International Journal of Chemical Research and Development 2024; 6(1): 10-15

ISSN Print: 2664-6552
ISSN Online: 2664-6560
Impact Factor: RJIF 5.5
IJCRD 2024; 6(1): 10-15
https://www.chemicaljournal.in/
Received: 17-11-2023
Accepted: 26-12-2023

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Effect of Zinc, Iron, Ferritin, Vitamin B_{12} and thyroid function on hair Loss in Iraq Women

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DOI: https://doi.org/10.33545/26646552.2024.v6.i1a.61

Abstract
Background: Thyroid hormones exert influence on all physiological systems, including the hair follicle. Roughly 50% of women experience diffuse hair loss. Vitamins are necessary for stimulating cellular growth, and a lack of these vital elements might result in extensive hair loss. However, it is frequently seen that pregnant women often have vitamin insufficiency, which can significantly affect the growth and quality of their hair. This study investigates the possible impact of Ferritin, TSH, Zinc, vitamin B_{12}, and vitamin D levels on female alopecia in various age groups and stages of pregnancy.
Aims of the study: Assessing the concentrations of zinc, iron, ferritin, thyroid hormones, and vitamin B_{12} in women experiencing hair loss, and elucidating the interconnection among these factors.
Methodology: A case-control study conducted 90 people who experienced diffuse hair loss, consisting of 45 healthy women and 45 controls who were carefully selected to match the patients in terms of age and sex. Between April and December 2022, a laboratory carried out a confidential sample collection, enlisting both patients and controls.
Results: The investigation revealed that there was no statistically significant disparity in thyroid hormone levels (T_3, T_4, TSH, vitamin D_3) among the groups. Nevertheless, there existed a markedly substantial disparity in the concentrations of iron, ferritin, zinc, and B_{12}. In addition, the study found a negative association between T_3 and ferritin, as well as between vitamin D_3, ferritin, zinc, and TSH. Moreover, there existed a highly pronounced inverse correlation between TSH and T_3, as well as between zinc and ferritin, and zinc and T_3.
Conclusion: This study conducted a comparative assessment of ferritin, TSH, zinc, Hb, vitamin B_{12}, and vitamin D levels in several groups of women with alopecia. The study highlights the significance of reduced levels of vitamin B_{12} and other vitamins as factors that lead to hair loss.

Keywords: B_{12}, Zinc, thyroid function, hair loss

Introduction

Alopecia is a common disorder that can impact people of any age or gender. Women frequently seek the expertise of dermatologists for cosmetic reasons. Hence, it seems that females are more susceptible to hair loss in comparison to males [1].

The hair growth process has three main stages. Anagen, catagen, and telogen correspond to the phases of proliferation, involution, and quiescence, respectively [2].

Insulin-like growth factor 1, fibroblast growth factor 7, oestrogens, androgens, thyroid hormones, glucocorticoids, retinoids, prolactin, and growth hormone have an impact on the development and cycling of hair follicles [3].

The average rate of alopecia from the scalp during the telogen period is 50-150 hairs per day. However, a higher quantity of telogen follicles results in the incidence of significant hair loss. Chemotherapy interferes with the development of hair follicles, leading to atypical hair loss during the anagen phase. Diffuse hair loss can be caused by a variety of factors including heredity, physiological stress, emotional stress, drugs, medical conditions, and dietary deficiencies. Nevertheless, there is a continuous discussion concerning the influence of nutritional status and the effectiveness of supplements in treating hair loss [4].

It is advisable to assess all patients experiencing generalized hair loss for potential deficits in iron and thyroid hormones. The exact influence of zinc deficiency on diffuse hair loss remains uncertain. A recent study has revealed that insufficient levels of vitamin D might result in extensive hair loss [5].

Iron is essential for the production of enzymes, cytochromes, and transcription factors, and is vital for other physiological functions. Enables the oxidation-reduction process and controls DNA synthesis in dividing cells. The blood ferritin test is the established technique for evaluating iron levels, given its exceptional sensitivity and precision in detecting iron insufficiency. This refers to the amounts of ferritin within the cells and the total amount of iron stored in the body [6, 7].

The precise effects of iron deficiency on hair and hair follicle biology are not yet fully understood. Reduced iron availability can hinder the development of follicular matrix cells. Ferritin plays a crucial role in the cellular division process. Discrepancies in the concentrations of ferritin within cells and unbound iron can result in hair growth issues [8].

Du *et al*. (2008) identified genes that rely on iron in the hair follicle bulge. These genetic changes result in an elevation of hepcidin levels, a hepatic-produced chemical that reduces the uptake of iron. The thyroid gland secretes thyroid hormones in response to the release of TSH by the thyrotrophs in the anterior pituitary gland, which is triggered by the presence of thyroid hormones in the bloodstream [9].

The TSH receptor, situated on the basolateral membrane of thyroid follicular cells, is directly stimulated by thyroid-stimulating hormone (TSH). Thyroid hormone synthesis and secretion occur when the sodium/iodide symporter is stimulated by TSH. Thyroxine (T_4) and triiodothyronine (T_3), which are thyroid hormones, include iodine [8, 9, 10].

The sodium/iodide symporter (NIS) located in the basolateral plasma membranes of thyrocytes facilitates the active transport of iodide from the bloodstream into thyroid cells [11].

Thyroid hormones are essential for the development, specialisation, and regulation of metabolic equilibrium in mammals. Research has substantiated a correlation between thyroid disorders and alterations in the skin, hair, and physiological functions. Thyroid hormone nuclear receptors (TRs), functioning as ligand-dependent transcription factors, play a vital role in carrying out most of the effects of thyroid hormones [12].

Thyroid receptors (TRs) found in hair follicle cells indicate that thyroid hormones directly affect hair development, rather than only affecting metabolic function. T_4 exerts a prominent influence on peripheral organs, including hair follicles, following deiodination into T_3 [13].

Furthermore, Both T_3 and T_4 significantly enhance the production of melanin in the hair follicles. T_3 and T_4 exert direct control over multiple hair follicle functions, including prolonging the anagen phase, stimulating the hair matrix, facilitating keratinocyte proliferation, boosting pigmentation, and encouraging intracellular keratin synthesis [14].

Insufficient quantities of vitamins might result in hair loss during cellular growth and functioning. Inadequate consumption of certain minerals, namely a deficiency in iron, can result in hair loss in women. Haemoglobin (Hb) delivers oxygen and nutrients to hair follicles [15].

Inadequate iron levels result in hair loss. Ferritin and haemoglobin levels are indicative of iron deficiency. Hair loss can result from a lack of iron. Essential minerals, such as zinc and ferritin, as well as vitamins like vitamin D and B_{12}, and hormones, such as thyroid hormone, have an impact on the development of hair follicles [16].

Evaluate and enhance the concentrations of Ferritin and vitamin D in individuals without health conditions and those with diffuse hair loss, in order to compare their efficacy [17].

Methodology

The study comprised a total of 60 people who were involved in the "private laboratory" setting. A total of thirty women, ranging in age from 17 to 45 years, who were experiencing chronic diffuse hair loss, were included in the study. This study incorporated a comparable control group consisting of 30 females, aged 17 to 45 years. Age and demographics were considered. The study lasted for a period of five months, specifically from February to June 2023. At the time of recruitment, those with metabolic and endocrine diseases, those using hormone replacement medicine, undergoing chemotherapy or immunosuppressive therapy, and those using vitamin and mineral supplements were not included in the research. Consent was received from the laboratory front panels to retrieve data. A volume of 5 milliliters of blood was extracted from a vein and transferred into a tube containing gel. The specimens were stored at ambient temperature and subsequently isolated by subjecting them to centrifugation at a speed of 5000 revolutions per minute for a duration of 10 minutes. Subsequently, the serum was collected and the concentrations of vitamin D_3, TSH, T_4, and T_3 were assessed with the Fincare instrument. The spectrophotometer was used to assess the levels of ferritin, zinc, and iron, while a Cobas device was used to check the levels of vitamin B_{12}.

Results

Table 1 presents a comparison of thyroid function tests conducted on patients and control subjects. The findings of this comparison suggest that there is no statistically significant disparity (P>0.05) between the two groups in relation to T_3, T_4, and TSH.

Table 1: Thyroid function test among patients and control subjects

Parameters	Control group (n=20) Mean ± SD	Patients group (n=21) Mean ± SD	P. value
T_3	1.88 ± 0.55	1.77 ± 0.34	0.41^{NS}
T_4	108.72 ± 19.45	118.38 ± 30.30	0.23^{NS}
TSH	1.44 ± 0.86	4.77 ± 9.47	0.12^{NS}

NS: Non-significant at P>0.05 **SD:** standard deviation

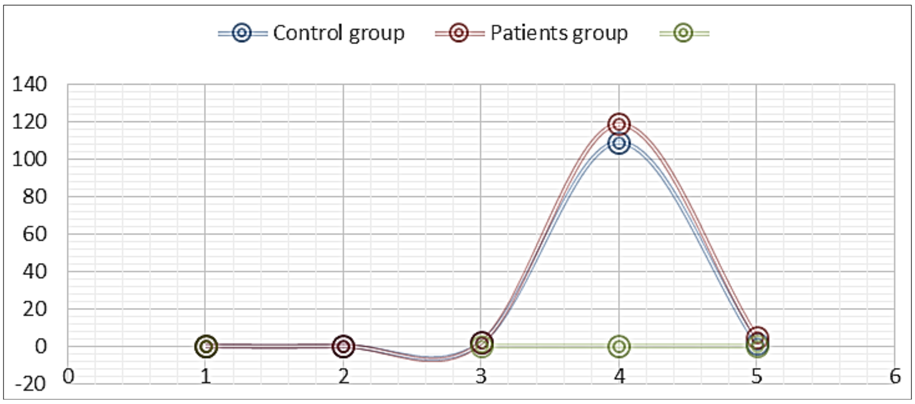

Fig 1: Thyroid function test among patients and control subjects

The data displayed in Table (2) demonstrate a remarkably significant reduction ($P<0.001$) in the concentrations of iron, ferritin, and zinc in the group of patients in comparison to the group of healthy individuals.

Table 2: Trace elements test among patients and control subjects

Parameters	Control group (n=20) Mean ± SD	Patients group (n=21) Mean ± SD	P. value
Iron	104.25 ± 25.58	32.58 ± 10.63	<0.001
Ferritin	155.40 ± 27.96	70.44 ± 31.36	<0.001
Zinc	61.75 ± 16.57	43.30 ± 10.78	<0.001

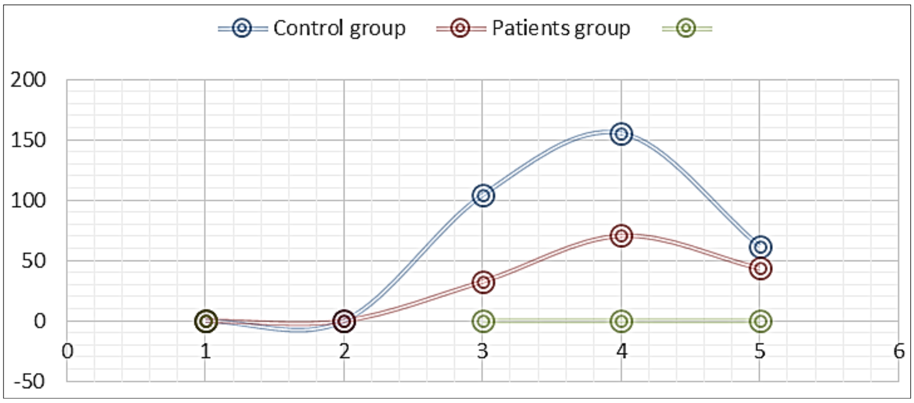

Fig 2: Trace elements test among patients and control subjects

The results presented in Table 3 demonstrates a significant decrease ($P<0.001$) in vitamin B_{12} levels in the patients group when compared to the control group. On the other hand, there is a negligible change ($P>0.05$) in the levels of vitamin D_3 when comparing the two groups.

Table 3: Vitamin B_{12} and D_3 test among patients and control subjects

Parameters	Control group (n=20) Mean ± SD	Patients group (n=21) Mean ± SD	P. value
Vit. B_{12}	209.0 ± 27.01	151.67 ± 21.02	<0.001
Vit. D_3	27.38 ± 7.23	26.04 ± 8.87	0.59^{NS}

NS: Non-significant

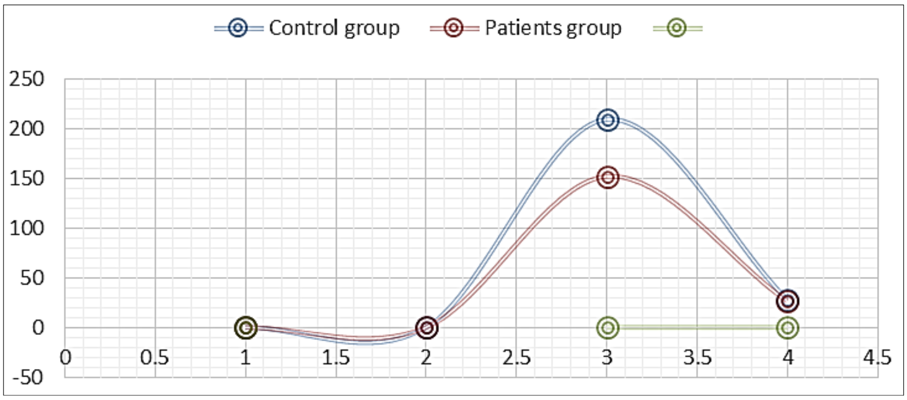

Fig 3: Vitamin B_{12} and D_3 test among patients and control subjects

Table 4 demonstrates a noteworthy negative association between ferritin and both T_3 and vitamin D_3 (r=-0.511 and r=-0.494, respectively) in the patients' group. Additionally, there is a considerable positive link between ferritin and zinc (r=0.597). Both of these connections are statistically significant. A positive and statistically significant association (r=0.002) has been established between T_3 and TSH. The strong negative correlation coefficients (-0.715 for T_3 and -0.512 for TSH) indicate that zinc has a role in producing unfavorable results.

Table 4: Correlation of study parameters with each other in patients group

Correlations								
		Iron	**Vit. B_{12}**	**Ferritin**	**T_3**	**T_4**	**TSH**	**Vit. D_3**
B_{12}	Pearson Correlation	0.210						
	Sig. (2-tailed)	0.360						
Ferritin	Pearson Correlation	-0.066	-0.080					
	Sig. (2-tailed)	0.777	0.731					
T_3	Pearson Correlation	-0.047	0.120	-0.511*				
	Sig. (2-tailed)	0.840	0.605	0.018				
T_4	Pearson Correlation	0.101	0.029	0.309	0.290			
	Sig. (2-tailed)	0.662	0.899	0.173	0.202			
TSH	Pearson Correlation	0.299	-0.233	-0.192	0.602**	0.351		
	Sig. (2-tailed)	0.188	0.309	0.404	0.004	0.118		
Vit. D_3	Pearson Correlation	0.195	-0.002	-0.494*	0.065	-0.158	0.077	
	Sig. (2-tailed)	0.398	0.994	0.023	0.781	0.494	0.740	
Zinc	Pearson Correlation	-0.185	-0.144	0.597**	-0.715**	-0.227	-0.512*	-0.054
	Sig. (2-tailed)	0.423	0.533	0.004	0.000	0.323	0.018	0.816
*. Correlation is significant at the 0.05 level (2-tailed).								
**. Correlation is significant at the 0.01 level (2-tailed).								

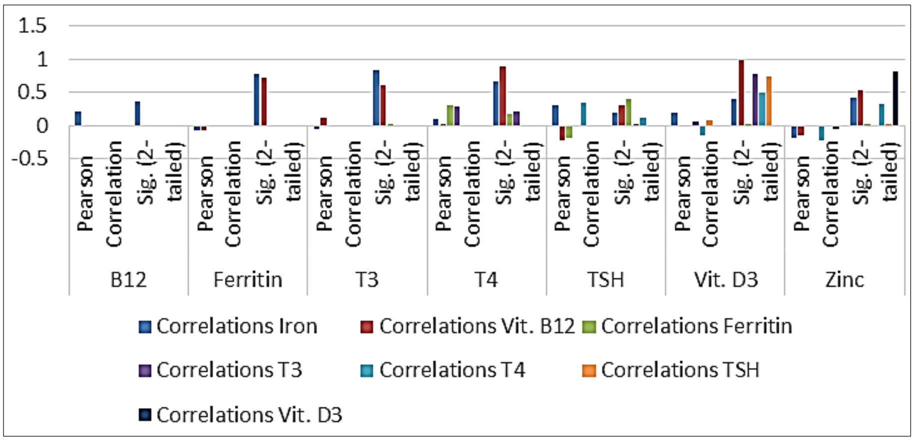

Fig 4: Correlation of study parameters with each other in patients group

Discussion

This result is agree with [20]. Insufficient zinc levels may be associated with hair loss in women. Zinc is a vital mineral that has a significant impact on the health of the scalp and the growth of hair. Inadequate zinc levels can result in hair weakness and hair loss. Zinc plays an important role in hair health and growth, as zinc affects the hair follicles and enhances their strength. Zinc also enhances immunity and helps in the creation of some hormones that have a role in influencing the growth and health of hair. A deficiency in zinc levels can lead to hair loss [18, 19].

The relationship between iron and hair loss is clear. Iron is considered one of the very important elements in the body that plays an effective role in the process of transporting oxygen [21, 22].

Ferritin deficiency causes iron deficiency anemia. Therefore, there is a relationship between ferritin and hair loss due to the important role of ferritin in the body. In light of this, the determination of ferritin levels is an essential component in the process of evaluating hair loss in female applicants [23, 24].

Because women who have low levels of vitamin B_{12} experience hair loss, vitamin B_{12} is regarded to be one of the most significant vitamins for maintaining healthy hair and promoting its development. The health of the cells and nerve cells in the scalp can be negatively impacted by a lack of vitamin B_{12}, which can result in a lack of strength in the hair roots and scalp, ultimately leading to hair loss [25, 26].

It is also the case that if you have a significant shortage in vitamin B_{12}, this will result in hair loss, particularly in women. This shortfall may be compensated for by taking nutritional supplements that are abundant in vitamin B_{12}. For another thing, women in Iraq have low levels of vitamin B_{12} because of their nutritional nature, since they do not consume a wide variety of foods, and because of the economic condition. This is proof of the widespread hair loss that is occurring among women in Iraq [27].

The thyroid gland can be either hyperactive or underactive, and both of these conditions can cause hair loss. Additionally, the thyroid gland has an impact on the health of the scalp and hair, in addition to having a direct influence on the metabolic processes that occur within the body.

The skin and hair are also affected by fluctuating amounts of thyroid hormones, which can result in a loss of hair and a weakening of the compasses. According to this perspective, there are a number of research that both support and refute it. Within the confines of a laboratory setting, a research was carried out to calculate the concentrations of T_3 and T_4. The results revealed that T_4 promotes the growth of hair matrix keratinocyte cells and inhibits their programmed cell death [28].

T_3 did not elicit significant activation of keratinocytes. The study also showed that thyroid hormone levels directly increased the growth phase of hair follicles and reduced the resting phase. Ultimately, T_3 and T_4 promoted the pigmentation of hair follicles. The study revealed that T_3 and T_4 hormones have a significant impact on the development of human hair follicles, indicating that a deficiency in hypothyroid hormone directly causes obvious hair loss [29].

Iron is vital for the organism. Humans possess the capacity to synthesise haemoglobin and myoglobin, which play a crucial role in the transportation of oxygen across the body. Iron aids in the production of hormones and supports proper development and maturation. Unbound intracellular iron has the ability to produce free radicals, which can cause damage to cellular machinery. Serum ferritin levels function as a marker of the quantity of iron stored in the body. Low blood ferritin levels are indicative of iron insufficiency, typically resulting in anemia, although they can also be associated with hypothyroidism and ascorbate deficiency [30].

Low levels of ferritin have been associated with hair loss in clinical investigations. One hypothesis proposes that reduced levels of ferritin contribute to hair loss by serving as a cofactor for ribonucleotide reductase, the enzyme that controls the pace of DNA synthesis. Due to their rapid division, hair follicle cells require ribonucleotide reductase, a protein that may be hindered by a deficiency of iron. This process decreases the rate at which cells are replaced and regenerated, resulting in a decrease in the development of hair. Consequently, individuals experiencing hair loss are regularly assessed for their iron levels [31].

Effective hair cycle management requires the inclusion of iron, zinc, and selenium. Iron deficiency is a leading cause of telogen effluvium (TE) and is the most prevalent nutritional deficit globally. The presence of iron as a cofactor for the DNA synthesis enzyme, which controls the rate at which DNA is produced, could potentially impact the hair growth cycle. Several research have indicated the presence of low blood ferritin levels, The storage form of iron in patients with chronic TE, AnA, and AA is Nevertheless, other studies have presented contradictory findings [32].

Zinc, an essential component of numerous metalloenzymes that regulate protein synthesis and cellular transcriptional efficacy, has been linked to hair brittleness and hindered cell division in patients with zinc deficiency [33].

In a study that examined 312 patients with alopecia (AA, MPAnA, FPAnA, or TE) and 30 healthy individuals as controls, it was shown that the serum zinc level was significantly lower in patients with all forms of hair loss compared to the healthy controls ($P = 0.002$) [34].

This research is an exceptional opportunity. Prior studies have demonstrated that administering zinc orally is beneficial for individuals with zinc deficiency experiencing telogen effluvium (TE) and alopecia areata (AA). Furthermore, as alopecia associated with zinc deficiency can be reversed, assessing serum zinc levels is valuable for patients with unexplained hair loss. Zinc supplementation may be beneficial for those with hair loss, particularly those with a zinc deficiency. However, there is currently little evidence to support its effectiveness for individuals who do not have a zinc deficiency [35,36].

Vitamin B_{12} is essential for the creation of red blood cells, appropriate neurological function, and DNA synthesis. The active forms of vitamin B_{12} are 2-Methoxyadenosylcobalamin and 3-methylcobalamin. Vitamin B_{12} acts as a cofactor for methionine synthase and has a vital function in the production of about one hundred substances, including proteins, RNA, and DNA. The recommended daily dose of vitamin B_{12} for individuals in the United States is 2.4 micrograms. Given its low toxicity, there is currently no defined maximum threshold for vitamin B_{12} intake [37].

Vitamin B_{12}'s function in nucleic acid synthesis [38]. Nevertheless, there is a scarcity of studies investigating the relationship between B vitamins and hair loss. A study conducted by Turkish researchers found that there were no notable differences in the levels of serum folate and vitamin B_{12} between 43 patients with AA and 36 healthy individuals. The investigators also found no association between the duration or intensity of the sickness and the levels of serum. A separate study conducted in Turkey involved a total of 75 patients with AA and 54 individuals serving as controls. Analysed blood samples to quantify the levels of folic acid and vitamin B_{12}. The findings were consistent with the prior Turkish study, which found no notable disparities in vitamin B_{12} and folate concentrations between those with the disease and those in good health [39, 40].

Conclusion

This study sought to examine the concentrations of ferritin, TSH, zinc, haemoglobin, vitamin B_{12}, and vitamin D in several cohorts of women experiencing hair loss. All the participants were female individuals who were undergoing alopecia. The study's findings demonstrate the significance of diminishing levels of vitamin B_{12} and other vitamins as factors contributing to hair loss. These findings were found in the researchers' investigation.

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