

Lec 4 Epidemiology

The term **epidemiology** is of **Hellenic origin**; it consists of the preposition “epi”, which means “among” or “against”, and the noun “demos”, which means “people”.

Epidemiology is **defined** as the study of the distribution of disease or a physiological condition in human populations and of the factors that influence this distribution. The ultimate **goal** of epidemiological studies is to determine evidence-driven preventive and therapeutic strategies.

The epidemiologic research in periodontology must have the following requirements:

- 1- Provide data on the **prevalence** of periodontal diseases (the frequency of their occurrence) in different populations, as well as its **severity**.
- 2- Elucidate aspects related to the **etiology** and the **determinants** of these diseases (causative and risk factors).
- 3- Provide documentation concerning the **effectiveness of preventive** and **therapeutic measures** on a population basis.

Terms used in epidemiology to describe the Occurrence of Diseases

Prevalence is the **proportion** of persons affected by the disease at a given point in time. It is measured **by dividing** the sum of all examined individuals that exhibit the disease by the sum of all individuals examined

(e.g., 9% of the US population had severe periodontitis in the 2009-2010 NHANES survey).

Incidence is the rate that a disease occurred in a previously healthy population **over a period of time** (e.g., the incidence of peri-implantitis for patients with mandibular over dentures is 17% after 5 years).

Risk

is the probability that an individual will develop a particular disease during follow-up. It is a **number ranges between 0 and 1** which should accompanied by a specific period of time (follow-up). For example, It has been reported that dentists have 0.003 risk within a year for developing an HIV infection subsequent to an accidental needle stick with HIV contaminated blood.

Odds

for an event is the probability that an event occurred divided by the probability that an event did not occur. If the probability for observing an event is small, then the odds and

the probability are almost identical. For example, the odds for developing an HIV infection after an accidental needle stick with HIV-contaminated blood are 0.003 (0.003/0.997).

Epidemiologic Study Designs

Epidemiologic study designs fall within two broad categories:

A- Observational studies such as case-control, cross-sectional and cohort studies.

- ❖ **Case-control studies and cohort studies** are two epidemiologic study designs **that identify common causes** of chronic disease, such as smoking, ionizing radiation.

1. Cross-sectional studies

In Cross-sectional studies, the presence or absence of disease and the characteristics of the members of a population are **measured at a point in time**.

2. Cohort Studies

Cohort studies can also be referred to as exposure-based study designs. Subjects who are **free of the disease of interest** are classified with respect to an exposure (e.g., cigarette smoking, diabetes). Those subjects are followed **longitudinally** for the assessment of periodontal outcomes.

3. Case-Control Studies

Case-control studies are typically referred to as outcome-based study designs. Persons with an outcome (condition) of interest (i.e., cases) are compared with persons without a condition of interest (i.e., controls) with respect to the history of the suspected causal factors (exposure). For example, if an individual suffers from food poisoning (outcome) after a party, he or she is likely to compare his or her past food intake (exposure) with those individuals who did not experience food poisoning.

The primary goal of a case-control study is to find out what past exposures or factors are different between patients with a disease versus those without the disease.

2- Interventional studies such as clinical controlled trials (randomized and nonrandomized).

- ❖ **Controlled trials** are study designs that assess the diagnosis, management, and prognosis of chronic diseases and that either confirm or refuse the suspected causes of disease identified in case-control or cohort studies.

Epidemiologic studies, which are at a higher level of evidence than case reports and animal studies, have had a powerful impact on reducing the incidence of some chronic diseases by reliably identifying their primary causes.

❖ . **Randomized Controlled Trials**

Randomized controlled trials in periodontics typically assign patients randomly to a **treatment and non treatment groups**. Patients are then monitored, and subsequent outcomes are assessed.

Methodologic issues

Examination of the periodontal status of a given individual includes clinical assessments of inflammation in the gingiva, recordings of probing depths and clinical attachment levels, as well as radiographic assessments of the amount of loss of supporting alveolar bone. The assessments are carried out using different indices. The characteristics of indices include:

- 1. Reliability:** Index should be measured consistently at different time and under varied conditions.
- 2. Validity:** It must measure what it is intended to measure, so it should correspond with actual clinical stage of the disease.
- 3. Quantifiability:** Should be amenable to statistical analysis.
- 4. Sensitivity:** The index should be able to detect reasonably small shift of the condition.
- 5. Clarity, Simplicity and objectivity:** The examiner should be able to remember the criteria easily, easily to apply and the criteria should be clear.
- 6. Acceptability:** The use of index should not be painful and embarrassing to the subject.
- 7. Practicality:** Use of the technique should be practical in particular circumstances of the survey.

Assessment of inflammation of the periodontal tissues

Presence of inflammation in the gingiva is usually recorded by the use of a probe, and often according to the principles of the **Gingival Index System outlined by Loe (1967)**. According to this system,

- 0. Normal gingiva.
- 1. Slight change in color, edema and no bleeding on probing.
- 2. Redness, edema and bleeding on probing.
- 3. Marked redness and edema, ulceration, tendency to spontaneous bleeding.

A parallel index scores plaque deposits (Plaque Index System) on a scale from 0 to 3 (Silness & Loe 1964):

- 0. No plaque.
- 1. Plaque can be recognized by running probe across the tooth surface.
- 2. Visible plaque.
- 3. Abundance of plaque.

Bleeding after probing to the base of the probeable pocket (**Gingival Sulcus Bleeding Index**) has been a common way of establishing the occurrence of subgingival inflammation, characterized by the presence of an inflammatory infiltrate adjacent to the ulcerated pocket epithelium.

- 0. No bleeding occurs after probing.
- 1. Bleeding emerges within 15 seconds after probing.

Assessment of loss of periodontal tissue support

One of the early indices providing **indirect information** on the loss of periodontal tissue support was the **Periodontal Index (PI)** developed by Russell (1956), and until the 1980s it was the most widely used index in epidemiologic studies of periodontal disease. Its criteria are as:

- 0. Tooth with healthy Periodontium.
- 1. Tooth with gingivitis around only part of the tooth circumference.
- 2. Tooth with gingivitis encircling the tooth.
- 6. Pocket formation.
- 8. Loss of function due to excessive tooth mobility

Periodontal Disease Index (PDI), developed by Ramfjord (1959), is a system designed to assess destructive disease; **it measures loss of attachment** instead of pocket depth and is, therefore, an irreversible index. The scores ranged from 0→6 include periodontal health or gingivitis (score 0→3) and various level of attachment loss (score 4→6).

Score

0 No inflammation, no alterations in the gingiva

Gingiva

1 Mild to moderate gingivitis at some locations on the gingival margin

2 Mild to moderate gingivitis of the entire gingival margin surrounding the tooth

3 Advanced gingivitis with severe erythema, hemorrhage, ulceration

Periodontium

4 Up to 3 mm of attachment loss, measured from the cemento-enamel junction

5 3-6 mm of attachment loss

6 More than 6 mm of attachment loss

The PDI contains a gingivitis index in scores 1, 2 and 3, and a measure of attachment loss independent of gingivitis, in scores 4, 5 and 6. **The PDI is not indicated for private practice but for epidemiologic studies.**

The number of probing assessments per tooth has varied in epidemiologic studies from two to six, while the examination may include either all teeth present (full-mouth) or a subset of Ramfjord index teeth (partial-mouth examination).

Radiographic assessment of alveolar bone loss

Radiographs have been commonly employed in:

1. Cross-sectional epidemiologic studies to evaluate **the outcome of periodontal disease on the supporting tissues rather than the presence of the disease itself**, and are thought to provide **valid estimates of the extent and severity** of destructive periodontitis.

2. Radiographic assessments have been particularly common as a means for monitoring periodontal disease progression in longitudinal studies.

Radiographic assessment of alveolar bone loss includes:

- Presence of an intact lamina dura.
- The width of the periodontal ligament space.
- The morphology of the bone crest.
- The distance between the cemento-enamel junction and the most coronal level of alveolar bone crest.

Assessment of periodontal treatment needs

An index system aimed at assessing the need for periodontal treatment in large population groups was developed. The principles of the **Community Periodontal Index for Treatment Needs (CPITN)** can be summarized as follows:

1. The dentition is divided into six sextants (one anterior and two posterior tooth regions in each dental arch). The treatment need in a sextant is recorded when **two or more teeth not intended for extraction are present**. If only one tooth remains in the sextant, the tooth is included in the adjoining sextant.
2. Probing assessments are performed either around all teeth in a sextant or around certain index teeth (only the most severe measure in the sextant is chosen to represent the sextant; recommended for epidemiologic surveys).

3. The periodontal conditions are scored as follows:

- **Code 0** is given to a sextant with no pockets, calculus or overhangs of fillings and no bleeding on probing
- **Code 1** is given to a sextant with no pockets, calculus or overhangs of fillings, but in which **bleeding occurs after gentle probing** in one or several gingival units
- **Code 2** is assigned to a sextant if there are no teeth with pockets exceeding 3 mm, but in which **dental calculus and plaque-retaining factors** are identified subgingivally
- **Code 3** is given to a sextant that harbors **teeth with 4–5-mm deep pockets**
- **Code 4** is given to a sextant that harbors teeth with **pockets that are 6 mm** deep or deeper.

4. The treatment needs (TNs) scores range from 0 to 4 and are based on the most severe periodontal condition code in the entire dentition, recorded as above. Thus,

- **TN 0** indicates no need for periodontal therapy in the presence of gingival health (Code 0),
- **TN 1** need for improved oral hygiene (Code 1);
- **TN 2** need for scaling, removal of overhangs, and improved oral hygiene (Codes 2 + 3);
- **TN 3** more advanced treatment needs (Code 4).

The examination is performed with a special probe, It is CPI probe with 0.5 mm ball tip with black band between 3.5 mm and 5.5 mm and ring at 8.5 mm and 11.5 mm from the ball tip for measurement of loss of attachment.

Calibration (Alignment and assessment)

Calibration must be carried out to record measurements in order to obtain reliable and valid measurements.

1. **Intra examiner calibration:** means that the same patient is examined by the same examiner for the same condition at **different time points**.
2. **Inter examiner calibration:** the same patient is examined for the same condition by different examiners.

Prevalence of Gingivitis and Periodontitis

Gingivitis has been observed in children younger than five years of age. In general, the prevalence and severity of gingivitis increased with age, beginning at approximately five years of age reaching their highest point in puberty and then very gradually decreased but remaining relatively high throughout life but the **highest prevalence of the gingivitis** occurred during **puberty** (the prevalence of gingivitis in age **(18-20)** is about **42%**).

Periodontal disease increased in prevalence and severity with increasing age. The increase may be result of accumulative effect of episodes of periodontal destruction or a gradual increase of severity of destruction caused either by deterioration of oral cleanliness or by change in host response and/or plaque composition with increase age. In **Iraq, the prevalence of periodontitis is 40%**

Causes

Periodontal disease is a chronic multifactorial destructive disease, which has complex causes. The terms **necessary cause, component cause, and sufficient cause** help to define the challenges of determining the cause of the periodontal disease. The set of causes that initiate a chronic disease is referred to as a sufficient cause.

Each **sufficient cause** consists of multiple **component** causes. Consider the hypothetical example in which four sufficient causes exist for non-iatrogenic destructive periodontal disease .The first sufficient cause in this example includes the following component causes: smoking, delayed neutrophil apoptosis, an interleukin1 gene defect, dental plaque, a tooth, and an unspecified gene defect. These **different elements** of a sufficient cause are referred to as **component causes**. All component causes of a sufficient cause

need to be present for the disease process to be initiated. Multiple sufficient causes may be responsible for a given disease.

A component cause, which is an element of all the sufficient causes for a given disease, is referred to as a necessary cause (plaque).

Risk factors

Risk factor may indicate an aspect of personal behavior or lifestyle, an environmental exposure, or an inherited characteristic that is known to be associated with disease-related conditions, based on epidemiologic evidence. Such a factor does not cause a disease, but may increase probability of occurrence of that particular disease (tobacco smoking, Diabetes, Pathogenic bacteria and microbial tooth deposits).

The principles of the risk assessment process consists of the following four steps:

1. The **identification** of one or several factors that appear to be associated with disease.
2. In case of **multiple factors**, a study involving these factors must be carried out that **discloses which combination of factors** most effectively discriminates between health and disease
3. **The assessment step**, in which **new populations** are screened for this particular combination of factors, with a subsequent **comparison** of the **level of the disease** assessed **with the one not exposed** to the combined factors.
4. The targeting step, in which exposure to **the identified factors is reduced by prevention** or intervention and the effectiveness of the approach in suppressing the incidence of the disease is evaluated.

Potential or putative risk factors

(risk indicators) are **first identified** and thereafter tested until their **significance as true risk factors is proven or rejected** such as HIV, osteoporosis, infrequent dental visits (step 1 to 3).

Finally, distinction must be made between prognostic (predictors) factors (related to the progression of pre-existing disease, such as previous history of periodontal disease, bleeding on probing) and true risk factors (related to the onset of the disease). For example, it is established in longitudinal studies of periodontal disease progression, that the amount of alveolar bone loss or the number of teeth present at baseline may be used to predict further progression of the disease. Although they may be excellent predictors for further disease progression, they clearly cannot be considered as risk factors.

Risk Determinants

are **true risk factors** that cannot be modified such as genetic factors, age, gender, socioeconomic status and stress.

Non-modifiable background factors

1. Age

Both the prevalence and the severity of periodontitis increase with age. It represents the **cumulative effect** of prolonged exposure to true risk factors.

2. Sex

There is no established difference between men and women in their susceptibility to periodontal disease, **although men have been shown to exhibit worse periodontal conditions than women** in multiple studies from different populations. This may be accounted for better oral hygiene practices and/or increased utilization of oral health care services among women in addition to differences in pro-inflammatory responses between men and women.

3. Race/ethnicity

Differences in the prevalence of periodontitis between countries and different races have been demonstrated.

4. Gene polymorphisms

Several studies illustrated those gene polymorphisms severity markers of periodontitis. However, there is insufficient epidemiologic evidence that convincingly establishes any of gene polymorphisms as true risk factors for periodontitis.

Environmental, acquired, and behavioral factors (modifiable)

1. **Specific microbiota** Three species (*Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, and *Tannerella forsythia*) were identified as causative factors for periodontitis depending on sufficient data accumulated.

2. **Cigarette smoking** Smoking is one of the major risk factors for periodontitis. Smoking has been shown to affect the vasculature, the humoral and cellular immune responses, cell signaling processes, and tissue homeostasis. Moreover, it affects bacterial colonization and aggregation, and results in higher levels of colonization by key periodontal pathogens.

3. **Diabetes mellitus (DM)** Several studies suggest a two-way relationship between DM and periodontitis. Beyond the observed increased severity of periodontal tissue destruction in subjects with DM, studies indicate a higher incidence of DM complications and poorer metabolic control of diabetes in periodontitis patients.

4. **Obesity** Pathway of insulin resistance, hyper-inflammatory state and an aberrant lipid metabolism are prevalent in obesity. All of which may collectively result in an accelerated breakdown of the periodontal tissue.

5. **Osteopenia/osteoporosis** Women with low bone mineral density are more likely to have gingival recession and/or pronounced gingival inflammation and clinical attachment loss.

6. **Human immunodeficiency virus infection** Studies published in the late 1980s seemed to indicate that both the prevalence and the severity of periodontitis were exceptionally high in patients with acquired immunodeficiency syndrome. Recently, there is no consensus in accepting this finding.

7. **Psychosocial factors** The mechanisms by which psychosocial stress may affect the periodontal status are complex. It has been suggested that one of the plausible pathways may involve behavioral changes leading to smoking and poor oral hygiene that, in turn, may affect periodontal health. However, more studies are needed to fully elucidate a possible relationship between psychological factors and periodontal disease