International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Impact of Nutritional Deficiencies on Hypothyroidism Condition: A Meta Analysis

Keerthi H Pillai

Research Scholar, Department of Home Science, Government college for women, Thiruvananthapuram, Kerala, India.

ABSTRACT

Purpose: Aim of this study is to analyse the nutritional deficiencies among hypothyroidism patients, and to understand the role each nutrient in maintaining the thyroid health and to understand the consequences of nutrient deficiencies on this population. Study Design/Methodology/Approach: A comprehensive review of existing literature was conducted using databases such as PubMed, Semantic Reader, and Semantic Scholar. The search was conducted using following keywords such as hypothyroidism, nutritional deficiencies, and its effect on thyroid disorders. The analysis included various studies assessing the relationship between nutritional status and thyroid function. Findings: The investigation revealed that hypothyroidism patients frequently lack critical nutrients, such as iodine, selenium, iron, zinc, and vitamins D and A. Each nutrient plays a vital role in thyroid hormone synthesis and overall endocrine function. Iodine is essential for thyroid hormone synthesis, while selenium act as a cofactor for the conversion of T4 to T3. Iron is important for the synthesis of thyroid peroxidase enzyme that helps in iodination of thyroglobulin. Nutritional deficiencies also cause other health complications such as goitre, osteoporosis, anaemia, heart problems and problems with immune response. Women reproductive health is another complication that causes irregular menstruation and infertility and pregnancy complications such as miscarriage. Originality/Value: Important highlights of this study include the relation between nutrients and thyroid health especially in case of hypothyroidism. Study also shows the relevance of various intervention programmes in maintaining the thyroid health which is becoming a global concern. Interventions include providing awareness about important nutrients for good thyroid and nutrition counselling that help them to manage the thyroid health more effectively.

Keywords: Hypothyroidism, Nutritional deficiencies, iodination, Osteoporosis, miscarriage.

1. Introduction:

Thyroid hormone performs various functions in all cell types. Thyroid malfunction is prevalent across the globe which is controllable and treatable[10]. Among them most common is Hypothyroidism. Hypothyroidism is a condition where body's thyroid gland does not produce enough hormones to meet body's needs. This condition is also referred to as under active thyroid [11]. There are various reasons that causes hypothyroidism. Genetic conditions and environmental factors are the two main classes of causes. Environmental factors like diet, exercise plays very important role in maintaining the thyroid. So proper intake of diet that contain enough nutrients are essential for proper thyroid.

Major nutrients especially vitamins like Vitamin D and minerals such as Iodine, Iron, Selenium, Zinc are the major trace elements for thyroid. Micronutrients, mostly iodine and selenium are required for the

synthesis of thyroid hormone and function [1]. These elements deficiency affects the thyroid function and leads to thyroid disorders most frequently Hypothyroidism [2]. Maintaining a physiological balance of all these nutrients through a proper diet or taking nutraceuticals is essential to prevent thyroid disorders and for overall health.[3].

Thyroid gland is dependent on iodine to synthesize hormones, Selenium which is an important element is a cofactor of deiodinases that helps in t3 synthesis. Zinc helps in carrying various thyroid activities and contributes to hormonal binding. Vitamin A also helps in thyroid function along with its various activities. Magnesium with its deficiency causes inflammation and oxidative stress which affects the thyroid gland. Vitamin D is associated with Hashimoto thyroiditis [2]. These minerals and vitamins and its influence on thyroid gland helps in reducing all the thyroid related problems if proper diet and intervention is taken.

2. Objectives of the study :

- To analyse the nutritional deficiencies among hypothyroidism patients.
- To understand the role of each nutrient in maintaining the thyroid health.
- To understand the consequences of nutrients deficiency among hypothyroidism patients.

3. Methodology:

This study was carried out by reviewing various databases using the keywords Hypothyroidism nutritional deficiencies, nutrients and its effects, thyroid disorders. PubMed, Semantic Reader, Semantic scholar was searched to find studies that assess the relation between Nutritional deficiencies and hypothyroidism.

4. Important Nutrients for Thyroid

Thyroid gland is the endocrine gland that performs many important functions in our body. Basal metabolic rate in our body that is the conversion of food to energy and maintaining the body temperature, maintaining the growth of infants during pregnancy especially foetal brain development, Development of new cells and damage of old cells , proper functioning of Heart are the main functions of thyroid gland. For the thyroid gland to perform all these functions hormone production that is thyroid hormone production should be proper. Thyroid Hormone production is dependent on several factors within our body. One of them can be genetic predisposition other one is environmental factors such as diet, exercise. These environmental factors can be controlled and maintained to an extent. So, a diet with proper nutrients to some extend helps thyroid to maintain its hormone production.

Important nutrients that is good for thyroid are basically the Vitamins like Vitamin D and minerals especially trace elements like Iron, Iodine, Selenium, Zinc.

Iron :

Iron is a very important micronutrient that helps to perform several important functions in our body. Iron deficiency is one of the major problems worldwide especially affecting pregnant women, adolescent girls, women of child bearing age[11,12]. Prevalence of iron deficiency is high among thyroid patients especially among hypothyroidism patients. While considering the iron status for studying the thyroid hormone synthesis females belonging to reproductive age group who have iron loss through menstruation is taken for study[7]. Iron deficiency is a condition were body lacks enough amount of iron especially in blood . In blood it is part of haemoglobin which is a very important protein that helps in the transport of oxygen from lungs to other organs and parts of the body. Iron deficiency affects this major process of

oxygen transport . It also affects the thyroid especially thyroid peroxidase enzyme[13,14]. Anaemia is one of the major problems of iron deficiency.

Iron deficiency affects the thyroid causing thyroid dysfunction. Iron deficiency basically affects the thyroid peroxidase enzyme that helps in iodination of tyrosine residues in thyroglobulin. Thyroglobulin is a precursor for thyroid hormone synthesis. Iron deficiency affects the hypothalamus pituitary thyroid axis that causes altered thyroid hormone levels that leads to further complications and other thyroid disorders[5]. Most of the studies were carried out on pregnant women and women of child bearing age . There prevalence of anaemia is high due to iron deficiency. Role of iron in thyroid basically lies in thyroid hormone synthesis. So, deficiency of Iron definitely causes complications in thyroid functions especially Hypothyroidism.

Iodine :

Element Iodine was discovered by Bernard Courtois and louis joseph gay lussac and Sir Humphry Davy in 1811[17].Iodine is another important element that affects the thyroid metabolism. Iodine deficiency was common in the world that led to a group of problems and together they were referred to as iodine deficiency disorders in short IDD. IDD include goitre , cretinism, myxedematous cretinism , mental retardation, hypothyroidism[15]. Consuming Iodine rich foods will help to reduce this problem to some extent. Iodine rich foods include mostly sea foods like sea fish, sea weed, shell fish and dairy products and egg, brown algae (Kelps), bread and food with iodinated salt[17]. Randomised controlled intervention trials were carried out in iodine and iron deficient populations. And it was found out that providing iron along with iodine gives better results and shows improvements in thyroid function when compared to providing iodine alone. Earlier iodine deficiency was considered to be one of the major reasons for hypothyroidism . As part of that , a global iodised salt programme implemented to reduce this iodine deficiency and related hypothyroidism. Consuming iodine salt along with vitamin A supplementation is found to enhance the thyroid function and thyroid size[8].

Iodine plays a very important role in thyroid hormone synthesis. Iodine is absorbed in our body as iodide a form of iodine from the blood stream. Thyroid gland has proteins called thyroglobulin that contain tyrosine residues. These iodine binds with tyrosine residues and forms a gel like structure. These tyrosine with iodine later converts T4 to T3. And until signal is received for the release of thyroid hormones iodine is stored within this colloid. Release of thyroid hormones are controlled by hypothalamus and pituitary. They release Thyroid stimulating hormones that stimulates the release of thyroid hormones. Deficiency of iodine and iron affects the release of thyroid stimulating hormones and there by its release. Major component of T4 and T3 itself is iodine so deficiency of iodine leads to improper synthesis of T4 and T3 thyroid hormones.

Iodine supplementation in the form of iodised salt and iodised vegetable oil sometimes improves the condition in both developed and developing countries were both have this problem. A reduction in dietary iodine content is associated with other conditions like hypertension where they were recommended to reduce the consumption of iodised salt[1]. Double fortified oil or food products containing both iron and iodine is a good solution to improve the thyroid function and also makes all the important nutrients available from a single product.

Selenium:

Second important trace element for thyroid function and activation is selenium[6]. The normal thyroid gland retains higher concentration of selenium making it available when needed. It is usually expressed as selenocysteine proteins. Even in the circumstances of inadequate supply of selenium thyroid gland

retains selenium[5]. There are three different selenium dependent enzymes .They are Type 1, type 2, type 3 iodothyronine deiodinases that can activate and inactivate thyroid hormones. This makes selenium one of the essential micronutrients for normal growth and development. Selenium which is found in the form of selenocysteine is a very important catalyst that protect the thyroid from free radical damage[1]. Deiodination is important for the activation and inactivation of T4 and T3 in thyroid gland. Glutathione peroxidase helps in thyroglobulin biosynthesis an important follicle of thyroid hormones for its synthesis, storage and secretion[7].

Consumption of selenium in adequate amount will help proper thyroid hormone synthesis, metabolism , and protects the thyroid gland from damage by excessive iodide exposure. Deficiency of both selenium and iodine causes myxedematous cretinism to develop. Those areas were both selenium and iodine deficiency were common supplementation of iodine first is mandatory before selenium to prevent hypothyroidism. Usually, persons under special circumstances like parenteral nutrition for long term, cystic fibrosis, phenylketonuria, develop both deficiency of elements. There are several selenocysteine proteins examples are glutathione peroxidase, deiodinases, thioredoxin[5]. The thyroid gland of humans has highest selenium content per gram of tissue among all organs. Both deficiency of selenium and iodine is found in central Zaire region developing myxedematous form of endemic cretinism. Though selenium helps in translation of selenocysteine proteins there is no direct relation between both selenium and selenoprotein activities. This is because there are some other factors involved in selenium dependent expression control. This can be thyroid carcinoma, autoimmune disease.[6].

Some studies were carried out to assess the impact of supplementation of micronutrients on iodine status or thyroid hormone synthesis. Among 57 studies twenty intervention studies and thirty-seven observational studies were included. This was a pre designed , piloted data extraction that is done from individual studies. A positive association was found between concentrations of selenium , zinc, and iron and also with iodine status from observational evidence[9].

Vitamin D :

Vitamin D is one of the fat-soluble vitamins which is produced in our skin with the help of sunlight. Hence it is also referred to as sunshine vitamin. Study based on the review carried out in Pubmed considers two types of vitamin: vitamins D2 and vitamin D3. Vitamin D3 is known as cholecalciferol and D2 is referred to as ergocalciferol. Vitamin D3 that is cholecalciferol is synthesized in skin. Vitamin D is present in our skin in the form of 7 – dehydrocholesterol. This when exposed to ultraviolet B ray is converted to vitamin D3. Vitamin D is also available from dietary sources like fatty fish , some types of plants and fungi[4]. Fish liver oil or cod liver oil is also rich in vitamin D. Vitamin D has many important physiological roles in our body. One among them is calcium absorption. Calcium absorption and vitamin D are correlated to each other. A person with vitamin D deficiency, there calcium absorption won't be proper . So, they develop problems associated with bone and conditions like osteoporosis. This study shows the relation between vitamin D in pathogenesis of hypothyroidism[4]. Deficiency of vitamin D is associated with presence of anti-thyroid antibodies leading to problems like hypothyroidism. So those who have hypothyroidism have more chances of low serum vitamin D level and associated bone problems like osteoporosis.

Major findings of this study shows that vitamin D deficiency is higher in overt and subclinical hypothyroidism when compared to euthyroidism. Prevalence of vitamin D deficiency is more in Auto immune thyroid disease when compared to healthy individuals. Another major finding of the study is that patients with elevated level of anti-thyroid antibodies had lower levels of 25(OH)D3[4].

Another study considers vitamin D level of < 25nmol/L as the criteria level. Total of 70% of them suffered from Hypothyroidism[18]. Study involving 161 hypothyroid patients and 162 healthy control groups criteria level taken was < 75 nmol/L and found out that hypothyroid patients are 91.9% [19].

There are several autoimmune thyroid diseases . Among them Hypothyroidism is the most common organ specific one . These are diseases involving genes resulting from the combination of genetic pre disposition and environmental factors like iodine , selenium, drugs, irradiation, smoking, infections, stress etc. All these genes involve lymphocytic infiltration and leads to production of thyroid specific auto antibodies.

Hypothyroidism and all other autoimmune thyroid diseases are T cell mediated . While exerting an inhibitory action on adaptive immune system vitamin D plays a significant role in improving the innate response on immune system. 1,25(OH)2 D has the ability to supress the adaptive immune system and enhances the tolerance level of immune system. That is a positive factor for a number of auto immune diseases including Hypothyroidism[4].

Vitamin A: Beta carotene - precursor of vitamin A:

Beta carotene is another form of vitamin A which is a fat-soluble vitamin. It is mostly present in red- or orange-coloured fruits and vegetables. They are known as the precursor of vitamin A because they are converted to vitamin A biologically. Vitamin A or beta carotene is also an important Antioxidant. It prevents the oxidation of cells by activated oxygen and protect the cells from damaging. They are also known as phytochemicals. That is it protects various enzymes that is involved in several mechanisms from free radical damage.

Several recent studies have shown a positive association between vitamin A or beta carotene and thyroid function. Not only it plays a significant role in reducing conditions like cancer , cardiovascular diseases, neurological diseases due to its antioxidant properties but also helps in autoimmune conditions like hypothyroidism. Vitamin A derivatives are expected to be as a potential therapeutic option for thyroid problems. Also, hormone thyroxine produced by thyroid gland helps in conversion of beta carotene to vitamin A. From this study it was found out that vitamin A have potential therapeutic benefits on different thyroid disorders[10]. Among them effect on hypothyroidism is taken into account. Intake of vitamin A enhances free T4 concentrations among hypothyroidism patients[20].

Consequences of Nutritional deficiencies among hypothyroidism patients:

Nutritional deficiencies especially among hypothyroidism patients worsens their condition in a very bad way. They develop several complications like goitre, heart problems, anaemia, skin problems, low immunity making them susceptible to diseases.

- Goitre : It is a condition as a result of iodine deficiency that causes enlargement of thyroid gland.
- Vitamin D deficiency affects their bones and skin causing osteoporosis.
- Iron deficiency causes anaemia.
- Heart complications can develop through nutrition deficiency in hypothyroidism patients.
- Complications of irregular menstruation and nutrition deficiency worsens this condition that shows how weak that person's body is .And this will further lead to Infertility in serious cases and also prone to develop many pregnancy complications like miscarriage etc.
- Digestive functions are affected especially causes constipation . Nutrient deficiency can increase this symptom.
- Deficiencies particularly selenium and zinc increase the risk of autoimmune disorders, like Hashimoto thyroiditis.

Several complications can develop among thyroid patients dur to nutritional deficiencies. So proper diet and Nutrition intervention is necessary for good thyroid.

5. CONCLUSION

The interplay between nutrition and thyroid is one of the critical areas of study. It is critical especially in the context of hypothyroidism, which remains a prevalent disorder globally. This paper has examined the role of micronutrients in thyroid and how its deficiency affects the thyroid gland. The findings of this study show how important vitamins and minerals are to maintain a proper thyroid health.

The investigation into nutritional deficiencies among hypothyroidism patients found that it follows a trend that is most of them lack important nutrients such as iodine, selenium, Iron, Zinc among vitamins vitamin D. Each of these nutrients plays a vital role in thyroid hormone synthesis, metabolism, and overall endocrine function. For instance, Iodine is important for thyroid hormone synthesis its deficiency leads to development of several conditions like goitre and exacerbated hypothyroidism condition. Similarly, selenium acts as a cofactor for enzymes that facilitate the conversion of thyroid hormones, while iron is crucial for the synthesis of thyroid peroxidase, an enzyme necessary for the iodination of thyroglobulin.

The impact of these deficiencies extends beyond thyroid function. It leads to a cascade of health issues such as anaemia, osteoporosis, cardiovascular complications, and impaired immune response. This relation of hypothyroidism with different nutrients emphasizes the need for healthcare providers to consider nutritional status as a critical component of managing hypothyroidism. The impact of nutritional deficiencies extends to the reproductive health of an individual. Women with hypothyroidism may suffer from irregular menstruation, infertility, and increased risk of pregnancy such as miscarriage. So addressing the nutritional needs in this population is not only good for there thyroid but also for their reproductive health.

Recommendations for Nutritional Interventions

From the findings of this study, it is imperative to implement a comprehensive nutritional assessments and interventions for individuals diagnosed with hypothyroidism. Healthcare providers should prioritize education that addresses the importance of a balanced diet rich in iodine, selenium, iron, zinc, and vitamins D and A. Proper nutrition counselling should be provided for the hypothyroidism patients so that they can implement their management plan more efficiently.

In addition to this public health initiatives should focus on providing more awareness about the significance of micronutrient sufficiency in thyroid health. Various strategies should include promoting consumption of iron and iodine rich foods. Encourage them to consume iodized salt and also depend on supplements in case of deficiencies. In addition to this future research should consider to explore more on the relation between nutrition and thyroid health. Especially research on different population belonging to different environments should take into account.

In conclusion prioritize nutritional health among thyroid patients and implement proper interventions to enhance their thyroid health. This will help to improve the conditions of hypothyroidism patients.

References

1. Triggiani, V., Tafaro, E., Giagulli, V.A., Sabbà, C., Resta, F., Licchelli, B., & Guastamacchia, E. , “Role of iodine, selenium and other micronutrients in thyroid function and disorders. Endocrine, metabolic & immune disorders drug targets”, August 2009, 9 (3), 277-94 .
2. Hungria, S., Sena, X., & Marques, Y.L. , “Nutritional Deficiencies and Hypothyroidism”, 2020.

3. Trukhan, D.I., Druk, I.V., & Viktorova, I.A., "Not iodine alone. Role of selenium, zinc, vitamins A, C, E in the physiology and pathology of the thyroid gland, Clinical review for general practice", April 2024.
4. Kim, D. , "The Role of Vitamin D in Thyroid Diseases". International Journal of Molecular Sciences", September 2017, 18, 1949 .
5. Zimmermann, M.B., & Köhrle, J., "The impact of iron and selenium deficiencies on iodine and thyroid metabolism: biochemistry and relevance to public health". , Thyroid : official journal of the American Thyroid Association, October 2002 , 12 (10), 867-78 .
6. Köhrle J. "The trace element selenium and the thyroid gland". Biochimie, May 1999, 81(5), 527–533.
7. Köhrle J. , "Selenium, Iodine and Iron-Essential Trace Elements for Thyroid Hormone Synthesis and Metabolism". *International journal of molecular sciences*, February 2023, *24*(4), 3393.
8. Hess, S.Y., " The impact of common micronutrient deficiencies on iodine and thyroid metabolism: the evidence from human studies. Best practice & research", Clinical endocrinology & metabolism, February 2010, 24 (1), 117-32 .
9. O'Kane, S.M., Mulhern, M.S., Pourshahidi, L.K., Strain, J.J., & Yeates, A.J., "Micronutrients, iodine status and concentrations of thyroid hormones: a systematic review", Nutrition Reviews, June 2018, 76, 418–431.
10. Farasati Far, B., Broomand Lomer, N., Gharedaghi, H., Sahrai, H., Mahmoudvand, G., & Karimi Rouzbahani, A. , " Is beta-carotene consumption associated with thyroid hormone levels?", Frontiers in Endocrinology, May 2023, 14.
11. Garofalo, V., Condorelli, R. A., Cannarella, R., Aversa, A., Calogero, A. E., & La Vignera, S., "Relationship between Iron Deficiency and Thyroid Function: A Systematic Review and Meta-Analysis.", November 2023, *Nutrients*, *15*(22), 4790.
12. Kumar S.B., Arnipalli S.R., Mehta P., Carrau S., Ziouzenkova O. Iron Deficiency Anemia: Efficacy and Limitations of Nutritional and Comprehensive Mitigation Strategies. Nutrients. 2022;14:2976. doi: 10.3390/nu14142976.
13. Zimmermann M.B., Hurrell R.F. Nutritional iron deficiency, Lancet, 2007;370:511–520. doi: 10.1016/S0140-6736(07)61235-5.
14. Pasricha S.R., Tye-Din J., Muckenthaler M.U., Swinkels D.W., Iron deficiency, Lancet, 2021;397:233–248. doi: 10.1016/S0140-6736(20)32594-0.
15. Hess S.Y., Zimmermann M.B., Arnold M., Langhans W., Hurrell R.F. , "Iron deficiency anemia reduces thyroid peroxidase activity in rats". , J. Nutr. , 2002;132:1951–1955. doi: 10.1093/jn/132.7.1951.
16. Creswell J Eastman, M.D. and Michael B Zimmermann, M.D., "The Iodine Deficiency Disorders", National library of medicine, February 2018.
17. Hatch Mcchesney A, Lieberman H.R. , "Iodine and Iodine deficiency : A Comprehensive review of a Re emerging Issue ", 2022, Nutrients, 14.
18. Kivity, S.; Agmon-Levin, N.; Zisappl, M.; Shapira, Y.; Nagy, E.V.; Dankó, K.; Szekanecz, Z.; Langevitz, P.;Shoenfeld, Y. Vitamin D and autoimmune thyroid diseases. Cell. Mol. Immunol. 2011, 8, 243–247
19. Tamer, G.; Arik, S.; Tamer, I.; Coksert, D. Relative vitamin D insufficiency in Hashimoto's thyroiditis. Thyroid, 2011, 21, 891–896.

20. Rabbani E, Golgiri F, Janani L, Moradi N, Fallah S, Abiri B, et al. Randomizedstudy of the effects of zinc, vitamin a, and magnesium co-supplementation on thyroid function, oxidative stress, and hs-CRP in patients with hypothyroidism. Biol Trace Element Res (2021) 199(11):4074–83.
21. Zhttps://doi.org/10.3390/nu15224790
22. https://medlineplus.gov
23. https://doi.org/10.3390/ijms24043393
24. https://doi.org/10.1016/s0300-9084(99)80105-9