Hidden Hunger (MiND): The Hidden Enemy of MetS – A Review on the Root Cause.

Dr Upendra Kaul, Dr S. C. Manchanda, Prof. Dr N. S. Verma, Dr Debasis Basu, Dr Banshi Saboo, Dr Anuj Maheshwari, Dr A Panneer Selvam, Dr P. K. Hazra, Dr P. Manokar, Dr Aakanksha Pathria, Dr Vanessa Mascarenhas.

Abstract:

This review will emphasize Hidden Hunger, its prevalence in India, complications and consequences, pathophysiology, and strategies to prevent hidden hunger in India. Nutrients are broadly classified into two segments, 1. Macronutrients consist of carbohydrates, proteins, and fats, 2. Micronutrients consist of essential vitamins and minerals. Consumption of both Micro and Macronutrients are recommended to be taken as per Dietary Allowance (DA) is required for healthy living & better outcomes from the medications that are taken for managing chronic(0) illness. Hidden Hunger known as micronutrients deficiency (MiND) affects more than 2 billion (200 crores) or 1 in 3 people, globally. But the worrisome situation is that half of the global population suffering from Hidden Hunger lives in India (approximately 100 crores). Hidden Hunger (MiND) impacts health throughout life for all age groups. Here we are coining to Hidden Hunger as a 'Hidden Enemy' because it is existing at the cellular level and affects biochemical actions like productions of Enzymes, Co-Enzymes, Hormones, different chemical messengers, etc. Initially, lack of essential vitamins and minerals will not lead to any major signs and symptoms (1) It affects the cellular function, when it is there for a very long period of time. (1) Key targeted interventional strategies to address Hidden Hunger (MiND) in the short-term and long-term (between 5 to 10 years) include Food fortification, Biofortification, and Micronutrient supplements, dietary diversification by eating seasonal fruits, vegetables, meat, and dairy products as a part of a balanced diet.

In today's context it becomes Imperative to address Hidden Hunger first, and in the patient's suffering from lifestyle disorders (T2DM, Hypertension, Dyslipidaemia), which will help to get the optimum outcome of the targeted goals.

Keywords: Balanced Diet, Hidden Hunger, Micronutrients, Micronutrient supplement, MiND, Nutrition, Vitamins and Minerals.

Acronyms: MiND: Micronutrient Deficiency, MetS: Metabolic Syndrome, LSM: LifeStyle Modification, BW: Bodyweight, T2DM: Type-2 Diabetes Mellitus, RDA: Recommended Dietary Allowance

1. Introduction

Everyone has the right to adequate food in a quantity and quality sufficient to satisfy their dietary needs. Nutrition is a basic need of humans which is essential for a healthy life. World Health Organization (WHO) recognizes an unhealthy diet (imbalanced diet) and no physical activity as risk factors for non-communicable diseases. High saturated fat intake, low fruit, and less vegetable intake, physical inactivity, overweight, and obesity, increased blood sugar, alleviated blood cholesterol, alleviated blood pressure, high intake of salt/sodium are the major factors that lead to non-communicable diseases (NCDs)[1]. Thereby, impacts the prevalence of obesity[2,3,4] and NCDs[1]. (2)

A healthy diet is one of the very important modifiable factors in the prevention of diseases, including cardiovascular disease (CVD) and obesity[5]. Nutrients are broadly classified into two segments 1. Macronutrients consist of carbohydrates, proteins, and fats, 2. Micronutrients consist of essential vitamins and minerals. (3). Consumption of both Micro and Macronutrients are recommended to be taken as per Dietary Allowance (DA) is required for healthy living & better outcomes from the medications that are taken for managing chronic illness. A healthy diet is diverse and has a balance in calorie shares of different types of foods like rainbow vegetables, whole grains, fruits, fats, milk, legumes, animal proteins, and its products. (3)(4) The Indian's mostly consume processed cereals like Maida, (refined wheat flour) and semolina along with packaged food like savouries (namkeens), chips, chocolates, sugary beverages, and other food consumed outside of the home[6]. Our personal experience says, in today's era of urbanization many families in India have a trend of dining out on weekends, leading to eating unhealthy, calorie-dense food, which may be one of the leading reasons in India which increases the burden of chronic diseases (Obesity, Metabolic Syndrome, CVD, etc.) (4)

Based on current eating habits, poor imbalanced monotonous cereal-based diet, less intake of fruits and the vegetable majority of people in India are suffering from, a form of undernutrition called Hidden Hunger *(Micronutrient Deficiency, now will be referred as 'MiND')*[7]. (6) This review will emphasize Hidden Hunger, its prevalence in India, complications and consequences, its pathophysiology, and strategies to prevent & address hidden hunger.

2. Hunger and its classifications. (5) (7)

Hunger is classified into three types**.** A. Physical, B. Emotional, & C. (6)(8) Hidden

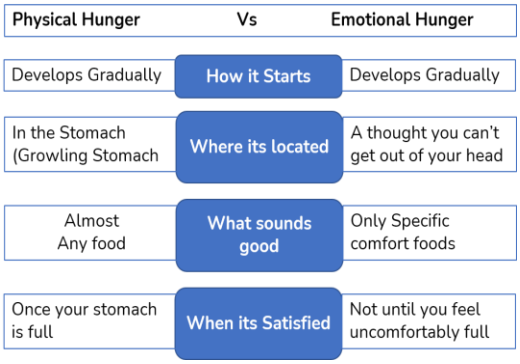

Figure 1: Physical vs Emotional Hunger

Modified From:
https://www.resiliencecentertulsa.com/blog/tag/physical+hunger

A. ***Physical Hunger:*** We feel it when the body's energy level goes down.(9) Hence, we need to eat food to meet the body's energy demand. Once your body's demand for energy is satisfied, the feeling of hunger stops. This is a necessity on daily basis for our physical health and activities.

B. Emotional Hunger: We know it as a craving for food. Foods we like most, we can eat anytime & by seeing them, our mouth starts watering. Even our body's demand for energy is satisfied our craving for food is not satisfied. More of its psychological and not necessary for our healthy leaving. Many of us also turn to food for comfort, stress relief, or to reward ourselves and we tend to reach for junk food, sweets, and other comforting but unhealthy foods. You might reach for junk a pint of ice cream when you're feeling down, order a pizza if you are bored (11) or lonely. Emotional Hunger is the craving for food to make yourself feel better- to feel the emotional needs, rather than your stomach. (10)

C. Hidden Hunger: Occurs at the cellular level and is difficult to diagnose during Out-Patients Department (OPD) setup's because there will be no signs and symptoms of Hidden Hunger. But it is important to know and address Hidden Hunger (Micronutrients Deficiency), in all stages of lifecycle micronutrients are important for biochemical (From new born to old age). (7)

3. What are Hidden Hunger and its prevalence?

The 'Hidden Hunger' which is caused by micronutrient deficiency does not produce hunger as we know it. We might not feel it in the stomach (as physical hunger), but it strikes at the core of our health and vitality, it's at the cellular level. Hidden Hunger known as micronutrients deficiency involves more than 2 billion (200 crores) or 1 in 3 people, globally (FAO, 2013)[8]. This is indeed an eye-opener that half of 2 billion suffering from Hidden Hunger are living in India (approximately 100 crores). This study highlights the current risk factors of "Hidden Hunger" in India is severe[7]. (8) Poor or imbalanced diet is the most common cause of Hidden Hunger (MiND - Micronutrient Deficiency), moreover it may lead to decreased absorption, high requirements for metabolism during infections, trauma, & surgery. (9) Diet rich in staple crops, such as wheat, maize, which provide more calories (energy) but relatively low amounts of essential vitamins and minerals, are resulting in hidden hunger[8].In India, micronutrient malnutrition across the social strata is a common and serious problem due to imbalanced food intake, which can lead to high morbidity and mortality[9]. Reports of the National Nutrition Monitoring Bureau is alarming as the intake of micronutrient (essential vitamins and minerals) of 70% of the population of India is less than 50% of the recommended daily allowance (RDA)**[9].** These might be one of the risk factors leading to an increased burden of chronic diseases in India.

4. Consequences of Hidden Hunger in the long run.

Hidden Hunger (MiND) impacts health throughout the life-cycle with different age groups (Figure 2)[10,11], trapped in the cycle of hidden hunger generation after generation. (12)

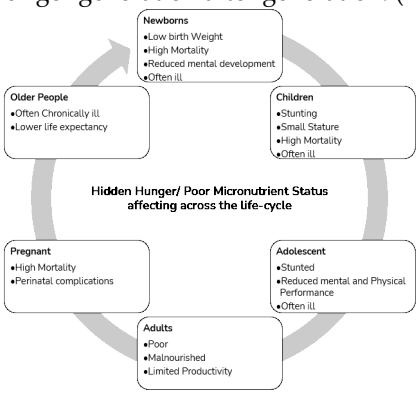

Figure 2: Hidden Hunger affecting across the life-cycle (Modified from ACC/SCN 2000)[12].

It has been observed that multiple micronutrients deficiency always co-exists even when the patient is identified for one major Vitamin or Mineral deficiency-related syndrome. Consequences of Hidden Hunger occur short-term (Mortality, morbidity, disability), long-term (Adult height, cognitive ability, economic productivity, reproductive performance, **metabolic and cardiovascular diseases**), and intergenerational[12] (*as shown in figure 2*). The long-term

consequences of hidden hunger not only affect individuals but also have a detrimental impact on the overall economy of the societies at large especially in developing countries like India[11]. (10)(13)

Emerging evidence suggests that Hidden Hunger (MiND) plays a very significant role in the pathogenesis of various chronic diseases like obesity, diabetes mellitus, dyslipidemia, hypertension, kidney disease, neurodegenerative and cardio-metabolic disorders via causing insulin resistance (IR) [13, 14]. (14) (24) Pragmatic evidences directs that insufficiency or deficiency of micro-nutrients (Hidden Hunger) which are involved in activities or production of insulin(11) could also impact various biochemical reactions leading to derangements of several metabolic cascade pathways like pancreatic β-cell dysfunction, oxidative stress, defect in insulin receptor signalling, etc.(15) which leads to metabolic syndrome (T2DM, dyslipidaemia, obesity, hyperuricemia, hypertension, and a prothrombotic, proinflammatory state), (12) because of this complex aetiology of insulin resistance, which makes it hard to treat. (13) Treatment failure is also seen in some clinical trials like ACCORD[15], in which insulin injection and several oral hypoglycaemics fail to achieve blood sugar to normal levels in wake-of Hidden Hunger. (14)(16)(14) This indicates that micronutrient supplements (can address Hidden Hunger) can be a novel nutritional therapeutic target to combat IR and Syndrome X[13].

5. Mechanism of Hidden Hunger-associated chronic disease.

Hidden Hunger (Micronutrient deficiency) has chronic complications and lethal consequences. At the initial stage of the mild form of multiple micronutrients deficiency, there are no symptoms thus is more difficult to diagnose. Later if such suboptimal status of multiple micronutrients continues, a person will pass through a chain of stages with severe physiological and biochemical aftereffect[16]. The "endpoint" of deficiency disease are the clinical signs of inadequacies. (15) Hidden Hunger exists long before actual symptoms appear, which means the deficiency symptoms are not seen at the right time[17].(17) (16)

Here we are referring to Hidden Hunger as a 'Hidden enemy' because it is existing at (18) the cellular level and affects biochemical actions like productions of enzymes, co-enzymes, hormones, different chemical messengers, etc., initially lack essential vitamins and minerals will not lead to any major signs and symptoms until it has been existing for a longer period (more than several months) to distress the cellular functions. This has been explained and proven by "triage theory", which says during states of low intake or higher need, the micro-nutrients are transported from tissues to organs depending on their requirement (as explained in Figure 3) but the survival is given priority[17]. (17) (19)

So, with this theory, Dr Bruce Ames proved and explained why modest deficiency of multivitamins/minerals is insufficient to elicit clear symptoms of severe deficiency. Our entire body is made of cells, tissue, and organs, all the metabolic activities occur at cellular levels which are driven by various enzymes. What drives the activity of these enzymes is different vitamins and minerals (as a co-factor) [18]. However, enzymes are classified into 2 types according to their essentiality, first is considered as survival proteins (enzymes) required for survival and reproduction and second are longevity proteins essential for future long-term protection. (20) So, if a person is suffering from hidden hunger (micronutrient deficiency) it will trigger a built-in mechanism that will favour enzymes required for survival and reproduction (E.g., blood clotting, glucose utilization, etc.) and thus sacrifice longevity enzymes required for future long-term protection (e.g., DNA repair & synthesis, prevention of cell damage, cell repair.) – as shown in figure 3[19].

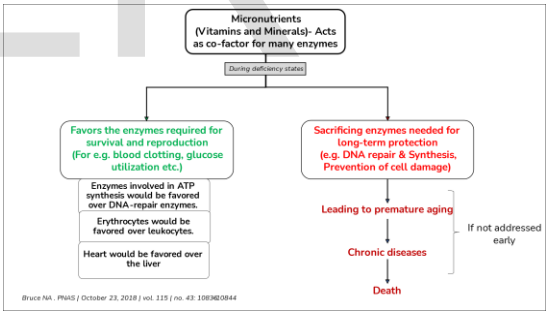

Figure 3: Micronutrient deficiency favours survival enzymes over longevity enzyme[18, 19]

Thus, the consequences of such would be evident at all the levels like **metabolic reactions** -Enzymes involved in ATP synthesis would be favoured rather than DNA-repair enzymes, **in cells** - Erythrocytes rather than leukocytes**, in organs** - Heart rather than the liver. (18) In these scenarios, our body is actually trading long-term health over short-term health[18]. (19) One proven example wherein Vitamin K acts as a co-factor for >16 enzymes (required for blood clotting, bone mineralization, etc.). If intake of vitamin K is less or is deficient, the low concentration of vitamin K present (20) in the body will favour enzymes necessary for

survival and sacrifice enzymes needed for future protection (as shown in figure 4)[19]. (21)

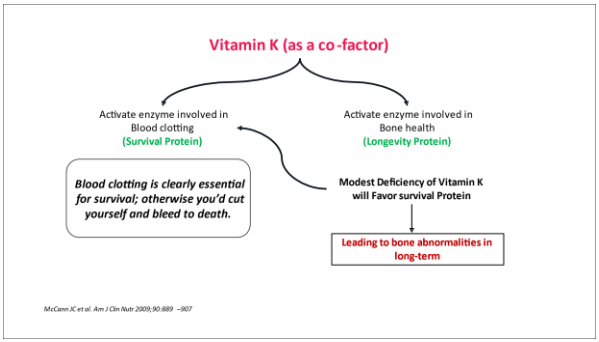

Figure 4: During the low intake of vitamin K[19]

These occurrences if not addressed for a long time, will lead to oxidative stress at cellular levels, causing chronic ailments. (21)(22) Thus, various strategies are required which address Hidden Hunger (micronutrient deficiency), prevent and treat complications of same. In today's scenario not only prevention of Hidden Hunger is essential, but addressing Hidden Hunger is equally important in the person suffering from lifestyle disorders (T2DM, Hypertension, Dyslipidaemia), which will help to get an optimum outcome of the targeted goals.

6. Key Tactics to treat and prevent Hidden Hunger and its Implications:

The sustainable development goal 2 (SDG2) recognized by the united nation (2016) aims to attain 'zero hunger by 2030 (*Mission Statement: "End hunger, achieve food security and improved nutrition and (22) (23) promote sustainable agriculture").*[20](24).In South Asia, improvement in addressing hidden hunger is too slow, if this trend continues achieving the goal of 'Zero Hunger' will be missed by 2030, specifically in India because of its large growing population share[7]. With the projected increase in population to 1 billion and 60 million (160 Crore) by 2050, India will have to face challenges of both insufficient food supply to the growing population and addressing the current nutritional gap[21].

The Key requisite interventional policies to address Hidden Hunger (MiND) in the short-term and long-term (between 5 to 10 years) have to include Food fortification, Bio-fortification, (23) and Micronutrient supplements, dietary diversification by eating seasonal However, there is an urgent need to bridge the nutrition gap with the provision of dietary supplements in powder or tablet form as a complementary strategy to fortification and biofortification.

fruits, vegetables, meat, and dairy products as a part of a balanced diet, details are given in Table 1[7, 22].

Table 1: Interventional Strategies to address Hidden Hunger

Interventional Strategies	**Supply chain Stage**	**Description**
Food fortification	Food processing level	The process of intentionally adding an essential micronutrient to food, to improve its nutritional quality and provide a public health benefit with minimal risk to health
Biofortification	Crop production /field level	The practise of increasing the bioavailable concentration of essential micronutrients in a harvested crop through genetic selection or agronomic intervention
Dietary Diversity	Individual	The greater the diversity of a diet increases chances of sufficiency in terms of micronutrient supply
Supplementation	Household-level	Concentrated solutions of a particular micronutrient to offer nutritional enhancement to an individual's diet (typically ingested orally as in tablet or powder form)

7. Clinical pieces of evidence on micronutrient supplements.

We searched relevant databases using different search engines and have included a few shreds of evidence of micronutrient supplements in adults showing beneficial outcomes especially in chronic diseases like diabetes, hypertension and obesity. The supplementation of essential micronutrients in the prevention and treatment of various chronic diseases is clinically proven, briefed in below-given table 2.

Table 2: Clinical evidence of micronutrients supplementation

Study	Design	No. of subjects	Treatment and Duration	Clinical Outcomes
Omar GMN et al.[23]	Randomized Controlled Trial	N=32 with T2DM (Age: > 18years)	Group 1: Micronutrient supplement + Metformin Group2: Metformin Alone, for 1 month.	Noteworthy reduction in FBS, PPBS, HbA1c, TC, TG, LDL, and VLDL and increase in HDL in Micronutrients + metformin group as compared to metformin alone group. Louca P et al. (24)(25)
Louca P et al.[24]	Community-Based Survey	N=4,45,850, (Age: >18 years)	Consistent dietary Additions (Multivitamin minerals, Omega-3 fatty acid, Vitamin D, Vitamin C) constantly for at least for 3 months. (25) (26)	Multivitamins had a lower risk of testing positive for SARS-CoV-2 by 13% (Odds Ratio: 0.87, p=0.0001)
Li Y et al.[25]	Randomized, double-blind, placebo-controlled trial	N=96, with obesity (Age: 18-55 years)	*Treatment Group (n=32):* Micronutrients Supplement. Calcium supplement (162 mg) group (n=32) Placebo group (n=32), for 26 weeks	Micronutrient supplement group had meaningfully Total cholesterol, lower Body weight, Fat Mass, and LDL-C, Body Mass Index, pointedly higher Resting Energy Expenditure, and HDL-C. (26)(27) In obese individuals, multivitamin and mineral supplementation could reduce Body Weight and fatness and improve serum lipid profiles, possibly through increased energy expenditure and fat oxidation. Mark SD et al. (25)
Mark SD et al.[26]	Randomized, double-blind, placebo-controlled trial	(N=3318, Age= 40-69 years) – Risk of Hypertension and Cerebrovascular disease.	***Treatment Groups:*** *1.* Micronutrients Supplement group. 2. (30)Placebo, For 72 months (6 years)	Supplementation with a multivitamin/ The mineral combination may have reduced mortality from cerebrovascular disease (29) (RR=0.63) and the prevalence of hypertension (RR=0. 93) in this rural population with a micronutrient-poor diet. **Supplemented group appearing advantage within the first year of the trial**

8. Conclusion

In summary, we need to address Hidden Hunger on top priority looking into its seriousness and higher prevalence of Hidden Hunger (MiND) in India. It has been observed that multiple micronutrients deficiency always co-exists even when the patient is identified for one major Vitamin or Mineral deficiency-related syndrome. We observed that chronic diseases like metabolic syndromes are associated with Hidden Hunger and thus this indicates that micronutrients can be a novel nutritional therapy to combat insulin resistance and MetS. The existing scenario of Hidden Hunger and its difficulties in India point towards, the importance has to be on educating people on the significance of nutrition-rich food with a balanced diet. (27)Most Health Care Practitioners (HCPs) would agree that majority of chronic diseases are results of poor lifestyle choices, so as HCPs it is important to educate and bring awareness among people about adopting and adherence to lifestyle changes (LSC), more importantly, reasonable intake of micronutrients (vital vitamins and minerals) as a part of a balanced diet. Because the role of micronutrients is very significant in the prevention and treatment of chronic ailments as they are working at cellular levels. (28) The clinical efficacy of micronutrients supplement has been established in the prevention and treatment of various chronic diseases. Key targeted interventional strategies to address Hidden Hunger (MiND) in the short-term and long-term (between 5 to 10 years) include Food fortification, Biofortification, and Micronutrient supplements, Dietary diversification. Priority is to be given in the treatment group. And it is necessary to find out the presence of Hidden Hunger (MiND) to ensure a better outcome of the treatment goal. The protocol needs to have a focus on both disease management & nutrition management (with therapeutic LSM & supplementations if needed) over only medical management. As a nation we all must follow the 'Zero Hunger goal that is set as interventional strategies, to regress the progression of lifestyle diseases.

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Conflicts of Interest: None

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