AFGHAN MEDICAL JOURNAL
KABUL UNIVERISITY OF MEDICAL SCIENCES ABU ALI IBN SINA
Volume 2, Issue 2 | August 2025 AMJ e-ISSN: 3007-0805

EVALUATION OF THE ETIOLOGY OF PERI-IMPLANTITIS: A NARRATIVE REVIEW

Hassina Shadab[1], Ahmad Shekeb Sobat[2*] , Noor Ahmad Shah Noor[3,] Aisha Nawabi[4]

[1,4]Periodontics Department, Kabul University of Medical Sciences

[2, 3] Oral and Maxillofacial Surgery Department, Kabul University of Medical Sciences

Abstract

Background: Peri-implantitis is a situation that begins as gingival inflammation around a dental implant (peri-implant mucositis) and then extends to the bone that supports the dental implant. It causes bone loss at the coronal part of the fixture and can be determined by deep gingival pockets, bleeding, or discharge during investigation. Learning how to find, understand the etiology, assess the progress, find out its prevalence, and manage peri-implantitis is essential for both dental students and residents.

Objectives: This study aimed to identify the different factors that stimulate the onset of peri-implantitis and to use this knowledge to support practical prevention techniques.

Methods: A comprehensive survey of previous studies was done using two main online sources: PubMed and Google Scholar. PubMed showed 1,512 beneficial articles, while Google Scholar gave a much higher number, with 7,940 relevant findings.

Results: Periodontal disease, inadequate supportive therapy, and cigarette smoking are recognized as significant systemic risk factors contributing to the development of peri-implantitis. Local factors such as poor plaque control, mucosal inflammation,

Improperly designed implant crowns, residual submucosal cement, and a lack of keratinized mucosa surrounding the implant also play critical roles in increasing the risk of peri-implantitis. Effective management of both systemic and local risk factors is essential to prevent and control this condition.

Conclusion: Peri-implantitis is a broad and complex condition caused by several variables. The main causes of it are a history of periodontal disease, smoking, patient noncompliance with regular checkups, poor cleaning habits, rough implant surface, and residual cement around the implant interface.

Keywords: Etiology, Peri-implantitis, Peri-mucositis, Risk factors.

Introduction

A gum problem around dental implants caused by plaque, which can be treated and reversed, is called Peri-implant mucositis. It affects only the soft tissue and often shows signs like redness, swelling, and bleeding when touched gently. If this situation is not treated, it can worsen and turn into peri-implantitis, when the infection spreads

Deeper and starts damaging the supporting bone of the implant. This condition is characterized by increased

Pocket depth, bleeding on probing and discharge, and loss of the bone-implant interface at the coronal part [1].

Dental implants can also face problems like swelling and tissue damage, just as gums and bones around natural teeth. These situations are called

* **Corresponding Author:** Ahmad Shekeb Sobat, Oral and Maxillofacial Surgery Department, Kabul University of Medical Sciences (KUMS),
Email shekebsobat1@gmail.com, Tel +93776004847
Received 25 Jan 2025; Received in revised form 17 July 2025; Accepted 05 August 2025; published Online 25 August 2025.

mucositis and peri-implantitis [1-3]. Sometimes, it is difficult for dentists to distinguish between them because they share similar signs [4].

Bleeding when probing around an implant may indicate a potential issue, but there is not enough proof to say it can reliably predict future disease [5].

Peri-implantitis is more severe than mucositis because it gets worse and cannot be reversed. It affects both the gingiva and the bone around the implant, breaks down the bone tissue, compromising the attachment between implant and bone, forming deeper pockets around the implant, and sometimes resulting in the discharge of pus [1-3]. Bleeding, bone loss, and deep gingival pockets around an implant are not always caused by inflammation. For example, placing the implant too deep can also lead to these issues [6]. The health of the tissues around an implant can also be affected by several design features, such as the shape and type of the implant, how the parts are connected, and the materials and structure of the abutments and the attached crown or bridge [5].

In the last three decades, peri-implantitis has become a major concern in modern dentistry. It is essential for dental students- both beginners and advanced- to learn how to recognize the condition, understand its underlying factors, monitor its development, be aware of its prevalence, and explore effective treatment approaches [7].

A recent analysis by Mombelli and his team estimated that peri-implantitis impacts about 20% of individuals.

With dental implants and 10% of the implants themselves. Still, these findings should be interpreted with caution due to heterogeneity among studies. The report also shows that bone alterations commonly happen in the first few weeks after abutment placement, causing bone loss, which is normal and should not be considered as peri-implantitis. Therefore, it is advised to take an X-ray after the placement of the prosthetic part to have a baseline for assessing any future bone loss around the fixture [8].

Many dangerous bacteria have been found in cases of peri-implantitis, such as Prevotella Nigrescens, Streptococcus constellatus, Aggregatibacter actinomycetemcomitans, Porphyromonas gignivalis, Treponema denticola, and Tannerella forsythia[9, 10]. Rams and colleagues revealed that of 120 patients, 71.7% were resistant to one or more kinds of antimicrobial drugs [10]. Peri-implantitis is an infectious disease generated by different anaerobic bacteria, but, in contrast to periodontitis, it includes bacteria that are usually not related to gingival disease [11]. Staphylococcus aureus firmly binds to titanium surfaces; therefore, it has an important role in the development of peri-implantitis. As reported by Salvi et al, it accurately predicts the condition with positive and negative predictive values of 80% and 90% respectively [12]. Also, inflammation around the implants with smooth surfaces develops more quickly than that with rough surfaces [13-15].

Dental plaque is the main cause of peri-implantitis, just like gingival disease [16]. Intact periodontium is influenced by various elements such as dental maintenance, oral health routine, gene expression alteration in gene activity, body health, and nutritional habits [17, 18]. Gram-negative anaerobic bacteria are linked with both peri-implantitis and periodontitis; nevertheless, peri-implantitis includes a broader range of microbes [19]. Immune cells like B-lymphocytes and plasma cells are present in the peri-implantitis area. Under microscopic examination, lesions of peri-implantitis are larger than periodontitis lesions, which show increased blood vessel formation and a higher amount of cells in the connective tissue [20]. The concentration of Matrix metalloproteinase is 97% in peri-implantitis, which is greater than 78% observed in chronic periodontitis compared to healthy gingiva [21]. Tissue affected by peri-implantitis also includes antibodies targeting components of the extracellular matrix [22]. Peri-implantitis progresses more quickly, resulting in bone loss that is faster and more intense than in periodontal disease. This fast bone loss could result from unique microbial populations around implants, the body's different immune response, and the lack of keratinized tissue [23,24].

Factors associated with higher chance of peri-implant disease include the plaque accomulation, smoking habits, history of periodontitis, implant design and surface topography, excess cement, an angled abutment greater than 30 degrees, exposure to radiation therapy, the thickness of keratinized tissue, interval after implant insertion, patient's gender and diabetic condition [25-29]. Another factor associated with the development of peri-implantitis is occlusal overload, history of implant failure, abnormal oral habits, and inappropriate direction of implant are also contributing factors [30-33]. Peri-implant mucositis is a precursor for the development of peri-implantitis, though there is limited data supporting the link between systemic health conditions and peri-implant mucositis risk. The connection between peri-implantitis and alcohol use is also supported by some studies. Additionally, systemic disorders like scleroderma, ectodermal dysplasia, lichen planus, osteoporosis, rheumatoid arthritis, and Sjögren's syndrome might have a negative impact on peri-implantitis progression and the overall success of implants [27, 34].

A study by Denmark and Martin Saaby conducted in 2016 identified that cigarette smoking, periodontal disease, and improper fitting of crown margin are key risk factors contributing to peri-implantitis [35].

According to Koldsland and co-researchers, individuals who have a history of periodontitis are more prone to develop peri-implantitis [36]. This observation was confirmed in a recent systematic review presented by Carra et al. [37] and also highlighted in the consensus report from the 2017 World Workshop38 and the connected review by Schwarz et al [37,39]. Patients with poor plaque control and who do not attend regular checkups show a high incidence of peri-implantitis. Among risk factors, access to oral hygiene has been emphasized as an important element. A study by Serino et al.40 demonstrated that implants not accessible for oral hygiene aids had a high risk for peri-implantitis. In this study, we want to determine the most prevalent cause of peri-implantitis. This study was to investigate the underlying causes of peri-implantitis and identify the most common contributing factor.

Literature Review

Several studies have been carried out about this subject, which are listed below.

A study by Claudio Marcanito with his team revealed that peri-implantitis is a relatively frequent condition, which occurs in 4,7% of cases in 74% of implants and can reach 8.9%in 55% of implants depending on diagnostic criteria, and this condition is notably more prevalent in individuals with a history of periodontal disease and smoking[41].

In a 2020 study, Ciona Nobert and Hashimi Dena defined peri-implantitis as a prevalent condition with contributing factors such as periodontal disease, smoking, diabetes, and obesity; furthermore, there are some local factors that can lead to peri-implantitis, such as mucosal inflammation, residual cement, and inappropriate prosthesis [42].

Stacchi Claudio and colleagues, through a systematic review, assessed the influence of smoking and periodontal disease as risk factors in implant loss and peri-implantitis. Their analysis concluded that the evidence supports that periodontal disease is a direct risk factor for peri-implantitis, with minimal [43].

Although Mazel Anthony and his team used a systematic review and meta-analysis to demonstrate that peri-implantitis typically involves multiple causative factors and is linked to clinical symptoms such as excessive plaque accumulation, BOP, and poor oral hygiene. This condition tends to be more common in individuals undergoing treatment for periodontitis [44].

In a 2019 study, Joerg Meyle and his colleagues noted that there is enough evidence to conclude that the amount of general risk factors influences the short- and long-term success of implant treatment. Periodontal disease and long-term stability are significantly affected by smoking. Therefore, one of the important factors is a careful evaluation of the patient's history [45].

We should inform patients with a history of periodontitis about the increased risk of peri-implantitis. In the presence of periodontitis, successful management is very important in order to remove all local factors and maintain periodontal health before fixture insertion. In case there is not sufficient removal of the local factor, we should change the time of implant placement to any other time.

Smokers and alcohol addicts should alter their habits or at least decrease the amount of smoking through counselling sessions to improve the long-term success of dental implants. This should be accompanied by frequent visits to maintenance care to detect early changes in the periodontium [46]. In a 2016 systematic review by Claudio Stacchi and colleagues, the authors identified whether previous periodontitis and smoking habits contribute to implant failure and the development of peri-implantitis. Their findings indicate that a history of periodontitis is not a significant risk factor for implant failure. Additionally, the effect of smoking on periodontium health and implant failure remained inconclusive [43].

Materials and methods

A narrative literature balloon search was conducted using two major databases, PubMed and Google Scholar. Using these words((Peri-Implantitis OR Periimplantitis OR(Peri-Implant Disease) OR Peri Implantitis) AND (Etiological factors) OR (Risk factors)). The search on PubMed identified a total of 1,512 relevant articles, while the search on Google Scholar returned a significantly larger number of results, amounting to 7,940 articles. The research is a narrative review, which was conducted using the keywords peri-implantitis, etiology, and risk factors of peri-implantitis on 20/11/2022. All included articles are

related to the topic and meet the standards of the Practical Research Center of Kabul University of Medical Sciences.

Inclusion criteria

1- Articles published in the period of 2000-2022.

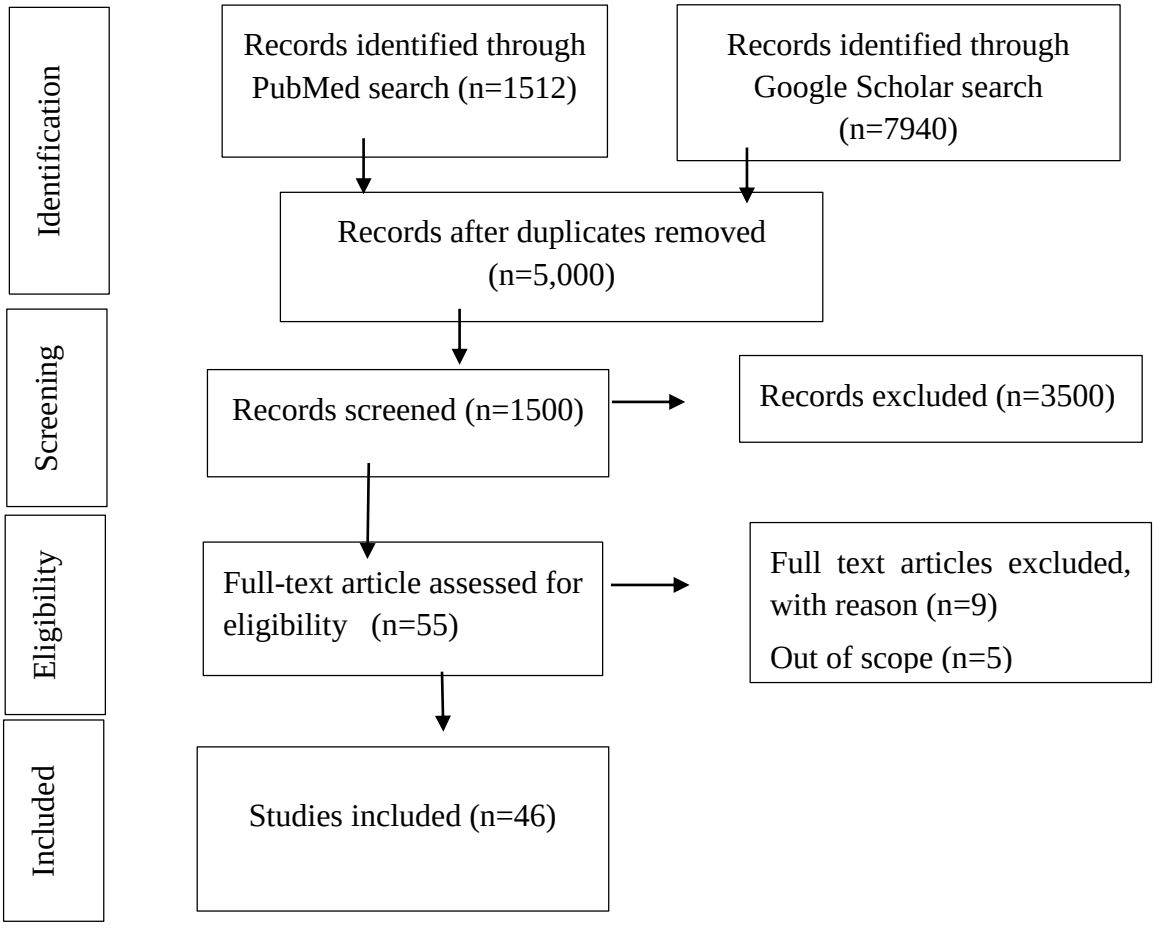
2- Articles match the variables of the goal.

Exclusion Criteria

1- Articles on the treatment and prevention of peri-implantitis.

2- Not related to the variables.

- **Date of Search**: 20/11/2022
- **Keywords Used**: Etiology, Peri-implantitis, Peri-mucositis, Risk factors.



Results

Claudio Marcanito and his colleagues concluded in the study that peri-implantitis is not a rare complication and that the prevalence of this inflammatory condition is about 4.7% in 74% of implants and more than 8.9% in 55% of implants, and that it depends on the parameters that determine peri-implantitis. High levels of peri-implantitis have been seen more often in patients with periodontal disease and in people who smoke [41].

In their 2020 research, Ciona Nobert and Hashimi Dena found that peri-implantitis is a widespread and complicated condition influenced by multiple factors. Major contributors include periodontal disease, smoking, elevated blood sugar, and obesity. Additionally, local issues such as mucosal inflammation, leftover cement, and poorly designed prosthetics also contribute to the development of peri-implantitis [42].

Stacchi Claudio and colleagues concluded that, based on a systematic study conducted to evaluate the role of smoking and periodontal disease as a risk factor for implant loss and the development of peri-implantitis, they concluded that: There is little evidence that periodontal disease can be a risk factor for the development of peri-implantitis[43].

In their systematic review and meta-analysis, Mazel Anthony and his team demonstrated that peri-implantitis arises from multiple factors. Typically, it involves loss of bone around the implant margin and is commonly accompanied by symptoms like heavy plaque buildup, bleeding upon probing, and challenges in maintaining oral hygiene. This condition tends to occur more frequently in individuals with a history of periodontitis [44].

In a 2019 study, Joerg Meyle and his team found sufficient evidence that several overall risk factors impact both the immediate and lasting outcomes of implant therapy. Notably, smoking has a strong effect on periodontal health and the long-term durability of implants. As a result, thoroughly assessing a patient's medical history is essential before treatment [45].

Patients who have previously experienced periodontal disease need to be made aware of their higher risk for peri-implant complications. If periodontitis exists, effectively managing it is crucial to eliminate local issues and restore periodontal health before proceeding with implant placement. If treatment is unsuccessful, implant placement should be postponed or avoided altogether.

Patients who smoke should be offered support to quit smoking, and those struggling with alcohol addiction should receive comparable treatment, as these measures can help enhance the long-term outcomes of implant therapy. Regular follow-up appointments are also important to monitor and catch any early signs of periodontal changes [46].

In 2016, Claudio Stacchi and colleagues carried out a systematic study to examine whether previous periodontitis and smoking habits could contribute to implant failure and peri-implantitis. Their findings indicated that a history of periodontitis is not a significant risk factor for implant loss. Additionally, the study was unable to establish clear conclusions regarding the impact of smoking on supporting tissues and implant failure [43].

In a 2005 North American study led by Bjorn Klinge and his team, it was observed that patients losing teeth due to periodontal disease face a greater chance of implant failure. The study also noted that cigarette smokers have a higher likelihood of developing pre-implantitis compared to non-smokers [46].

In a 2020 study conducted by Dina Hashimi and Nobert Ciona, they concluded that periodontal diseases, lack of basic supportive care, cigarette smoking, and hyperglycemia are among the important risk factors for peri-implantitis. Poor plaque control, mucosal inflammation, poorly designed Crohn's implant, and submucosal cement are among the local risk factors for periimplantitis [42].

Another study conducted by Frank Schwarz in Germany in 2017 found that the risk of peri-implantitis increases in patients with a history of chronic periodontitis, poor plaque control skills, and irregular post-implant maintenance care. They also stated that diabetes and cigarettes are potential risk factors. Peri-implantitis is associated with factors such as excess submucosal cement and a lack of keratinized mucosa around the implant [29].

Another study conducted by Joerg Myles in Germany in 2015 stated that smoking is one of the important risk factors for peri-implantitis and implant loss [45].

In a 2015 study conducted by Claudio Satcchi, they concluded that the risk of peri-implantitis was significantly higher in patients with a history of periodontitis compared to healthy people. And stated that periodontitis is a possible risk factor for peri-implantitis. However, there is not enough information about cigarettes in studies [43].

No A	Author	Year	Variables					Remarks
			Smoking	History of Periodontitis	Excess cement	Surface topography of the implant	Inadequate hygiene	
1	Khamissa RAG	2012					•	
2	Zitzmann NU	2008						
3	Wilson V	2013						
4	Schwarz F	2008				•		
5	Mombelli A	2012	•	•				
6	Smeets R	2014	•	•				Systemic disease
7	Berglundh T	2000			•		•	
8	Atieh M	2020		•				Microbial composition
9	Iusan SAL	2022					•	
10	Rams TE	2013					•	
11	Chralampakis G	2012				•	•	
12	Salvi GE	2008					•	Different microbial composition
13	Degidi M	2012				•		
14	Saulacic N	2019				•		No difference
15	Subramani K	2009				•	•	

16	Berglundh T	2017					•	Lack of keratinized tissue
17	Najeeb S	2016						
18	Niazi F	2016						
19	Matsuda S	2016						
20	Carcuac O	2014						
21	Zhang L	2018						
22	Papi P	2017						
23	Teles R	2013						
24	Hasturk H	2015						
25	Renvert S	2015						
26	Staubli N	2017						
27	Katafuchi M	2018						
28	Jepsen S	2015						
29	Fiorillo L	2022				•		Hormone therapy and lack of keratinized tissue
30	J Periodontolgy 2000	2013						
31	Sasada Y	2017						
32	Schwarz F	2014						
33	Monje A	2019						
34	Krennmair G	2010						
35	Saaby	2016						
36	Koldsland OC	2010						
37								
38	J Periodontology 2000	2017						
39								
40	Serino G	2011		•				
41	Maecantonio C	2015	•	•				Diabetes, genetic, keratinolytic mucosa
42	Hashimi DT	2020	•	•			•	Hyprglycemia
43	Stacchi C	2016		•				
44	Mazek A	2019						
45	Meyle J	2019	•					
46	Klinge B	2005	•	•				
47	Staubli N	2017				•		
48	Andreas S	2021						

Claudio Marcanito carried out research in Brazil, indicating that various risk factors can contribute to the onset and worsening of peri-implantitis. The study provided solid evidence that having a history of periodontitis may increase the risk for peri-implantitis. Although smoking has not been confirmed as a definitive risk factor, extra caution is advised when managing implants in smokers. Additionally, factors like diabetes, genetic traits, and the presence of keratinized mucosa require more detailed research and evaluation [41].

Excess cement is a possible risk indicator for peri-implant diseases and is more frequent with soft tissue healing periods shorter than 4 weeks [47].

High doses of bisphosphonates, hormone therapy, and the presence of titanium particles are among the systemic factors for peri-implantitis [29].

Discussion

Peri-implantitis is one of the most common conditions around the dental implant, and in this review, we want to investigate its risk factors.

The literature emphasizes that the type and quality of soft tissue around dental implants play a key role.

A systematic review published in 2016 aimed to find if periodontitis history and smoking may act as predisposing factors for implant failure and the development of peri-implantitis. At the end, they emphasize that the history of periodontal disease and smoking negatively affect the progression of peri-implantitis [18].

Some other reviews show that past periodontal disease is a predictive indicator for peri-implantitis; also, they point out that bone resorption and deep pockets by themselves are not sufficient to confirm the diagnosis of peri-implantitis. Many non-infectious factors, like surgical methods, design of the implant, implant insertion, thickness of the surrounding bone, and excessive bite forces, may cause bone loss.

A systematic review found insufficient evidence to support the concept that a history of periodontal disease increases the risk of peri-implantitis [3].

There was a significant increase (20%) of marginal bone loss around the implant with a history of smoking and periodontitis compared to a nonsmoker with tooth loss due to other causes. As a result, this study showed that increasing the severity of peri-implantitis in patients with a history of smoking and periodontitis and the presence of both factors did not increase the severity of disease compared to either of them [35].

Residual cement hurts the maintenance of oral hygiene, causing inflammation and infection of the tissue around the implant [15]. Nonetheless, these conclusions should be approached carefully due to certain limitations in the data.

Pre-clinical animal studies suggest that changes to implant surface properties might worsen the progression of peri-implantitis. However, clinical research has not found clear evidence that different implant surface types affect how often peri-implantitis occurs. This study suggests that it needs to combine analyses to find the effect of smoking and periodontitis

as potential risk factors. Insufficient oral care and excess cement are significant risk factors for peri-implantitis. The other main factor for peri-implantitis is the accumulation of plaque [26, 40].

The rough surface of implants is more prone to peri-implantitis as they are plaque-retentive and promote colonization of bacteria.

Among the above studies we have reviewed, the higher range of studies highlighted that a history of peri-implantitis, smoking, neglect of regular maintenance, rough implant surfaces, and excess cement are the most prevalent factors contributing to peri-implantitis.

Conclusion

Based on the current review article, peri-implantitis is a common, complex, and multifactorial disease. Its known risk factors include periodontal disease, lack of maintenance, cigarette smoking, hypoglycemia, inadequate plaque control, mucositis, rough implant surface, excess cement, high doses of bisphosphonates, hormone therapy, and the presence of titanium particles.

The most common etiological factors are a history of periodontal disease, smoking, lack of maintenance and oral hygiene, rough surface of the implant, and excess cement around the implant abutment.

Ethical Considerations

Since the study was not interventional, it is devoid of ethical considerations.

Suggestions:

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