A Comprehensive Analysis of the Association between Thyroid Dysfunctions and Periodontal Health: Systematic Review

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ABSTRACT

Objectives: The purpose of this systematic literature review was to establish a correlation between thyroid dysfunctions and periodontium health.
Material and Methods: The systematic review was conducted according to PRISMA statement. An electronic search was performed using MEDLINE (PubMed) and Google Scholar databases using a combination of keywords "hypothyroidism", "hypothyroidism", "thyroid", "thyroid dysfunction" and "periodontitis". The research covered the period from January 1, 2019 and July 1, 2024, included studies written in English, conducted in humans.
Results: The results showed that hyperthyroidism can be associated with a higher prevalence of periodontitis due to decreased oral microbiome diversity, serum thyroid-stimulating hormone levels, increased periodontal pocket depth, clinical attachment loss and interleukin-6. Hyperparathyroidism after parathyroidectomy may lead to a slightly higher risk of tooth extraction in the first two years afterward because decreasing lamina dura, increasing periodontal ligament width. And hypothyroidism negatively affects the homeostasis of calcium and phosphorus in the oral fluid and can change the composition of bone minerals.
Conclusions: Hyperthyroidism increases the risk of periodontitis by promoting deeper periodontal pockets, reducing oral microbiome diversity, altering alveolar bone structure and elevating inflammatory markers like interleukin-6, which are linked to disease progression. Hypothyroidism worsens periodontal disease by disrupting calcium-phosphorus balance and causing alveolar bone changes, especially in young individuals. Both conditions affect periodontal homeostasis, emphasizing the bidirectional relationship between endocrine and periodontal health. Dentists should monitor thyroid dysfunction, as managing thyroid levels may improve periodontal treatment.

Keywords: hyperthyroidism; hypothyroidism; periodontitis; thyroid dysfunction; thyroid.

Accepted for publication: 20 December 2024
To cite this article:
Jakonyte A, Pliavga V, Juodzbalys G.
A Comprehensive Analysis of the Association between Thyroid Dysfunctions and Periodontal Health: Systematic Review
J Oral Maxillofac Res 2024;15(4):e1
URL: http://www.ejomr.org/JOMR/archives/2024/4/e1/v15n4e1.pdf
doi: 10.5037/jomr.2024.15401

INTRODUCTION

Periodontitis is an infectious disease affecting the tissues surrounding the tooth, characterized by various clinical, microbiological, and immunological features [1-3]. The global prevalence of periodontitis is a significant concern. According to the World Health Organization, periodontal disease affects about 19% of the world's adult population, equating to more than 1 billion cases worldwide [2]. Consequently, the relationship between various systemic diseases and periodontium health is currently under investigation [2,3]. Studies have confirmed associations between periodontitis and several diseases, including diabetes, coronary heart disease, chronic obstructive pulmonary disease, obstructive sleep apnea, premature birth, chronic kidney disease, cancer, COVID-19, rheumatoid arthritis, and stroke [2-4]. However, the relationship between periodontium health and thyroid dysfunction remains poorly understood, though it is of significant relevance to the dental community.

The connection between the thyroid gland and the oral cavity may be rooted in their anatomical relationship. The thyroid gland differentiates from the first pharyngeal pouch, sharing its origin with the tongue root. This anatomical link may lead to structural abnormalities such as thyroglossal duct cysts and inflammation. Inflammation of the lingual thyroid gland is usually caused by incorrect embryological descent of the thyroid gland through the thyroglossal duct to its final anatomical position, resulting in thyroid tissue remaining at the base of the tongue [5]. This can be an incidental finding or cause partial airway obstruction. In symptomatic cases, this lingual thyroid tissue can be surgically removed. There is evidence that removing excessive thyroid tissue or administering too much thyroid-stimulating hormone (TSH) can lead to hypothyroidism [5], which may increase the risk of bleeding gums [6], cause adverse changes in alveolar bone composition [7,8], inhibit osteogenic differentiation of periodontal ligament stem cells [9], reduce calcium nodule formation [7], impair collagen synthesis [9] and the development of chronic inflammatory process in the periodontium [7].

TSH secretion is increased from the anterior pituitary gland when thyroid hormone levels are reduced [10,11], and serum TSH concentrations are considered the most reliable indicators of thyroid status. The American Thyroid Association recommends serum TSH determination starting at the age of 35, with follow-up every five years [12]. When TSH levels are too low, hyperthyroidism, a form of thyroid dysfunction, occurs.

In contrast to hypothyroidism, hyperthyroidism is a syndrome associated with the the overproduction of thyroid hormones (T3 and T4), typically accompanied by suppressed levels of TSH [13]. Additionally, the literature suggests that hyperthyroidism may alter oral microbiome diversity [14], promote deeper periodontal pockets [15,16], higher levels of plaque, gingival index (GI) [16], and pro-inflammatory reactions in the periodontium [17]. Studies have also shown that experimental periodontitis combined with hyperthyroidism in rats results in destructive lesions of the periodontal connective tissue, hyperkeratotic zones in the gingival epithelial lamina, and deepening of the gingival sulcus [15]. However, there is a lack of systematic conclusions to support the connection between thyroid dysfunction and periodontal health. Therefore, the aim of this systematic literature review is to evaluate the impact of thyroid pathology on periodontal health.

MATERIAL AND METHODS

Protocol and registration

A systematic review was based on PRISMA (Preferred Reporting Item for Systematic Review and Meta-Analyses) statement [18].

Focus question

The focus question was based on Population, Intervention, Comparison, and Outcome (PICO) framework: (P) patients diagnosed with thyroid dysfunction and undergoing periodontal examination, (I) evaluation of the impact of thyroid dysfunction on periodontal health, (C) compared groups of patients with hypothyroidism or hyperthyroidism, (O) periodontal health characteristics depending on thyroid dysfunction parameters.

The focus question was: "Do thyroid dysfunctions, such as hypothyroidism or hyperthyroidism, have an impact on the onset and progression of periodontitis?" (Table 1).

Information sources

The systematic electronic literature search strategy involved both electronic databases and hand searches. An electronic search was conducted on the National Library of Medicine database (MEDLINE) through its online site PubMed and Google Scholar.

Table 1. PICOS framework of the framed clinical question

Component	Description
Population (P)	Patients diagnosed with thyroid dysfunction and undergoing periodontal examination
Intervention/exposure to a risk factor (I)	Evaluation of the impact of thyroid dysfunction on periodontal health
Control (C)	Compared groups of patients with hypothyroidism or hyperthyroidism
Outcome (O)	Periodontal health characteristics depending on thyroid dysfunction parameters

Search

According to the PRISMA guidelines, the resource databases were explored through advanced searches. Different keywords and their combinations were used utilizing Boolean operators, including AND and OR, to conduct online research. The keywords and search inquiries that were used during the primary stage were as follows: ("Thyroid" OR "hypothyroidism" OR "hyperthyroidism" OR "thyroid dysfunction" AND "periodontitis"). The choice of keywords was intended to be extensive, to collect as much relevant data as possible, and to refine the search results, without relying on electronic means alone.

Selection of studies

The resulting articles titles were independently screened by two independent reviewers (A.J. and V.P.) according to the exclusion and inclusion criteria. A third reviewer (G.J.) checked for potential mistyping. A full-text analysis was performed for those articles that met the selection criteria. The reviewers independently checked the results, and disagreements were resolved by discussion with the senior investigator (G.J.). Reviewers were calibrated by calculating Cohen's kappa coefficient (κ) values to ensure inter-rater reliability of abstracts and titles on a sample of 10% of publications.

Types of publication

The systematic literature review included all human prospective and retrospective cohort studies, in which authors evaluated the effect of various thyroid dysfunctions to periodontal health.

Types of studies

In this review were included retrospective cohort and population studies published from January 1, 2019 and July 1, 2024. The systematic literature review included studies on humans published in the English language. Letters, editorials, meta-analyses, systematic literature reviews, conference abstracts, guidelines, PhD theses, and abstracts were excluded.

Types of participants/population

In this systematic literature review investigated patients diagnosed with thyroid dysfunction who underwent periodontal examination.

Inclusion and exclusion criteria

All studies applied the following inclusion criteria:

- Studies published within the last 5 years.
- Studies conducted on human: male and female, individuals ≥ 18 years old.
- Studies in which patients are diagnosed with thyroid dysfunction such as hypothyroidism or hyperthyroidism and are evaluated for periodontium health (such as periodontal pockets, missing teeth, extracted teeth, periodontal changes, GI, gingiva bleeding).

The following articles were excluded as follows:

- Studies involving patients with specific systemic diseases, immunologic disorders, uncontrolled diabetes mellitus and Grave's disease.
- Insufficient information regarding the selected topic.
- Not accessible relevant data, such as the impossibility of contacting the authors for any reason.
- Journals of publication not cited in open access checklist for predatory publishers.

Sequential search strategy

The selection of articles was carried out in two stages. During the first stage, the titles and abstracts of the articles were reviewed. Articles that did not meet the selection criteria and were duplicates were excluded. Some studies were rejected only after reading the abstract. During the second stage, all selected publications were analyzed and the texts were checked against the inclusion criteria to confirm the eligibility of each study. Title and abstract screenings were performed using an online screening tool Rayyan® (Qatar Computing Research Institute; HBKU, Doha, Qatar [www.rayyan.ai]).

Data extraction

The data were independently extracted from studies in the form of variables, according to the aims and themes of the present review.

Data items

Data was collected from the included subjects and categorized as follows:

- "Author (Year)" - revealed the author and year of publication.
- "Type of study" - indicated the type of the study.
- "Number of patients" - described the number of patients examined.
- "Type of thyroid dysfunction" - the type of thyroid dysfunction, whether it is hypothyroidism or hyperthyroidism.
- "Effects of thyroid dysfunction impact on the periodontium"- describes the influence of thyroid dysfunction parameters on periodontal health.
- "Main characteristics of the periodontium" - described the main characteristic of the periodontium in case of thyroid dysfunction.

Risk of bias within studies

The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for cohort studies (Table 2) and JBI Critical Appraisal Checklist for analytical cross-sectional studies (Table 3) were used to assess the methodological quality of the studies that met the inclusion criteria. "Yes" "no", "unclear", or "not applicable" was given to each criterion.
Methodological quality was categorized as follows: "high risk of bias", when the study scored up to 49% of positive answers; "moderate risk of bias", when study scored between 50 and 69% of positive answers; "low risk of bias", when study reached more than 70% of favourable answers.

Statistical analysis

Zotero® version 6.0.37 (George Mason University, Fairfax County, Virginia, USA) reference manager software was used for article management. The level of agreement between the two raters in selecting abstracts and studies to be read in full-text were measured using Cohen's kappa coefficient (κ).

Table 2. The Joanna Briggs Institute Critical Appraisal Checklist for cohort studies

Question number	Defined question
Q1	Were the two groups similar and recruited from the same population?
Q2	Were the exposures measured similarly to assign people to both exposed and unexposed groups?
Q3	Was the exposure measured in a valid and reliable way?
Q4	Were confounding factors identified?
Q5	Were strategies to deal with confounding factors stated?
Q6	Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?
Q7	Were the outcomes measured in a valid and reliable way?
Q8	Was the follow-up time reported and sufficient to be long enough for outcomes to occur?
Q9	Was follow-up complete, and if not, were the reasons to loss to follow-up described and explored?
Q10	Were strategies to address incomplete follow-up utilized?
Q11	Was appropriate statistical analysis used?

Table 3. The Joanna Briggs Institute Critical Appraisal Checklist for analytical cross-sectional studies

Question number	Defined question
Q1	Were the criteria for inclusion in the sample clearly defined?
Q2	Were the study subjects and the setting described in detail?
Q3	Was the exposure measured in a valid and reliable way?
Q4	Were objective, standard criteria used for measurement of the condition?
Q5	Were confounding factors identified?
Q6	Were strategies to deal with confounding factors stated?
Q7	Were the outcomes measured in a valid and reliable way?
Q8	Was appropriate statistical analysis used?

Meta-analysis was not performed due to the heterogeneity of studies and lack of data.

RESULTS

Study selection

The database search showed 84 articles in the MEDLINE (PubMed) and Google Scholar databases. Figure 1 illustrates a summary of the article selection process using a PRISMA flow diagram. After removing duplicates, 77 articles remained. In the first stage of selection, the titles and abstracts of the articles were read, and after applying the selection criteria, suitable articles were selected. Considering missing titles and abstracts, we had 13 full-text articles. Excluding 3 animal studies, 2 *in vitro* studies and 2 article involving minors. Six publications were included in the systematic literature review. The level of agreement between the two authors (A.J. and V.P.) in selecting abstracts were measured at $\kappa = 0.86$.

Study exclusion

The reasons for excluding 7 studies are given in Table 4.

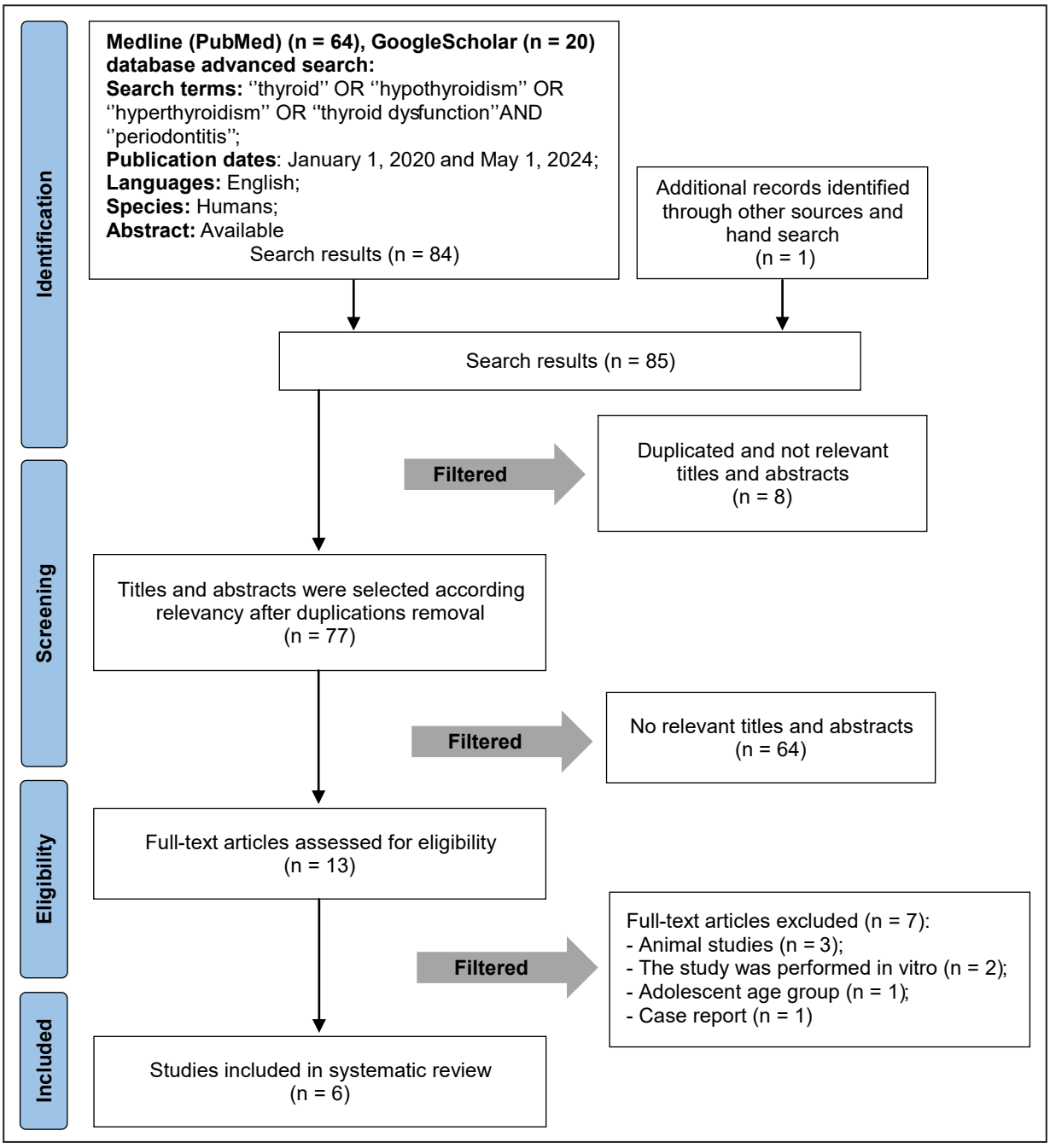

Figure 1. Flow diagram of studies selection according PRISMA guidelines.

Table 4. Excluded studies

Study	Year of publication	Reason for rejection
Baiju et al. [6]	2021	Case report
Zeng et al. [9]	2023	Experimental laboratory study
Shcherba et al. [15]	2022	Animals study
Shcherba et al. [17]	2021	Animals study
Kwon et al. [21]	2022	History of periodontitis and CPIs did not show significant associations with histories of thyroid disease. Among 14,860 participants with no history of thyroid disorders, those with higher CPIs were more likely to have abnormal TFTs (OR = 1.381; 95% CI = 1.241 to 1.537; P < 0.0001)
Shcherba et al. [26]	2019	Animals study
Yetkin Ay et al. [27]	2022	Because of the adolescence period, which results in exaggerated host response to the dental plaque, and projected with the presence of gingivitis in the whole study population

CPI = community periodontal index; TFT = thyroid function tests.

Quality assessment of the included studies

The quality of the included studies is summarized in the Table 5 and 6. All studies were characterized by the JBI score as high quality: three cohort studies [8,14,19] were characterized > 8 and 3 cross-sectional studies [7,16,20] had a mean of > 9.

Study characteristics

Six publications were included in the systematic literature review (Table 7). Three publications [8,14,19] were cohort studies and 3 publications [7,16,20] were cross-sectional studies. A total of 17,104 subjects were included in the results.

The included publications investigated the association of hypothyroidism [7] and hyperthyroidism [8,14,16,19,20] with changes of periodontium health. All the selected articles reported a positive association between periodontium health and thyroid dysfunctions.

In the selected articles, thyroid dysfunction was assessed using different methods. Song et al. [19] TSH was measured using an electrochemiluminescent immunoassay. Han et al. [20] used TSH level data from the database. Thyroid dysfunction has also been tested by other authors [14] using thyroid hormones and related biomarkers. These included total and free thyroxine (TT4 and FT4), total and free triiodothyronine (TT3 and FT3), thyroglobulin (TG), thyroglobulin antibodies (TGAb), thyroid peroxidase antibodies (TPOAb), and TSH.

Periodontium health changes and their relationship to thyroid dysfunctions were assessed differently by each author. Only two authors used the Community Periodontal Index (CPI) to measure periodontal changes [16,19]. Mykolaivna [7] used data on the incidence of periodontitis in patients from a database. Kadhom et al. [16] investigated plaque and gingival status: they used plaque index (PLI), GI, periodontal pocket depth (PPD), and clinical attachment

Table 5. Results of cohort studies from The Joanna Briggs Institute Critical Appraisal Checklist

Study	Year of publication	Study design	Checklist										
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Lexomboon et al. [8]	2023	Cohort study	+	+	?	+	+	+	?	+	+	NA	+
Zheng et al. [14]	2023	Cohort study	+	+	+	+	+	+	+	+	?	-	+
Song et al. [19]	2021	Cohort study	+	+	+	?	+	+	+	+	+	+	+

? = unclear; + = yes; - = no; NA = not applicable.

Table 6. Results of cross-sectional studies from The Joanna Briggs Institute Critical Appraisal Checklist

Study	Year of publication	Study design	Checklist							
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Mykolaivna [7]	2021	Cross-sectional	+	?	+	+	+	+	+	+
Kadhom et al. [16]	2023	Cross-sectional	+	+	+	+	+	+	+	+
Han et al. [20]	2023	Cross-sectional	+	+	?	+	+	+	+	+

? = unclear; + = yes; - = no; NA = not applicable.

Table 7. Characteristics of the included studies

Study	Number of patients	Type of thyroid dysfunction	Effects of thyroid dysfunction impact on the periodontium	Main characteristics of the periodontium
Mykolaivna [7]	100	Hypothyroidism	Hypothyroidism associated with negative dynamics of calcium-phosphorus in oral fluid: increased phosphorus and decrease of calcium content of inflammatory-dystrophic process in the periodontium	The development of chronic inflammatory process in periodontium
Lexomboon et al. [8]	6151 (1415 male; 4736 female)	pHTP (primary after PTX)	Primary pHTP patients were more likely to have risk of tooth extractions and periodontal interventions during the first two years after PTX and pHTP	Characteristic periodontal bone remodeling parameters: decreasing lamina dura, increasing periodontal ligament width but not periodontal inflammatory parameters, such as bleeding on probing and furcation involvement and periodontal status
Zheng et al. [14]	2943 (1484 male; 1459 female)	Hyperthyroidism	Hyperthyroidism associated with lower oral microbiome diversity. Patients microbiome diversity metrics improved after treatment and restoration of thyroid function, suggesting that the decrease in the microbiome diversity may be closely related to the progression of the disease	Increased progression of periodontal disease
Kadhom et al. [16]	90 (all female)	Hyperthyroidism	Hyperthyroid patients have increased PPD, CAL, IL6, which show a positive association with periodontal disease progression	Increased PPD, CAL and IL6
Song et al. [19]	5468 (2866 male; 2602 female)	Hyperthyroidism	Hyperthyroidism when is low TSH levels (< 1.76 mIU/L) were rather associated with a higher prevalence of periodontitis	CPI code ≥ 3, indicating that at least one site had a > 3.5 mm pocket in the index tooth 11, 16, 17, 26, 27, 31, 36, 37, 46, and/or 47 of 1423 periodontitis patients
Han et al. [20]	2352	Hyperthyroidism	Hyperthyroidism patients with low serum TSH levels are more likely to have periodontitis	The development of chronic inflammatory process in periodontium

pHTP = hyperparathyroidism; PPD = periodontal pocket depth; PTX = parathyroidectomy; CAL = clinical attachment loss; TSH = thyroid-stimulating hormone; CPI = clinical attachment loss.

loss (CAL). Han et al. [20] simply used the updated the Centers for Disease Control and Prevention (CDC)/American Academy of Pediatrics (AAP) definitions to monitor periodontitis and periodontal status was divided into four categories based on objective clinical measurements of adhesion loss and PPD: no periodontitis, mild, moderate, and severe periodontitis.

Hyperthyroidism

TSH level

The authors of two studies reported that hyperthyroidism in the setting of low serum TSH was significantly associated with periodontitis, independent of various risk factors for periodontitis [19,20]. Song et al. [19] studies found that the highest significant prevalence of periodontitis was at serum TSH < 1.76 mIU/L (26.5%) and the lowest at > 2.83 mIU/L (20.9%, P = 0.003). Subgroup analysis in this study showed that the association between TSH levels and periodontitis remained significant regardless of age, gender, body mass index, smoking, alcohol consumption, or physical activity [19]. Han et al. [20] also described that periodontitis and thyroid dysfunction are closely related and that the development of periodontitis is strongly associated with low TSH levels (hyperthyroidism).

Changes of alveolar bone

Lexomboon et al. [8] found that primary hyperparathyroidism (pHTP) after parathyroidectomy (PTX) leads to a slightly higher risk of tooth extraction in the first two years after PTX. Characteristic periodontal bone remodelling parameters: decreasing lamina dura, increasing periodontal ligament width but not periodontal inflammatory parameters, such as bleeding on probing and furcation involvement and periodontal status. The more severe the primary pHTP before PTX, the higher the likelihood of postoperative periodontal interventions.

Microbiome

Zheng et al. [14] found that both subclinical

and clinical hyperthyroidism increased the progression of periodontal disease due to decreased oral microbiome diversity, although high TPOAb was associated with higher microbiome diversity. No significant differences in microbiome composition were observed between them (P = 0.716 and 0.916). It was also found that patients microbiome diversity metrics improved after treatment and restoration of thyroid function.

Mediators of inflammation

Kadhom et al. [16] found that interleukin-6 (IL-6) levels were significantly increased in the hyperthyroidism group which show a positive association with periodontal disease progression. Patients with hyperthyroidism and periodontitis showed a significant difference in PPD and clinical adhesion loss (CAL). The PLI was also higher (P < 0.05). However, there was a positive non-significant correlation between PPD and CAL with IL-6 in hyperthyroid patients. Both periodontal PPD, CAL and IL6 were higher in hyperthyroidism patients with a significant difference.
A meta-analysis was not performed because the results of the studies were not uniform.

Hypothyroidism

Only one study examined the effects of hypothyroidism on periodontal health. Mykolaivna [7] observed that hypothyroidism causes adverse changes in bone mineral composition and exacerbates periodontal disease. In young people with generalized periodontitis, against the background of hypothyroidism, negative changes in calcium-phosphorus homeostasis in the oral fluid are observed: there was a tendency to increased phosphorus and decrease of calcium content of inflammatory-dystrophic process in the periodontium.

DISCUSSION
Summary of evidence

Present systematic literature review is based on the results of an analysis of six publications. Although the researchers used different methodologies to assess thyroid dysfunction and periodontal health, all the publications show some form of association between endocrine gland activity and periodontal changes.
Most of the selected publications indicate that the level of TSH in blood serum can influence periodontal health. When thyroid hormones are out of balance, the proper mechanisms of physiological systems and development are disrupted. This literature review found that the lower the TSH levels the more associated with significantly higher odds for periodontitis independent of other periodontitis risk factors [19,20]. Song et al. [19] described that the highest prevalence of periodontitis occurred in the study group with serum TSH levels < 1.76 mIU/L (26.5%, P = 0.003). However, according to Zeng et al. [9] hypothyroidism is equally important in periodontium health in the setting of elevated serum TSH levels. Zeng et al. [9] confirm that hypothyroid patients need to adjust serum TSH levels, as hypothyroidism-induced increases in TSH ≥ 10 mU/L inhibit osteogenic differentiation of periodontal ligament stem cells: including decreased calcium nodule formation, decreased alkaline phosphatase levels, and decreased collagen synthesis. Also according to Baiju et al. [6] in a case report of a 55-year-old woman with a TSH of 150 µIU/mL found that hypothyroidism leads to an increase in subcutaneous and subepithelial mucopolysaccharides, which reduces the ability of small blood vessels to contract and leads to gum problems. Even with good individual oral hygiene [21], gingival problems do not disappear until the TSH level is corrected by treatment prescribed by an endocrinologist. Therefore, correction of TSH levels in patients with thyroid dysfunctions such as hypo-, hyperthyroidism may be beneficial to improve orthodontic, implant, and periodontitis outcomes in these patients.
Microbial diversity is often closely related to the health status of the host. Generally, in the absence of oral diseases, healthier hosts have a higher oral microbiome diversity. Thyroid dysfunction is thought to affect the abundance of microorganisms in the oral environment [14]. The oral microbiome participates in the regulation of metabolic processes that involve thyroid function, while altered metabolic processes due to thyroid dysfunction can lead to changes in the oral microbiome. Zheng et al. [14] found that both subclinical and clinical hyperthyroidism were associated with reduced oral microbiome diversity, while high TPOAb was associated with higher microbiome diversity. No significant differences in microbiome composition were observed between them (P = 0.716 and 0.916). However, patients microbiome diversity metrics improved after treatment and restoration of thyroid function, suggesting that the decrease in the microbiome diversity may be closely related to the progression of periodontium disease. Shcherba et al. [22] found in rats that periodontitis in the presence of thyroid dysfunction increases the diversity

and number of oral microbial flora. They found that hyperthyroidism was characterized by a higher prevalence of *S. aureus*, yeast fungi and *Candida albicans* strains. As the studies have been carried out in different ways, the results are conflicting and the significance remains unclear.

TPOAb is considered to be the most sensitive marker for autoimmune thyroid disease [1] and has been hypothesized to be associated with periodontitis [19]. However, studies [9,19] did not find a significant effect of TPOAb on periodontitis.

There is also data that thyroid dysfunction can influence the alveolar bone composition. Mykolaivna [7] concluded that hypothyroidism in young patients negatively changes the composition of bone minerals and exacerbates periodontal diseases. Negative homeostasis of calcium and phosphorus in the oral fluid has been observed in patients with hypothyroidism. As the inflammatory-dystrophic periodontal process develops, calcium decreases and phosphorus increases. In patients with generalized periodontitis, the average concentration of oral fluid phosphorus against the background of reduced thyroid function was 4.24 (SD 0.58) mmol/l and was 1.7 times higher than in the group without endocrine pathology, $P < 0.01$. This means that in patients with periodontal diseases and hypothyroidism, pathological changes in metabolic processes occur, the release of mineral components, especially calcium, increases. This study showed that periodontal pathology in hypothyroidism is characterized by the development of a chronic inflammatory process, which is accompanied by a marked decrease in calcium and phosphorus homeostasis in the oral fluid [7]. It is important to mention that insufficient vitamin D levels can increase the risk of developing thyroid-related diseases because it regulates the secretion of TSH. However, vitamin D is also important in the regulation of bone homeostasis and calcium and phosphorus metabolism. A systematic review and meta-analysis showed that circulating vitamin D was significantly lower in patients with chronic periodontitis compared to the control group [23]. This suggests that vitamin D may be important in demonstrating the link between thyroid and periodontal health. And the relationship between hyperthyroidism and bone changes was described by Shcherba et al. [15], who found in a morphological periodontological experiment that in rats with hyperthyroidism, areas of growth of bone tissue into connective tissue were detected, which indicated violations of the organization and metabolic processes of the bone tissue of the alveolar process. Lexomboon et al. [8] investigated the association of primary pHTP after PTX with oral health and found that the risk of tooth extraction (15%) is slightly increased in the first two years. This can be predicted by preoperative serum ionised calcium levels and adenoma weight. There is also evidence that TSH regulates bone metabolism independently of thyroid hormones, including the fate of osteoblasts and osteoclasts [9]. However, more research would be needed to substantiate this claim.

There is also evidence that the relationship between thyroid dysfunction and periodontal health may be based on the activity of inflammatory processes. Kadhom et al. [16] found that IL-6 levels were significantly increased in the hyperthyroid group. Periodontitis patients showed a significant difference in PPD, CAL and PLI ($P < 0.05$). There was a positive non-significant correlation between PPD and CAL (clinical growth loss) with IL-6 in hyperthyroid patients. This means that IL-6 is not a significant marker for assessing the association of hyperthyroidism with periodontitis that can be used in clinical practice. Also, Lexomboon et al. [8] in the study mentioned that periodontal inflammatory parameters do not change in the presence of pHTP. However, according to Shcherba et al. [15], both hyperthyroidism and hypothyroidism can cause periodontal inflammation. Specifically, hyperthyroidism increases the production of inflammatory mediators, leading to damage to the entire periodontal apparatus, progression of periodontitis and impaired tissue repair. One of the most important cytokines, tumour necrosis factor alpha (TNF-α), has the ability to stimulate the production of other pro-inflammatory cytokines and osteoclasts. Shcherba et al. [17] showed that TNF-α levels in the supernatant of periodontal homogenate from rats with periodontitis alone increased significantly by 2.4-fold ($P < 0.001$) in rats with periodontitis, by 2.7-fold ($P < 0.001$) in rats with periodontitis under hypothyroidism, and by a maximum of 3.3-fold ($P < 0.001$) in rats with periodontitis and hyperthyroidism. This indicates that thyroid dysfunction (especially hyperthyroidism) induces an overproduction of inflammatory mediators, which leads to a marked damage of the entire periodontal apparatus, thus causing periodontitis progression. Although Monea et al. [24] also observed that IL-6 and TNF-α, which are produced in the context of thyroid dysfunction, play a role in the initiation of processes and in the amplification of the inflammatory cascade in periodontal tissues, the results are questionable because elevated IL-6 is associated with many oral disorders, including periodontal disease [25].

The results of this study are important for the regions of Central, Northern and Eastern Europe after

the Chernobyl accident in 1986. Due to the consequences of increased radiation, the number of cases of thyroid dysfunction has increased. The relationship with other diseases must be clearly investigated in order to adapt knowledge to the proper treatment of patients [17]. Periodontists should consider thyroid disease and endocrinologists should assess the presence of periodontitis when evaluating patients, as early recognition of both conditions can enhance treatment outcomes. However, more detailed studies are needed to confirm the statement whether periodontal treatment reduces the risk of thyroid dysfunction, or *vice versa*.

Limitations

The results of the studies mentioned in this literature review may have been influenced by the skill of the dentists performing the periodontal assessment and reliance on national data. It is also important to mention that not all doctors used the same group of teeth, periodontal status assessment, some used the CPI index, divided periodontal activity into 3 groups, assessed the amount of dental plaque, attachment loss. The relatively small sample size of the studies may also have influenced the results. Ethnographic and geographic differences among people should also be taken into account when evaluating these results. The results of this systematic literature review could have been more significant if a quantitative analysis (meta-analysis) of the results had been carried out, but this could not be done given the heterogeneous nature of the publications selected. This systematic review does not reveal which dental treatment protocol should be followed in patients with thyroid dysfunction to achieve the best systemic results for periodontal treatment. Finally, the results of this systematic literature review are not sufficient to substantiate the association between thyroid and periodontal health and more clinical or population-based studies are needed.

CONCLUSIONS

Hyperthyroidism increases the risk of periodontitis by promoting deeper periodontal pockets, reducing oral microbiome diversity, altering alveolar bone structure (e.g., decreased lamina dura, increased periodontal ligament width), and elevating inflammatory markers such as interleukin-6, which are associated with periodontal disease progression. Hypothyroidism exacerbates periodontal disease by altering calcium-phosphorus balance and causing changes in alveolar bone, particularly in young individuals. Both conditions disrupt periodontal homeostasis, highlighting the bidirectional relationship between endocrine and periodontal health. Therefore, dentists must pay attention to patients with thyroid dysfunction, as managing thyroid function can help treat periodontal diseases more effectively.

ACKNOWLEDGMENTS AND DISCLOSURE STATEMENTS

The authors did not receive any specific grants or financial support from funding agencies for this work, and there are no conflicts of interest among them.

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To cite this article:
Jakonyte A, Pliavga V, Juodzbalys G.
A Comprehensive Analysis of the Association between Thyroid Dysfunctions and Periodontal Health: Systematic Review
J Oral Maxillofac Res 2024;15(4):e1
URL: http://www.ejomr.org/JOMR/archives/2024/4/e1/v15n4e1.pdf
doi: 10.5037/jomr.2024.15401

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