

# **GRADUATION PROJECT**

*Degree in Dentistry*

## **PERIODONTAL DISEASE AND DIABETES**

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## ABSTRACT

**Introduction:** Periodontal diseases and diabetes are both considered as chronic diseases. Patients with diabetes have a weaker immune system and the likelihood of having periodontal diseases is higher (1,2).

Periodontal disease affects tissues that surround the teeth: bone, cementum, soft tissues, and periodontal ligaments.(3)

Many different types of diabetes exists but this review of literature focuses on: Diabetes type I is “a chronic autoimmune disease which is characterized by insulin deficiency and resultant hyperglycemia”(4). Diabetes type II is “a non-insulin dependent diabetes” (5). It is when the body cannot produce insulin or when it produces insulin, it cannot be used because it is incorrect. (6,7)

**Objectives:** The aim is to evaluate the association and correlation between diabetes and periodontal diseases. More specifically to evaluate the correlation between diabetes type 1 and periodontal diseases and the correlation between diabetes type 2 and periodontal diseases.

**Materials and methods:** Keywords were searched on: Medline and Pubmed. To refine the search, advanced research was created: (((periodontal diseases) AND (diabetes type 1)) OR (periodontal diseases)) AND (diabetes type 2). Some filters were added: articles published in the last 5 years, English language, full text, and human species.

**Results:** 16 articles were selected, 5 dealt about periodontal diseases and diabetes type 1 and 11 were about periodontal diseases and diabetes type 2.

**Discussion:** Some contradictions were encountered but overall, an association between both diseases was found. Suffering from diabetes led to having a higher inflammation of the periodontal tissues and then to increase the risk of developing periodontal diseases.

**Conclusion:** There is a correlation between both chronic diseases. Patients with diabetes tend to be more subject in developing a periodontal disease. The challenge now is to know how to manage, create new protocols and prevent the development of periodontal diseases in these patients.

## KEYWORDS

Periodontal diseases, diabetes type I, diabetes type II, association, and correlation.

## RESUMEN

**Introducción:** Las enfermedades periodontales y la diabetes se consideran enfermedades crónicas. Los pacientes con diabetes tienen un sistema inmunitario más débil y la probabilidad de padecer enfermedades periodontales es mayor. (1,2)

La enfermedad periodontal afecta a los tejidos que rodean los dientes: hueso, cemento, tejidos blandos y ligamentos periodontales. (3)

Existen muchos tipos de diabetes, pero esta revisión de la literatura se centra en: La diabetes tipo I es "una enfermedad autoinmune crónica que se caracteriza por la deficiencia de insulina y la hiperglucemia resultante"(4). La diabetes tipo II es "una diabetes no insulino dependiente" (5). El organismo no puede producir insulina o cuando la produce, no puede ser utilizada porque es incorrecta. (6,7)

**Objetivos:** El objetivo es evaluar la asociación y correlación entre la diabetes y las enfermedades periodontales. Mas concretamente, evaluar la correlación entre las enfermedades periodontales y las diabetes tipo I y tipo II.

**Materiales y Métodos:** Palabras claves se buscaron en Medline y Pubmed. Se creó una búsqueda avanzada: (((enfermedades periodontales) AND (diabetes tipo 1)) OR (enfermedades periodontales)) AND (diabetes tipo 2). Se añadieron algunos filtros: artículos publicados en los últimos 5 años, lengua inglesa, texto completo y la especie humana.

**Resultados:** Se seleccionaron 16 artículos, 5 trataban sobre enfermedades periodontales y diabetes tipo I y 11 sobre enfermedades periodontales y diabetes tipo II.

**Discusión:** Se encontraron algunas contradicciones, pero en general se halló una asociación entre las dos enfermedades. Se observó que padecer diabetes llevaba a tener una mayor inflamación de los tejidos periodontales y a aumentar el riesgo de desarrollar enfermedades periodontales.

**Conclusión:** Existe una correlación entre estas dos enfermedades crónicas. Los pacientes con diabetes tienden a ser más propensos a desarrollar una enfermedad periodontal. El reto ahora es saber cómo tratar y prevenir el desarrollo de enfermedades periodontales en estos pacientes.

## PALABRAS CLAVES

Enfermedades periodontales, Diabetes tipo I, diabetes tipo II, asociación y correlación.

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# 1 INTRODUCTION

Periodontal diseases and diabetes are both considered as chronic diseases. In this review of literature, the aim is to understand the correlations and links between both conditions. Patients suffering from diabetes have a weaker immune system than patients considered healthy and therefore the likelihood of having periodontal diseases is higher. Moreover, due to a low immune response the periodontal diseases will develop and be more violent than in healthy patients. (1,2)

## 1.1 Periodontal diseases

Periodontal disease affects tissues that surround the teeth, such as: bone, cementum, soft tissues, and periodontal ligaments.(3)

There are a multitude of periodontal diseases which are classified into a classification. Many along the years were made to help dentists give the best diagnosis and treatment. In this review of literature, we will focus more on the new classification made in 2018 because it is the most up to date one. (8)

In table 1, we can observe the new classification.

**Table 1.** Classification of periodontal and peri-Implant diseases and Conditions 2017 (8)

CLASSIFICATION OF PERIODONTAL AND PERI-IMPLANT DISEASES AND CONDITIONS 2017										
<b>Periodontal Diseases and Conditions</b>										
<b>Periodontal Health, Gingival Diseases and Conditions</b>			<b>Periodontitis</b>			<b>Other Conditions Affecting the Periodontium</b>				
<a href="#">Chapple, Mealey, et al. 2018 Consensus Rept link</a>			<a href="#">Papapanou, Sanz et al. 2018 Consensus Rept link</a>			<a href="#">Jepsen, Caton et al. 2018 Consensus Rept link</a>				
<a href="#">Trombelli et al. 2018 Case Definitions link</a>			<a href="#">Jepsen, Caton et al. 2018 Consensus Rept link</a>			<a href="#">Papapanou, Sanz et al. 2018 Consensus Rept link</a>				
<a href="#">Trombelli et al. 2018 Case Definitions link</a>			<a href="#">Tonetti, Greenwell, Kornman. 2018 Case Definitions link</a>			<a href="#">Papapanou, Sanz et al. 2018 Consensus Rept link</a>				
Periodontal Health and Gingival Health	Gingivitis: Dental Biofilm-Induced	Gingival Diseases: Non-Dental Biofilm-Induced	Necrotizing Periodontal Diseases	Periodontitis	Periodontitis as a Manifestation of Systemic Disease	Systemic diseases or conditions affecting the periodontal supporting tissues	Periodontal Abscesses and Endodontic-Periodontal Lesions	Mucogingival Deformities and Conditions	Traumatic Occlusal Forces	Tooth and Prosthesis Related Factors
<b>Peri-Implant Diseases and Conditions</b>										
<a href="#">Berglundh, Armitage et al. 2018 Consensus Rept link</a>										
Peri-Implant Health	Peri-Implant Mucositis			Peri-Implantitis			Peri-Implant Soft and Hard Tissue Deficiencies			

### 1.1.1 Gingivitis

In **table 2** we can observe the first part of the classification which is describing: periodontal health and gingivitis.

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**Table 2.** Periodontal health and gingivitis (8)

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<b>Periodontal Health and Gingivitis: Consensus Report</b> Chapple, Mealey, et al. 2018 <i>Active link to consensus report</i>	<b>Gingival Diseases: Case Definitions and Diagnostic Considerations</b> Trombelli, Tatakis, et al. 2018 <i>Active link to case definitions</i>
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**PERIODONTAL HEALTH, GINGIVAL DISEASES/CONDITIONS**

- 1. Periodontal health and gingival health**  
Lang & Bartold 2018 [link](#)
  - a. Clinical gingival health on an intact periodontium
  - b. Clinical gingival health on a reduced periodontium
    - i. Stable periodontitis patient
    - ii. Non-periodontitis patient
- 2. Gingivitis – dental biofilm-induced**  
Murakami et al. 2018 [link](#)
  - a. Associated with dental biofilm alone
  - b. Mediated by systemic or local risk factors
  - c. Drug-influenced gingival enlargement
- 3. Gingival diseases – non-dental biofilm induced**  
Holmstrup et al. 2018 [link](#)
  - a. Genetic/developmental disorders
  - b. Specific infections
  - c. Inflammatory and immune conditions
  - d. Reactive processes
  - e. Neoplasms
  - f. Endocrine, nutritional & metabolic diseases
  - g. Traumatic lesions
  - h. Gingival pigmentation

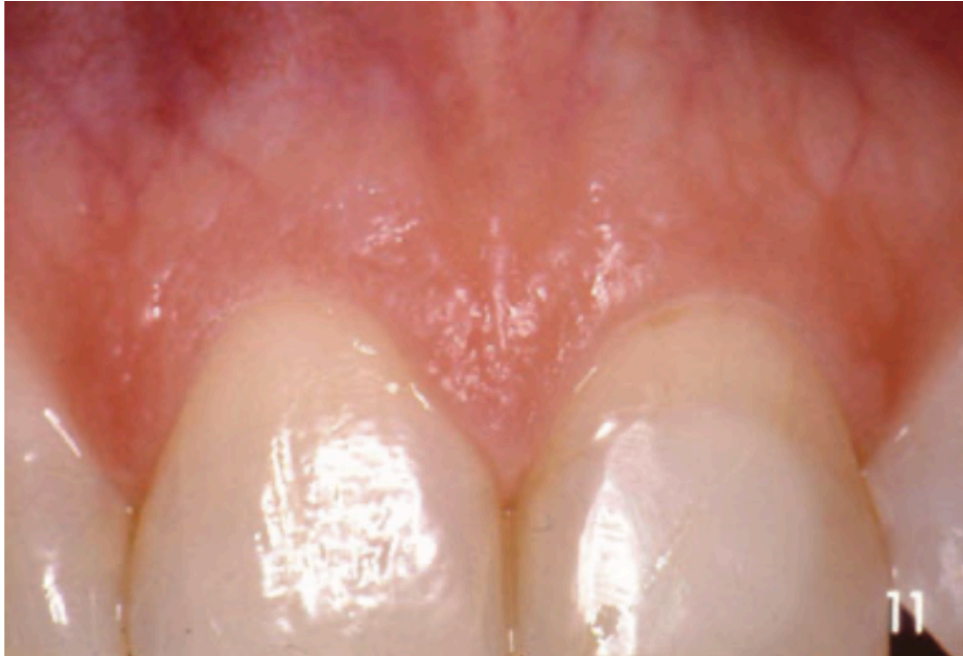
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#### 1.1.1.1 Healthy periodontium

In a periodontium considered healthy, we do not observe any inflammation nor bleeding. It is usually described as a “stippled, pale pink gingiva that is well adapted to the underlying bone.”

The probing is considered physiological: it ranges between 1 to 3 mm. Moreover, no signs of loss of attachment can be observed. (3)

In **figure 1**, we can observe how a normal and healthy periodontal tissue should look like when looking at the patients' mouths: pink gingiva with no sign of inflammation nor bleeding.



**Figure 1.** Healthy periodontal tissues (9)

#### 1.1.1.2 Gingivitis

Gingivitis is the inflammation of the gingival tissues, usually gingivitis happens before periodontitis, and is considered a pathological state. Due to the inflamed gingival tissues, we can usually observe bleeding on probing, and it is a sign of the pathology. It is reversible, and it is usually caused by poor and not appropriate oral hygiene. (10,11)

Here, **Figure 2** is an image that represents gingivitis, which is part of the first stage in the classification. We can observe swollen red gingiva and bleeding on the extremities with is a sign of the inflammation of the tissues. With correct oral hygiene, the patient will go back to an healthy periodontal state.

Indeed, with good oral hygiene and treatment such as professional calculus removal by doing a scaling of the teeth, the patient can go back to the original healthy state of the tissues. (3,11)

Gingivitis can be caused by plaque accumulation or due to other causes. Indeed, the different risk factors are dental plaque, pregnancy due to hormonal changes, poor oral hygiene, smoking, old age... (8,10,11)



**Figure 2.** Gingivitis (9)

### 1.1.2 Periodontitis

Down below, we can observe **table 3**, which is the second part of the new classification, and it includes: periodontitis.



**Table 3. Periodontitis (8)**

<b>Periodontitis Consensus Report</b> Papapanou, Sanz et al. 2018 <i>Active link to consensus report</i>	<b>Staging and Grading of Periodontitis:</b> Framework and Proposal of a New Classification and Case Definition Tonetti, Greenwell, Kornman 2018 <i>Active link to case definitions</i>
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**FORMS OF PERIODONTITIS**

**1. Necrotizing Periodontal Diseases**  
Herrera et al. 2018 [link](#)

- a. Necrotizing Gingivitis
- b. Necrotizing Periodontitis
- c. Necrotizing Stomatitis

**2. Periodontitis as Manifestation of Systemic Diseases**  
Jepsen, Caton et al. 2018 Consensus Rept [link](#)    Albandar et al. 2018 [link](#)  
*Classification of these conditions should be based on the primary systemic disease according to the International Statistical Classification of Diseases and Related Health Problems (ICD) codes*

**3. Periodontitis**  
Fine et al. 2018 [link](#)    Needleman et al. 2018 [link](#)    Billings et al. 2018 [link](#)

- a. **Stages:** Based on Severity<sup>1</sup> and Complexity of Management<sup>2</sup>
  - Stage I: Initial Periodontitis
  - Stage II: Moderate Periodontitis
  - Stage III: Severe Periodontitis with potential for additional tooth loss
  - Stage IV: Severe Periodontitis with potential for loss of the dentition
- b. Extent and distribution<sup>3</sup>: localized; generalized; molar-incisor distribution
- c. **Grades:** Evidence or risk of rapid progression<sup>4</sup>, anticipated treatment response<sup>5</sup>
  - i. Grade A: Slow rate of progression
  - ii. Grade B: Moderate rate of progression
  - iii. Grade C: Rapid rate of progression

### 1.1.2.1 Periodontitis

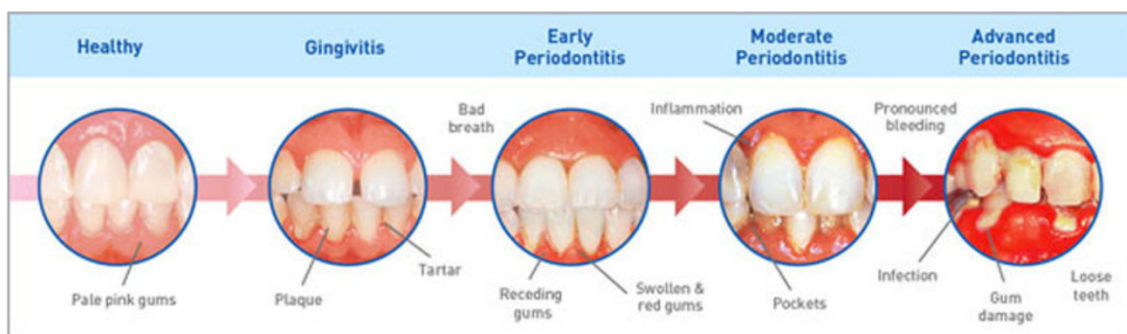
Periodontitis is “a multifactorial, chronic inflammatory disease” of the teeth’s surrounding soft tissues due to the accumulation of plaque and calculus and the presence of pathogens (such a bacteria). When the disease progresses, it results in the loss of tissues. Moreover, it is considered a very common disease and common risk factors are smoking, old age, gingivitis, diabetes, uncontrolled diabetes and poor oral hygiene. (2,3,11–17)

We can observe swollen and red gums, with active bleeding and chronic inflammation. The patient might feel discomfort and he might have bad breath. Moreover, we can see the apparition of periodontal pockets, which are pockets that are deeper than usual. With the help of x-ray, we can see bone loss and therefore some loss of attachment.

With this condition, we can just stabilize and avoid the progression of it, using specific treatments. Going back to the original tissues is usually not possible because most times, destroyed tissue cannot be regenerated. (2,3,8,10,11,17)

However, depending on how much bone loss there is and if the loss of bone is a vertical defect, some bone could be regenerated using periodontal surgeries.

Here on **figure 3**, we can observe the different stages and development of periodontal diseases, from an healthy state to an advanced periodontitis.



**Figure 3.** *Periodontal diseases stages* (11)

To diagnose such disease, clinicians will evaluate the depth of each pocket using dental probes, which is measured from the gingival margin to the end of the pocket, the clinical attachment level, the level of bone using periapical x-ray and the bleeding on probing. (2,11,12,17)

Treatment used to stabilize the condition consist in treating the active periodontal pockets and removing calculus from them to reduce their depth and inflammation. The treatment is called scaling and root planning. Moreover, chlorhexidine gluconate could be given to the patient as part of the treatment because of its antimicrobial properties and it decreases dental plaque and gingivitis.(3,11,17–19)

If not treated, it could lead to severe consequences such as the loss of an extreme amount of bone and gingival tissue, followed by the attachment's loss of the teeth and will then lead to teeth loss. Moreover, controlling diabetes, better oral hygiene and reducing or to stop smoking gives a better prognosis to the disease. Regular checkups

and control are ways to diagnose the disease in its earlier stages. Moreover, all of the above will lead to a better treatment's prognostic. (2,3,8,10–12,17,19)

Sometimes more invasive treatment such as surgery might be needed if the disease is very severe, with regenerative surgery some bone could be regenerated. (3,11,12,17)

Moreover, in recurrent periodontitis which does not seem to get better, and the patient continues having deep pockets, antibiotics could be prescribed after performing a microbiological study. Topical antibiotics could be put inside the periodontal pockets or taken in an oral way. Indeed, it will indicate the type of bacteria present in the periodontal pockets and will help us give the most suited antibiotic therapy. A combination of non-surgical treatment, surgical treatment and antibiotic therapies could be used in some extreme periodontitis cases. (3,11,17,19)

In **figure 4**, a loss of bone and gingiva can be observed as well as the inflammation of the periodontal tissues. What is observed in this image is periodontitis. As said before, this stage of the disease could be controlled with treatment, but the lost tissues cannot be restored.



**Figure 4.** Periodontitis (9)

### 1.1.2.2 Necrotizing periodontal diseases

This form of periodontal disease is considered very aggressive and rapid, where the interdental papillae and the gingival tissues become necrotic and bleed, and it is associated with discomfort and pain. If the diseases progress, we can observe the affectation of the bone. It is “a virulent, rapidly progressing disease that is mostly seen in immunosuppressed patients, such as those with HIV”.

Patients suffering from necrotizing periodontal diseases will present painful ulcers and loss of attachment of the gingiva, accompanied with bad breath. When we compare it to periodontitis, deep probing is usually not found in this disease.

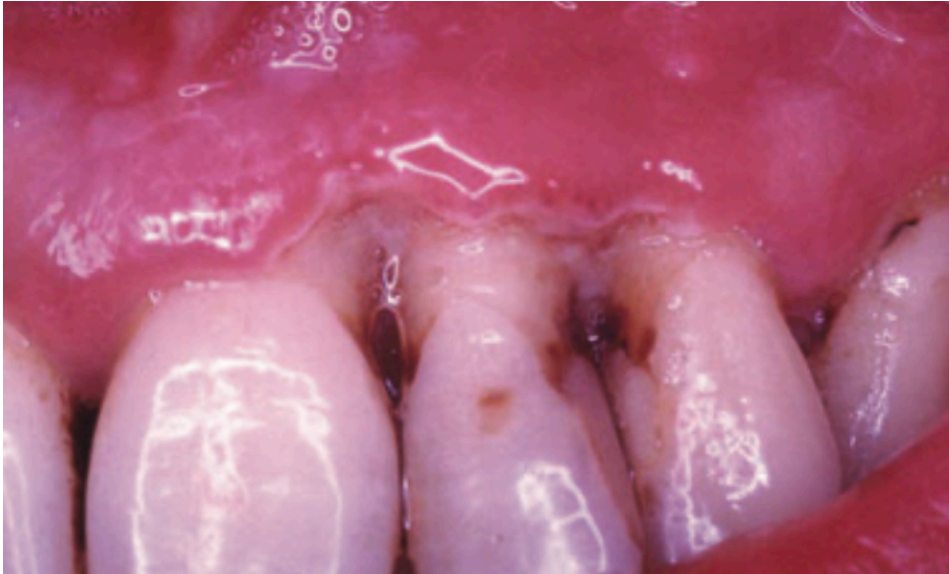
Some risks factors that can encourage the appearance of the disease are smoking, stress and anxiety and immunosuppressed patients (suffering from HIV for example).

To diagnose the disease, periapical x-ray will be needed to observe the bone level and sometimes a biopsy can be done to see a non-specific inflammation. (3,20)

As a treatment a mechanical debridement to remove dead and necrotic tissues is usually done, then to clean the area chlorhexidine 0.12% and cotton can be used. It is important to emphasize on improving the patient’s oral hygiene and advise them to use mouthwashes that contain chlorhexidine 0.12% or hydrogen peroxide. That way the treatment can have better prognosis.

Moreover, when the patient is in pain NSAID can be prescribed to reduce the pain and inflammation. When the patient’s state worsens, antibiotics such as Metronidazole or Amoxicillin could be given. In extreme cases, a surgical approach might be needed.(20)

In **figure 5 and 6**, necrotizing periodontal diseases can be observed, bleeding tissues is seen as well as the necrosis of the periodontal tissues.



**Figure 5.** Necrotizing periodontal diseases (9)



**Figure 6.** Necrotizing periodontal diseases (9)

#### 1.1.2.3 Periodontitis due to systemic diseases

This section of the new classification includes any cases of periodontitis that are due to systemic diseases such as uncontrolled diabetes for example. Some of them are not related to the volume of the dental plaque like neoplastic pathologies and in the case of uncontrolled diabetes it due to a multitude of different causes. (8)

### 1.1.3 Periodontal disease in pregnant women

Pregnant women go through a lot of hormonal changes: change in estrogen levels, and this can alter the inflammatory response. Due that, it is not uncommon to see a pregnant woman with a periodontal disease. Usually, after giving birth, they return to their periodontal tissues' original healthy state.(3)

It is said that pregnant women suffering from a periodontal disease are more at risk of developing gestational diabetes. (13)

### 1.1.4 Diagnosis of periodontal diseases

In this part, we will discuss about the diagnosis. Clinically patients can be put into stages and grades to know the stage of the periodontal disease.

To diagnose the different diseases, different tests need to be done, which are: bitewings and 16 periapical x-rays to measure the bone level that is left, probing of the pockets (measured from gingival margin to the end of the pocket), measuring the clinical attachment loss and recession, bleeding on probing, evaluate the grade of mobility and evaluate the level of exposed root furcation. A healthy gingiva has no bleeding on probing, no bone loss, a probing lower or equal to 3 mm. Patients suffering from gingivitis, the probing depth is usually equal to 3 or lower, 1-2 mm of attachment loss and on the x-ray exam no bone loss can be observed.(11,12)

Here below, **table 4** helps us to determinate clinically in what periodontal stage the patient is in.

We can observe that for periodontitis the clinical manifestation is different than for gingivitis. Patients with a generalized probing depth greater than 4 mm or punctual probing more than 6mm, with bleeding on probing and insertion and bone loss, we should consider classify them following into stage and grade of periodontitis.

**Table 4. “Stages of periodontitis” (17)**

Periodontal stage		Stage I	Stage II	Stage III	Stage IV
Severity	Interdental CAL at site of greatest loss Radiographic bone loss Tooth loss	1 to 2 mm Coronal third (<15%) No tooth loss due to periodontitis	3 to 4 mm Coronal third (15% to 33%)	≥5 mm Extending to middle or apical third of the root Tooth loss due to periodontitis of <4 teeth	≥5 mm Extending to middle or apical third of the root Tooth loss due to periodontitis of ≥5 teeth
Complexity	Local	Maximum probing depth ≤4 mm. Mostly horizontal bone loss	Maximum probing depth ≤5 mm. Mostly horizontal bone loss	In addition to stage II complexity: • Probing depth ≥6 mm • Vertical bone loss ≥3 mm • Furcation involvement Class II or III • Moderate ridge defect	In addition to stage III complexity: Need for complete rehabilitation due to: • Masticatory dysfunction • Secondary occlusal trauma (tooth mobility degree ≥2) • Severe ridge defect • Bite collapse, drifting, flaring • Less than 20 remaining teeth (10 opposing pairs)
Extent and distribution	Add to stage as descriptor	For each stage, describe extent as localised (<30% of teeth involved), generalised, or molar/incisor pattern			

The stage of periodontitis is initially determined based on clinical attachment loss (CAL). If CAL is not available, then radiographic bone loss can be used. A history of tooth loss due to periodontitis may modify the stage. In the presence of any complexity factor, the stage may shift to a higher tier. For example, the presence of class II or III furcation involvement would shift to either stage III or IV regardless of CAL, radiographic bone loss, or tooth loss due to periodontitis. The extent and distribution is primarily determined by the percentage of teeth involved<sup>2</sup>. The table was modified from Papapanou et al. (2018).<sup>2</sup>

The next **table 5**, indicated us how to classify each case of periodontitis into grades.

**Table 5. “The grade of periodontitis” (17)**

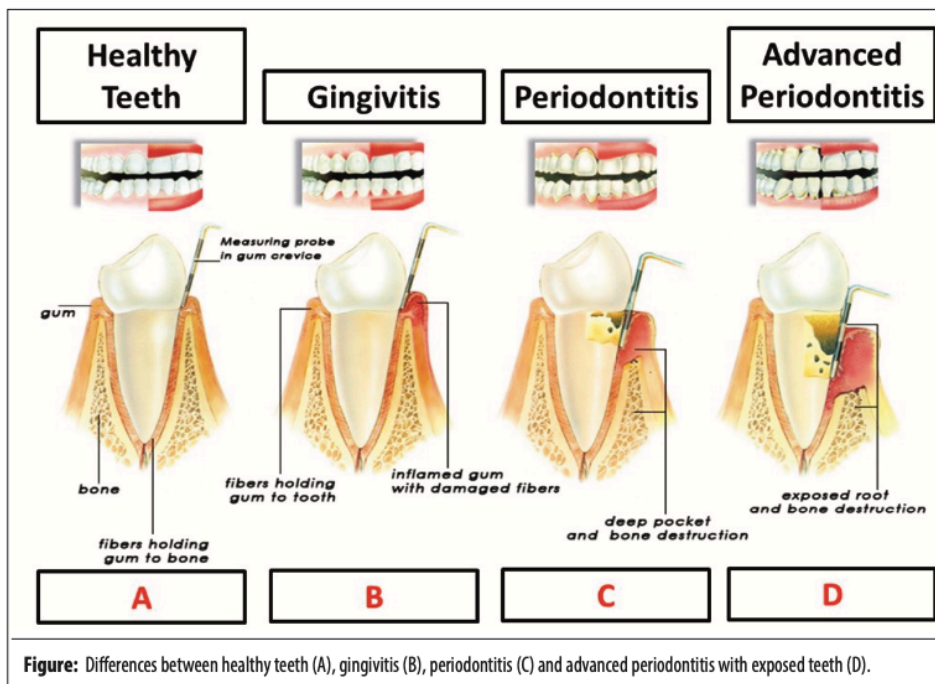
Periodontitis grade			Grade A: Slow rate of progression	Grade B: Moderate rate of progression	Grade C: Rapid rate of progression
Primary criteria	Direct evidence of progression ≥2 mm over 5 years	Longitudinal date	(radiographic bone loss or CAL)	Evidence of no loss over 5 years	<2 mm over 5 years
Case	Indirect evidence of progression	% bone loss/ age phenotype	<0.25 Heavy biofilm deposits with low levels of destruction	0.25 to 1.0 Destruction commensurate with biofilm deposits	≥ 1.0 Destruction exceeds expectation given biofilm deposits; specific clinical patterns suggestive of periods of rapid progression and/ or early onset disease (e.g. molar/ incisor pattern; lack of expected response to standard bacterial control therapies)
Grade modifiers	Smoker ≥10 cigarettes/day	Risk factors	Smoking	Non-smoker	Smoker <10 cigarettes/day
Diabetes			Normoglycaemic/ no diagnosis of diabetes	HbA1c <7.0% in patients with diabetes	HbA1c ≥7.0% in patients with diabetes

Grade is primarily determined by the direct evidence of progression. If not available, then the indirect evidence of progression can be used. In the presence of risk factors for periodontitis, the grade can shift to a higher tier.<sup>2</sup> The table was modified from Papapanou et al. (2018).<sup>2</sup> CAL, clinical attachment loss; HbA1c, haemoglobin A1c.



Here represented in **figure 7**, we can see the probing technique done during the diagnosis of periodontal diseases and the differences that we may encounter from a healthy state to a very extreme case of periodontitis.

We can see how the periodontal probe is inserted inside the gingiva and how deep the probe goes down depending on how advanced the periodontal disease is.



**Figure:** Differences between healthy teeth (A), gingivitis (B), periodontitis (C) and advanced periodontitis with exposed teeth (D).

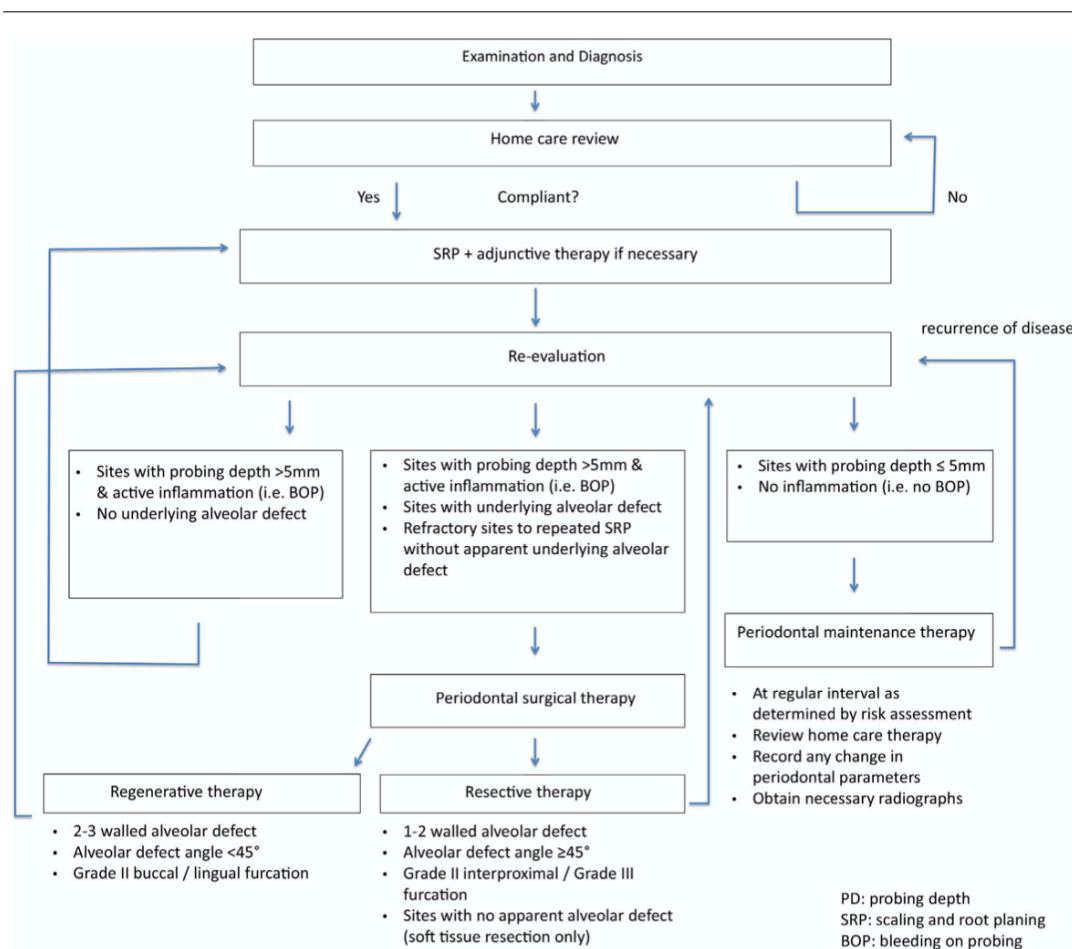
**Figure 7.** Differences between healthy teeth, gingivitis, periodontitis, and advanced periodontitis with exposed teeth. (1)



Down below shown in **table 6** we can find a chart that helps the dentists to follow a clinically paths when treating periodontal diseases.

Indeed, Patients suffering from periodontal diseases should follow a maintenance therapy their whole life, with regular checkups. Following this chart dentists have a treatment path they can follow, this why it is important to correctly classify each case to give the most suited treatment to the patients. (17,21)

**Table 6.** “A decision tree for treating patients with periodontitis”(17)



## 1.2 Diabetes

Many types of diabetes exist such as: diabetes type I, diabetes mellitus, gestational diabetes, types of diabetes due to other causes: neonatal diabetes, monogenic diabetes syndrome and diabetes mellitus secondary to pancreatic disorders.(5,6)

We are going to focus more on type 1 and 2, which are so far, the most studied ones.

### 1.2.1 Diabetes type 1

Diabetes type I is “a chronic autoimmune disease which is characterized by insulin deficiency and resultant hyperglycemia”(4) “Type 1 diabetes mellitus (T1DM) results from the autoimmune destruction of  $\beta$  cells of the endocrine pancreas (22).

Indeed, it is considered as an autoimmune disease because immune system cells (lymphocyte T) do not recognize the B cells (produced by the pancreas and the cells that secrete insulin) and mark them as foreign bodies and then destroy them. (4,22) The patient will have a low level of insulin, and this could have repercussions on the patient’s body.

When the patient does not have enough insulin; he could suffer from hypoglycemia, ketoacidosis, polyuria, and polydipsia (5), and this is a risk for the patient’s life. It could lead to seizures and loss of consciousness. Not treating this disease could lead to serious problems such as: neuropathies, retinopathies, nephropathies, cardiovascular problems, and it could affect many other organs. (4)

Not only genetic factors play a big role in this condition but also environmental factors too, such as: viral pathogens, which represents a high-risk factor in developing diabetes type 1 and food that we may consume such as products with cow’s milk. The environmental factors could be controlled by using vaccination against viruses that could increase the risk of developing diabetes type 1, such as: the rubella viruses and coxsackieviruses B. Moreover, supervising and controlling the diet is advised to control the environmental risk factors. (22)

To diagnose type 1, a run through different blood tests is required: high fasting blood glucose level (more than 126 mg/dl).

Symptoms between adults and children might be a little divergent but, in most cases, patients might be suffering from different symptoms: polyuria, loss of weight and polydipsia (4,5).

Patients suffering from this type of diabetes need to manage their glycemia level. New therapies exist, but the most common treatment for patients suffering from this type is insulin. It can be under different forms: insulin pump or insulin injections. (4)

### 1.2.2 Diabetes type 2

Diabetes type II, which is also called diabetes mellitus it is “a non-insulin dependent diabetes” (5). It can be defined as: “a metabolic syndrome characterized by chronic hyperglycaemia resulting from any of the several conditions that cause defective insulin secretion and/or action.”(6)

Diabetes mellitus is when the body cannot produce insulin or when it produces insulin, the insulin made cannot be used because it is incorrect. This hormone is made by the pancreas with the aim to move glucose from the blood stream to the cell. Like diabetes type 1, glucose level needs to be controlled otherwise some life-threatening consequences could be the result. (18) There are many risks factors that could lead to diabetes mellitus such as: being overweighted, old age and sedentary lifestyle. (5)

To diagnosis diabetes mellitus different tests are done: fasting plasma glucose test (more or equal to 7mmol/L, plasma glucose test (more or equal to 11. 1mmol/L) and the HbA1c level which shows the average blood glucose level (more or equal to 48mmol/mol).

Moreover, prediabetes test could be done to diagnose the pre-stage of the disease. This test uses the same tests. (5,6,23)

Patients suffering from diabetes mellitus will suffer from polyuria, polyphagia and polydipsia. (6)

In type 1 and 2, Patients should control their glucose level, patients will have to monitor their blood sugar, control their diet daily and do more physical activity. Moreover, Insulin treatment can be administered in both types, what differs is the type of insulin given. (23)

### 1.2.3 Gestational diabetes

It is a type of diabetes that happens during pregnancy due to hormonal changes that pregnant women go through. (6) This type of diabetes is diagnosed in the second or third trimester of the pregnancy, moreover after giving birth to their child, mothers should get recurrent diagnosis for diabetes type 2 and prediabetes.(5)

### 1.3 Diabetes and periodontal disease: patient management

First, diabetic patient with periodontal diseases should go for regular check-ups at the dental office, where periodontal diseases will be evaluated but also dental carries and other pathologies.

Moreover, dentists should emphasize on the importance of a good oral hygiene and therefore should encourage their patients on brushing every day and multiple times a day. They should advice using mouthwashes with chlorhexidine 0.05 %, 0.12% or 0.2%, to use toothpastes adapted for periodontal diseases and irrigation inside deep periodontal pockets, using interdental brushes and floss when appropriated.

If patients suffer from periodontal diseases the dentist will give a specific treatment: for periodontitis, the usual treatment is scaling and root planning. The dentist will adapt each treatment to each case.

Finally, having a controlled glucose level could lead to a better prognosis when doing periodontal treatments. (1)

## **2 OBJECTIVES**

### 2.1 General Objective

To evaluate the possible association and correlation between diabetes and periodontal diseases.

### 2.2 Specific Objectives

To evaluate the correlation between diabetes type 1 and periodontal diseases.

To evaluate the correlation between diabetes type 2 and periodontal diseases.

### 3 MATERIALS AND METHODS

#### 3.1 Online research and source of information

Databases	Terms used	Filters and limits applied
PubMed	<ul style="list-style-type: none"><li>- Periodontal diseases</li><li>- Periodontitis</li><li>- Gingivitis</li><li>- Diabetes type I</li><li>- Diabetes type II</li><li>- Association</li><li>- Correlation</li></ul>	<ul style="list-style-type: none"><li>- Published in the last 5 years</li><li>- English language</li><li>- Full text</li><li>- Human specie</li></ul>
Medline	<ul style="list-style-type: none"><li>- Periodontal diseases</li><li>- Periodontitis</li><li>- Gingivitis</li><li>- Diabetes type I</li><li>- Diabetes type II</li><li>- Association</li><li>- correlation</li></ul>	<ul style="list-style-type: none"><li>- Published in the last 5 years</li><li>- English language</li><li>- Full text</li><li>- Human specie</li></ul>

Different databases we used in this research such as: PubMed and the online library of the *Universidad Europea*: Biblioteca CRAI where the access to Medline Complete was available.

The last search on PubMed and Medline Complete was on the 20<sup>th</sup> of February of 2023.

### 3.2 Eligibility criteria

Table 8. Inclusion and exclusion criteria for my research

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> <li>- Sources published in the last 5 years.</li> <li>- Sources which are considered research and studies of a sample: patients suffering from diabetes or/and periodontal diseases. Patients with controlled or/ and uncontrolled diabetes.</li> <li>- Review and systematic reviews that are related to the topic and evaluate the correlation and association of periodontal diseases and diabetes.</li> <li>- Studies focused on: Periodontal diseases and Diabetes.</li> <li>- Studies published in English language.</li> <li>- Studies that evaluate probing depth, clinical attachment loss, bleeding on probing in their study, number of missing teeth, GI and PI index.</li> </ul>	<ul style="list-style-type: none"> <li>- Articles published greater than 5 years ago.</li> <li>- Articles which are not in English language.</li> <li>- Any studies that do not have a sample related to my topic: samples do not contain diabetes and/or periodontal patients in their research study. Studies that evaluate the effectiveness of periodontal treatments on diabetic patients with periodontal diseases.</li> <li>- Studies that are not link to the topic and do not answer the objectives in any way throughout the article.</li> <li>- Animals' studies</li> <li>- Studies that included participants with other type of pathologies and diseases than periodontal diseases and diabetes.</li> <li>- Effectiveness of periodontal therapy or treatment.</li> </ul>

### 3.3 Search strategy

To have more efficient research, the first step was to write down a list of keywords that were related to the project. The keywords chosen were periodontal diseases, diabetes, association, correlation, diabetes type I and diabetes type II.

Then, the main filters used for the research were evaluated and chosen, to bring limits to the information researched: Articles written in English language, Articles published in the last 5 years, articles where the full text could be accessed, and studies made on human species.

Moreover, the Boolean operators was applied: the words “AND” and “OR” were used to refine the research.

First, (Periodontal diseases) AND (diabetes) was written in the PubMed database’s advanced research section and various sources were found.

However, too many data were shown: 1020 articles, therefore another advanced research was carried out to refine the search and to find less result’s number but with more relevant data.

Indeed, the advanced research was modified:

((periodontal diseases) AND (diabetes type 1)) OR (periodontal diseases)) AND (diabetes type 2)

Using this advanced research across the databases, it helped narrowing down the results:

368 results were obtained on Medline Complete, and 318 results were obtained on PubMed.

From there, duplicates of the same article were removed and a total of 499 articles were find across both databases.



Using the inclusion and exclusion criteria listed in the table above, a selection of articles was made to include them into the result section. By the end of the selection 16 articles were included in the results table and 483 were excluded.

**PICO**

<b>Patients</b>	<ul style="list-style-type: none"> <li>-Patients with periodontal diseases and diabetes</li> <li>-Patients put into the controlled groups (so patients with periodontal diseases and no diabetes, patients with just diabetes)</li> <li>-Patients spread into two groups: controlled diabetes and uncontrolled diabetes: where periodontal statue will be evaluated.</li> </ul>
<b>Intervention</b>	<p>Probing depth, clinical attachment loss, bleeding on probing, PI index, GI index, missing teeth, fasting blood sugar level, after consumption blood sugar level and glycosylated hemoglobin.</p>
<b>Comparison</b>	<ul style="list-style-type: none"> <li>-Healthy patients and patients with diabetes type 1 or 2 looking at relation with the development of periodontal diseases.</li> <li>-Patients with periodontal diseases and the development of diabetes.</li> </ul>
<b>Outcome</b>	<p>Prevalence of periodontal diseases in patients with diabetes type 1 or 2</p> <ul style="list-style-type: none"> <li>-Prevalence of diabetes type 1 or 2 in patients with periodontal diseases.</li> </ul>

**Table 9.** PICO

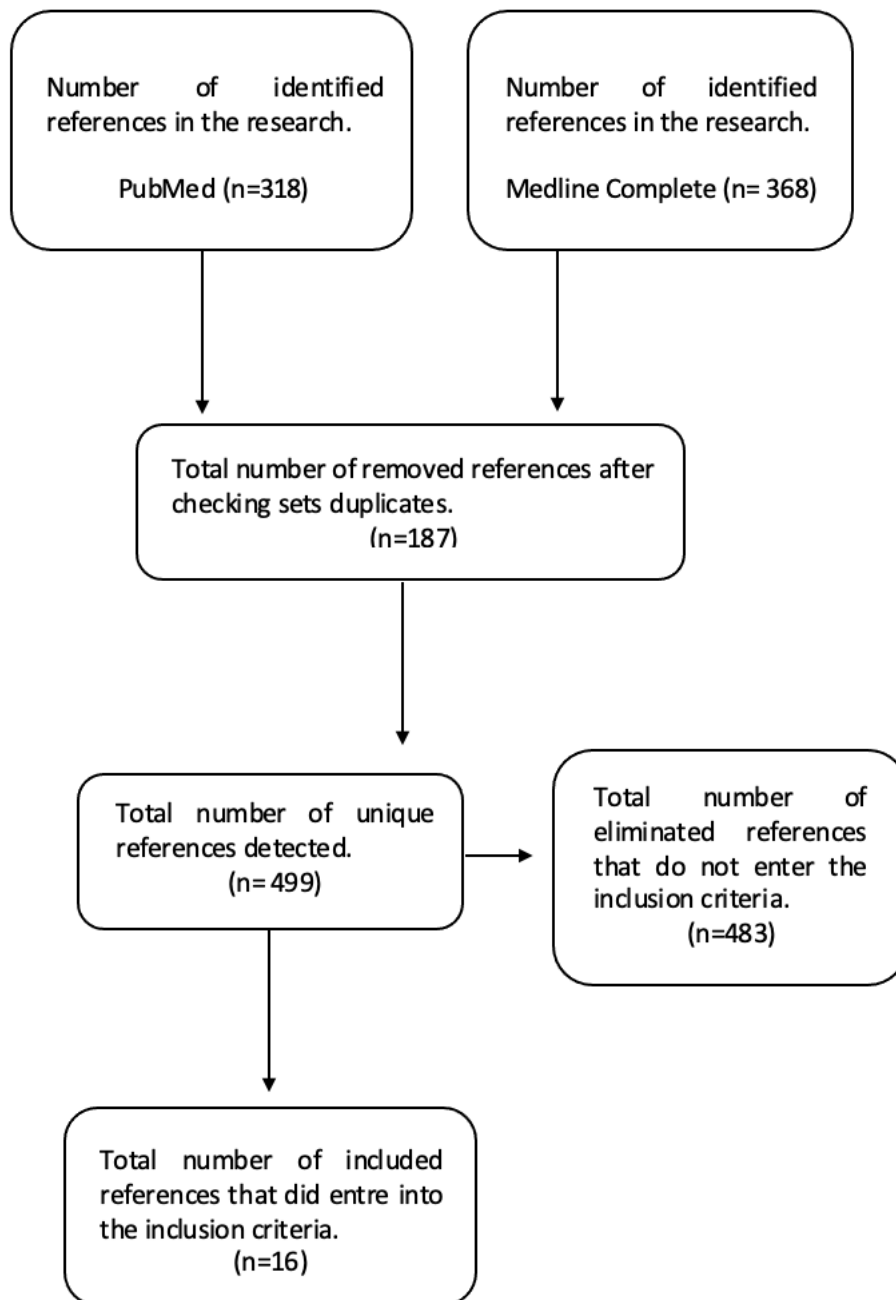
### 3.4 Limitations

Some limitations were encountered when trying to find articles. At first, the advanced research chosen: “Periodontal diseases AND diabetes”, was not precise enough and led a to a massive number of results found.

To have a more filtered research and have a lower number of articles, some advanced research terms were used: periodontal diseases and diabetes type 1 and 2, to focus on these pathologies and their correlation and association.

Moreover, the studies encountered were not only focused on the association between periodontal diseases and diabetes. Therefore, filters in the population, age, gender could not be set.

### 3.5 Flowchart Diagram



**Table 10.** flowchart that represents the research strategy

#### 4 RESULTS

Table 11. Results

References	Focus	Method	Sample and evaluation time	Findings/ Prevalence and association of periodontal diseases and diabetes
(24)	This study provides us data about patients with diabetes type II. Focusing on the control of blood sugar level and the tissues' inflammation ..	-Randomized clinical trial -Double blind -Spearman's coefficient correlation -Whitney test -Multiple linear regression analysis: to evaluate an association  - mean, standard deviation and normal distribution (when $p > 0.05$ ) were used:	187 (106 female and 81 male) participants with diabetes type 2 diagnosed in the last 3 years were used in the study: 48 to 65 years old  187 participants spread into two groups: control and intervention groups.  -6 months follow up period.  -patients considered	At the start no correlation was found between periodontal parameters (plaque index (PI), gingival index (GI), probing depth, clinical attachment loss) and the blood sugar level. The same results were found at 3 and 6 months.  At the start: Spearman rank  -Glycosylated hemoglobin and: plaque index (PI):

		<p>statistical significance (2 tailed) was found when: <math>p &lt; 0.05</math></p>	<p>having periodontitis: Clinical attachment loss (CAL)=more or equal to 3mm and probing depth (PD) of more than two teeth= 3 mm.</p>	<p><math>p=0.322</math>, gingival index (GI): <math>p=0.237</math>, CAL: <math>p=0.181</math>, PD: <math>p=0.201</math></p> <p>At 6 months: Glycosylated Hemoglobin and: PI: <math>p=0.767</math>, GI: <math>p=0.587</math>, CAL: <math>p=0.753</math>; PD: <math>p=0.779</math></p>
(25)	<p>This study evaluates the association between periodontitis and the development of diabetes through a longitudinal timeline.</p>	<p>Longitudinal study</p>	<p>1206 Subjects that were not diagnosed with diabetes yet (951 finished the study) aged from 40 to 65 years old.</p> <p>Throughout a 3 years period Evaluation:</p> <p>-glucose and insulin levels: fasting and after</p>	<p>-69 developed diabetes type 2 during the 3 years.</p> <p>-At the start the subjects had similar results in the different tests.</p> <p>-Subjects that had higher CAL, had more plaque, bleeding on probing (BOP) and lost teeth.</p>

			<p>75 g of glucose consumption.</p> <p>- study groups:</p> <p>diabetes: fasting blood sugar level: <math>\geq</math> 126mg/dl and after consumption of glucose: <math>\geq</math>200 mg/dl and glycosylated haemoglobin <math>&gt;</math>6.5%</p> <p>prediabetes: fasting blood sugar level: 100-125mg/dl, after consumption of glucose: 140-199 mg/dl and glycosylated haemoglobin 5.7-6.4%</p> <p>Healthy patients</p> <p>- parameters Evaluated on teeth: PD, CAL, BOP, plaque</p>	<p>- Changes in CAL and higher PD were inked to an increase of developing diabetes.</p> <p>-Subjects that had a high bleeding on probing had less prevalence in developing diabetes.</p> <p>-No correlation was found between Subjects with mild periodontitis and having diabetes (IRR=1.40;95% CI: 0.98-2.02). A subject with higher stage of periodontal diseases had lower risk of having diabetes.</p> <p>-Subjects with high CAL were usually older.</p>
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			<p>index, missing teeth.</p> <p>Periodontitis: severe, moderate, and mild.</p>	<p>-Lower the teeth number (from 4 to 10) (IRR=0.62; 95% CI= 0.46-0.85) the more chances of developing diabetes than subjects that had more teeth (from 25 to 28).</p> <p>- When there is a variation in CAL (IRR=1.25; 95% CI=1.09-1.42) an increase of diabetes can be observed.</p> <p>However, if CAL (IRR= 0.86 mm; 95% CI= 0.74-0.99) and PD (IRR=0.81mm ;95% CI=0.67-0.99) stayed similar subjects did not have higher risks of developing diabetes.</p> <p>-No relation when looking at BOP, PI</p>
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				because there were no real changes in the IRR.
(26)	This research studied groups of young subjects with diabetes types II and the prevalence between their chronic pathology and the development of periodontal diseases.	Cross-sectional study and a questionnaire	300 subjects with diabetes type 2 -Evaluating: Periodontal disease stage, PD, CAL, BOP, PI and GI (score from 0-3) -Groups: Periodontitis group and non-periodontitis.	-Non periodontitis group: less BOP and missing teeth. Better daily oral hygiene than periodontitis group. -Periodontitis group: more BOP and missing teeth Higher PD CAL, plaque, and gingival index than in non-periodontitis group. Subjects had lower control of their blood sugar level and higher concentration of glycosylated haemoglobin. Subjects in this group were



				<p>consuming more insulin than in the other group.</p> <p>-An association was found: As the blood sugar/glycosylated haemoglobin increased, the risk of periodontal diseases increased.</p>
(27)	Evaluate the correlation and consequence of periodontal diseases on diabetes.	-Longitudinal study	-2047 participants with incident diabetes and diabetes from before the experiment started.  -Evaluate PD and CAL	-Between the groups (with different blood sugar level and different glycosylated hemoglobin levels) no significant differences were found looking at PD and CAL.
(28)	To determine the association between a patient having	-Cohort study  -Longitudinal study  -Random selection	7827 subjects that did not suffer diabetes (4007) or were in prediabetes (fasting blood	-55.2% no or mild periodontitis, the rest were severe and moderate cases.

	<p>periodontitis and the prevalence of developing diabetes.</p>		<p>sugar level 100-12mg/dl, after taking in glucose 140-199 mg/dl and glycosylated haemoglobin of 5.7-6.5%) (3820) phase at the start of the experiment were used.</p> <p>-subjects with periodontal disease, they classified the level of periodontitis using: PD, CAL, BOP and missing teeth.</p>	<p>- 61.6% of the patients that were healthy had no or mild level of periodontitis and the rest had a moderate or severe level.</p> <p>-no diabetes at the start: 38.8% prediabetes and 2.2%diabetes.</p> <p>Prediabetes at the start: 68.1% stayed in the same condition and 19% then had diabetes.</p> <p>-2<sup>nd</sup> evaluation of the different types of periodontal diseases level and changes in the diabetes' development:</p> <p>-moderate to severe group: 58% prediabetes and 11.7% diabetes.</p>
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				-no or mild level: 48.5% prediabetes and 9.3% diabetes.
(29)	Review of literature about the prevalence of periodontitis and patients with diabetes type 2.	Meta-analysis, review of literature and epidemiological study.	Evaluated parameters: PD, BOP, CAL, missing teeth, PI and GI index.  They evaluated 27 studies.	-With diabetes mellitus: 67.8% had periodontitis, they had a greater PD, PI index, CAL, missing teeth, and BOP.  -Without diabetes: 35.5%.  -Patients with diabetes type 1 had a higher risk (78.8%) of periodontitis than patients with type 2 (70.5%).
(30)	This study about the association between diabetes type two and the prevalence of periodontal diseases in	-Cross sectional study  -pilot study	-427 Subjects with diabetes type 2.  -periodontal parameters that were evaluated: GI index, PD, CAL, PI and Oral	-95.1% of the subjects had periodontal lesions: mild: 30.9%, moderate:51.1% and severe:13.1%  -Positive correlation

	those patients.		hygiene index, and debris index.	between bad glycemic control and periodontal disease stage: with higher valued of PD and CAL
(31)	To determine if there is a correlation between diabetes type 2 and periodontal disease	-Cross sectional study	-372 subjects with different levels of periodontal diseases and 48 of them suffered from diabetes mellitus.  -used x-ray  -Two groups: with diabetes and without diabetes.	-positive correlation between severe periodontitis and presence of diabetes type 2
(32)	To determine the periodontal differences between healthy, prediabetes and diabetes patients	-Study that lasted for 6 months	-41 healthy, 41 pre-diabetes and 43 diabetes type 2 subjects.  Parameters evaluated: PD, CAL, BOP, PI index, glycosylated	-No relevant differences were found when looking at the periodontal parameters of patients with diabetes and prediabetes.

			haemoglobin, and bone loss.	<p>-A significant difference between diabetic patients and healthy patients was found:</p> <p>Diabetics range: PD: 5.8, BOP: 55.3, CAL: 3.8, PI:49.2, Bone loss: 4.7 and lost teeth: 13.2</p> <p>Healthy patients' range: PD: 2.5, BOP: 23.5, CAL: 0.6, PI: 20.4, Bone loss: 2.2, Lost teeth: 4.8</p>
(33)	To understand the correlation between poor glycemic control and periodontal diseases.	-Study for 1 year.	<p>107 subjects with diabetes type 1 and 2 and 53 healthy subjects.</p> <p>Looking at the glycemia and haemoglobin level, PI, GI and CI index.</p>	<p>-Patients with diabetes type 1 had higher glycosylated hemoglobin values: 9.61% compared to 7.65% in type 2 patients. As well as higherglycemia.</p>

				<p>-Healthy patients had lower PI, GI and CI index.</p> <p>-older diabetic Patients with poor oral hygiene which had significant periodontal changes.</p> <p>Inflammatory cells (lymphocytes were found on tissues).</p>
(34)	To understand if there is a link between the periodontal disease's severity and diabetes type 2	-Follow up study (15 years) -questionnaire and interviews	395 subjects without diabetes: to check they screened for diabetes looking at fasting blood sugar level, blood sugar level after consumption and glucose tolerance test.  Evaluate the periodontal parameters: PD	-81 subjects then got diabetes type 2.  -Periodontal state of the 81 Subjects with diabetes type 2:  Healthy periodontum: 15% PD between 4 and 5mm: 21% PD more than 6mm: 27%  Subjects with no teeth: 19%

				<p>-Positive correlation with deep PD and diabetics patients was found in subjects with teeth whereas a negative correlation was found in subjects without teeth.</p>
(35)	To determine the correlation between diabetes type 1 and periodontal diseases.	-Cohort study	<p>-Group 1: 50 participants with diabetes type 1.</p> <p>-Group 2: 50 healthy participants.</p> <p>Parameters evaluated: glycosylated haemoglobin, diabetes 1 antibodies, PD, BOP, CAL, recession of the gum and mobility grade.</p> <p>Periodontal diseases were</p>	<p>-Glycosylated hemoglobin: Group 1: 8.3% and group 2: 5.2%</p> <p>- Both groups had similar brushing frequency and habits, group 1 cleaned less in interproximal than group 2(60%-40%).</p> <p>-No significant differences can be seen between group 1 and 2 when looking for the appearance of a periodontal</p>

			<p>classified: mild, moderate, and severe.</p>	<p>disease: gingivitis: 68% in group 1 and 60% in group 2</p> <p>Periodontitis: group 1: 30% and group 2: 35%</p> <p>-The only significant difference was seen when looking at BOP: group 1: 40.5 and group 2: 29.4.</p> <p>Factors that had a link with periodontal diseases in this experiment were the age of the participant (being older increased the risk of developing a periodontal disease) and Bleeding on probing.</p>
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(36)	The effect of type 1 diabetes on the oral cavity and periodontal tissues.	-Study that used Random selection	-50 young (10-18 years old) subjects which were diabetics type 1.  -3 groups: well controlled (1), poorly controlled diabetes (2) and the controlled group (3)  Evaluate: PI, approximate plaque and GI index, bleeding.	-Between group 1 and 2, slight difference when looking at PI and approximate PI.  PI: the highest value was in group 2: 1.72, group 1: 1.41 and control group: 1.33  Approximate plaque index: group 1: 52.79%, group 2: 58.06% and group 3: 58.77%  GI: group 1: 1.02, group 2: 1.02 (slight inflammation of the periodontal tissues) and group 3: 0.92  Bleeding: group 1: 15.67%, group 2: 22.22% (slight gingivitis) and group 3: 16.36%
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(37)	To understand the two-way relationship between both chronic diseases.	-Cross-sectional study	-136 Subjects with type 1 diabetes, aged from 18 years old and above, who are taking daily insulin treatment.  -Parameters evaluated: glycosylated haemoglobin, glucose coefficient variation, PD, gingival recession, CAL	-PD (r=0.27% p=0.007%) and CAL (r=0.31% p=0.002%) were linked to how the glucose changed.
(38)	To evaluate the correlation between diabetes type 1 and periodontal diseases.	Systematic review	-patients that have diabetes type 1  - In this diabetic sample compare the ones that had periodontal diseases and the ones that did not. Also, they were compared to patients that	-Diabetic subjects had a bigger prevalence and risk of periodontal diseases in their group than in the healthy group.  To develop gingivitis: 1.47 fold more, periodontitis: 1.66 fold more

			<p>did not have diabetes</p>	<p>- Age determines the presence or not of periodontal diseases: younger patients (lower than 20 years old) have a lower prevalence of periodontitis but a higher incidence of gingivitis.</p> <p>-Link between CAL and glucose coefficient variation (r=0.31 p=0.002)</p> <p>-Glycosylated haemoglobin linked to PI (Rho=0.34, p=0.002), GI (Rho=0.30, p=0.009), BOP (Rho=0.44, p=0.0001), PD of more than 3 mm (Rho=0.21, p=0.06)</p>
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(39)	To determine if there is a correlation between Diabetes type 1 and periodontal diseases	Review of literature	Young subjects (lower than 40 years old) that have (4248) or not (16992) diabetes type 1 but no periodontal diseases.	<p>-Non-diabetic subjects had periodontal diseases: 50.8%, more prevalent in subjects with bad oral hygiene.</p> <p>-Diabetic subjects: had periodontal disease: 34.6% they had more risk of developing the disease (periodontitis or gingivitis)</p> <p>-Higher blood sugar was found to increase periodontal inflammation, more cervical fluid with cytokines in it that attack the gingiva which leads to new lesions appearance.</p> <p>Diabetic subjects have more of this fluid. In diabetic</p>
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				<p>subjects, the blood vessels are not strong, and this causes injuries which leads to changes in the gingiva and could increase the risk of developing the disease.</p> <p>-Patients that did not control their blood sugar had more risks of developing periodontal diseases due to the damages of the blood vessels that occur in these situations. They had higher PD, BOP, CAL, PI</p>
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\* PD= probing depth, CAL= clinical attachment loss, BOP= bleeding on probing, PI= plaque index, GI= gingival index.

## 5 RESULTS ANALYSIS

### 1) Periodontal diseases and diabetes type 2

In source (24), no significant differences in the results through time was observed, therefore more studies need to be executed. However, in this study they concluded that the inflammation of the periodontal tissues can have noxious repercussions on the control of blood sugar level and having diabetes rises the probability of having a periodontal disease. Moreover, it was observed that inadequate control of blood sugar level would lead to a rise in the periodontal diseases' gravity. (24)

In reference (25), subjects that did not have diabetes type 2 participated in the study. 69 subjects ended up having diabetes type 2. Relevant values were seen when there was a variation in CAL, patients had more risk of developing diabetes type 2 when CAL changed (IRR=125; 95% CI=1.09-1.42). These subjects with variations in CAL were usually older and had a higher PI and BOP and missing teeth. Patients who were almost edentulous had more risks of developing diabetes than subjects who had only less than 3 teeth missing. A lower risk of developing diabetes type 2 was seen when looking at the periodontitis' severity (severe and moderate), the probing depth and BOP. No significant correlation was found between mild stage of periodontitis and the development of diabetes type 2. (25)

In reference (26), all subjects had diabetes type 2. Patients with periodontitis had greater measures when looking at BOP, PD, CAL, PI, GI and missing teeth. This group had lower control on their blood sugar, consumed more insulin and had more glycosylated hemoglobin.(26)

In source (27), between groups with different blood sugar level and different glycosylated hemoglobin level no significant differences were found looking at PD and CAL. In this study no correlation was demonstrated between periodontal diseases and the risk of developing diabetes. (27)

In source (28), subjects that were healthy or had pre-diabetes were used in this study. 55.2% had mild or no periodontitis and 44.8% had severe or moderate grade of periodontitis. In this 55.2% subjects, 61.6% did not have diabetes.

By the end of the experiment subjects that were considered healthy, 38.8% developed pre-diabetes and 2.2% diabetes type 2. 68.1% of the patients that had pre-diabetes continued with the same pre-diabetes level and 19% worsened into having diabetes type 2.

Looking at the different levels of periodontitis, patients with moderate and severe periodontitis at the end, 58% had pre-diabetes and 11.7% had diabetes. Patients with no or mild level, 48.5% had pre-diabetes and 9.3% had diabetes type 2.

Patients who had severe level of periodontal diseases had more chances to have diabetes type 2 (increase of 53%). Moreover, they found out a correlation between obese subjects and the development of diabetes. However, when the periodontal factor was added, a negative correlation was found: The prevalence of developing diabetes type 2 in obese subjects with severe to moderate periodontitis (RR=2.40) was lower than in patients that had no or mild periodontitis (RR=2.70). No significant differences were found across the results to conclude a significant correlation. (28)

In reference (29), 67.8% of patients with diabetes type 2 had periodontitis. However, 35.5% of the patients with periodontitis did not have diabetes.

Higher prevalence of patients with diabetes type 1 (78.8%) to have periodontitis than in patients in diabetes type 2 (70.5%). With these results we could say that when having any type of diabetes, the prevalence of having a periodontal disease was higher.(29)

From (30), subjects with diabetes type 2 were recruited. In these subjects some periodontal lesions were observed. Most of them (51.1%) had a moderate periodontal disease. It was also found that subjects that had a bad blood sugar control had a higher prevalence of having a more aggravated periodontal disease stage with higher periodontal probing and clinical attachment loss. (30)

From (31), they found out only one association: there was a positive correlation between severe periodontitis and the presence of diabetes type 2. (31)

In source (32), when looking at the periodontal parameters: PD, BOP, CAL, PI and bone loss in patients with diabetes type 2 or pre-diabetes, there was no significant difference that would associate one having more risk of developing a periodontal disease than the other. However, when comparing healthy and diabetes patients a difference was found  
Diabetics range: PD: 5.8, BOP: 55.3, CAL: 3.8, PI:49.2, Bone loss: 4.7 and lost teeth: 13.2  
and

Healthy patients' range: PD: 2.5, BOP: 23.5, CAL: 0.6, PI: 20.4, Bone loss: 2.2, Lost teeth: 4.8

We can say that a subject having diabetes type 2 has more risk of having a periodontal disease than a patient that is considered healthy.(32)

From reference (33), patients with diabetes type 1 had high blood sugar than patients with diabetes type 2. These patients had higher PI, GI and CI.

Moreover, patients which were older and had a bad oral hygiene were found to have periodontal lesions and changes because lymphocytes were found on the periodontal tissues which led to the chronic inflammation of the tissue and destruction of it.(33)

From source (34), subjects at the start of the study did not suffer from diabetes type 2 and at the end of the study 81 of them had it. 15% had a healthy periodontal state, 21% had a periodontal probing of 4-5mm, 27% and a periodontal probing of 6mm or more, and 19% had no teeth. We can say that a positive correlation is found when looking at deepness of the periodontal probing and the prevalence of diabetes type 2. Indeed, patients that had diabetes type 2 had a higher percentage of having a deep probing depth. However, patients without teeth did not have a significant correlation between the development of periodontal diseases and diabetes type 2. (34)



## 2) Periodontal diseases and diabetes type 1

In reference (35), no significant association was found between the development of periodontal diseases and the fact that the patients had diabetes type 1, the only difference found was when looking at the bleeding on probing: in diabetic patients: 40.5 and 29.4. This could be analyzed as diabetic patients had slightly more inflammation of the gingiva, even though both groups had similar oral hygiene. (35)

From source (36), patients that did not control their diabetic state had higher PI and BOP (22.22%) than the other group which were the well-controlled diabetic group and the control group. This slight inflammation observed in the not control diabetic group just tells us that the patient has a slight gingivitis. For the other parameters the difference was not significant. (36)

In this study from reference (37), subjects with diabetes type 1 were gathered. PD ( $r=0.27\%$   $p=0.007\%$ ) and CAL ( $r=0.31\%$   $p=0.002\%$ ) were linked to how the glucose changed. Indeed, changes in blood sugar made the CAL and PD measurements greater/worse. Patients controlling their blood sugar had better prognosis if they already had a periodontal disease or less prevalence of periodontal diseases.

In subjects which had better control of their blood sugar in diabetics type 2, better measurements and less severe periodontal disease were observed. (37)

In source (38), diabetic subjects had more risk of having periodontal diseases than the ones that did not suffer from diabetes type 1. Also, it was seen that age is a determining factor on the risk of developing periodontal diseases and the kind of it. Gingivitis was more seen in patients that were younger than 20 years old and periodontitis were seen in patients between 20 and 40 years old. In this literature a link between the change in glucose level and CAL was seen, the more it changed the greater the CAL was. Also, the glycosylated hemoglobin had an influence of the PI, BOP, GI, PD, the greater the concentration of it, the greater the values of the different parameters mentioned were. (38)

Finally in reference (39), 34.6% of the patients with diabetes type 1 ended up having periodontal diseases. Subjects with diabetes type 1 and high blood sugar had an increase in the periodontal inflammation. This is because these subjects had more cervical fluid which contain cytokines and therefore increased the inflammation. Moreover, the diabetic patients had fragile blood vessels and lesion were seen. Moreover, not controlling their blood sugar increased their risk of developing blood vessels lesions and followed by having also periodontal lesions.

Low control of blood sugar was found to be linked to an increase in PD, BOP, CAL and PI.

(39)

## 6 DISCUSSION

### 6.1 Periodontal diseases and diabetes

Overall, a correlation between periodontal disease and diabetes can be seen across most of the results. It was observed that in having diabetes increased the prevalence of having periodontal diseases. (26,27,30–34)

Some factors affected the prevalence of periodontal diseases and diabetes: the age, the oral hygiene, and the weight. Indeed, diabetic patients which were older, had a poorer oral hygiene or a heavier weight with diabetes tend to have more risk in developing periodontal diseases.

Being older means that both diseases were established for a longer time than in younger patients. Having a heavier weight could be related to having a poor glycemic control which leads to more inflammation of the periodontal tissues and aggravates the established periodontal disease (if there was any) or develops a periodontal disease.

Moreover, poorly controlled blood sugar level in diabetic patients was related to a higher risk of having a periodontal disease because there is a higher prevalence for the periodontal tissues to be inflamed and destroyed. (28,33,37,39)

### 6.2 Periodontal diseases and diabetes type 2

In articles (25–33), high prevalence and risk of developing periodontal diseases was found in patients suffering from diabetes type 2. Indeed, patients that had poorly controlled blood sugar and glycemic level tend to have more severe forms of periodontal diseases. Whereas patients that had better glycemic control had a mild periodontitis or no periodontal disease. In diabetic patients, periodontal parameters were overall greater: deeper probing depth, more bleeding on probing, more clinical attachment loss and more missing teeth, bigger PI and GI.

However, some articles did not find any significant correlation between patients that had periodontal diseases and the development of diabetes type 2. It was observed that patients with severe to moderate periodontal diseases had a low risk of developing diabetes type 2. There was no correlation found between patients with mild periodontal diseases and the development of diabetes type 2.(25)

Moreover, no differences were observed when looking at PD and CAL and when comparing patients with different blood sugar level and glycosylated hemoglobin level. Therefore, the difference in a high or a low blood sugar level did not impact the development of a periodontal disease. (27)

### 6.3 Periodontal diseases and diabetes type 1

In articles (35,36) no significant correlation could be demonstrated between patients that had diabetes type 1 and the prevalence of having periodontal diseases. In diabetic patients had a significant higher bleeding on probing than non-diabetic patients which indicated that diabetic patients had more inflamed tissues. Moreover, (36) a slight difference was observed when looking at diabetic patients with different glycemic controls. Patients with poor control tend to have a PI and BOP which meant they had more inflamed tissues (gingivitis).

It was seen across some studies that the older the subjects are the greater risks in developing periodontal diseases. (35,37)

Developing periodontal diseases was linked to glucose changes in diabetic patients. Patients with poorly control blood sugar had more risk of having greater probing depth and clinical attachment loss. Patients that were more controlled had a less severe type of periodontal disease (if there was already one) or no periodontal diseases.

Gingivitis was more seen in younger patients and periodontitis in older ones. The greater the glycosylated hemoglobin concentration was the greater the PI, BOP, GI, PD, values were. (37–39)

## 7 CONCLUSION

The correlation between periodontal diseases and diabetes has been evaluated many years ago. However, research and studies are still being conducted to understand the mechanism behind it, to find new therapies, to prevent the appearance of periodontal diseases in these patients and to know how to manage them and create new protocols.

Looking at the general objective, we can say that there is a correlation between having diabetes and the development of periodontal diseases. Indeed, studies mostly found out a positive correlation between both. However, few did not find significant differences between groups evaluated (Healthy subjects and diabetic subjects) to conclude that there was indeed a correlation between both pathologies. Further research and studies were required.

When looking at the specific objectives: across the studies some contradictions were found in the results. A significant correlation was found between diabetic patients type 2 and periodontal diseases. Moreover, blood sugar level affected the appearance of periodontal diseases. Indeed, poorly controlled sugar level was linked to an increased level of periodontal diseases development.

Between diabetes type 1 and periodontal diseases a correlation was observed but further studies should be conducted to have more information on this correlation. Younger patients tend to have less severe periodontal diseases like gingivitis compared to older subjects that developed more severe cases like periodontitis.

To conclude, we can say that a correlation between diabetes and periodontal diseases exists. The association between both pathologies should open new fields of research on treatment therapies. Moreover, new protocol about the patient's management and spreading awareness in the professional and public sector should be adapted and put in place.

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## 9 ANNEXES

### ABBREVIATIONS

PD= Probing depth

CAL= Clinical attachment loss

PI= Plaque index

GI= gingival index

BOP= Bleeding on probing

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