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MACRO- AND MICRONUTRIENT INTERACTIONS WITH MALNUTRITION AFTER NUTRITION EDUCATION INTERVENTION, SPECIFICALLY WITH REGARD TO NUTRITIONAL THERAPY AND DIET MODIFICATION

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Cite this article:
Mahesar S, Mahesar SM, Aftab S, Channa MJ, Lakho SA. Analysis of the Impact of Nutritional Therapy and Diet Modification in Hypertension Patients. AJMAHS. 2023; 1(1):22-31.

ABSTRACT

Nutrition and food have a crucial role in creating and sustaining optimum health. Physicians are interested in providing their patients with clinical nutrition therapy, but little is known about how they adhere to specific nutrition, in my opinion. Foods can contain a variety of various amounts and qualities of nourishing ingredients, which together make up nutrition. Patients in nutrition therapy learn how to make informed decisions once they select the proper type and quantity of food. Since many decades, the problem of nutritional anemia iron, vitamin A deficiency (VAD), disorders, and PEM has slowly evolved into a double nutritional problem, with the issue of macronutrients in Pakistan and developing countries specifically relating to the Protein Energy Malnutrition (PEM). One of the factors that affect the occurrence of chronic malnutrition is a lack of micronutrients like zinc and vitamin A. Lesch-Nyhan syndrome (LNS) is intended to avoid malnutrition, promote the baby's linear growth, and aid in the recovery from mild acute malnutrition.

Keywords: Malnutrition, Vitamin-A deficiency, Anemia, PEM, Food Nutrition, Under Nutrition, Nutritional Therapy, Modification in Diet.

INTRODUCTION

Maintaining health and preventing illness require a high-nutrient diet. To support energy intake and prevent excessive weight gain, a healthy diet should balance macronutrients (fats, proteins, and carbohydrates), micronutrients, and energy[1]. Modern advancements in the global food economy and a sedentary lifestyle are major contributors to the widespread malnutrition and health issues present in all emerging nations. The most sensitive form of malnutrition is undernutrition or a loss of an appropriate diet[2]. Numerous and frequently connected factors lead to deficiencies in the vitamins listed below. One of the main causes of inadequate vitamin intake is poverty, which results in poor purchasing power since low-income households are unable to purchase their own food. It will raise the possibility of persistent illnesses and premature death. Physicians are concerned with specific, scientifically-based clinical nutritional treatments for their patients[3]. Protein energy malnutrition (PEM) is a change in pathological circumstances emerges owing to lack of protein calories. Malnutrition is an abnormal physiological condition brought on by imbalanced, inadequate, or excessive ingestion of nutrients[4,5]. Malnutrition has a severe impact on developing economies[6]. More than 150 million young children under the age of five are malnourished worldwide. The majority of these children live in just three South Asian nations, namely India, Bangladesh, and Pakistan, where this threat is responsible for about 54 percent of child fatalities (UNICEF, 2016). Diseases have a strong relationship with unhealthful nutrition, ecological environment, and overall living standards. In terms of the malnourished population (22 percent), stunted growth (45 percent), wasting (10.5 percent), and death (8.1 percent) among children under the age of five, Pakistan ranks 11th out of 118 nations in the Global Hunger Index (GHI)[7]. Likewise, 58 percent of the population experiences a lack of food security, according to the National Nutrition Survey (2011). Women and children who are malnourished suffer from shortages in both macro- and micronutrients. A little over 31.5 percent of the kids are underweight, 43.7 percent are stunted, and 15.1% are fading away. Iron, zinc, vitamin A, and vitamin D deficits affect children (39-61 percent), pregnant women (38-69 percent), and non-pregnant women (26-68 percent) (GOP-Pakistan), 2011[8]. PEM is a significant issue for public health in developing nations. The main cause of PEM[5] is marasmus-kwashiorkor, which is connected to co-morbidities such anemia, TB, diarrhea, and malaria[9]. These causes can be fatal. PEM is a problem that has been addressed by a number of programs, some of which use food-based tactics such dietary changes, food enrichment, and supplementation[10]. Families move from rural areas to urban areas in search of greater economic opportunities. Such households frequently experience harsher living conditions than they would in communities[11]. According to estimates, iron deficiency is the most common micronutrient deficiency in the world. It causes anemia, which in turn contributes to a number of diseases, as well as direct impacts on the development and operation of many organs, particularly the brain. One of the six goals of the World Health Organization's (WHO) Inclusive Enactment Plan on Maternal, Infant, and

preschool Child Nutrition is to decrease iron deficiency anemia[12]. Nations with lack of resources, where a poor diet and a high infection rate combine to persistently impede iron absorption, iron deficiency and iron-deficiency anemia are more common. The WHO advises governments of nations with a high prevalence of anemia to develop programs of universal iron supplementation for children and pregnant women because such people can rarely afford iron-rich meals, especially those that include the more accessible hemoglobin iron[13]. 190 million children under the age of five suffer from vitamin A deficiency (VAD), which is linked to an increased risk of morbidity and mortality and, in the most severe cases, can result in blindness[14].

LITERATURE REVIEW

The most significant health issues affecting children, teenagers, and women in reproductive age groups are micronutrient deficiencies, particularly Vitamin A and iron deficiency leading to anemia. Worldwide, anemia affects over 43% of infants under the age of 6 years, 5 months[15] . Therapeutic diet At least 2.80 million preschoolers in 1–60 countries are affected by a deficiency (VAD), and at least 251 million people including adolescents and pregnant women have asymptomatic VAD[16]. Micronutrient insufficiency is a major factor that affects people of all ages in developed and developing nations, but it seems to have particularly devastating consequences on young children and toddlers. Micronutrients are essential for immunological responses at the cellular and humeral levels, cellular signaling and functioning, learning and cognitive abilities, work capacity, reproductive health, and even the evolution of microbial virulence[17,18]. They cannot be synthesized by the frame. The food plan must be used to make them available[19]. This highlights the knowledge of the significant role of micronutrients in the morbidity and mortality of neonates rather than negating the significance of protein-energy deficiency for infant mortality[20]. Two major developments in the knowledge of the global significance of malnutrition are[1] the statistics of 53 countries that show a direct correlation between protein-energy malnutrition (measured by underweight) and increased infant mortality rates, and[2] the results in 6 of 8 major diet studies. A supplementation experiment showing reductions in infant mortality of 20–50%[21]. Possible strategies include encouraging breastfeeding, providing micronutrient supplements, preventing protein-energy malnutrition as much as possible, and improving the general technique and hygiene of available weaning foods[22]. According to recent estimates, despite recent efforts in the prevention and management of these deficiencies, 1.2 billion people worldwide may be at risk for vitamin A, iodine, and/or iron insufficiency. Particularly in Southeast Asia and sub-Saharan Africa, the incidence is overwhelming. Zinc, foliate, and the B vitamins are among the other micronutrient deficits affecting public health. There are several micronutrient deficiencies present in various environments, indicating the need for honest approaches to assess and address multiple micronutrient malnutrition [23]. An iron deficiency is no longer the primary cause of anemia, one of the major global dietary concerns. However, it is also linked to lacks in other nutrients, such as riboflavin, folic acid, vitamins A, B6, and B12. While iron deficiency is a significant contributor to

anemia in developed nations, vitamin A, zinc, and folic acid deficiencies are significant nutritional contributors in poor nations in addition to iron deficiency[24]. Nutritional causes of anemia include insufficient dietary intake, particularly poor complementary feeding (CF) practices or iron mal-absorption, an increased iron cell count for everyone through rapid growth, and persistent blood loss due to blood disorders, similar to foliate and Vitamin B12 deficiencies. Early-life anemia has a negative long- and short-term impact on children's mental, physical, and social development; it leads to immune system abnormalities, poor motor, and cognitive growth[25].

NUTRITIONAL THERAPY OF PEM

Formulas made with milk are the cure for desire. Patient feeding management should be introduced as animal feed without restrictions at the start of nutritional therapy. After one week, consumption costs for children must reach 175 kcal/kg and 4 g of protein, while for adults; they must reach 60 kcal/kg and a few g of protein. Multivitamins should be taken daily and with meals to help with it. The best methods for preventing chronic diseases are still poverty eradication, population growth, and nutrition education of PEM[26].

The food supplies to be high in calories, high in quality, appropriately sourced protein. Animal based foods are not necessary **(Fig 1)**[27].

- **Energy:** The infant must consume between 150 and 200 Kcal/Kg of current body weight each day. Children under 2 years old should receive 200 Kcal/Kg of body weight, whereas older children should receive between 135 and 175 Kcal/Kg of body weight[28].
- **Protein:** 5 g of protein per kg of body weight per day must be accepted for the current weight. If animal protein is the primary source, the energy from protein should make up 10% of the total daily calories computed[29].

Figure 1: Vegetarian Food Pyramid

- **Fats:** Unsaturated fat worsens diarrhea and makes about 40% of the total energy consumed by children[30].
- **Electrolytes:** For a two-week period, a daily addition of potassium chloride (2.4g) and magnesium chloride (0.5g) to the weight loss program is required[31].
- **Vitamins:** If vitamin A deficiency is present, oral administration of a single dose of 50,000 IU of fat-soluble vitamin A must be accepted, along with the use of 500 measures daily[32].

SUGGESTED FOODS FOR PEM

A food plan, which gives all the vital vitamins inadequate quantities to meet your necessities, is suitable for balanced food plan. You want a plan to select an ok weight-reduction plan so simple

and appealing that everyone along with you, a young student moreover the elderly family members can understand and follow it. The experts have formulated this type of plan. This applied plan, called meals manual, helps to make sure exact nutrition via right meals choice **(Fig 2)**[33].

Food Group	Foods Included	Main Nutrients
1.	Cereals and their products – Rice, wheat, jowar, bajra, ragi, maize, other millets and their products	Energy, protein, iron, thiamin, niacin, fibre
2.	Protein foods – Dals, legumes, milk, eggs, fish, poultry, meat and their products	Proteins, energy, calcium, iron, B-complex vitamins, invisible fat, fibre
3.	Protective vegetables and fruits – (*a*) All green leafy vegetables, orange-yellow fruits and vegetables	Carotenoids, vitamin C, iron, calcium, folic acid, fibre
	(*b*) Vit. C-rich fruits and vegetables	Vitamin C, carotene, fibre
4.	Other vegetables and fruits – All gourds, beans, peas, potatoes, onions, etc., all other fruits — banana, apple, melons, grapes, etc.	Supplementary sources of minerals, vitamins and fibre
5.	Oils, fats, sugars and their products – Oils, ghee, butter, vanaspati, sugar, jaggery, jams, syrups	Energy, fat, essential fatty acids Energy

Figure 2: Different food group and their main nutrients

Protein Food

This group includes the most important sources of proteins in our dietary, consisting of dals, complete pulses, milk, eggs, fish, hen and meat. A 0.33 or more of our protein requirement is met by way of those foods. These foods are not handiest correct resources of proteins, but additionally of minerals and nutrients. Dals, eggs, and meat are true sources of iron.

In addition, milk is a very good source of calcium and riboflavin. Milk, eggs and liver are wealthy in diet A. These foods additionally supply a part of our requirement of the B nutrients. The meals on this group are numerous of their composition. Therefore, the serving length of those meals varies as given underneath:

- Dals and entire legumes or pulses 25 g.
- Milk and milk preparations 1 medium cup or one hundred fifty ml
- Egg (medium size 50–52g)
- Fish, meat and chicken 25 to 30 g
- Increasing the range of food to fulfill calorie and protein requirements.
- In addition to ghee 1-2tsp to boom energy without growing bulk.
- Consumption of sugar can be improved to growth the energy inside the eating regimen.
- The child also can take delivery of cereal and pulse mixture.
- If the affected person can manage to pay for milk, egg and skim milk may be included.

DISCUSSION

According to the current situation, pre mature births, a greater impermanence, impaired mental development, an increased risk of recurrent diseases, and persistent infections might result from inadequate % of all vitamin and mineral status. Poor nutrition is linked to 45child fatalities.

Malnutrition is primarily brought on by poverty since there is not enough food available **(Fig 3)**[34]. Ignorance can also contribute to poor nutrition and lack of food, as well as unsanitary living conditions and frequent infections.

Foods contain many nutrients. When appropriate quantities of the specific form of food are not eaten, many vital nutrients are not available in good enough quantities to the body. This leads to several deficiency diseases. Some common deficiency diseases determined are Protein

Energy Malnutrition (PEM), vitamin A deficiency, anemia because of lack or poor absorption of iron, and vitamin B complex deficiency.

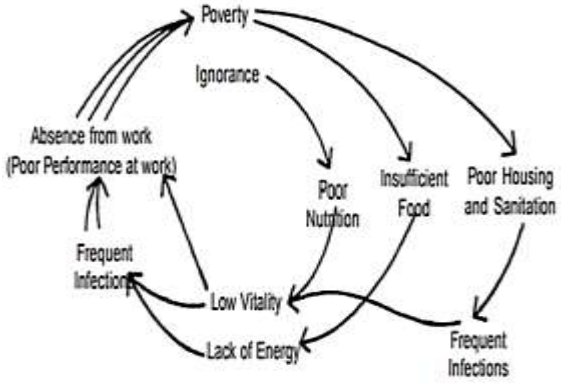

Figure 3: The Vicious Cycle of poverty

Protein Energy Malnutrition (PEM):

Protein Energy Malnutrition (PEM) or Protein Calorie Malnutrition (PCM) is the term used to describe a range of nutritional problems brought on by insufficient amounts of protein and calories in the diet. (PEM) is defined by the WHO as "an imbalance between the supply of protein and energy and the body's demand for them to ensure prime boom and function." One of the names of the disorder related to PEM is 'Kwashiorkor', a term utilized by Cicely Williams in 1934 to explain this circumstance even as working in West Africa. According to the Ghanaian language, Kwashiorkor syndrome is "the ailment a child develops while every other toddler is born." When there is not enough protein in the diet, kwashiorkor develops. However, there are sufficient amounts of calories or power derived from carbohydrate[35].

However, children experience a condition known as "marasmus" over extended periods of time when both protein and energy are insufficient **(Fig 4)**[36].

Due to the growth failure associated with nutritional marasmus, growth may be limited. Additionally, the body tissues' protein is depleted for strength because there is not enough protein and energy in the diet, leaving the youngster with only skin and bone. The young child is visibly hungry and awake, but not necessarily[37].

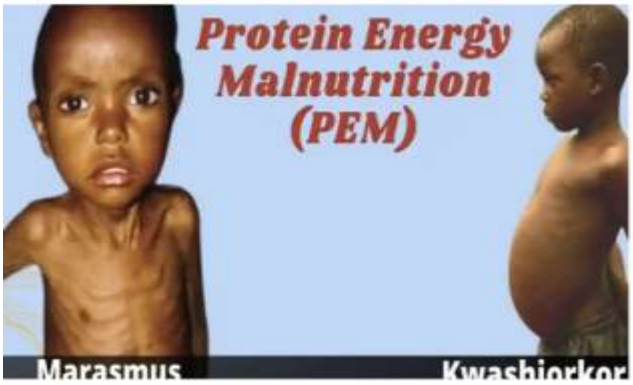

Figure 4: Kwashiorkor and Marasmus

Vitamin A Deficiency

Besides PEM another essential dietary concern is vitamin A deficiency. Direct result of lack of vitamin A is ingenious and perceptive impairment, eventually cause blindness **(Fig 5)**[38].

Figure 5: Deficiency of Vitamin A

Up-to-date survey of adolescents estimates that three to 8 consistent with cent of all preschool adolescents and 10 to 15 in keeping with cent of all school children suffer from vitamin A insufficiency. Symptoms may include dryness of the eye's conjunctiva and the cornea's cloudiness. At this level, night, blindness may be determined[39].

Iron Deficiency Anemia

Because of the lower hemoglobin level in the blood, anemia results in less oxygen reaching the cells. As a result, there is a noticeable decline in bodily functions, which lowers a man's or woman's ability to run. Considering the excessively high frequency of iron deficiency anemia. [(40)] Improvements in nutritional conduct can lessen the occurrence of anemia. These consist of leafy greens, which contain iron; vitamin C and calcium; and pulses, which provide protein, iron and B vitamins[41].

Iron-deficiency anemia can cause red blood cells to appear small, oval-shaped, and faded beneath a microscope. Iron deficiency anemia a character with iron-deficiency anemia might also have:

Faded skin, tinnitus, and adjustments in the sense of taste, discomfort, a desire to consume ice, sores or ulcers at the corners of their mouth[42].

Vitamin A rich green and yellow vegetables and fruits are rich sources of pro-nutrition with vitamin A, and includes all darkish inexperienced leafy veggies such as math (amaranth), and palak (spinach), methi (fenugreek), radish leaves, colocasia leaves, and so forth. It additionally includes mild green leafy greens which include cabbage, onion tops, and lettuce, and yellow-orange greens and culmination which include carrots, pumpkin, mangoes, papaya, oranges, cantaloupe (turbuz), and apricots[43].

Additionally, the dark green leafy vegetables meet around 50% of the daily need for vitamin C. portion size as a recommended amount of servings, one serving is 50 g of the greens or fruit or half of a Katori of sliced vegetables or fruit. In this group, it is advised to have one or more afternoon portions. In actuality, you may include dark-green leafy vegetables three times each week, yellow-orange vegetables twice per week, and light-green veggies once per week.

Recommendation for PEM

(a) Continue breastfeeding for as long as possible, but once the baby reaches the appropriate age, introduce complementary foods.

(b) Use locally available animal and vegetable protein sources to feed the child.

(c) Inform the mother and other members of the family group on a healthy diet for children.

Nutritional Therapy in Anemia

For instance, they are able to eat lots of iron-rich meals:

Meat, poultry, and fish, as well as leafy green vegetables like kale and broccoli. Legumes include pinto and black-eyed peas. Pasta, grains, rice, and cereals fortified with iron.

A doctor may recommend a complicated weight-loss program during pregnancy to address dietary-deficiency anemia that includes lots of meals that are fortified with minerals and are high in those minerals. If appropriate, they could also

recommend vitamins. Both the mother and the fetus require iron. Anemia can develop if a pregnant woman does not consume adequate iron.

Laboratory Investigation

Complete blood count (CBC): This blood test shows the number of blood cells, the hemoglobin concentration, the hematocrit level, and the implied corpuscular volume.

Serum iron levels: The amount of iron in the blood is determined by this test. Whether or not a person has low iron saturation levels may be determined by their iron level.

Peripheral smear: In this test, pink blood cells are examined under a microscope to check if they stand out as being smaller and paler than usual.

Check for transferrin or TIBC: This test will measure the level of transferrin in the blood.
If someone who is anemic can manage their anemia by losing weight. Transferrin or TIBC check: if someone is anemic can manage their anemia, selecting foods that are high in iron. Red meat, chicken, and red flesh Seafood, Beans, dark, young leafy vegetables, such as spinach, Dried fruit, including raisins and apricots, as well as breads, pastas, and cereals fortified with iron.

CONCLUSION

Individualized meal planning is essential for obtaining the proper proportion of macronutrients in a nutritional program. The meals and eating habits should be chosen in accordance with the patient's preferences, cultural practices, geographic region, product accessibility, and adaptability. It must be thoroughly explained to the patient's needs while paying close attention to their right strength and stability, as well as being equivalent to the prescription treatment that the patient is receiving and which is appropriate for their health. Patients should be reminded to eat at the right time as directed by their doctor. They are cautioned against skipping meals because doing so could result in macro- and micronutrient deficiencies. Comprehensive nutrition therapy should be a quite essential a part of control of PEM, anemia and vitamin A of all the subjects. Due to lack of sources and lack of knowledge amongst sufferers, doctors, policy makers and society as a whole, imparting such therapy to all of the patients with malnutrition can be challenging. It is suggested that the policy makers recognize the importance of vitamins medication and put sources in schooling and developing registered dietitians, so that as part of routine amendment therapy, it is able to be supplied to the patient. This approach can in turn lessen the load of malnutrition related complications.

AUTHORS CONTRIBUTION

SNM and SMS searched the literature and synthesized and edited the manuscript and MS, MJC and SA helped in literature search and review and edited the manuscript and contributes to the literature search. All authors read and approved the final version of the manuscript.

ABBREVIATIONS
PEM: Protein energy malnutrition
PCM: Protein calorie malnutrition
CBC: Complete blood count
WHO: World health organization.
VAD: Vitamin A deficiency.

LNS: Lesch-Nyhan syndrome.
GHI: Global Hunger Index.
TIBC: Total iron binding capacity.

FUNDING: No funding

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