Review Article

Long term effect of nutrition on thyroid disease

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INTRODUCTION

Statistics show that the thyroid gland is the commonest organ where autoimmune diseases occur. Research shows that postmortem findings of 40% and 20% of white males and females in the United States, respectively, indicated the presence of lymphocytic infiltration of the thyroid gland which is also similar to the rates reported by a study from the United Kingdom. Lower rates by half were noticed in black Americans and Japanese as...
reported by the same study, Hashimoto was the first to report this phenomenon as he also noticed the presence of circulating antibodies against the thyroid gland naming it autoimmune thyroid disease (AITD). Many factors as genetics, environment, and nutrition contribute to the development of AITD.

Many forms of thyroid diseases have been classified under AITD. These include hyperthyroidism or commonly known as Grave’s disease, and hypothyroidism commonly identified as Hashimoto’s thyroiditis. The mechanism of hypothyroidism in the latter is that the thyroid gland is destroyed by abnormal activation of an autoimmune cascade leading to a state of impaired synthesis and production of thyroid hormones which can clinically be noticed by the presence of generalized fatigue, constipation, weight gain, reduced tolerability to cold and exercise, depression and dry skin. It has been estimated that this disease affects around 2% of male and 15% of female patients that are usually aged over 60 years old. Thyroid peroxidase (TPO), which is an essential enzyme for the synthesis of thyroid hormones by oxidation of iodide to iodine, is affected by the presence of antibodies against it in this disease. Similarly, other antibodies have been indicated to attack another protein, namely thyroglobulin (Tg) which is also essential in the process of thyroid hormone synthesis. Grave’s disease, on the other hand, there is hyperthyroidism which simply refers to a state of increased thyroid hormones leading to a cascade of symptoms as irritability, intolerability to hot weather, weight loss, rapid heartbeats, and abnormal eye looking as ball protrusion, namely Grave’s orbitopathy. Unlike Hashimoto’s thyroiditis, the antibodies in this disease are directed against the thyroid-stimulating hormone receptors leading to further activation and stimulation of the thyroid gland.

Many nutritional elements have been linked to the function of the thyroid gland as any disturbance in these elements can lead to the development of relevant thyroid diseases. The most important elements include iodine, iron, selenium, zinc, and soy. In this current manuscript, we aim to discuss the effect of these nutritional elements on the development of thyroid diseases by reviewing relevant studies in the literature.

An extensive literature search of the Medline, Cochrane, and EMBASE databases was performed on 21 December 2020 using the medical subject headings (MeSH) or a combination of all possible related terms. Studies discussing the long term effect of nutrition on thyroid disease were screened for relevant information. We did not pose any limits on date, language, or publication type.

IODINE

Iodine is a major component of the thyroid hormones including thyroxine (T4) and triiodothyronine (T3) and also plays an important role in the synthesis of these hormones within the thyroid follicles. The relationship between the development of autoimmune thyroiditis secondary to the development of thyroid antibodies in the patient’s serum is a complex one as evidence shows that extra or reduced iodine levels below normal might be a trigger or a piece of evidence for the presence of circulating thyroid antibodies. Research also showed that the presence of TPO-antibodies and thyroglobulin (Tg) antibodies have been commonly found in cohorts suffering from AITD irrespective of the frequency of iodine intake, being high, moderate, or low. Iodine deficiency might lead to the development of an accessory thyroid goiter which is considered a foreign antigen leading to the synthesis of thyroid antibodies. On the other hand, many previous studies also showed that excess iodine intake beyond the recommended levels or intake of iodine in large amounts in iodine therapy in previous iodine deficiency-related diseases can also lead to the development of AITD. A study from China showed that the prevalence of AITD was found to be 0.5 to 2.8% after the introduction of iodine for three years based on the previous iodine intake of the included patients. Denmark is considered an area with mild to moderate iodine intake at the time when a study was conducted to investigate the 5 year effect of iodine fortification around the country in dietary supplementation. The study authors reported that although the serum iodine and iodine status of the investigated patients were acceptable, the levels of thyroid antibodies have increased by 14-20% from the baseline levels. This effect, however, was deemed to be short-term, and therefore, based on this experience, optimization of iodine in the patients’ daily diet has been recommended. The mechanism behind which AITD is initiated is the possibility of the high immunogenicity of the relevant Tg which are rich in iodine and are released and synthesized from the thyroid gland which may alter the immune system against the thyroid tissue. Another explanation has also been proposed regarding the abnormal activation of an intracellular adhesion molecule that is usually present within the thyrocytes leading to accelerated tissue inflammation and infiltration. This theory has been evidenced by previous animal studies and has been proven to be true. Excess iodine might also play a role in inhibiting the development of T-regulatory cells and increasing the synthesis and release of T-helper 17 cells that can infiltrate the thyroid gland and can initiate an autoimmune reaction leading to a series of cell necrosis and apoptosis.

Excessive iodine might also, in addition to initiating an AITD reaction, cause hypothyroidism. The story starts as excess iodine has been taken up by the gland leading to increased release of excess thyroid hormones. This leads to the activation of a counter-regulatory mechanism leading to decreasing the synthesis and release of thyroid hormones or in other words hypothyroidism. Moreover, high doses of iodine intake might affect thyroid hormone synthesis and release as such large amounts might affect the organization of the required amounts of iodine to pursue these processes which is called the Wolff Chaikoff.
effect. A previous report by Du et al reported that the prevalence of subclinical hypothyroidism was noticed to be higher in areas with increased intake of iodine. Therefore, recommendations should be applied regarding the intake of the recommended daily amounts of iodine which is estimated to be 150 μg for adults, 220 μg, and 290 μg for pregnant and breastfeeding women, respectively. On the other hand, recommendations by the World Health Organization suggest that the optimum daily amount of iodine should be 75 μg.10

SELENIUM

Selenium is a key element that can be profusely found within the thyroid gland as it has been found to take part in many cellular processes within the thyroid gland and also participates in the peripheral synthesis of thyroid hormones. Some selenoproteins have been identified to take action in such processes. These include deiodinases, glutathione peroxidases, and the selenoprotein S which has all been found within the thyroid gland. Many thyroid dysfunctional events may occur secondary to selenium deficiency. These include hypothyroidism or subclinical hypothyroidism, thyroid cancer, or enlargement, andAITD or Grave’s disease. A previous study by Wu et al which was conducted on 6000 Chinese patients, showed that having an adequate selenium status affected the prevalence of thyroid disease in the investigated population, irrespective of iodine levels. However, previous studies suggested an adequate intake of iodine was more than enough to reverse the pathological status of the thyroid gland. Previous studies also showed that selenium deficiency will lead to the development of Grave’s disease mostly as presented in their populations. A previous Chinese study reported a significant negative correlation between selenium levels in their patients’ serum and the presence of TPO and Tg antibodies. Another case-control Australian study reported that reduced selenium levels in their cases were significantly associated with the severity of an underlying Grave’s condition. However, selenium levels in Grave’s disease might be reduced secondary to the inflammation that the condition induces within the thyroid gland, and therefore, it would not be a healthy judgment that selenium reduction can cause Grave’s and not vice versa. A previous randomized controlled trial (RCT) showed that selenium administration was associated with significant improvement in mild Grave’s orbitopathy. The authors also showed that in these patients, significant improvement of their quality of life, and regression of the disease was noticed, in addition to less frequent improvement of eye disease. Many previous systematic reviews have analyzed the results of the previously published RCT. Wichman et al conducted the most recent one and analyzed 16 RCTs and reported that the results of their analysis showed that selenium supplementation was significantly associated with reducing serum TPO antibodies of the included patients at a follow-up period of 3, 6, and 12 months. The authors, however, reported that in chronic AITD, the significant effect was only noticed at three months of follow-up. There are no new big-sized studied to ameliorate this effect, however, promising protocols for big studies have been published and we hope that by the end of the study that further evidence shall be provided.

IRON, ZINC, SOY

Iron decreases the efficacy of the thyroid gland to synthesize thyroid hormones as it decreases the activity and action of the TPO. A previous investigation showed that thyroid hormones were low in women with low iron profiles compared to other patients who exhibited sufficient stores. It has also been reported that iron deficiency can affect the disappearance of symptoms and full recovery in 5-10% of patients suffering from thyroid diseases even after initiating a specific treatment. Therefore, it is essential to supplement iron for patients with an iron deficiency that are being treated for thyroid disease. This was indicated by a previous study which reported that significant improvement of symptoms of hypothyroidism was noticed in their included population after iron supplementation as they were suffering from iron deficiency. In addition to iron deficiency, previous reports also showed that zinc is an important factor for the integrity of the function of the thyroid gland and its deficiency can lead to the development of subclinical hypothyroidism due to its value regarding the activity of the deiodinase II compound. A previous study on animals showed that zinc deficiency led to a reduction of the thyroid hormones by about 30% from the normal baseline levels. The same effect was also noticed in humans as a previous study showed that normalization of hypothyroidism was noticed in a population with moderate zinc deficiency after being treated with zinc sulfate for 12 months. Although soy derivatives have shown great benefits in many aspects regarding the cardiovascular system and treating cancer in addition to managing menopausal irregularities, evidence shows that they have harmful effects on the thyroid gland. Sathyapalan et al concluded that patients with subclinical hypothyroidism and are being on daily soy supplementation products can easily develop hypothyroidism. In the same context, Mittal et al reported that in their population of women that were treated with a daily intake of 75 mg of isoflavones, they found that the level of T3 was significantly reduced in these women.

CONCLUSION

Evidence from the reviewed studies in the literature shows that many nutritional components are involved in thyroid hormone synthesis and functions. Although it is widely known that iodine is an essential component for the synthesis and release of these hormones, exaggerated intake of iodine can also lead to the development of hypothyroidism by negative feedback mechanisms. Besides, it can also trigger abnormal autoimmune reactions which can lead to the development of AITD.
Selenium is another important factor and evidence shows that it has been associated with Grave’s thyroiditis, however, further evidence is needed as recommended by previous investigations. Clinicians should also take care of iron, zinc, and soy levels during management to obtain a better prognosis.

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