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Oral health-related behaviors and prevalence of thyroid diseases in Iranian patients

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Objective. Thyroid disorders can affect the general health-related quality of life with complications such as fatigue, anxiety, depression, and systemic manifestations. The aim of this study was to investigate the relationship between the oral health-related behaviors, the prevalence of thyroid diseases, and the oral health-related quality of the life.

Methods. This cross-sectional and descriptive-analytical study was conducted on 419 patients with a history of thyroid disease and 100 healthy subjects with no thyroid disease as a control group. Demographic information including age, gender, BMI, smoking, alcohol consumption, and medical history was collected through questionnaires and interviews. An assistant of oral diseases evaluated the oral health-related behaviors and objective conditions of oral health status. The objective periodontal evaluation was based on the community periodontal index (CPI) and probing by WHO. The plaque index was examined by giving dental plaque disclosing tablets and chewing them for 30 seconds. Thyroid disease was based on the endocrinologist's opinion and triiodothyronine (T3), thyroxine (T4), and thyroid-stimulating hormone (TSH) criteria. In this study, to evaluate the oral health-related quality of life, the Oral Health Impact Profile (OHIP-14) questionnaire was used. The obtained results were analyzed using T-test, Multivariate logistic regression analysis, Chi-Square test, and SPSS-21 software. The significance level in data analysis was $p<0.05$.

Results. Among the 419 patients with a history of thyroid disorders included in the study, 82 (15.8%) had hyperthyroidism (TSH <0.4 mIU/L), 261 (50.3%) had normal thyroid (TSH <5.0 mIU/L), and 76 (14.6%) had hypothyroidism (TSH >5.0 mIU/L). Regarding the observation of the oral and dental health status in the group of participants with no history of thyroid disorder, 64% of subjects with thyroid disorders observed their oral and dental health well, while in the group of subjects with no history of thyroid disorder, 46.9% observed oral health well ($p<0.001$). The results revealed a significant relationship between the presence of periodontitis and a history of thyroid disorder ($p<0.021$). During the study, 11% of hyperthyroid patients, 4.6% of participants with normal thyroid status, and 1.3% of hypothyroid patients suffered from periodontitis. The score of oral health-related quality of life in participants without a thyroid disorder history was significantly lower than that with a history of thyroid disorder indicating that their oral health-related quality of life is better ($p=0.049$).

Conclusions. The results revealed a significant relationship between the presence of periodontitis and a history of thyroid disorder. However, there was no significant difference between two experimental groups regarding the presence of microbial plaque. The score of oral health-related

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quality of life in participants without a history of thyroid disorder was significantly lower than that with a history of thyroid disorder indicating that their oral health-related quality of life is better.

Keywords: oral health, behaviors, thyroid diseases, quality of life

Introduction

The oral cavity is an entrance to the digestive-respiratory system. It is a space where different microorganisms are present and inflammatory reactions occur. Oral health status and related behaviors are key factors to indicate inflammatory conditions in the oral environment (Kwon et al. 2022).

It has been reported that poor oral health status is associated with various systemic diseases such as diabetes and hypertension (Kim et al. 2014; Kudiyirickal and Pappachan 2015; Carrizales-Sepulveda et al. 2018; Pietropaoli et al. 2018). The microbial microflora of the human body biome has increased recently. Thus, many studies have been conducted on the effect of oral microbial flora on various diseases including cancer (Zhang et al. 2018). The oral health status and behaviors related to it play a vital role in determining the characteristics of the oral microbiome and related inflammatory-immunological conditions (Hashimoto et al. 2018; Jung et al. 2019).

The thyroid gland differentiates from the first pharyngeal arch during embryonic development. Thus, it is very likely that infection or inflammation in the oral cavity affects the thyroid gland based on the anatomical relationship. In other words, structural diseases (thyroglossal duct cyst) and inflammatory thyroid diseases (acute thyroiditis) occur after infection of the upper respiratory-digestive tract due to anatomical connection (Benbassat et al. 2007; Desailloud and Hober 2009). Thyroid disorders are the second most common disorders in the endocrine system, especially in women. They also affect other body systems (Chandna and Bathla 2011). For example, the rate of hypothyroidism in different societies has been reported to be 2–10%. Thyroid disorder is a general term that includes several different diseases involving the thyroid gland. This disorder is divided into two subgroups: hyperthyroidism and hypothyroidism. This classification is based on the serum level of thyroid-stimulating hormone (TSH), thyroxine (T4), and triiodothyronine (T3) hormones (Garber et al. 2012).

Thyroid disorders can affect the general health-related quality of life with complications such as fatigue, anxiety, depression, and systemic manifestations (Molania et al. 2021). Quality of the life is a multi-dimensional and broad concept. It indicates a person›s understanding of his life status based on the culture and value systems, expectations, standards and life experiences that affect the physical and mental health status, social communication, and personal opinions of the person. Several studies have reported that the quality of life is significantly affected by thyroid disorders (Rakhshan et al. 2017; Shivaprasad et al. 2018; Deo and Deshmukh 2019; Ehsani et al. 2022; Li et al. 2022).

Balance in the oral microbial flora is essential to control the immune system. A study reported a mutual association between oral health and thyroid diseases (Kwon et al. 2022). Another study has revealed that poor oral health and dental problems are more common in patients with thyroid disorders. It has been recently reported that oral lichen planus is significantly associated with Hashimoto›s thyroiditis. Thus, the immune system response in the oral cavity may be related to the disorder and thyroid disease. Overall, oral health status is highly associated with the function and pathological conditions of the thyroid gland. The rapid identification and intervention in patients with high risk of thyroid problems can control oral conditions (Kwon et al. 2022).

A study by Dong et al. (2021) has indicated that changes in oral microbial flora cause changes in TSH. A population-based cross-sectional study revealed that oral health affects thyroid function. However, researchers have recommended conducting more studies to determine the cause-and-effect relationship (Kwon et al. 2022). Jiao et al. (2022) have reported that oral microbial flora may be associated with thyroid diseases and microbial interactions can change the etiology of many diseases. Studies have indicated that the prevalence of dental caries and the severity of periodontal diseases increase more in patients with thyroid disorders than in healthy people (Poumpros et al. 1994). In addition, thyroid disorders can affect oral health by affecting the content and amount of saliva, since saliva plays a vital role in homeostasis, antimicrobial activity, and control of remineralization and demineralization (Muralidharan et al. 2013). Decreased saliva can cause xerostomia and dysphagia and increase the possibility of opportunistic infections (Molania et al. 2021). Thus, it is crucial to examine the oral health status, so we can evaluate its effect on thyroid disorders. Since there are limited studies in this area and no comprehensive study has been conducted on oral health, oral health-related quality of life and thyroid diseases and

comparison with the healthy population in Iran. The present study investigates the relationship between oral health-related behaviors and prevalence of thyroid diseases and the oral health-related quality of life.

Materials and Methods

Subjects and study design. This cross-sectional and descriptive-analytical study was conducted on 419 patients with a history of thyroid disease and 100 healthy participants with no thyroid disease as a control group. Demographic information, including age, gender, body mass index (BMI), smoking, alcohol consumption, and medical history was collected through questionnaires and interviews. An assistant of oral diseases evaluated the oral health-related behaviors and objective conditions of oral health status. The items included 1) the frequency of brushing and 2) the use of oral health products, including dental floss, mouthwash, etc. The study inclusion criteria included patients with confirmed thyroid disorders based on the criteria of the American Thyroid Association and the American Association of Clinical Endocrinology Association having at least 25 teeth in their mouth and no history of periodontal treatment in the last 4 months. Subjects with gastrointestinal diseases, organ transplants, and other systemic diseases or endocrine disorders, such as diabetes, subjects who have undergone antibiotic therapy in the last 4 months, lactating women, and patients who received corticosteroids were excluded from the study (Kwon et al. 2022).

The purpose of this study was explained to each participant and a questionnaire was provided to anyone who requested it. Additionally, all participants were assured that the information from the questionnaire would remain confidential and would only be examined for statistical purposes. Since such studies require the cooperation of participants, we tried to fully explain the purpose of the study and confirm the harmlessness of the study and the maintenance of confidentiality about the information obtained.

The study was approved by the ethics committee of Kerman University of Medical Sciences by the research deputy of Kerman University of Medical Sciences. A statement to confirm that all experimental protocols were approved by the research deputy of Kerman University of Medical Sciences. The informed verbal consent was obtained from the participants for examinations and participation in the study following the provision of the needed explanations by the research deputy of Kerman University of Medical Sciences. All the information on the subjects will remain confidential. All experiments were performed in accordance with relevant guidelines and regulations (such as the Declaration of Helsinki). The project was approved by the Ethics Committee of the university with the code IR.KMU.REC.1402.278.

Periodontal evaluation. The objective of the periodontal evaluation was stated based on the community periodontal index (CPI) and probing by WHO. CPI probe (ball point type), dental bed mirror, and disclosing tablet were used in the study. To investigate the CPI, the teeth were examined in each sextant and the relevant codes were recorded. The mouth was divided into six parts. The relevant codes were healthy (code zero), bleeding (code 1), mass (code 2), pocket depth of 4–5 mm and the black part of the prop is visible (code 3), pocket depth of 6 mm, and higher, the black part of the prop is not visible (code 4), and the sextant is removed (code X) and not registered (code 9). The plaque index was examined by giving dental plaque disclosing tablets and chewing them for 30 seconds and recording the codes of the absence of microbial plaque (zero code), the presence of microbial plaque in the interdental area, and less than one-third of the buccal or lingual side of the teeth (code one), the presence of microbial plaque on one third or less than two-thirds of the buccal or lingual area of the teeth (code 2), and the presence of microbial plaque on two thirds or more than two-thirds of the buccal or lingual area of the teeth (code 3) in six sextants (Ehsani et al. 2022; Kwon et al. 2022).

Thyroid function tests. Thyroid disease was stated based on the endocrinologist's opinion and T3, T4, and TSH criteria. The normal function of the thyroid was that the person did not have any diagnosis of thyroid disease during his life and the use of thyroid drugs and the TSH was normal (Kwon et al. 2022).

Oral health-related quality of life. To evaluate the oral health-related quality of life in this study, the Oral Health Impact Profile (OHIP-14) questionnaire was used. The validity and reliability of the Persian version were confirmed. This questionnaire includes 7 subgroups functional limitation, jaw pain, mental discomfort, physical disability, mental disability, and social disability. Each subgroup contains 2 questions. Test options are scored as never=zero, rarely=1, sometimes=2, often=3, and always=4. The total score was between zero and 56 (Navabi et al. 2010).

Statistical analysis. The obtained results were analyzed using T-test, multivariate logistic regression analysis, Chi-Square test by SPSS-21 software. The significance level in data analysis was $p<0.05$.

Results

Information from 519 participants was analyzed in this study. Among the 419 patients with a history of thyroid disorders in the study, 82 (15.8%) had hyperthyroidism (TSH <0.4 mIU/L), 261 (50.3%) had normal thyroid (TSH <5 mIU/L), and 76 (14.6%) had hypothyroidism (TSH >5 mIU/L). Among the total participants, 17.8% (92 subjects) were male. The mean age of the subjects was 42.8±13.6 years (mean±SD). The mean age of participants who did not have a history of thyroid disorders was 38.6±11.8 years. The mean age of patients with a history of thyroid disorders was 42.0±13.1 years (p=0.002). In this study, women comprised 59.6% of subjects without a history of thyroid disease, while women in the group with a history of thyroid disease comprised 87.5% of subjects in the group (p<0.001) (Table 1). Regarding marital status, 74% of participants without a history of thyroid disorder were married, while 90% of subjects with a history of thyroid disorder were married (p<0.001) (Table 1).

Regarding education, 67% of participants without a history of thyroid disorder had a university education, while in the group of subjects with a history of thyroid disorder, 42% of them had a university education (Table 1). Regarding the job status, 44% of participants without a history of thyroid disease were self-employed, while in the group with a history of thyroid disease, 14.8% of subjects were self-employed (p<0.001) (Table 1). Regarding income, 19% of participants in the group without a history of thyroid disease had the income of less than 30 million rials, while in the group with a history of thyroid disorder, 62.1% of subjects had an income of less than 30 million rials (p<0.001) (Table 1).

Regarding the observation of the oral and dental health status, 64% of subjects without a history of thyroid disorders observed their oral and dental health well, while in the group of subjects with a history of thyroid disorder, 46.9% observed their oral health well (p<0.001) (Table 2). Regarding the frequency of brushing, in the group of participants without a history of thyroid disorder, 70.3% stated that they brush their teeth once a day, while 47% of patients with a history of thyroid disorder brushed their teeth once a day. Additionally, in the group without a history of thyroid disorder, 52% of subjects brushed their teeth twice a day, while in the group with a history of thyroid disorder, 18.4% brushed their teeth twice a day (p<0.001) (Table 2). Regarding flossing, 39% of participants without a

Table 1
Demographic status of study participants based on history of thyroid disorders

Variable	Category	Participants		p-value
		without a history of thyroid disorders	with a history of thyroid disorders	
		Number (%)	Number (%)	
Gender	Male	41 (40.4%)	52 (12.5%)	<0.001*
	Female	59 (59.6%)	365 (87.5%)	
Marital status	Married	74 (74%)	377 (90%)	<0.001*
	Single	26 (26%)	42 (10%)	
Education level	Non-university	33 (33%)	243 (58%)	<0.001*
	University	67 (67%)	176 (42%)	
Job status	University student	2 (2%)	8 (1.9%)	<0.001*
	School student	7 (7%)	10 (2.4%)	
	Retired	24 (24%)	63 (15%)	
	Self-employed	44 (44%)	62 (14.8%)	
	Retired	8 (8%)	20 (4.8%)	
	Housekeeper	15 (15%)	256 (61.1%)	
	Unemployed	0 (0%)	0 (0%)	
Income	< 30 million Rials	19 (19%)	260 (62.1%)	<0.001*
	>30 million Rials	81 (81%)	159 (37.9%)	

*p<0.05 is significant

history of thyroid disorder did not use dental floss. However, in the group of patients with a history of thyroid disorder, 66.2% of people did not use dental floss (Table 2). In terms of frequency of visits to the dentist's clinic, patients in the group with a history thyroid disorder had more visits to the dentist's clinic compared to the group of subjects without a history of thyroid disorder (419 vs. 97) (p<0.001) (Table 2). In the group without a history of thyroid disorder, a higher percentage of participants consumed alcohol, smoked cigarettes and hookah than in the group of subjects with a history thyroid disorder (all p<0.001) (Table 2).

The results revealed a significant relationship between the presence of periodontitis and a history of thyroid disorder (p=0.021). In the group of patients with a history of thyroid disorder, 5.3% of them had periodontitis, while in the group of subjects without a history of thyroid disorder, none had periodontitis (Table 3). However, there was no significant difference between two experimental groups regarding the presence of microbial plaque (p=0.064). Due to the small number of subjects with periodontitis in the study groups, multivariate statistical analysis is impossible (Table 3).

Investigating the relationship between periodontitis and thyroid disorder status during the study, 11% of hyperthyroid patients, 4.6% of subjects with normal thyroid status, and 1.3% of hypothyroid patients suffered from periodontitis (Table 4). However, no significant difference was observed between these groups of participants regarding the microbial plaque status (Table 4). Additionally, the disease duration was significantly associated with

Table 2
Status of behaviors related to oral health and risk factors related to oral health

Variable	Category	Participants		p-value
		without a history of thyroid disorders	with a history of thyroid disorders	
		Number (%)	Number (%)	
Oral health	Good	64 (64%)	195 (46.9%)	<0.001*
	Moderate	34 (34%)	189 (45.4%)	
	Poor	2 (2%)	32 (7.7%)	
Brushing	No	1 (1%)	36 (8.6%)	<0.001*
	Once	47 (47%)	294 (70.3%)	
	Twice	52 (52%)	77 (18.4%)	
	Three times	0 (0%)	11 (2.6%)	
Flossing	No	39 (39%)	276 (66.2%)	<0.001*
	Once	59 (59%)	124 (29.7%)	
	Twice	2 (2%)	11 (2.6%)	
	Three times	0 (0%)	6 (1.4%)	
Mouthwash	Yes	1 (1%)	4 (1%)	0.985
	No	99 (99%)	413 (99%)	
Frequency visits to clinic	1	39 (40.2%)	93 (22.2%)	
	2	13 (13.4%)	63 (15%)	
	3	9 (9.3%)	55 (13.1%)	
	4	36 (37.1%)	208 (49.6%)	
Smoking	Yes	16 (16%)	11 (2.6%)	<0.001*
	No	84 (84%)	408 (97.4%)	
Hookah	Yes	22 (22%)	2 (0.5%)	<0.001*
	No	78 (78%)	415 (99.5%)	
Alcohol consumption	Yes	16 (16%)	0 (0%)	<0.001*
	No	84 (84%)	418 (100%)	

*p<0.05 is significant

the presence of periodontitis, so the mean period of periodontitis was 12.3±11.1 years (mean±SD) in patients who had a history of thyroid disorder and periodontitis. However, the mean time of developing thyroid disorder was 7.1±6.3 years in subjects with a history of thyroid disorder and without periodontitis (p=0.042).

Investigating the quality-of-life score of participants in the study revealed that the score of oral health-related quality of life in subjects without a history of thyroid disorder was significantly lower than that of subjects with a history of thyroid disorder, indicating that their oral health-related quality of life is better (p=0.049) (Table 5). Additionally, the quality-of-life score in participants without periodontitis was significantly lower than that of subjects with periodontitis (p<0.001) (Table 5). Moreover, indirect relationship was found between the quality-of-life score and disease duration in patients with a history of thyroid disorder. Accordingly, participants› oral health-related quality of life increased significantly with increasing disease duration (r=-0.185, p<0.001) (Table 5).

Discussion

Periodontitis is a chronic inflammatory disease of the teeth-supporting tissues (Zhou et al. 2019; Madero-Cabib and Bambs 2021). Periodontitis consequences can affect the systemic health of the person. Periodontitis is associated with cardiovascular diseases, type 2 diabetes mellitus, neurodegenerative disorders such as Alzheimer's disease, and cancer (Wikstrom et al 2011; Fu et al. 2019; Furuta et al. 2020). Inflammation can damage the walls of blood vessels and increase the risk of atherosclerosis and heart failure. Bacteria associated with periodontitis, such as *Porphyromonas gingivalis*, can enter the bloodstream and contribute to the spread of neoplasms such as colorectal cancer. Periodontitis can change the body's immune response and affect the production of antibodies that may be involved in several autoimmune diseases such as rheumatoid arthritis. Functionally, thyroid disease can lead to hypothyroidism, hyperthyroidism, or euthyroidism. Both hypothyroidism and hyperthyroidism can have significant oral manifestations. Hypothyroidism

Table 3
Relationship between microbial plaque status, periodontitis, and a history of thyroid disorders

Variable	Category	Participants		p value
		without a history of thyroid disorders	with a thyroid disorder history	
		Number (%)	Number (%)	
Periodontitis	No	100 (100%)	397 (94.7%)	0.021*
	Yes	0 (0%)	22 (5.3%)	
Microbial plaque status	0	1 (1%)	7 (1.7%)	0.064
	1	99 (99%)	400 (95.5%)	
	2	0 (0%)	0 (0%)	
	3	0 (0%)	12 (2.9%)	

*p<0.05 is significant

Table 4
The relationship between microbial plaque status, periodontitis, and thyroid disorder status during the study

Variable	Category	Disorder status during the examination		
		Hyperthyroidism	Normal	Hypothyroidism
		Number (%)	Number (%)	Number (%)
Periodontitis	No	73 (89%)	249 (95.4%)	75 (98.7%)
	Yes	9 (11%)	12 (4.6%)	1 (1.3%)
Microbial plaque status	0	3 (3.7%)	3 (1.1%)	1 (1.3%)
	1	74 (90.2%)	253 (96.9%)	73 (96.1%)
	2	0 (0%)	0 (0%)	0 (0%)
	3	5 (6.1%)	5 (1.9%)	2 (2.6%)

Table 5
Relationship between microbial plaque status, periodontitis, and thyroid disorder with quality-of-life score

Variable	Category	Quality of life score	
		Mean±S.D.	p value
History of thyroid disorder	No	60.5±4.6	0.049*
	Yes	61.7±5.2	
Thyroid disorder status during the study	Hyperthyroidism	62.5±3.8	0.290
	Normal	61.5±4.7	
	Hypothyroidism	61.3±7.7	
Periodontitis	No	61.4±4.6	<0.001*
	Yes	63.5±6.0	
Plaque status	0	64.8±2.1	0.115
	1	61.4±4.5	
	2	–	
	3	62.8±16.9	

*p<0.05 is significant

can affect periodontal health lead to delayed tooth growth, taste changes, tooth inflammation, salivary gland disorders, and endanger the health of periodontal tissues. Hyperthyroidism can increase tooth sensitivity and cause caries, periodontal disease, and burning mouth syndrome (Gronkjr et al. 2018; Furuta et al. 2020; Song et al. 2021a).

Some studies have indicated that the rate of dental caries and the severity of periodontal diseases are higher in patients with thyroid disorders than in healthy people (Carrizales-Sepulveda et al. 2018; Zhang et al. 2018). Thyroid disorders can affect oral health by affecting the content and amount of saliva (Hashimoto et al. 2018).

Our study, as the first study, can be valuable in the relationship between oral health and thyroid disorders in Iran. Regarding the oral and dental health status, in the group of participants with no history of thyroid disorder, 64% of subjects observed their oral and dental health well, while in the group of patients with a history of thyroid disorder, 46.9% observed oral and dental health well. Several studies confirmed that patients with a thyroid disorder have poor oral health, but there are very rare studies on whether poor health can indicate a thyroid disorder.

Poor oral health is a crucial public health problem that affects middle-aged and elderly people. Brushing is a convenient and low-cost care to maintain oral health. Good oral health behavior is vital for the effective removal of dental plaque and the prevention of periodontal diseases. Additionally, caries and periodontal conditions can affect several systemic disorders and have local impacts on the tooth and supporting tissues (Benbassat et al. 2007). Previous studies have indicated that oral bacteria can enter the bloodstream through caries lesions or periodontal problems, and stimulate the body›s inflammatory response or activate specific cytokines. However, existing studies have revealed that the association between oral health practices and chronic conditions may differ among ethnic or geographic populations (Ehsani et al. 2022; Inchingolo et al 2024).

A study by Guo et al. (2023) has indicated that brushing (less than once a day) was associated with a higher risk of nutritional endocrine or metabolic diseases, which is consistent with other studies (Wikstrom et al. 2011; Gronkjr et al. 2018; Fu et al. 2019; Furuta et al. 2020; Song et al. 2021a).

A study by Kwon et al. (2022) on the association of thyroid disease history and common behaviors related to oral health has provided similar results. Results have also confirmed that the frequency of thyroid disorders is significantly higher in people with a history of periodontal disease and high CPI. Middle-aged women are at high risk of thyroid diseases.

Our study also confirmed that prevalence of thyroid diseases and the risk of disorders are higher in middle-aged women, which is consistent with the study of Kwon et al. (2022). A recent study indicated that about 25% of the middle-aged population has a thyroid disorder. Thus, it is vital to cautiously investigate thyroid disorders in the middle-aged population. This study revealed that a higher percentage of participants in the group with no history of thyroid used alcohol, cigarettes, and

hookah than in the group of patients with a history of thyroid disorder.

In a study by Kwon et al. (2022), the frequency of thyroid disease and thyroid disorder was higher in patients who had a history of smoking. Smoking is a major risk factor for thyroid disease, but its effect is higher in males than in females. Alcohol consumption is also a lower risk factor for hypothyroidism. This study has also indicated that the group that consumed alcohol for more than one month had a lower prevalence of thyroid diseases. Age, gender, smoking, alcohol consumption, diabetes, and hypertension are also other factors that significantly affect thyroid disorders. Some studies have also reported a close association between diabetes and thyroid disorders. Diabetic patients are at increased risk for oral diseases including periodontitis. Thus, it is vital to examine the relationship between these diseases (Kwon et al. 2022). This study revealed a significant association between the presence of periodontitis and a history of thyroid disorder, 5.3% of patients with a history of thyroid disease had periodontitis, while no one had periodontitis in the group of subjects without a history of thyroid disorder. However, there was no significant difference between two experimental groups regarding the presence of microbial plaque. In the group of patients with hyperthyroidism, 11% had periodontitis, in the group of participants with normal thyroid function, 4.6% had periodontitis and in the group of patients with hypothyroidism, 1.3% had periodontitis. However, there was no significant difference among these people regarding the microbial plaque status. The disease duration was also significantly associated with the presence of periodontitis; the mean period of periodontitis was 12.3±11.1 years in patients who had a history of thyroid disorder and had periodontitis. However, the mean time of developing thyroid disorder was 7.1±6.3 years in patients with a history of thyroid disorder and without periodontitis.

Hypothyroidism can contribute to systemic inflammation in the body and gingivitis (Gupta et al. 2014; Aldulaijan et al. 2020; Lorusso et al. 2022). Rats with hypothyroidism had increased periodontal development (Schneider 1969; Shcherba et al. 2021). A significant increase in the depth of periodontal pockets has been reported in patients with hypothyroidism compared to normal people (Poumpros et al. 1994; Shcherba et al. 2020). Hypothyroidism can compromise the immune system. It also makes the body more susceptible to infections, including gum infections related to periodontitis (Rahangdale and Galgali 2018; Shcherba et al. 2022).

In addition, hypothyroidism can affect bone metabolism and lead to a reduction in bone mineral density, changes in the bone remodeling process, and an increased risk of periodontitis-related bone loss (Dhanwal 2011; Mancini et al. 2016; Contald et al. 2020; Ursomanno et al. 2021).

Finally, it can affect blood flow and compromise the body's capability to deliver nutrients and oxygen to the gums (Werneck et al. 2014; Minervini et al. 2023). Reduced blood flow can also impair the gum healing capability (Vargas et al. 2006; Shcherba et al. 2020). However, regarding hyperthyroidism, no specific studies have been reported that directly show its impact on periodontal status, except for a few case reports and experimental models (Poumpros et al. 1994). Overall, the high metabolism related to hyperthyroidism may have potential implications for periodontal health (Silver et al. 1949; Shcherba et al. 2019; Ahmed et al. 2020). Some studies have indicated that people with autoimmune thyroiditis such as Hashimoto's thyroiditis may be at an increased risk of developing periodontitis (Roth and McAuliffe 1989; Patil et al. 2011; Morais et al. 2016; Xu et al. 2021; Vural et al. 2023).

In the study by Kwon et al. (2022), the history of periodontal disease and CPI was not significantly associated with thyroid diseases. Additionally, unlike the expectations, participants with poor oral health behaviors have a lower prevalence of thyroid diseases. This could be because females have fewer periodontal diseases than males and behaviors related to oral health are more appropriate. Thus, gender is considered an intervening factor in the relationship between oral health status and thyroid diseases. Epidemiological risk factors for thyroid diseases depend on iodine intake, genetic factors, race, gender, age, radiotherapy exposure, and drug use.

In a cross-sectional study by Kshirsagar et al. (2018), the severity of tooth decay and periodontal destruction was higher in 100 participants with thyroid disease than in the control group.

Gum bleeding, loss of adhesion, severity of periodontitis, and tooth caries were higher in females than in males. Similarly, in a comparative cohort study by Song et al. (2021b), it has been found that prevalence and severity of periodontitis in different groups of thyroid function, including patients with hypothyroidism, and hyperthyroidism, prevalence of periodontitis based on TSH level was inversely associated with periodontitis. Additionally, in a retrospective study, Chrysanthakopoulos and Chrysanthakopoulos (2016) have indicated that the presence of deep periodontal pockets (more than 5

mm) is significantly associated with thyroid disease. It is also associated with the male gender, smoking habit, congenital heart disease, mitral valve prolapses, hypertension, stroke, heart attack, other endocrine diseases, vascular diseases, liver diseases, diabetes mellitus, kidney diseases, respiratory allergies, and anemia. In contrast, there was no association between thyroid disease and CAL loss.

Gao et al. (2024) have revealed an association between periodontitis and hypothyroidism. They also have shown that changes in thyroid function did not cause periodontitis, but periodontitis causes hypothyroidism. The study by Salehi et al. (2022) has revealed a statistically significant difference between the BI, PI, and GI indices in the case and control groups. Many studies revealed that thyroid disorders are associated with poor periodontal status (Poumpros et al.1994; Zahid et al. 2011; Kelderman-Bolk et al. 2015; Babu and Patel 2016; Beriashvili et al. 2016; Albandar et al. 2018; Kshirsagar et al. 2918; Shcherba et al. 2019; Aldulaijan et al. 2020).

Some studies have reported that plaque and gingival indices in patients with thyroid disorders were higher than in healthy populations (Feitosa et al. 2009; Rahangdale and Galgali 2018). A review study confirmed the positive relationship between hypothyroidism and periodontitis (Rahangdale and Galgali 2018).

Feitosa et al. (2009) have shown that the reduction in the serum level of thyroid hormones can lead to periodontal involvement in the form of bone loss due to the increase in the activity of osteoclast cells and the reduction in blood supply in the periodontal ligament, leading to the formation of periodontal pocket and alveolar bone resorption in patients with hypothyroidism.

Rahangdale and Galgali (2018) have concluded that there is a statistically significant difference between pocket depth and clinical attachment loss in two groups with hypothyroidism and healthy people. The study by Yerke et al. (2019) has indicated that the number of teeth with higher pocket depth in the case group was significantly different from the control group. Babu and Patel (2016) have shown that PI and GI indices in children with thyroid disorders are significantly higher than in healthy people. Unlike the previous results, several authors indicated a significant association between periodontal disease and thyroid disease. The study by Kwon et al. (2022) has shown that thyroid diseases are more common in people who brush their teeth. However, the authors found no significant associations between CPI ≥3 and abnormal thyroid function tests.

A cohort study by Babu and Patel (2016) has shown that dental caries and periodontal health were significantly higher in the group with thyroid disorder compared to the control group. It has been shown that thyroid hormonal changes, such as hypothyroidism and hyperthyroidism, are associated with the oral microbiome. For example, pathogens may have systemic impacts that can disrupt endocrine function. Maintaining good oral health and eliminating oral infections quickly may help reduce these risks (De Luca and Shoenfeld 2019). This study has indicated that the score of oral health-related quality of life in subjects without a history of thyroid disorder was significantly lower than that of patients with a history of thyroid disorder indicating that their oral health-related quality of life is better. The quality-of-life score in patients without periodontitis was significantly lower than that of subjects with periodontitis. There was an indirect association between the quality-of-life score and disease duration in patients with a history of thyroid disorder. Accordingly, the oral health-related quality of life of patients increased significantly with the increasing disease duration.

Quality of life is a multidimensional and broad concept. It means a person's understanding of his life status based on the culture and value systems, expectations, standards, and life experiences that affect the physical and mental health status, social communication, and personal opinions of the person. Several studies have shown that the quality of life is significantly affected by thyroid disorders. In the study by Salehi et al. (2022) it has been shown that the mean oral health-related quality of life in thyroid patients was significantly different from the control group. It has been reported in many articles that the quality of life is poorer in patients with thyroid disorders than in healthy people (Wekking et al. 2005; De Luca and Shoenfeld 2019; Moron-Diaz et al. 2021).

The study by Rakhshan et al. (2017) has shown no significant difference between the case and control groups in the quality of life in the physical dimension. However, the indicators of physical symptoms, anxiety, and depression in the mental health dimension showed a statistically significant increase in the case group. In a review study by Vita et al. (2020), it has been found that patients with hyperthyroidism experience a worse quality of life than healthy people. Observing and teaching oral and dental health and treatment of caries and periodontal involvement in patients with thyroid disorders are strongly recommended to improve their systemic health and quality of life.

Conclusions

The results revealed a significant relationship between the presence of periodontitis and a history of thyroid disorder. In this regard, in the group with a history of thyroid disorder, 5.3% of patients had periodontitis, while in the group without a history of thyroid disorder, no person had periodontitis. However, there was no significant difference between two experimental groups regarding the presence of microbial plaque. The score of oral health-related quality of life in subjects without a history of thyroid disorder was significantly lower than that of subjects with a history of thyroid disorder indicating that their oral health-related quality of life is better. Additionally, there was an indirect relationship between the quality-of-life score and disease duration in subjects with a history of thyroid disorder. Accordingly, the oral health-related quality of life of patients increased significantly as disease duration increased.

Limitations of the study include non-cooperation with a number of participants and incomplete filling of a number of questionnaires.

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