Micronutrient deficiencies contribute to lack of energy, frequent illness, and compromised immune system which in turn have short-term and long-term impact on overall growth and development. Hence there is a need to assess and address the MNDs at the earliest.

Keywords: Growth and development, Knowledge attitude practice, Micronutrient deficiencies, Minerals, Pediatricians, Vitamins

INTRODUCTION

India, the country with the second largest population in the world, is facing an evolving challenge of a double burden of malnutrition, which also involves micronutrient deficiencies.¹ According to Global Nutrition Report 2020 by World Health Organization (WHO), among children under 5 years of age, 149.0 million are stunted, 49.5 million are wasted and 40.1 million are overweight.² India alone contributes 37.9% to the total stunted population. The national prevalence of wasting and over

weight is 20.8% and 2.4% respectively.³ With nutrition transition, both undernutrition and overweight coexist in the population. However, whether under or overweight, the risk of micronutrient deficiency is high. Micronutrients (vitamins and minerals) are an essential component of the diet and are necessary for normal cellular and molecular function. While micronutrients are only needed in trace amounts, their deficiency can result in wide-ranging negative health effects.⁴

Micronutrient deficiencies (MNDs) have a direct impact on individuals and on societies, resulting in poorer health,

lower educational attainment and decreased work capacity and earning potential. Micronutrient deficiencies have consequences throughout an individual's life span and are perpetuated across the generations.⁵ Although any individual can experience micronutrient deficiency, pregnant women and children are at the greatest risk of developing deficiencies. This is not only as a result of low dietary intake, but also from higher physiological requirements.

The nutritional status of pregnant women is not only relevant for her own health but can also have important consequences for the development of her child.⁶ Children under-five are particularly vulnerable, as rapid growth and development necessitates a higher demand for micronutrients.⁴ Children who are stunted or born with intrauterine growth retardation (IUGR) are also shown to complete fewer years of schooling and earn less income than adults, which hinders their cognitive growth and economic potential. Lower income, poor health and reduced access to proper nutrition then continue to impact on the health of children born into future generations, establishing a vicious cycle.⁷

Micronutrients (vitamins and trace elements) are needed in amounts <100 mg/day and are crucial in development, production and functioning of enzymes (zinc, copper, manganese, selenium, magnesium, molybdenum); hormones (iodine, chromium) and growth regulator proteins; reproductive and immune system; bone and membrane structure (calcium, phosphorus, magnesium, vitamin D); oxygen binding (Iron), etc.⁸ Iron, iodine, folate, vitamin A, and zinc deficiencies are the most widespread MNDs, and all these MNDs are common contributors to poor growth, intellectual impairments, perinatal complications, and increased risk of morbidity and mortality.⁵

Iron deficiency is the most common MND worldwide and leads to microcytic anemia, decreased capacity for work, as well as impaired immune and endocrine function. It is associated with delayed mental and psychomotor development and an increased risk of maternal mortality. Poor nutrition, leading to iron deficiency, is the principal underlying factor in more than 60% of all anaemia cases. India contributes almost one quarter to the global burden as calculated by the Global Burden of Disease in 2016. Iodine deficiency disorder is also widespread and results in goiter, mental retardation, or reduced cognitive function. Iodine is an essential nutrient and is needed to produce thyroid hormone. Iodine deficiency disorders (IDD) can lead to enlargement of the thyroid, hypothyroidism and, in severe cases, to mental retardation. Goitre is the most visible indication of iodine deficiency. National salt iodization programmes have substantially reduced the global burden of iodine deficiency. Zinc deficiency is characterized by growth retardation, loss of appetite, and impaired immune function. In more severe cases, zinc deficiency causes hair loss, diarrhoea, delayed sexual maturation,

impotence, hypogonadism in males, and eye and skin lesions. Nearly one fifth of children <5 years of age have zinc deficiency. Vitamin B₁₂ and folate are necessary for the formation of healthy red blood cells, repair of body cells and tissues, and for the synthesis of DNA. Vitamin B₁₂ is also important for maintaining normal nerve function. A deficiency in vitamin B₁₂ or folate can lead to macrocytic (enlarged red blood cell) anaemia. Vitamin B₁₂ is found primarily in foods of animal origin and risks for deficiency are therefore higher where access to these foods is limited. Vitamin D is essential for bone health and adequate intake is required to prevent growth faltering in children. Vitamin A is an essential micronutrient that is particularly important for immune function. Vitamin A is critical during periods of rapid growth and inadequate intake can lead to deficiency which, in severe cases, may cause visual impairment (night blindness) and increase the risk of morbidity and mortality from common childhood infections. Single MNDs rarely occur alone; often, multiple MNDs coexist.⁹

It is estimated that around two billion people in the world are deficient in one or more micronutrients.¹⁰ At least half of children worldwide younger than 5 years of age suffer from vitamin and mineral deficiencies.¹¹ Unlike energy-protein undernourishment, the health impacts of micronutrient deficiency are not always acutely visible; it is therefore sometimes termed 'hidden hunger' (the two terms can be used interchangeably).⁶ Micronutrients are not produced in the body and must be derived from the diet.¹¹ Micronutrient intake in daily diet is far from satisfactory and largely less than 50% recommended dietary allowance (RDA) is consumed by over 70% of Indian population.¹² Heavily cereal based diets, with little dietary diversity constitutes a risk, particularly in children, as their developmental potential could be affected.¹³

Micronutrient deficiencies are highly prevalent and affect far beyond the known effects like anemia, goiter, asymptomatic to devastating, often hard to recognize, mimic many diseases, have fewer signs but gamut of symptoms, and can involve multiple system. Only few have practicable laboratory diagnosis. Hence, they need high index of suspicion and a detailed dietary history for diagnosis.⁸

With the wide prevalence of MNDs, this study was conducted to understand the pediatricians' perspectives on diagnosis and management of micronutrient deficiencies.

METHODS

The study was approved by Institutional Ethics Committee, Asian Institute of Medical Sciences, and all participants provided informed consent.

Participants

The study participants were pediatricians with a minimum 6 years of experience, practicing in community or private set up predominantly in the urban/semi-urban areas.

Study design and subjects

This was a cross sectional questionnaire-based study conducted across the country from August 2019 to November 2019, to understand pediatricians' knowledge, attitude, and practices on diagnosis and management of micronutrient deficiencies in children. The questionnaire was closed-ended; on prevalence, causes, diagnosis, management, and long-term impact of micronutrient deficiencies in children of ages 2 to 6 years (Annexure A). Four hundred and ninety pediatricians participated in this study.

Statistical analysis

The analysis for the study was performed using Statistical Package for Social Sciences (SPSS, IBM, USA). A descriptive analysis of the data was performed and expressed in percentages.

RESULTS

Knowledge on Micronutrient deficiency

Number of cases with micronutrient deficiency seen by pediatricians

According to majority of paediatricians (94%), MNDs are commonly seen in their clinical practice. Majority of pediatricians (89-94%) reported that they have observed MNDs in stunted, wasted and obese children in their clinical practice.

About 91% pediatricians reported common deficiency of mineral elements like iron, zinc, iodine, etc.; 82% observe vitamin deficiency (vitamin A, vitamin D, vitamin C, etc.); while 64% reported protein deficiency and 50.0% reported calorie deficiency (mean values represented in Figure 1).

Etiology

Survey revealed that not eating a balanced diet (or eating junk food) was the cause of nutrient deficiency as per majority (97%) of paediatricians. Also, 89% paediatricians reported children being fussy/picky eaters, 73% reported consumption of grains, fruits, vegetables, etc. low in micronutrient, 71% reported chronic illness as causative factors for MNDs (mean values represented in Figure 1).

Physiological effects

A total of 97% pediatricians opined that impact of nutrient deficiency leads to falling ill frequently, whereas, 95% said it leads to lack of energy/weakness, and 93% reported it leads to loss of weight or causes thinness (mean values represented in Figure 1).

Attitude on management of micronutrient deficiencies

Also, almost all pediatricians are of the opinion that all of vitamins, minerals and proteins are important nutrients for building immunity, in the order: minerals, vitamins and protein.

About nutrients required for bone development, 97% of the pediatricians said that minerals are the most important, followed by 94% who said vitamins and 74% said protein.

While assessing the impact on quality of growth, 57% paediatricians strongly agree that MNDs have an impact on height and weight of children. Data for 3 pediatricians was missing and results for growth quality were calculated for 487 pediatricians.

A total of 92% pediatricians agree to strongly agree that MNDs can lead to lowering of immunity (causing frequent illness) (Mean values represented in Figure 1)

Practices in management of micronutrient deficiencies

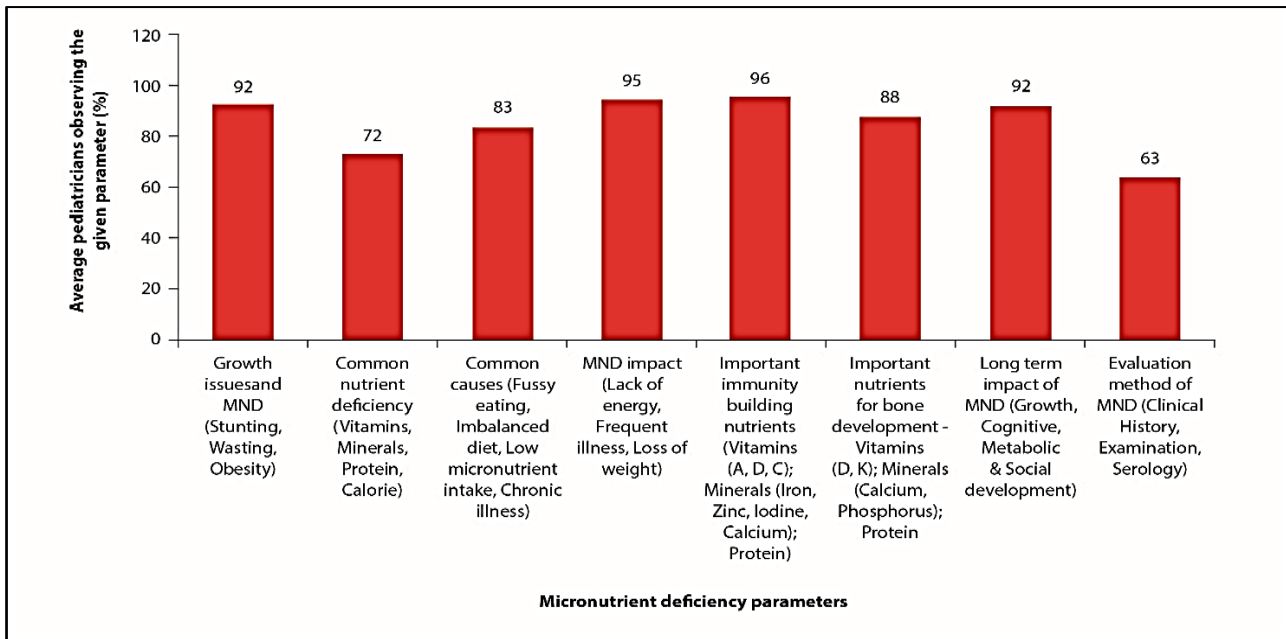
Diagnosis

Most paediatricians i.e. 88%, believe that multiple MNDs can be evaluated by physical examination and clinical history (68% paediatricians), followed by 31% paediatricians recommend serological tests, while only 3% paediatricians reported that they do not evaluate MDs.

Treatment

Four hundred and eighty-two pediatricians out of four hundred and ninety-two answered the question about how many children do they suggest intervention for MD. Of these 482 pediatricians, 72% suggest intervention in 25% to >50% children and 1% pediatricians do not feel the need to suggest intervention.

Majority of pediatricians (approximately 92%) strongly agree to agree that MNDs have a long-term impact on various aspects like growth, cognitive development, metabolic development and social development, as represented in Figure 1.



Values represented as mean %.

Figure 1: Summary on pediatricians views on children with MND.

DISCUSSION

Micronutrients is an umbrella term which constitutes essential vitamins and minerals necessary for the normal cellular and molecular functions like metabolism and tissue function.⁵ Micronutrient deficiencies of iodine, iron and vitamin A are projected to cost around 0.8-2.5% of the gross domestic product of India. Various schemes have been launched through the years in India to improve nutrition and health status of the population; but still a large portion of the population is affected.¹⁴ As per our survey, about 94% pediatricians commonly see micronutrient deficiencies in their practice, with about 92% reporting deficiencies in stunted and wasted children and obese children. Also, minerals, vitamins, proteins and calorie deficiencies are seen by about 72% pediatricians. Consumption patterns, dietary habits, adequate diversity in foods and meal frequency play an important role in nutrition; and when provided in insufficient amount, makes the children vulnerable to undernutrition, especially stunting and micronutrient deficiencies, and to increased morbidity and mortality.¹⁵ Similar to this report, in our study, not eating a balanced diet; children being a fussy/picky eaters; consumption of grains, fruits, vegetable which are low in micronutrients or chronic illness were considered common causes of MNDs by approximately 83% pediatricians. Similar observations are also reported in other studies from Israel¹⁶ and India.¹⁷ According to Global Nutrition Report 2020, worldwide, out of the 16.6 million children under 5 years of age with severe acute malnutrition, only about 1-quarter received treatment in 2017, which highlights the urgent need to address this intolerable burden.²

Also about 95% paediatricians in our survey reported that MNDs lead to lack of energy/weakness, frequent incidents of illness, loss of weight/thinness; and hence all micronutrients like vitamins (A, D, C), minerals (iron, zinc, iodine, calcium), and proteins are important for immunity building, as reported by about 96% pediatricians. Equivalent facts were reported by Bhaskaran et al in a review, which mentions that deficiencies like vitamin A, iron and zinc have shown to have effect on lowering of immunity leading to frequent illness.¹⁸ Our survey results are also comparable to NFHS-4 report which states that micronutrients like vitamin A and iron are essential for immune system functioning and their deficiency leads to anemia, increase in severity of infections such as measles and diarrhoea and slows recovery from illness.¹⁵

Furthermore, the Global Nutrition Report 2020 states that micronutrient deficiencies can negatively impact eyesight, bone growth and immunity.² As per our study too, more than 90% pediatricians said that vitamins (D, K, etc.) and minerals (phosphorous, calcium, etc.) along with proteins are essential for bone development and immunity building. Thus, it becomes necessary to evaluate multiple micronutrient deficiencies; and in our survey nearly 63% pediatricians assess clinical history, examination and serological tests for diagnostic evaluations of MNDs. Government of India has been carrying out various nutrition supplementation programmes on national and state level due to which, prevalence of stunting and undernutrition has found to be decreased in children age 0-59 months as seen by comparing NFHS-3 and NFHS-4 data. Stunting has decreased from 48% in 2005-06 to 38% in 2015-16, underweight prevalence decreased from 43% to 36%, but prevalence of wasting has remained almost the same.

Also, prevalence of anemia in the same age group of children has found to be decreased from 2.9% to 1.6%. To decrease iodine deficiency, the programs initiated for fortification of salt with iodine lead to 93% of households using iodized salt as per NFHS-4 results compared to 76% of NFHS-3 result.¹⁵ On these lines of food fortification and nutrition supplementation, around 70% pediatricians suggest intervention in up to 50% cases as these MNDs have long term impact on growth, cognitive development along with metabolic and social development. Micronutrient deficiencies cause short-term outcomes such as increased prevalence of low birth weight to decreased child survival, and long term outcomes such as impaired cognitive development, stunted growth and persistent behaviour problems throughout childhood and adolescence.^{16,19} Majority pediatricians in this study (92%), reported that nutrient deficiencies cause long term impact on all the aspects of growth, cognitive development, metabolic development and social development. Single micronutrient deficiencies are easy to identify and treat compared to deficiencies of multiple micronutrients. This survey thus considers current knowledge of micronutrient requirements in children in various health conditions and in cases where supplements may be clinically required. While the required amounts of micronutrients are very small, MNDs can have wide-range negative health impacts.⁵

CONCLUSION

Micronutrients are essential elements to orchestrate a range of physiological functions. Predominantly, numerous MNDs are found, which together contribute to impaired growth and intellect; and higher morbidity. Although major MNDs can be reversed by providing supplementation or medication, certain deficiencies may lead to permanent effects. The gravity, timing and proportion of MND determine its consequences. In this cross-sectional study while assessing pediatricians' outlook on diagnosis and management for micronutrients, we observed that high percentage of paediatricians come across children with vitamin, mineral, protein and calorie deficiencies that leads to lack of energy, frequent illness, and compromised immune system; which in turn has long term impact on overall growth and development. Most paediatricians believe that a systematic clinical history and examination helps in assessing these deficiencies, prompting them to opt for nutritional management in these children to decrease the impact of MNDs.

ACKNOWLEDGEMENTS

The authors are full-time salaried employees of Abbott Nutrition International. Writing assistance was provided by MediccaPress Ltd.

Funding: No funding sources

Conflict of interest: The authors are full-time salaried employees of Abbott Nutrition International

Ethical approval: The study was approved by the Institutional Ethics Committee Asian Institute of Medical Sciences

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Cite this article as: Gungam P, Kadhe G, Shaikh IA. Clinical assessment of micronutrient deficiencies in 2-6 year old children- a survey with pediatricians. *Int J Contemp Pediatr* 2021;8:255-62.

ANNEXURE

(KAP questionnaire)

1. Is micronutrient deficiency (2 or more micronutrients) is commonly seen in your clinical practice?
 - Yes
 - No
 - Cannot comment
2. Do you commonly see micronutrient deficiency in the following cases in your clinical practice?
 - Stunted children
 - Wasted children
 - Obese children
 - All of the above
3. Out of the following which are the most common nutrient deficiencies seen in children's diet?
 - Vitamin deficiency (A, D, C etc.)
 - Mineral Deficiency (iron, zinc, iodine etc.)
 - Protein deficiency
 - Calorie deficiency
 - All of the above
4. What are the common causes of nutrient deficiency?
 - Fussy/picky eater
 - Not eating a balanced diet (e.g. Junk food)
 - Consumption of grains, fruits, vegetable etc. Low in micronutrient
 - Chronic illness
 - Other
 - All of the above
5. What could be the impact of nutrient deficiency?
 - Lack of energy/weakness
 - Falling ill frequently
 - Loss of weight/thinness
 - All of the above
6. What according to you are the most important nutrients for immunity building?
 - Vitamins (A, D, C, etc.)
 - Minerals (iron, zinc, iodine, calcium etc.)
 - Protein
 - All of the above
7. What according to you are the most important nutrients for bone development?
 - Vitamins (D, K etc.)
 - Minerals (phosphorous, calcium etc.)
 - Protein
 - All of the above
8. Micronutrient deficiency can impact quality of growth (height/weight)?
 - Strongly disagree
 - Disagree

- Neutral
- Agree
- Strongly agree

9. Micronutrient deficiency can lead to lowering of immunity (frequent illness)?

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

10. How do you evaluate multiple micronutrient deficiency?

- Clinical history
- Examination
- Serology
- Do not evaluate

11. How many children do you suggest intervention?

- >25%
- 25-50%
- More than 50%
- None of them

12. If not intervened early do you see the impact of nutrient deficiency causing long term impact on the following?

- Growth
- Cognitive development
- Metabolic development
- Social development
- All of the above