UNIVERSITY OF LATVIA
FACULTY OF MEDICINE

ORAL HEALTH IN PATIENTS WITH AND WITHOUT DEPRESSIVE COMPONENT DURING COVID-19 PANDEMICS

DIPLOMA THESIS

Author: **Vladlen Kruglak**

Student ID: vk15021

Thesis supervisor: **Lecturer Baiba Krauze, DDS**

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ABSTRACT

"Stress" has been dubbed the "Health Epidemic of the 21st Century" by the World Health Organization. The Covid-19 pandemic, a disease caused by Sars-CoV-2, has become a worldwide stressor. Stressors result in deterioration of population wellbeing, leading to different level of depressive symptoms or even depression. Both can affect as general health as well oral health. The effects can be physiological and behavioural, showing the predominantly negative effects of stress on periodontal health.

The aim of this study is to investigate oral health in patients with and without depressive component during Covid-19 pandemic. For evaluation of oral health CPITN index is used.

Keywords: stress and oral health, periodontal disease, dental biofilm, depressive symptoms, depression and oral health, Covid-19 pandemic stress, pathophysiology of stress.

ABSTRAKTS

Pasaules Veselības organizācija stresu ir nodēvējusi par 21. gadsimta epidēmiju. Covid-19 pandēmija, slimība, ko izraisa Sars-CoV-2, ir kļuvusi par globālu stresa faktoru. Stresa faktori pasliktina populācijas labklājību, izraisot dažāda līmeņa depresijas simptomus vai pat depresiju, kas var ietekmēt gan vispārējo, gan mutes veselību. Stresa ietekme var būt fizioloģiska un biheiviorāla rakstura, taču abos gadījumos novērojama izteikti negatīva ietekme uz periodonta veselību.

Šī pētījuma mērķis ir pētīt mutes veselību pacientiem ar un bez depresijas komponenta Covid-19 pandēmijas laikā. Mutes veselības novērtēšanai tiek izmantots CPITN indekss.

Atslēgvārdi: stress un mutes veselība, periodonta slimība, zobu bioplēve, depresijas simptomi, depresija un mutes veselība, Covid-19 pandēmijas stress, stresa patofizioloģija.

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LIST OF SYMBOLS

ACTH – adrenocorticotropic hormone

ANS – autonomic nervous system

CgA – chromogramin A

Covid – 19 – coronavirus disease

CPITN – Community Periodontal Index of Treatment Needs

CRH – corticotrophin-releasing hormone

CRP – C-reactive protein

CVD – cardiovascular disease

HPA – hypothalamic pituitary adrenocortical axis

IL – interleukin

NK – natural killers

NUG – necrotizing ulcerative gingivitis

PHQ – 9 – Patient Health Questionnaire – 9

SAA – salivary alpha-amylase

SAM – sympathetic adreno-medullary system

SARS-CoV-2 – severe acute respiratory syndrome coronavirus 2

TNF – tumour necrotizing factor

WHO – World Health Organisation

1 INTRODUCTION

Oral health and mental health have always been considered as integral part of general health. According to World Health Organisation (WHO), mental health is a state of wellbeing in which an individual realizes own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to country (WHO, 2016).

Mental disorders such as depression and anxiety are pervasive problems worldwide and have significant impact on physical health. Mental illness is associated with many of chronic diseases like, cardiac diseases, diabetes, cancer etc. and have long-term effect on social and economic aspects of life (WHO, 2017). In recent years, psychological diseases are seen to be growing in a rapid way and becoming a major public health problem (Suresh, 2015).

Around 300 million people throughout the world were suffering from depression according data from 2018 (Dupayan et al., 2018). Depression is the fourth leading cause of disability and could be the second by 2020 based on the WHO documents (WHO, 2017). They account for 10% of the global burden of the disease, and it was expected to rise to 15% by 2020 (Dangore-Khasbage et al., 2012).

These problems can become chronic or recurrent and lead to substantial impairments in an individual's ability to take care of everyday responsibilities (WHO, 2012).

Psychiatric disorders are well known to affect the orofacial region but they often are unrecognized because of the common and limited nature of their presenting features (Suresh, 2015).

Usually, depressive symptoms develop due to different adverse and stressful life events.

The 2019 coronavirus disease (Covid - 19) pandemic has become a global health threat, according to the latest data from the WHO, over 110 million people have been infected worldwide by February 21, 2021, with more than 2.4 million deaths reported (WHO, 2021). In the early stage of the Covid-19 pandemic, people were highly exposed to acute biopsychosocial stressors generated by the pandemic, and many studies reported a high prevalence of psychological distress in health care workers and general populations (Zhang et al., 2020; Wang et al., 2019; Cao et al., 2020; Hao et al., 2020).

Additionally, variables such as occupation, education background and gender were found to have impact on the symptoms of anxiety and depression during the pandemic (Wang et al, 2019). The female gender, younger age, higher education background and students were significantly associated with more negative psychological effects of Covid - 19 and higher levels of stress, anxiety, and depression (Wang et al. 2020). There was also a significant

correlation between psychological outcomes with specific physical symptoms, like myalgias, dizziness, and coryza.

Depression as all other mental disorders should be diagnosed by specialist – psychiatrist, but three confirmatory factors exist what indicates the presence of a depressive component. Those are mood and social-cognitive symptoms, worrying symptoms, and somatic and information-processing symptoms. Not in all cases when person has those components, the depression could be diagnosed, and some medical intervention should be prescribed.

Persons with impaired psychological and mental wellbeing show poorer oral health due to poor oral hygiene maintenance, higher intake of carbonates resulting from the reduced serotonin level, poor perception of oral health self-needs, length of psychotropic treatment, and less access to dental care (Matevosyan, 2010; Skośkiewicz-Malinowska et al., 2018).

Individuals suffering from depression and depressive symptoms are prone to have periodontal diseases (Monteiro da Silva, 1996). Chronic stress and depression are supposed to reduce the immune responsiveness leading to more pathogenic infection and concomitant periodontal tissue destruction. Depression can mediate risk and progression of periodontitis through changes in health- related behaviours, such as oral hygiene, smoking and diet (Aleksejuniene, 2002). Increasing the risk of infections by modification of the immune system function and increasing pro-inflammatory cytokines and induction of vascular inflammation are of the most suggested mechanisms of action of depression and anxiety on the human body. It is proposed that these two conditions can cause oral and dental problems since emotional changes can influence oral mucosa.

Until recently, the psychosocial consequences of oral health conditions have received little attention, as these are rarely life threatening. Historically, the oral cavity has been dissociated from the rest of the body when considering general health status. Recent researches has highlighted that oral disorders have emotional and psychosocial consequences that are as serious as other disorders (Thomson et al., 2011).

The aim of this study was to investigate oral health in patients with and without depressive component during Covid-19 pandemic. As additional goals stated were to examine a possible association to psychosocial factors like psychological stress and symptoms of depression, whith changes in oral hygiene regimens during the Covid - 19 pandemic and to what extent periodontal health was influenced. Investigation of periodontal health was chosen because of strong evidences of negative influence of stress on periodontal health and was done using CPITN index.

2 MATERIALS AND METHODS

This is descriptive, cross-sectional, quantitative study.

Ethical approval was obtained from Research Ethics Committee of the University of Latvia, Faculty of Medicine.

The aim of this study was to investigate oral health in patients with and without depressive component during Covid - 19 pandemic.

The null hypothesis generated was that patient with depressive component could have more pronounced signs of periodontal disease than those without depressive component during Covid-19 pandemic.

2.1 Literature review

Objective

The aim of the literature review was to find and compile evidence-based literature scoping on:

1. Periodontal health and disease definition and etiological factors of periodontal disease.
2. Methods to evaluate periodontal health, highlighting use, advantages and disadvantages of CPITN index.
3. Definition, etiological factors and pathophysiology of stress.
4. Definition and sequencing of depressive symptoms and depression.
5. Impact of stress and depressive symptoms to oral health, highlighting impact on periodontal health.
6. Covid-19 pandemic as stressor and its impact to physical and mental wellbeing of person.

Methodology

To meet the criteria for inclusion the studies had to have:

1. Focus on general and/or oral manifestation of stress, depressive symptoms and anxiety, and overall health and disease of periodontal tissue.
2. Involve studies of impact of Covid-19 pandemic to general and oral health.
3. Been published between 1950 and 2022– the articles and books published in this period of time, addresses the historical and evidence-based concepts and contents related to the research problem and topic.

Literature search was undertaken during the period between September 2021 and March 2022.

Search of the English literature was done using following keywords and their combinations: stress and oral health, periodontal disease, dental biofilm, depressive symptoms, depression and oral health, Covid-19 pandemic stress, pathophysiology of stress.

Used databases were:

- National Center for Biotechnology Information – NCBI ,
- PubMed,
- ResearchGate,
- ScienceDirect,
- WebMed,
- PsychSceneHub,
- PocketDentistry,
- ClinicalKey.

Websites of official organizations that were used – American Psychiatric Association, Colgate, Very Well Mind, Mental Health First Aid, The British Broadcasting Corporation, King University Bristol, Psychiatric Times, ED Catalogue. The remaining sources were applied using Google Search Engine.

Potential papers - titles and abstracts of search results - were assessed for relevance, which was done together with the supervisor.

Results

In total 701 988 results with key words and their combination were found and 141 were relevant from articles and books and used as references.

Out of all articles, "Psychosocial stress, lifestyle and periodontal health", "Investigating oral health among individuals with depression: NHANES 2015–2016", "The effects of stress on periodontal treatment: a longitudinal investigation using clinical and biological markers", "Periodontal emotional stress syndrome: Review of basic concepts, mechanisms and management" were some of articles that had a fair amount of information needed to this research project.

Two books contained a lot of relevant material were "Carranza's Clinical periodontology, 12th edition" and "Clinical Periodontology and Implant Dentistry, 6th Edition".

2.2 Quantitative research

2.2.1 Questionnaire

Objective:

The aim of the questionnaire is to compare the literature review findings with answers from examining a possible association to psychosocial factors like psychological stress and symptoms of depression and changes of emotional wellbeing, overall and oral hygiene regimens during the Covid - 19 pandemic in patients who are suffering from depressive symptoms and those without. Analysis of gathered information should prove or disapprove the null hypothesis generated, that patient with depressive component could have more pronounced signs of periodontal disease than those without depressive component during Covid - 19 pandemic.

Methodology:

Participants were found through a network of personal relationships and social interactions, such as through friends and, also through social media like Facebook. More-over patients were informed about the aim of this study, and they showed interest in participation, because it was interesting for them to see the result, and they acknowledged that the atypical stress situation caused by the Covid - 19 pandemic could affect their daily lives.

After the approval of the Ethics Commission participants were asked to fill the questionnaire on prepared survey on paper. All answers from the questionnaire are kept private and anonymous.

The questionnaire consists of Consent form and 2 parts - Psychological part and Oral health part (Annex No. 1-3 in English; Annex No. 4-6 in Latvian). 13 questions are in Psychological part (Part 1) and 10 - in Oral health part (Part 2). Questionnaire was constructed by the researcher´s own work, with inspiration from personal logics, analysis of evidence-based literature and PHQ-9 Depression Test Questionnaire (Annex No. 7). The PHQ-9 is the depression module and it has been validated for use in primary care. It is not a screening tool for depression but it is used to monitor the severity of depression and response to treatment.

All participants had to answer questions that were related to the assumed relation between stress, depressive symptoms and anxiety and oral health problems, and mark gender and age.

141 patients were interested to participate, but 81 were excluded regarding exclusion criteria or they changed their mind.

Inclusion criteria:

- Adult – 18 years of age and more.
- Both genders.
- No scaling and root planning should be performed in last 6 months.
- Subjects without any life-threating disease.
- Patients without previous depressive episodes or depression diagnosed.
- Occlusion where CPITN could be calculated.

Exclusion criteria:

- Edentulous patients.
- Pregnancy.
- Controlled or uncontrolled diabetes.
- Diagnosed depression.
- Any acute infection.
- Scaling and root planning performed in last 6 months.
- Patient receiving antibiotic therapy or received it for 1 month prior to study.

In result the study included 60 people – 33 females and 27 males. In total age range in female subjects was 23 – 76 years, but in male subjects – 23 – 74 years.

Group 1 - Patients who did not experience a depressed mood during the Covid-19 pandemic did not seek medical advice and did not experience the problem prior to the pandemic.

Group 2 - Patients who experienced a depressed mood during the Covid-19 pandemic have complained to a general practitioner, but have not been referred to a psychiatrist, have not been diagnosed with depression, have not been prescribed and have not taken antidepressants. Nor have they had any such complaints before the pandemic.

Group 1 questionnaires were marked with blue circle, but Group 2 questionnaires were marked with yellow circle.

19 females in age range of 23 – 76 years and 11 males in age range of 23 – 63 years were included in Group 1 without depressive symptoms. 14 females in age range of 24 – 73 years and 16 males in age range of 24-74 yeras were included in Group 2 with depressive symptoms. All participants had to fill the questionnaire on prepared survey on paper. All questions are related to the assumed relation between depressive components (depressive mood) and oral health problems.

2.2.2 CPITN index

All patients included in the survey underwent full extraoral and intraoral examination regarding clinical protocol of Students Dental Clinic (Dentistry Programme of Medical Faculty at University of Latvia).

Intraoral examination protocol of dental hard tissue:

1. Dental tissues are examined, and pathologies and dental restorations are noted by student and then checked by supervisor.

Examination of periodontal tissues should be done as well, registering depth of gingival sulcus, bleeding on probing, attachment loss, gingival recession, furcation involvement. For all patients of Students Dental Clinic filling of periodontal chart is obligatory (Annex No. 9). From those charts all the information needed for CPITN can be achieved. Periodontal examination in the Students Dental Clinic is done under supervision of inter-calibrated instructors. Measurements should be done in 6 points (MB, B, DB, DL, L, ML for lower jaw and MB, B, DB, DP, P, MP for upper jaw) (Fig. 2.1).

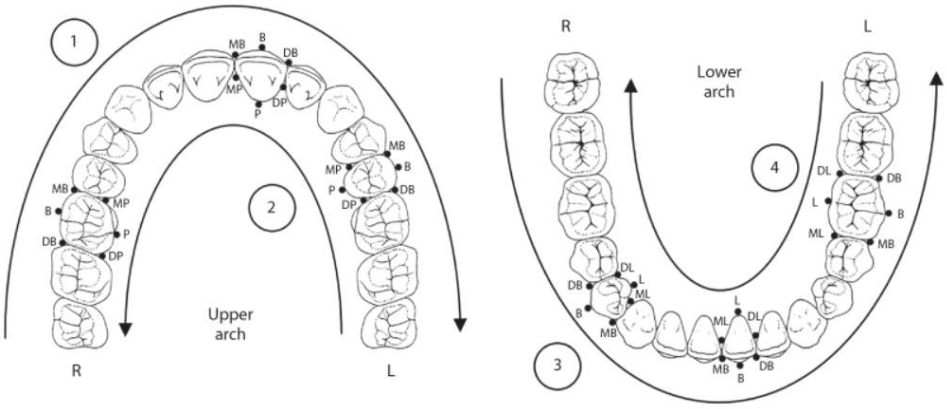


Fig. 2.1 **6 points periodontal examination. Adapted from PocketDentistry**

2. The community periodontal index of treatment needs (CPITN) assessment.

The goal of the community periodontal index of treatment needs (CPITN) is to determine the periodontal conditions and treatment needs in populations. In Students Dental Clinic it is used as preliminary diagnostic tool.

The CPITN is primarily a screening procedure which requires clinical assessment for the presence or absence of periodontal pockets, calculus and gingival bleeding (Fig. 2.2).

Fig. 2.2 **Probing manipulation. Adapted from PocketDentistry**

WHO periodontal probe (Fig. 2.3) was used. All examinations were done by researcher under equal clinical environment.

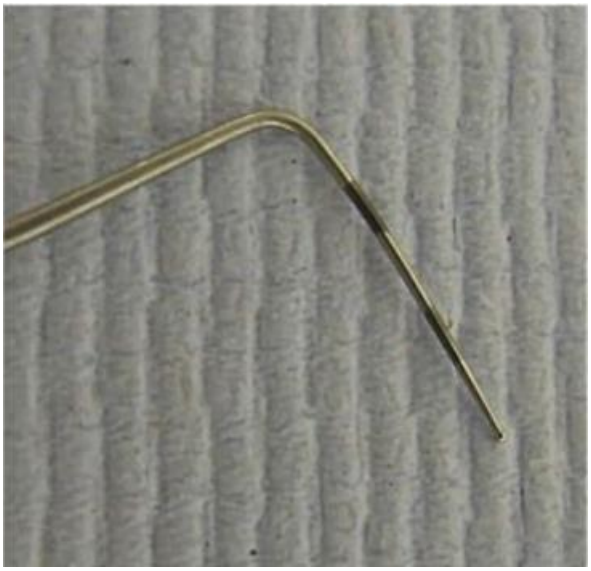
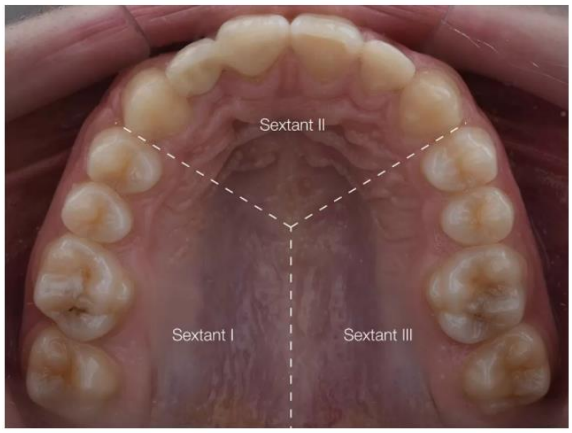


Fig. 2.3 **The WHO-C (clinical) probe. The key elements of this probe are a ball end with a 0.5-mm diameter, a black band at 3.5–5.5 mm, and a second black band at 8.5–11.5 mm. Adapted from PocketDentistry**

The dentition is divided into 6 parts – sextants – measurements are done and CPITN then is calculated (Table 2.1; Fig. 2.4)

Table 2.1 **Record of CPITN**

17-14	13-23	24-27
47-44	43-33	34-37



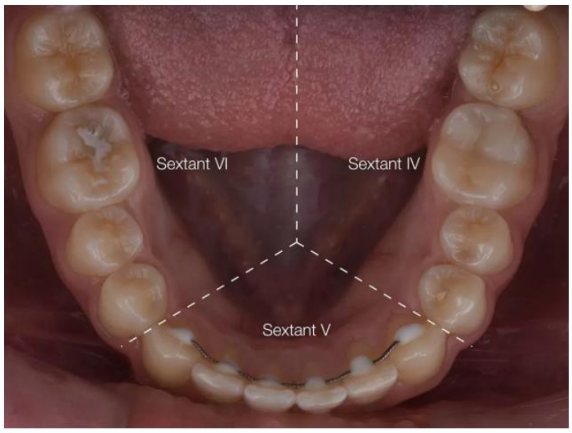


Fig. 2.4 **Division of occlusion in sextants. Adopted from PocketDentistry**

Each sextant is given a score.

For clinical practise the highest score in each sextant is defined after examined all teeth.

The highest score is determined for each sextant.

Third molars are not included except where they are functioning in place of second molars.

The treatment need in a sextant is recorded only if there are 2 or more teeth present and not indicated for extraction.

Table 2.2 **Codes of periodontal condition and treatment needs calculating CPITN**

CPI codes	Periodontal condition	Treatment needs codes
0	No bleeding No calculus No pathological pockets	No treatment needs
1	Bleeding on probing No calculus No pathological pockets	TN 1 – oral hygiene education, oral hygiene should be improved
2	Presence of supragingival or subgingival calculus with or without bleeding No pathological pockets	TN 2 – oral hygiene education, oral hygiene should be improved. Phase I periodontal treatment
3	Pathological pockets of 4-5 mm with or without calculus or bleeding	TN 2 - oral hygiene education, oral hygiene should be improved. Phase I periodontal treatment

4	Pathological pockets of 6 mm with or without calculus or bleeding	TN 3 – oral hygiene education, oral hygiene should be improved. Phase I periodontal treatment with future possible Phase II periodontal treatment planning
X	When only 1 tooth is presented in the sextant	X – no results

Results

Combination of horizontal bar graph and sector diagrams, which were performed using Word Excel, were used analyzing data obtained from questionnaires and CPITN calculation. Descriptive statistics were done using Spearman test and Mann Whitney U test.

3 LITERATURE REVIEW

3.1 History of periodontal diseases

Gingival and periodontal diseases have afflicted humans since the dawn of history. Studies in paleopathology have indicated that destructive periodontal disease, as evidenced by bone loss, affected early humans in such diverse cultures as ancient Egypt and early pre-Columbian America. The earliest historical records that involve medical topics reveal an awareness of periodontal disease and the need for treatment. Almost all early writings that have been preserved have sections or chapters dealing with oral diseases, and periodontal problems comprise a significant amount of space in these writings. Calculus and systemic disease were frequently postulated as causes of periodontal disorders. However, methodic and carefully reasoned therapeutic discussions did not exist until the Arabic surgical treatises of the Middle Ages. Modern treatment, with illustrated text and sophisticated instrumentation, did not develop until the time of Pierre Fauchard during the eighteenth century. (Newman, 2015)

3.2 Definition and characteristics of healthy periodontal tissue

Periodontal tissue contain gingiva, periodontal ligament, root cementum and supporting alveolar bone.

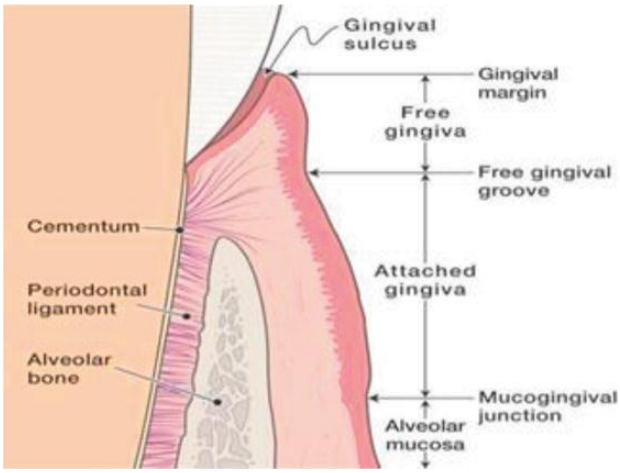


Fig. 3.1 **Periodontium components. Adapted from Newman, 2015**

3.2.1 Gingiva

In an adult, normal gingiva covers the alveolar bone and tooth root to a level just coronal to the cemento-enamel junction (Fig. 3.2). The gingiva is divided anatomically into marginal, attached, and interdental areas and the specific structure of different types of gingiva reflects each one's effectiveness as a barrier to the penetration by microbes and noxious agents into the deeper tissue. (Newman., 2015)

Gingival sulcus is defined as the space or shallow crevice between the tooth and the free gingiva, which extends apical to the junctional epithelium. It is V-shaped and barely permits the entrance of a periodontal probe. Under normal or ideal conditions it is about 0 mm. The so-called probing depth of a clinically normal gingival sulcus in humans is 2 to 3 mm (Reddy, 2011).

Fig. 3.2 **Healthy gingiva. Adapted from Newman, 2015**

3.2.2 Periodontal ligament

The periodontal ligament is the soft, richly vascular and cellular connective tissue which surrounds the roots of the teeth and joins the root cementum with the socket wall (Fig. 3.3). In the coronal direction, the periodontal ligament is continuous with the lamina propria of the gingiva and is demarcated from the gingiva by the collagen fiber bundles which connect the alveolar bone crest to the root (the alveolar crest fibers). (Lang & Lindhe, 2015)

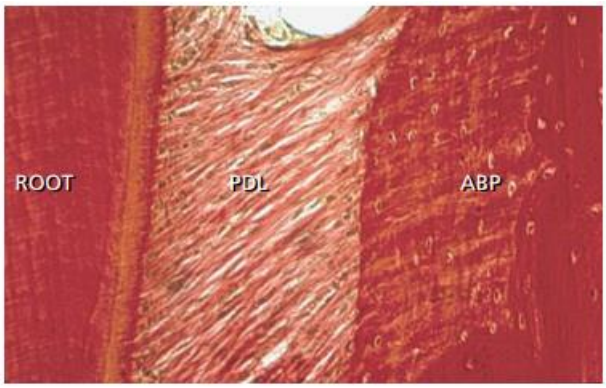


Fig. 3.3 **Periodontal ligaments – PDL. Adopted from Lang & Lindhe, 2015**

3.2.3 Root cementum

The cementum is a specialized mineralized tissue covering the root surfaces and, occasionally, small portions of the crown of the teeth (Fig. 3.4). It may also extend into the root canal. Unlike bone, the cementum contains no blood or lymph vessels, has no innervation, does not undergo physiologic resorption or remodelling, but is characterized by continuing deposition throughout life. Like other mineralized tissues, it contains collagen fibrils embedded in an organic matrix. Its mineral content, which is mainly hydroxyapatite, is about 65% by weight, a little more than that of bone (60%). Cementum serves different functions. It attaches the principal periodontal ligament fibers to the root and contributes to the process of repair after damage to the root surface. It may also serve to adjust the tooth position to new requirements. (Lang & Lindhe, 2015)

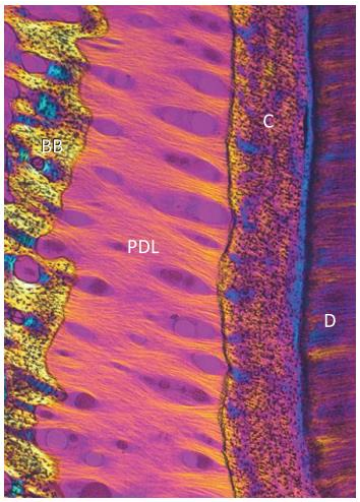


Fig. 3.4 **Cementum – C. Adopted from Lang & Lindhe, 2015**

3.2.4 Bone of the alveolar process

The alveolar process is defined as the parts of the maxilla and the mandible that form and support the sockets of the teeth (Fig. 3.5). The alveolar process extends from the basal bone of the jaws and develops in conjunction with the development and eruption of the teeth. The alveolar process consists of bone that is formed both by cells from the dental follicle (to produce the alveolar bone proper) and cells which are independent of this follicle (to produce the alveolar bone). Together with the root cementum and the periodontal membrane, the alveolar bone proper constitutes the attachment apparatus of the teeth, the main function of which is to distribute forces generated by, for example, mastication and other tooth contacts.

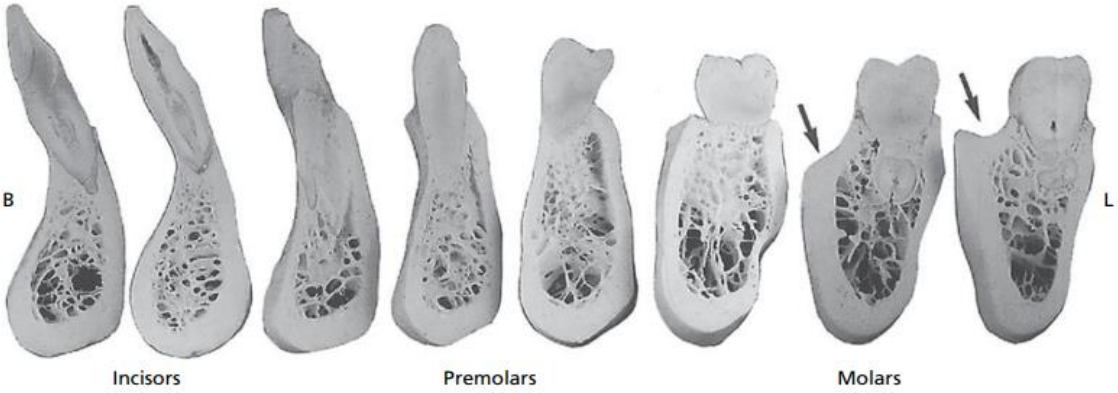


Fig. 3.5 **Mandibular alveolar bone. Adapted from Lang & Lindhe, 2015**

3.3 Dental plaque and dental calculus

Bacteria make up approximately 70 -80% of total dental plaque material. One mg of dental plaque is estimated to contain 250 million bacteria. Other than bacteria, mycoplasma, fungi, protozoa and viruses may be present. The material among the bacteria in dental plaque is termed as intermicrobial or cellular matrix. It contains organic and inorganic portions. The organic matrix is composed of protein - polysaccharide complex produced by microorganisms. Carbohydrates in the form of levans (fructans) provides mainly energy while glucans (dextran) provide not only energy, but also act as the organic skeleton of plaque. Other carbohydrates are galactose and rhamnose. Glycoproteins provide the protein component and small amounts of lipids are also present. Inorganic components include, primarily calcium, phosphorus with small amounts of magnesium, potassium and sodium. (Reddy, 2011)

3.3.1 Formation and development of dental plaque

Pellicle is the initial organic structure that forms on the surfaces of the teeth and artificial prosthesis. The first stage in pellicle formation involves adsorption of salivary proteins to apatite surfaces. This results from the electrostatic ionic interaction between hydroxyapatite surface which has negatively charged phosphate groups that interacts with opposite charged groups in the salivary macromolecules. (Reddy, 2011)

Dental plaque is an adherent intercellular matrix consisting primarily of proliferating microorganisms, along with a scattering of epithelial cells, leukocytes and macrophages.

Plaque can also be defined as the soft deposits that form the biofilm adhering to the tooth surface or other hard surfaces in the oral cavity, including removable and fixed restorations.

Structurally, dental plaque is now considered to be a biofilm of complex and dynamic microbial community. It contains areas of high and low bacterial biomass interlaced with aqueous channels of different sizes, which are the nutrient channels for bacterial colonization. The intercellular matrix forms a hydrated gel in which bacteria can survive and proliferate. Hence, biofilm adheres firmly to the tooth surface and is resistant to mechanical removal, as well as antibiotics. (Lang & Lindhe, 2015; Newman, 2015)

Based on its relationship to the gingival margin, plaque is differentiated into two categories, supragingival and subgingival plaque.

3.3.2 Supragingival plaque

Supragingival plaque is further differentiated into coronal plaque, which is in contact with only the tooth surface, and marginal plaque, which is associated with the tooth surface at the gingival margin.

Subgingival plaque can be further differentiated into attached and unattached subgingival plaque.

Attached plaque can be tooth, epithelium and/or connective tissue associated. (Newman, 2015) It can be detected clinically only after it has reached a certain thickness. Small amounts of plaque can be visualized by using disclosing agents. The color varies from grey to yellowish-grey to yellow (Fig. 3.6). The rate of formation and location of plaque vary among individuals and is influenced by diet, age, salivary factors, oral hygiene, tooth alignment, systemic diseases and host factors. (Lang & Lindhe, 2015)

Fig. 3.6 **Supragingival plaque. Adapted from PocketDentistry**

3.3.3 Subgingival plaque

It is usually thin, contained within the gingival sulci or periodontal pocket and thus cannot be detected by direct observation. Its presence can be identified only by running the end of a probe around gingival margin (Fig. 3.7). (Reddy, 2011)

Fig. 3.7 **Subgingival plaque. Adapted from Land & Lindhe, 2015**

3.3.4 Composition of dental plaque

Once the bacteria are adhered to the pellicle, subsequent growth leads to bacterial accumulation and increased plaque mass. Dental plaque growth depends on growth via adhesion of new bacteria and growth via multiplication of attached bacteria.

The initial bacteria that colonize the pellicle surface are mostly gram-positive facultative microorganisms such as Actinomyces viscosus and Streptococcus sanguis, as the plaque matures, secondary colonization of Prevotella intermedia, Capnocytophaga, Porphyromonas gingivalis takes place. (Reddy, 2011)

Supragingival plaque contains gram-positive cocci and gram-negative rods and filaments. The morphologic arrangement of the flora in supragingival plaque described as "corncob" formations, characterized by central core consisting of rod-shaped bacterial cells, e.g. Fusobacterium nucleatum and coccal cells, e.g. streptococci which attaches along the surface of the rod-shaped cell. The subgingival plaque differs from supragingival plaque, in that it contains many large filam ents with flagella and is rich in Spirochetes. (Fig. 3.8) (Reddy., 2011)

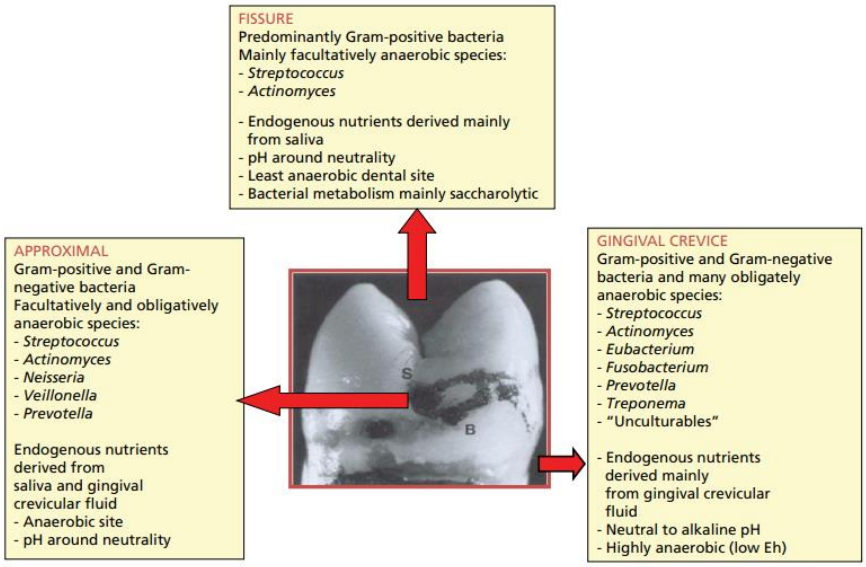


Fig. 3.8 **Predominant groups of bacteria found in distinct sites of the tooth surface, and key features of each habitat. Adapted from Adapted from Land & Lindhe, 2015**

Many of these microorganisms lack the adherence ability and utilizes supragingival plaque bacteria as a means of colonization of the subgingival area. Electron microscopic studies have demonstrated the existence of an organic material called cuticle between the root surface and subgingival plaque. It is covered by a dense layer of microorganisms and is believed to be a remnant or secretory product of the junctional epithelial cells. (Reddy, 2011)

3.3.5 Supragingival and subgingival calculus

Supragingival calculus is located coronal to the gingival margin and therefore is visible in the oral cavity. It is usually white or whitish yellow in color; hard, with a claylike consistency; and easily detached from the tooth surface. After removal, it may rapidly recur, especially in the lingual area of the mandibular incisors. The color is influenced by contact with such substances as tobacco and food pigments. It may localize on a single tooth or group of teeth, or it may be generalized throughout the mouth. The two most common locations for the development of - supragingival calculus are the buccal surfaces of the maxillary molars and the lingual surfaces of the mandibular anterior teeth (Fig. 3.9). (Newman, 2015)

Fig. 3.9 **Dental calculus on lingual surfaces of lower frontal teeth. Adapted from Lang and Lindhe, 2015**

In extreme cases, calculus may form a bridge-like structure over the interdental papilla of adjacent teeth or cover the occlusal surface of teeth that are lacking functional antagonists.
Subgingival calculus is located below the crest of the marginal gingiva and therefore is not visible on routine clinical examination. The location and extent of subgingival calculus may be evaluated by careful tactile perception with a delicate dental instrument such as an explorer. (Newman, 2015)

3.3.6 Composition of dental calculus

Supragingival calculus consists of inorganic (70-90%) and organic components. The major inorganic proportions of calculus have been reported as approximately 76% calcium phosphate, (Ca3[PO4]2); 3% calcium carbonate (CaCO3); and traces of magnesium phosphate (Mg3[PO4]2) and other metals. The percentage of inorganic constituents in calculus is similar to that of other calcified tissues of the body. The principal inorganic components have been reported as approximately 39% calcium, 19% phosphorus, 2% carbon dioxide, and 1% magnesium as well as trace amounts of sodium, zinc, strontium, bromine, copper, manganese, tungsten, gold, aluminum, silicon, iron, and fluorine. (Newman, 2015)
The organic component of calculus consists of a mixture of protein–polysaccharide complexes, desquamated epithelial cells, leukocytes, and various types of microorganisms.
Between 1.9% and 9.1% of the organic component is carbohydrate, which consists of galactose, glucose, rhamnose, mannose, glucuronic acid, galactosamine, and sometimes arabinose, galacturonic acid, and glucosamine. All of these organic components are present in salivary glycoprotein, with the exception of arabinose and rhamnose. (Newman, 2015)

Calculus is mineralized dental plaque. The soft plaque is hardened by the precipitation of mineral salts, which usually starts between the first and fourteenth days of plaque formation. Calcification has been reported to occur within as little as 4 to 8 hours. Calcifying plaques may become 50% mineralized in 2 days and 60 - 90% mineralized in 12 days. All plaque does not necessarily undergo calcification. Early plaque contains a small amount of inorganic material, which increases as the plaque develops into calculus. Plaque that does not develop into calculus reaches a plateau of maximal mineral content within 2 days. Microorganisms are not always essential in calculus formation, because calculus occurs readily in germ-free rodents.

Saliva is the source of mineralization for supragingival calculus, whereas the serum transudate called *gingival crevicular fluid* furnishes the minerals for subgingival calculus. The calcium concentration/content in plaque is 2 to 20 times that found in saliva. (Newman, 2015)

3.3.7 Etiologic significance of dental calculus

The incidence of calculus, gingivitis, and periodontal disease increases with age. It is extremely rare to find periodontal pockets in adults without at least some subgingival calculus being present, although the subgingival calculus may be of microscopic proportions.

Calculus does not contribute directly to gingival inflammation, but it provides a fixed nidus for the continued accumulation of plaque and its retention in close proximity to the gingiva. Subgingival calculus is likely to be the product rather than the cause of periodontal pockets. Plaque initiates gingival inflammation, which leads to pocket formation, and the pocket in turn provides a sheltered area for plaque and bacterial accumulation. The increased flow of gingival fluid associated with gingival inflammation provides the minerals that mineralize the continually accumulating plaque that results in the formation of subgingival calculus. (Newman, 2015)

3.4 Disease process of periodontal tissue

3.4.1 Microorganisms associated with periodontal disease

It is estimated that about 400 different species are capable of colonizing in the mouth. Counts in subgingival sites range from about 103 in healthy sulci to greater than 108 in deep periodontal pockets. It has not been possible to identify and study all the organisms present in the bacterial plaque, of nearly 400 species; only 30 of them are considered to be periodontopathic. Koch's postulates, generally used to identify the periodontal pathogenicity of a microorganism, are not applicable in periodontal disease, as more than one organism is involved in periodontal diseases.

Socransky in 1998 classified bacterias found in periodontal diseases in red, orange, yellow, green, purple and blue complexes (Fig. 3.10). Periodontopathogenic bacteria are divided into complexes depending on their properties and pathogenicity. These complexes are closely interrelated and together create a suitable environment. The red complex showed the strongest relationship with the clinical parameters considered most meaningful in periodontal diagnosis. The species from orange complex are closely associated with one another and this complex appeared closely related to the red complex. Similarly to the red complex, all species in the orange complex showed a significant association with increasing pocket depth. Red complex is extremely pathogenic and yellow is more of commensal. Red and orange complexes have been classified as late colonizer in the development and maturation of subgingival plaque and they have been closely related to the pathological conditions of periodontal tissue. Bacteria from the yellow complex have not been directly associated with changes in clinical signs of periodontal disease (such as bleeding on probing, probing pocket depth, and clinical attachment level). The purple and green are complexes present in the periodontal pocket but not significantly associated with signs of periodontal disease progression. Bacteria from blue complex are found is periodontal diseases, but are not directly related to some distinct periodontal disease.

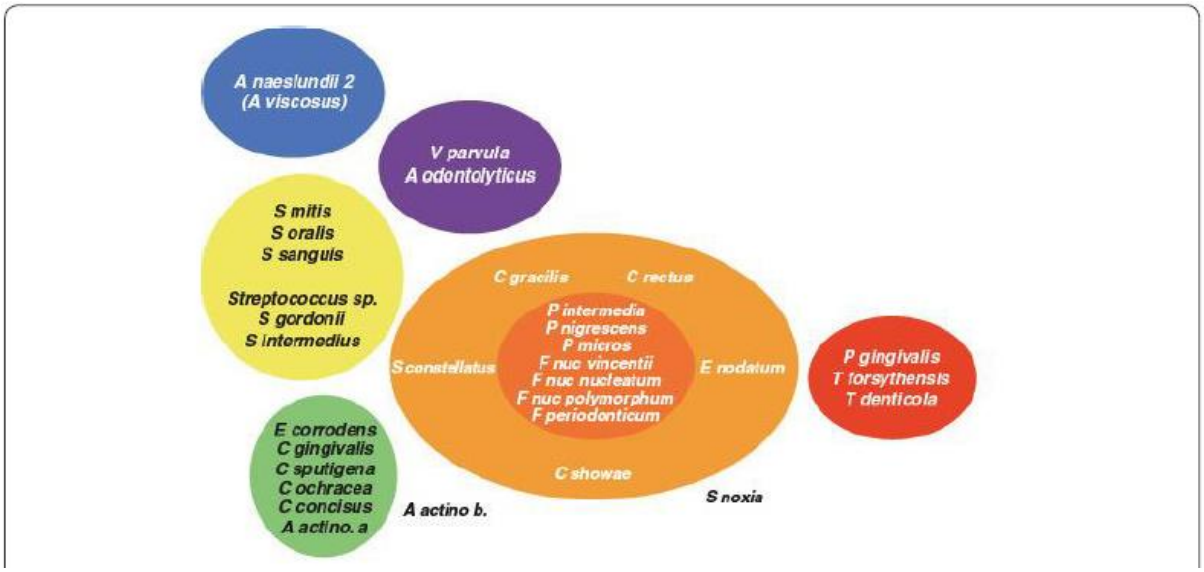


Fig. 3.10 **Bacterial types and microbial complexes in periodontal diseases by Socransky. Adapted from Newman, 2015**

3.4.2 Gingivitis

Gingivitis that is associated with dental plaque formation is the most common form of gingival disease.

Gingivitis has been characterized by the presence of clinical signs of inflammation that are confined to the gingiva and associated with teeth showing no attachment loss (Fig. 3.11). Gingivitis has also been observed to affect the gingiva of periodontitis-affected teeth that have previously lost attachment but that have received periodontal therapy to stabilize any further attachment loss. In these treated cases, plaque-induced gingival inflammation may recur but without any evidence of further attachment loss.

Fig. 3.11 **Gingivitis. Adapted from PocketDentistry**

Plaque-induced gingival disease is the result of an interaction between the microorganisms found in the dental plaque biofilm and the tissues and inflammatory cells of the host. The plaque–host interaction can be altered by the effects of local factors, systemic factors, medications, and malnutrition, all of which can influence the severity and duration of the response. (Newman, 2015)

Dental plaque-associated gingivitis is the most common periodontal disease, with a prevalence of 30–54% (Newman, 2015). This gingival inflammatory condition is triggered by bacteria accumulation, and it is characterized by clinical features such as swollen, tender, erythematous and bleeding gums, halitosis and pain.

Even though dental plaque is the necessary key factor for gingivitis development, the severity of the disease is also related to oral and systemic conditions, such as hormones, pharmacological treatment, smoking, hyposalivation and dental restorations etc. (Lang et Lindhe, 2015). Poor oral hygiene is a negative prognostic factor, regardless of other concurrent conditions, thus an adequate plaque control and removal of microbial biofilm is the essential therapeutic measure to adopt in gingivitis management

Most cases of gingivitis occur from lack of proper oral hygiene, which leads to the accumulation of dental plaque and calculus; however, many other factors can affect the gingiva's susceptibility to the oral flora.

Following factors are mentioned in literature as factors associated with gingivitis (Lang and Lindhe, 2015; Newman, 2015):

- Hormonal changes,
- Stress,
- Poor nutrition,
- Certain medications (e.g., phenytoin, calcium channel blockers, cyclosporine etc.),
- Diabetes mellitus,
- Immune dysfunction,
- Local trauma,
- Dental caries,
- Tooth crowding with overlapping etc.

3.4.3 Periodontitis

Periodontitis is defined as "an inflammatory disease of the supporting tissues of the teeth caused by specific microorganisms or groups of specific microorganisms, resulting in progressive destruction of the periodontal ligament and alveolar bone with increased probing depth formation, recession, or both." The clinical feature that distinguishes periodontitis from gingivitis is the presence of clinically detectable attachment loss. This loss is often accompanied by periodontal pocket formation and changes in the density and height of the subjacent alveolar bone. In some cases, recession of the marginal gingiva may accompany attachment loss, thereby masking ongoing disease progression if only probing depth measurements are taken without measurements of clinical attachment levels. The attachment loss associated with periodontitis has been shown to progress either continuously or in episodic bursts of disease activity. (Lang and Lindhe, 2015; Newman, 2015)

It has been observed that chronic periodontal destruction caused by the accumulation of local factors (e.g., plaque, calculus) can occur before the age of 35 years and that the aggressive disease seen in young patients may be independent of age and instead have a familial (genetic) association. (Newman, 2015)

Periodontitis is prevalent in adults but may also occur in children and adolescents; the amount of tissue destruction is generally commensurate with dental plaque levels, host defences and related risk factors. A key feature of both chronic and aggressive periodontitis is site specificity: the characteristic periodontal pockets and the accompanying attachment loss and bone loss do not occur uniformly throughout the dentition.

Fig. 3.12 **Generalised severe periodontitis. Adapted from PocketDentistry**

Some important risk factors of periodontitis are mentioned in literature as follows (Lang & Lindhe, 2015, Newman, 2015; Reddy, 2011):

- Smoking,
- Diabetes,
- Poor oral hygiene,
- Stress,
- Heredity,
- Crooked teeth,
- Underlying immuno-deficiencies - e.g., AIDS,
- Fillings that have become defective,
- Taking medications that cause dry mouth,
- Bridges that no longer fit properly,
- Female hormonal changes, such as with pregnancy or the use of oral contraceptives etc.

Periodontal disease is mostly prevalent in adults but it may also occur in children and adolescents. Prevalence of periodontal diseases depends upon the level of dental plaque formation and gingival tissue destruction. Site specificity is one of the key features for chronic and aggressive periodontitis. The severity of this disease depends upon depth of periodontal pocket i.e. attachment loss and bone loss of tooth. (Lang & Lindhe, 2015; Newman, 2015)

The epidemiology of periodontitis may vary across masses substantially. Frequently used parameters to collect data for occurrence of this disease are clinical attachment loss and probing depth of periodontal pockets which was first introduced. Various studies were conducted by researchers to find out prevalence rate in different countries. Globally 10- 15% of populations are suffering from tooth loss due to periodontal disease. (Newman, 2015)

Periodontal disease is a silent disease, often subclinical, but can negatively affect eating, aesthetics and speaking.

Loss of function due to tooth loss affects mastication, digestion and can greatly affect nutrition and diet. The considerable aesthetic consequences of bone and tooth loss and recession of the gingiva can also affect quality of life. Halitosis can be a considerable problem in social interactions143. Disrupted dentition with predominantly aesthetic consequences has been linked with poor employment prospects and marked social shyness and inhibitions. (Lang & Lindhe, 2015)

Comorbidities associated with chronic forms of periodontal disease, particularly chronic periodontitis, can also play a part in patient quality of life. Associations between chronic periodontitis and cardiovascular disease, stress and obesity have also been supported in the literature, but these associations might be explained by shared risk factors and comorbidity, rather than being directly causal (Reddy, 2011).

Periodontal disease has also been associated with poor pregnancy outcomes (preterm delivery and low birth weight), but the body of evidence and interventional studies failed to convincingly prove this correlation. Periodontal disease and pregnancy outcome might be linked by shared risk factors, comorbidity, inflammatory burden and metabolic syndrome, but the chances of a causal correlation are low, as the majority of babies are born to mothers (Newman, 2015).

3.4.4 Modifiable and nonmodifiable periodontal disease risk factors

Periodontal diseases are widespread in worldwide population and strongly influenced by modifiable and nonmodifiable factors (Lang & Lindhe, 2015; Newman, 2015; Reddy, 2011).

Modifiable periodontal factors:

- Microorganisms (specific pathogens),
- Smoking,
- Poorly controlled diabetes,
- Stress,
- Poor self-care,
- Untreated HIV or AIDS,
- Oral effects of some medications,
- Local factors,
- Obesity,
- Improper diet,
- Chronic inflammation,
- Some host responses.

Nonmodifiable periodontal risk determinants:

- Osteoporosis,
- Some hematological disorders (e.g., thrompocytophenia),
- Some host responses,
- Age,
- Gender,
- Race,
- Genetic disorders,
- Bone levels,
- Drug induced disorders,

- Normal hormonal variations (e.g., pregnancy, puberty, menopause, andropause).

If modifiable factors could be modified with treatment or changes in patient' s lifestyle (e.g., quit smoking, improved diet etc.), then nonmodifiable risk factors usually could be influenced in rather low level.

3.5. Periodontal indices

A prerequisite for any epidemiological investigation is the ability to quantify the occurrence and severity of the disease. Measurement is a process of assigning values to characteristics according to a set of rules. This is facilitated through indices, certain methodology, and criteria. An index quantitatively reflects the clinical state or conditions using set of criteria on a graduated numerical scale whereby one can easily define, describe, distinguish, compare, and analyse the status of an individual or a group with reference to that state and/or conditions. (Newman, 2015)

There are lot of periodontal indices what could be used in everyday clinical practice and epidemiological surveys (Fig. 3.13)

Table 1 Description of periodontal indices

Serial No.	Index	Author and year	Salient features
1.	Periodontal Index	Russell (1956)	• First index for periodontal disease • A weighted categorical scoring system • No longer considered valid
2.	Periodontal Disease Rate Index	Sandler and Stahl (1959)	• Each tooth is assessed utilizing radiographs and clinical measurements
3.	Periodontal Disease Index	Ramfjord (1959)	• More sensitive version of the PI for use in clinical trials • Scores the gingival status first using a 0 to 3 scale while clinical attachment level is scored on a scale from 4 to 6, on a selected group of teeth – 'Ramfjord teeth'
4.	Gingival Bone Count Index	Dunning and Leach (1960)	• Subjective measurement of gingival status is combined with proportionate measurements of bone loss from radiographs • Time consuming, thus, not used
5.	Gingival Periodontal Index	O'Leary (1967)	• Mouth is divided into six sextants and the highest score for each segment either gingival (0–3) or periodontal (4–6) is recorded • Not much used
6.	Navy Periodontal Disease Index	Grossman and Fedi (1974)	• Derived from gingival (0–2) and pocket (0, 5 and 8) scores of the six Ramfjord teeth
7.	Community Periodontal Index for Treatment Needs	World Health Organization (1982) by Ainamo, Barmes, Beagrie, Cutress, Martin and Infirri	• Assesses the presence or absence of gingival bleeding on probing, supra or subgingival calculus and periodontal pockets by using 0.5 mm ball tip WHO probe • Advantages include simplicity, speed and international uniformity, hence, popular
8.	Periodontitis Severity Index	Adams and Nystrom (1986)	• Assesses the presence or absence of periodontitis as product of clinical inflammation and interproximal bone loss determined radiographically using a Schei ruler • Use limited to longitudinal studies and lacks validation
9.	Extent and Severity Index	Carlos *et al.* (1986)	• Extent score is % of sites examined having attachment loss more than 1 mm whereas, the severity score is average loss of attachment per site among disease sites • Simple, reproducible
10.	National Institute of Dental and Craniofacial Research (NIDCR) protocol	NIDCR (1988–1994)	• Periodontal examination consisted of measurement of periodontal supporting tissues including attachment loss, probing pocket depth and furcation involvement • Used in U.S. National Health and Nutrition Examination Survey (NHANES III)
11.	Periodontal Index for Treatment	Eaton and Woodman (1981–1985)	• Clinical assessment of six teeth is done with a specially designed periodontal probe • Simple rapid and reliable periodontal screening
12.	Periodontal Screening and Recording Index	American Academy of Periodontology (1991)	• Divides mouth into six sextants and greatest score in each sextant of mouth is determined and recorded by using a plastic PSR probe • Simple, fast and preferred by patients
13.	Community Periodontal Index	World Health Organization (1997)	• Modification of CPITN index • Useful in periodontal research, especially to reduce the time needed for examinations when the study population comprises a large number of individuals
14.	Periodontitis Index	Albandar *et al.* (1999)	• Classifies each person as having either mild, moderate or advanced periodontitis, or with no periodontitis, based on the number (or percentages) of teeth showing certain thresholds of probing depth and attachment loss
15.	Dichotomous Periodontal Index	Dye *et al.* (2002), Tezal *et al.* (2004), Borrell *et al.* (2006), Brothwell and Ghiabi (2009), Persson *et al.* (2005)	• Record the presence or absence of pocket or clinical attachment loss against a cut-off point
16.	Genetic Susceptibility Index for periodontal disease	Moustakis *et al.* (2007)	• Used for both single nucleotide polymorphisms and microbial component of periodontal disease

Fig. 3.13 **Description of periodontal indices. Dhingra & Vandana, 2011.**

3.5.1 Community Periodontal Index of Treatment Needs - CPITN

CPITN was proposed by WHO in 1977 as an index to evaluate the periodontal treatment needs of populations. The main advantage of the index is that it is easy to use. As a result of this feature and the promotion of the use of the index by the WHO, it has been widely used internationally for several years.(Dhingra & Vandana, 2011; Newman, 2015)

CPITN was choosen for this study because it is recommended for periodontal epidemiological surveys and provides planning and maintaining of periodontal care program. This index has some important major advantages as simplicity, speed and international uniformity. Some limitations should be taken into acount as weel – index does not record the position of gingival margin and does not provide assessment of past periodontal breakdown. But those limitations do not interfere with the aim of this study.

3.6 Definition of depression and depressive symptoms

The most common mental disorder, depression, is internationally acknowledged as a considerable public health problem, major depression being one of the leading causes of premature mortality and disability in the world (WHO, 2016). Besides its associations with disturbances in psychological and social functioning, depression is also associated with various biological alterations.

The definition of the term "depression" is complicated because of the inherent ambiguity involved. In the psychiatric field, depression can be seen as a state of mood, as a special symptom manifesting itself in many different mental disorders, as a syndrome measured by depression rating scales, and as a clinical diagnosis operationalized in diagnostic classifications (Lehtinen and Joukamaa, 1994). Being depressive is not necessarily equal to having a mental illness. Occasional depressive mood experienced as low spirits, dejection, and sadness can be a normal reaction to disappointments, adversities, and loses and should be differentiated from depressive disorders, which represent actual psychological illness and are often accompanied by distinct impairment of psychological, somatic, and social functioning (Akiskal, 2000).

Despite a rather wide range of possible definitions, there appears to be a general consensus that the phenomenon variously called mild depression, minor depression, or depressive symptoms or components is a real condition and that it causes significant disruptions in functioning for those it affects (Martin et al., 1996; Solomon, 2001).

Depressive symptoms are very variable, and a person may experience one isolated symptom as well as a combination of several symptoms. It is very important to understand that the fact that a person is experiencing depressive symptoms does not mean that the person has depression. It should be emphasized that depression is a psychiatric diagnosis made by a psychiatrist. However, a person may experience depressive symptoms due to stress and anxiety.

<u>Depression symptoms include:</u>

- Feelings of sadness or unhappiness,
- Irritability or frustration, even over small matters,
- Loss of interest or pleasure in normal activities,
- Reduced sex drive,
- Insomnia or excessive sleeping,
- Changes in appetite - depression often causes decreased appetite and weight loss, but in some people, it causes increased cravings for food and weight gain,
- Agitation or restlessness — for example, pacing, handwringing or an inability to sit still,

- Irritability or angry outbursts,
- Slowed thinking, speaking or body movements,
- Indecisiveness, distractibility and decreased concentration,
- Fatigue, tiredness and loss of energy — even small tasks may seem to require a lot of effort,
- Feelings of worthlessness or guilt, fixating on past failures or blaming yourself when things aren't going right,
- Trouble thinking, concentrating, making decisions and remembering things,
- Frequent thoughts of death, dying or suicide,
- Crying spells for no apparent reason,
- Unexplained physical problems, such as back pain or headaches. (Kumar et al., 2012)

Depressive symptoms affect each person in different ways, so symptoms vary from person to person in manifestation and severity. Inherited traits, age, gender and cultural background all play a role in development of depression.

Women are more prone than men to experience depressive episodes. This distinction might be based on biological and hormonal differences. (Kennedy et al., 2013; Kessler, 2003). Women also report higher depressive symptoms levels, suggesting a difference between genders in expressing depressive symptomatology (Molina et al., 2014). To date, controversies are still more common than established conclusions in the literature.

Concerning gender differences in psychotherapeutic interventions, an anti-male vision of psychotherapy can be noted in men (Englar-Carlson, 2006), meaning that they consider men that seek help due to depressive symptoms to be more feminine (McCusker & Galupo, 2011). The gender role schema theory hypothesizes that cultural influences shape an individual's model of masculinity and femininity and potentially guide what are considered "acceptable" and "unacceptable" enactments of gender.

3.7 Stress

The word stress implies an experience of negative emotions that comes in the wake of anticipated physiological, biochemical, cognitive and behavioural changes that work towards either changing the stressor or making adjustments to its effects. (Baum, 1990)

Stress is a process that puts the bodily systems under strain in order to cope with the environmental demands that bring about psychological and biological changes that could account for an illness. (Cohen et al., 1995)

The environmental aspect highlights the evaluation of environmental situations that are in objective relation with the extensive adaptive demands. The subjective assessment of the ability to cope with the stressor comes under the domain of psychological stress perspective. Finally, the biological perspective refers to the multiple bodily systems that are activated and controlled by both psychologically and physically demanding situations. (Salleh, 2008)

If the stress is continued or prolonged, it can leave adverse effects on body's immune, cardiovascular, neuroendocrine and central nervous systems. (Anderson, 1998) When chronic stress goes untreated it can result into serious disabilities like insomnia, weakened immune system, high blood pressure, anxiety and muscle pain. It can also play a role in developing major disorders like depression, heart disease and obesity. (Baum & Polsusnzy, 1999)

While stress is a concern of an array of disciplines, including psychology, sociology, psychoneuroimmunology, we adopted a transdisciplinary approach to defining chronic stress based on the stress process paradigm of Pearlin et al., 1981. They conceptualized stress as a process "in which demands strain on an individual's ability to adapt - physiologically and emotionally - with implications for physiological and behavioural pathways" (Pearlin et al., 1981).

The pathway between stress and mental illness can be better understood with a thorough comprehension of physiology of stress.

There are different responses to stress (Table 3.1):

- Physical responses,
- Emotional and thought responses
- Behavioural responses

Table 3.1 **Responses to stress. Adapted from Dougal & Baum, 2011**

Physical responses	Emotional and thought responses	Behavioural responses
Muscle aches	Restlessness	Avoidance
↑ Heart rate	Agitation	Neglect
Weight gain	Worthlessness	↑ Smoking
Constipation	Depression	Poor Appearance
Muscle twitching	Guilt	↑Spending
Low energy	Anger	↓ Eating
Tight chest	Nightmares	Nail Biting
Dizziness	Sensitivity	↑ Talking
Stomach cramps	Numbness	Sexual Problems
Insomnia	Mood Swings	Fidgeting
Headache	↓Concentration	↓ Exercise
Nausea	Preoccupation	Aggressive speaking
Dry mouth	Insecurity	↑ Sleeping
Weight loss	Anxiety	↓ Relaxing activities
Weakness	Hopelessness	Withdrawal
Diarrhoea	Defensiveness	↑ Alcohol use
Trembling	Racing thoughts	↑ Eating
Chills	Intense thinking	Arguing
Sweating	Expecting the worst	Poor hygiene
Choking feeling	Lack of motivation	Seeking reassurance
Leg cramps	Forgetfulness	Skin picking
Hot flashes	Rigidity	↑ Body checking
Pounding heart	Intolerance	Foot Tapping
Chest pain		Rapid Walking
Numb or tingling hands/feet		Teeth clenching
↑ Blood pressure		Multitasking
Dry throat		↓ Fun activities
Face flushing		
Feeling faint		
Neck pain		
↑ Urination		
Light headedness		

3.7.1 The mental effects of chronic and acute stress

The first of these two findings suggests that the near-exclusive emphasis of stress research on life events has been misplaced. Chronic stresses appear to be more important predictors of depression, as structural effects of chronic stresses are larger than those of acute stresses. This is an important point because it speaks to the observation of Depue and Monroe, 1986 that the variance in depression screening scales may be more substantially due to chronic minor depression than to episodic major depression. If this observation is correct, it should not be surprising that chronic stresses explain more variance in depressive symptoms than do acute stresses.

If a stress has been ongoing for a long time, coping efforts have almost certainly been unsuccessful and this is likely to lead to an appraisal of the stress as more threatening (Lazarus & Folkman, 1984) as well as to an attribution of the cause as more stable (Abramson et al., 1978) and uncontrollable (Thoits, 1983), all of which are thought to increase the depression associated with stress.

The greater impact of chronic stress than acute stress on depressive symptoms, then, might reflect a greater impact of ongoing stress than resolved stress. Both lines of interpretation suggest that persistence of stress - failure to resolve stress - plays some part in explaining the stronger association with depressive symptoms of chronic stress than acute stress. (McGonagle & Kessler, 1990).

3.7.2 Pathophysiology of stress

There are two interconnected systems that are involved when experiencing stressful events: sympathetic adreno-medullary (SAM) system and hypothalamic-pituitary adrenocortical (HPA) axis.

In SAM activation, when a person is faced with a stimulus that disturbs his homeostasis it is labelled as a stressor by the cerebral cortex. This information travels to the hypothalamus which initiates the fight or flight response. This stimulates the adrenal medulla to secrete the catecholamine (epinephrine and norepinephrine). The combined effect of two produces an aroused bodily system i.e. high blood pressure, sweating, palpitation, constriction of blood vessels etc.

While in HPA activation, hypothalamus is known to secrete corticotrophin-releasing hormone (CRH). It rouses pituitary gland which in turn releases adrenocorticotropic hormone (ACTH). This stimulates the adrenal cortex to secrete glucocorticosteriods. Among these, cortisol is the

most important. It stores carbohydrate and decreases inflammation and helps the body returning to its original, steady state before the stress. (Everly & Lating, 2013) Prolonged HPA activation due to continued stress has been related with serious diseases. Various researchers have proposed that the consequences of HPA activation on health are far more significant than that of sympathetic arousal. (Cullinan et al., 1995) It is evident how physiological arousal could lead to maladaptive patterns of behaviour which would eventually influence a person's attitude towards seeking help and care. Evidence have been found that the combination of emotional arousal and neuroendocrine stimulation due to prolonged stress causes chronic insomnia. (Everly & Lating, 2013) As sleep is imperative for body's restoration, its disturbance and deficiency implies a significant pathway to disease. (Lazarus, 2006)

3.7.3 Stress mechanism

A study by Ardayfio et al., 2006 showed how chronic stress could lead to anxiety and depression. It presented that prolonged exposure to stress hormone, cortisol, contributed to symptoms of depression. According to this study, stress hormones help a person in responding to an immediate threat. However, if stress remains heightened, it could boost anxiety and lead to mood disorder or most commonly major depressive.

Repeated or recurrent stress is known to quicken or worsen the mood disorders. Studies have shown how early exposure to stressors in life and sensitivity to stress make a person susceptible to the depressive symptoms. (Lazarus, 2006)

Early life stressor has the power to bring about noticeable and durable changes in brain circuitry regulating stress reactivity, mood and behaviour. Impairment in central nervous system may take place due to early stressful life events and change in stress response system that can last through adulthood. The HPA activation due to physically and psychologically stressful experiences produces cortisol as explained above which in turn negatively impacts mood and behaviour. (McCorry, 2007)

3.7.4 Definition of oral-systemic relationship

A growing body of evidence has come to support the existence of an "oral-systemic" relationship (Bansal et al., 2013; Barnett, 2006; Li et al., 2000). This relationship has been demonstrated for some diseases more so than others, including respiratory infections, osteoporosis, childhood obesity, cardiovascular disease, and type II diabetes (Beck et al., Hahn

et al., 2005; Rodrigues et al., 2005). A shared impetus for the development of both oral and systemic disease may be the presence of stress. As a common risk factor for both diseases of the oral cavity as well as for non-communicable diseases (e.g. cancer, cardiovascular disease, diabetes, and respiratory disease), the minimization of stress has become an integral component of novel systemic healthcare promotion techniques, such as the common risk factor approach (Sheiham et al., 2000).

Chronic stress is likely to contribute to the progressive, long-term development of oral disease through at least two distinguishable pathways. First, stress can motivate individuals to cope in unhealthy ways that foster oral disease (e.g., substance use, including illicit drugs, alcohol and tobacco, poor diet, and sedentary behaviour). Second, chronic stress contributes to high allostatic load that can lead to the dysfunction of physiological systems critical to homeostasis, and thus, affect the underlying mechanisms of disease progression, more generally. (Shankardass, 2012)

3.7.5 Influence of stress and depressive symptoms to oral health

Individuals may experience potential sources of current stress, including people (such as children in the case of parents), places (such as densely populated intersections), and things (such as a paucity of money, food, and shelter).

Typically, stressors can be categorized into one of four types (Pearlin, 1981):

- major life events (such as a death in the family),
- ambient strains (such as a concern for safety in the neighbourhood you live in),
- role strains (such as stress related to workplace hierarchy), and
- quotidian nature strains (stresses that result from activities of a repeated nature, such as a daily commute to work).

Some factors may mediate whether or not the experience of stress currently translates into more chronic stress over time (manifestations), including whether or not they perceive certain stressors as threatening, and if so, manageable given resources at hand (Pearlin, 1981).

Then, where perceived current stress occurs, the coping behaviours used to deal with stressors mediate whether chronic stress manifests and harms oral health and general well-being in two main ways. First, if stressors associated with perceived current stress are not coped with in an effective manner, then chronic stress is more likely to occur. Allostatic load, a cumulative physiological impact of chronic stress, has been associated with periodontal disease (Sabbah et al., 2008), and some evidence indicates that this occurs due to increased inflammation (Buchwald et al., 2013). However, the precise causal mechanisms remain somewhat unclear.

Second, regardless of how effective coping behaviours are, they may manifest as habits that are either healthy (e.g., exercise and relaxation, problem solving) or unhealthy (e.g., tobacco, alcohol and other drug use, poor oral maintenance) with respect to oral disease.

As stress is one of the main reasons for depressive symptoms to appear, but psychological health disorder may also be a predictor of oral health problems (Gholami et al., 2017). There are other common oral health outcomes that is indicated to be associated with several psychological disorders such as anxiety, schizophrenia, and bipolar disorder (Fig. 3.14) (Pearlin, 1981).

Oral health outcome	Depression	Anxiety	Schizophrenia	Bipolar disorder
Poor oral hygiene	(Anttila et al., 2006) (Park et al., 2014) (Torales et al., 2017)	(Anttila et al., 2006) (Lkan et al., 2015) (Torales et al., 2017)	(Azodo et al., 2012) (Torales et al., 2017)	(Oflezer et al., 2018) (Torales et al., 2017)
Dental caries	(Kisely et al., 2016) (Hugo et al., 2012) (Yang et al., 2016) (Torales et al., 2017	(Torales et al., 2017)	(Cormac and Jenkins, 1999) (Kisely et al., 2015) (Yang et al., 2018)	(Kisely et al., 2015) (Oflezer et al., 2018) (Torales et al., 2017)
Periodontal disease	(Kisely et al., 2016) (Elter et al., 2002) (Rosania et al., 2009)	(Lkan et al., 2015) (Torales et al., 2017)	(Ramon et al., 2003) (Rekha et al., 2002) (Baghaie et al., 2017)	(Baghaie et al., 2017) (Oflezer et al., 2018)
Tooth loss	(Okoro et al., 2012) (Saman et al., 2014) (Torales et al., 2017)	(Okoro et al., 2012) (Torales et al., 2017)	(Kisely et al., 2011) (Kisely et al., 2015) (Baghaie et al., 2017) (Yang et al., 2018)	(Kisely et al., 2011)(Kisely et al., 2015)(Baghaie et al., 2017)

Fig. 3.14 **Common oral health outcomes associated with selected psychological disorders. Adapted from Almohaimeed et al., 2022**

Recent studies have shown a relationship between depression and oral diseases like periodontal disease, dental caries, but little data were available (Kisely et al., 2016).

A study led by Elter et al. in the United States in 2002, discussed the relationship between depression and periodontal disease. After adjusting for sex, smoking status, antidepressant drugs use, physical health, and baseline oral health, they concluded that after one-year depression affected periodontal health adversely.

However, a study done in 2003 by Persson et al. found that there is no relation between periodontal disease and depression after adjusting for sociodemographic data and health factors associated with periodontal disease like smoking.

Using the Behavioral Risk Factor Surveillance System (BRFSS) Anxiety and Depression Module (PHQ-8), Okoro et al. concluded in 2012 that there is a relation between missing teeth and depression and anxiety disorder. In 2014, Saman et al. studied the association of depression with partial and full edentulism patients. The study results found that after controlling for confounders like socioeconomic status - for example, race or ethnicity - chronic depression was associated with partial and full edentulism.

Contemporary studies demonstrate a relationship between depressive symptoms and depression and oral disease. However, vital oral health problems like dental prevention, dental access, and oral and dental health-related quality of life, have not been investigated by most of these studies. Preventative dental care and dental care access are critical to promoting oral health. Dental care, regular cleaning and check-ups have been shown to prevent dental caries and periodontal disease and improve oral health (Kandelman et al., 2012).

Poor dental health is well recognized as a source of systemic inflammation, with emerging literature identifying it as a risk factor for the progression of inflammatory diseases such as cardiovascular disease (CVD). For example, poor oral hygiene is associated with a 70% increased risk of CVD (Cesar et al., 2010), while periodontal disease is associated with a two-fold increase in the risk of CVD-related mortality (Aiwani et al., 2003).

3.8 Pathophysiology of impact of depression to oral health

There is now abundant evidence that depression is also an inflammatory disorder. This high prevalence condition is accompanied by chronic, low-grade inflammation, indicated by increased levels of acute phase proteins, such as C-reactive protein (CRP), as well as pro-inflammatory cytokines including interleukins and tumour necrosis factor (Raison et al., 2006). Data from large-scale, prospective studies have shown that elevated inflammatory markers, such as high-sensitivity CRP, increase the risk of developing major depressive disorder (Pasco et al., 2010). As such, the identification of potentially modifiable sources of such inflammation is imperative, particularly in view of the global burden of disease imposed by depression (Murray et al., 2012).

Currently, the relationship between poor dental health and depressive symptoms is not well understood. Many studies have investigated the contribution of depressive symptoms and the onset of periodontal disease or poor dental health, but few have explored the converse association at the population level. In regard to the former studies, depressive symptoms were found to be associated with periodontal destruction (Rosania et al., 2009), poorer perceived oral health (Marques-Vidal et al., 2006) and oral health concerns (Quine and Morrell, 2009). When the underlying contribution of behavioural and physiologic factors to these relationships has been explored, physiological mechanisms including salivary cortisol have been demonstrated to be more important than behaviours such as health care utilization (Rosania et al., 2009). Marques-Vidal et al.,2006 who reported that depressive symptoms were associated with poor dental health, concluded that the link was independent of limited dental health care. While these data provide some insight into the association between poor mental wellbeing and dental health, this relationship has seldom been explored at the population level or determined whether it exists independent of physiological indicators of systemic inflammation or inflammatory conditions.

3.9 Periodontal disease as manifestation of depressive symptoms

Periodontal diseases contribute directly and/or indirectly to systemic infections with bacteria involved in their etiology and pathogenesis (Stoykova et al., 2014). Thus, periodontal diseases are a risk factor for many other conditions such as infectious endocarditis, coronary disease, fatal or nonfatal stroke, premature labour, diabetes, certain pulmonary and sinus diseases (Choi et al., 2009). Maintaining good periodontal health is therefore essential for the patient's well-being well beyond the orofacial region. To achieve this goal, it is necessary to understand all the factors that can influence periodontal diseases.

The main etiological factor for the occurrence of periodontal disease is plaque accumulation (Lang & Lindhe, 2015; Newman, 2015). Nevertheless, the risk of occurrence and changes in the development, severity, and response to periodontal disease treatments depend on several individual factors. These factors include bacterial flora, poor oral hygiene, age, sex, diabetes, HIV, pregnancy, menopause, smoking, low socioeconomic status, and local factors (cavities, dental morphology, etc.). Some other general factors are stress, immune deficiency, and nutritional factors, which appear to modulate the body's immune response and determine the level of susceptibility to the disease (Newman, 2015). The list of these risk factors remains controversial (Stoykova et al., 2014).

3.10 Stress and periodontal disease

Stress is a specific human reaction in response to a trigger, and is characterized by three successive phases: alarm, resistance, and general coping syndrome (Selye, 1973). The stress response corresponds to the activation of the catabolic mechanisms: activating the adrenocorticotropic axis and the sympathetic autonomic nervous system (ANS), and withdrawal of the parasympathetic ANS. Recovery involves anabolic pathways including sleep and activation of a wave tone. These regulatory pathways allow the human body to react in a coordinated and adjusted manner for reestablishing homeostasis (eustress) (Bindushree et al., 2014).

The stressor characterizes any situation that activates the pathways of stress, irrespective of its nature, intensity, and duration (Selye, 1973). It may be external to the subject, imposed by an environmental change, or self-generated by negative influences or thoughts, including anxious thoughts.

3.10.1 Acute and chronic stress

Acute stress is the sudden and temporary response of the human body to a stressor which has a defined beginning and end. Exposure to the stressor results in an alarm response that is characterized by a “fight or flight” reaction (Bindushree et al., 2014). Chronic stress is the response to intermittent and repeated exposure to a stressor over a continuous period (Juster et al., 2010). Exposure to chronic stress has biological cost and can lead to neurobioimmune dysfunction (distress) (Bindushree et al., 2014; Juster et al., 2010).

3.10.2 Impact of chronic stress on periodontal disease

First link highlighted for necrotizing ulcerative gingivitis (NUG). Because of its particular nature (sudden onset of acute pain, ease of diagnosis), NUG is the periodontal disease associated with the most studied psychosocial factors. A link was established between NUG and psychogenic factors such as stress, anxiety, and depression in the 1970s (Formicola et al., 1970). These factors predispose to NUG by promoting bacterial growth and/or decreasing host defenses (Reners and Brecx, 2007).

This decrease would result in increased levels of corticosteroids and catecholamines via ANS. This could decrease gingival microcirculation and salivary flux and improve the nutrition of the Prevotella intermedia.

Since 1976, DeMarco has used the term “periodontal emotional stress syndrome” to describe the impact of the stress suffered by the soldiers involved in the Vietnam War on the progression of periodontal disease. It was not until the 1990s when there was any significant research into the relationship between stress and periodontal disease (da Silva et al., 1995).

Harmonization of the protocols was carried out between the years 2000 – 2010 with the systematic use of biomarkers to objectify the stress levels of an individual. These biomarkers include: measuring salivary cortisol levels, standardized stress scales and questionnaires, and the CPITN (Rosania et al., 2009). From there, studies conducted on animals (Carvalho et al., 2010; Rosania et al., 2009; Zhao et al., 2012) and on people, whether it be cohort, cross-sectional, case–control or clinical trials (Hilbert et al., 2006; Peruzzo et al., 2007; Stabholz et al., 2010) showed a positive correlation between stress and the occurrence of periodontal disease. According to several recent literature reviews, the evidence is currently sufficient to suggest that stress is a risk factor for the occurrence of periodontal disease in the presence of pathogens as well as the worsening of pre-existing periodontal diseases (Akcali et al., 2013; McCracken, 2009; Peruzzo et al., 2007; Stabholz et al., 2010).

Despite numerous experimental, clinical, and epidemiological studies on the relationship between stress and periodontal disease, the exact mechanisms linking these two phenomena remain largely unknown (Goyal et al., 2011; Hilbert et al.,2006; Warren et al., 2014). As a first step, these studies have shown the indirect impact of stress on the periodontium through changes in behaviour and lifestyle (food and oral hygiene, smoking, parafunctions, etc.) (DeMarco, 1976). More recently, the progress of neurology and psychoimmunoendocrinology and the growing interest in the study of stress and its medicopsychosocial consequences have made it possible to demonstrate a direct, biological impact of stress on the periodontium (Fig. 3.15) (Rettori et al., 2014).

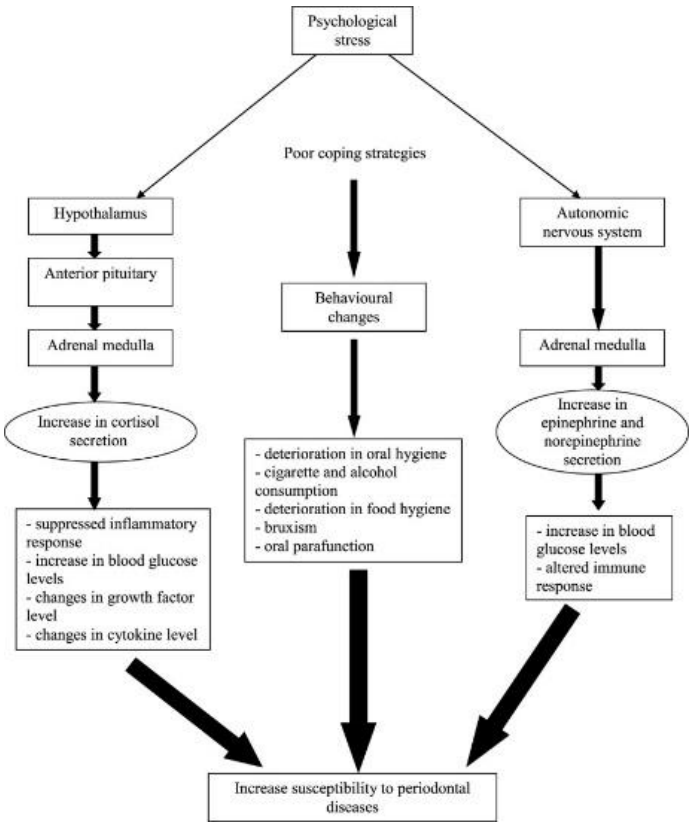


Fig. 3.15 **Biological mechanisms and behaviours linking stress and periodontal disease. Adopted from LeResche & Dworkin, 2002**

3.10.3. Reaction to stress

Reaction to stress could be behavioural, biological and immunological.

3.10.3.1 Behavioural reaction

Neglecting of oral hygiene shoul be mentioned as first from behavioural reactions. Oral hygiene depends in part on the mental health of the patient (Goval et al., 2013). It has been reported that psychological disorders can lead patients to neglect their oral hygiene resulting in a build-up dental plaque, which can be damaging for periodontal health (Deinzer et al., 2005). Studies have shown that the stress results in a decrease in oral hygiene levels and an increase in crevicular interleukin-1β levels (Johannsen et al., 2010). The authors conclude that stress is a risk factor for gingival inflammation (Johanssen et al, 2005).

The psychological state of an individual affects the diet as well. The choice, consistency, and quantity of food they consume (Sunhday et al., 2006) are mentioned as influenced. This may include an increase in the consumption of carbohydrate-rich foods and soft foods, which do not require as much chewing. This type of diet can result in plaque accumulation (Sunhday et al.,

2006). Overconsumption of high-fat foods induced by stress can lead to increased cortisol production and thus immunosuppression (Fentoglu et al., 2012; Sunhday et al., 2006;). Any changes to diet can cause stress and can be a risk factor for periodontal disease (Akcali et al., 2013; Fentoglu et al., 2012).

Of all the oral habits that can be picked up because of stress, smoking is the one which has the most damaging effect on the periodontium (Goval et al., 2013; Chiou et al., 2010) since:

- the frequency of periodontal disease is 7–8 times greater for smokers than for nonsmokers (Abu Ta'a, 2014);
- the severity of periodontal disease is higher among smokers (depth of periodontal pockets, periodontium, and bone attachment losses) (Abu Ta'a, 2014);
- smokers respond less favorably to periodontal treatments whether they be nonsurgical, surgical, and/or medically (Chiou et al., 2010; Abu Ta'a, 2014).

The presence of nicotine in the blood also results in the following (Goval et al., 2013):

- vasoconstriction because of the release of adrenaline and noradrenaline. This vasoconstriction blocks nutrients from reaching periodontal tissues;
- in vitro suppression in antibody response;
- inhibition of the neutrophil oral function.

Psychological disorders associated with stress can be expressed at the level of the oral sphere by the introduction of certain parafunctional habits including rare behaviours, which may include thumb-sucking and infantile swallowing. More frequently occurring behaviors include biting the tongue, lips, cheeks, or objects (pen, etc.). Nail-biting, object sucking, and tongue pressure on the teeth can also occur. These actions, when repeated, can lead to dental migration and occlusal trauma that can cause or aggravate periodontal disease. (Goval et al. 2013)

Bruxism can be defined, from a phenomenological point of view, as repetitive, involuntary, and unconscious masticatory movements and grinding (and/or tightening) of teeth, with no functional purpose, and is associated with an abnormal tooth position and jaw muscle discomfort (Manfredini et al. 2004). Many studies have shown that bruxism patients exhibit particular psychological traits, such as stress, anxiety, manic depressive symptoms, and mood disorders (Manfredini et al., 2004). The researchers suggested that bruxism could be considered a marker for chronic stress (Manfredini et al., 2004). Although the impact of bruxism on periodontal health has no consensus (Manfredini et al., 2004), it seems to be an aggravating factor for advanced periodontitis (Perltish, 2016) even if it has little or no influence on a healthy periodontium or early-stage periodontitis (Manfredini et al., 2015).

3.10.3.2 Biological reaction

Exposure to chronic stress will lead to biological mechanisms that will result in a decrease in the patient's immune response and chronic inflammation (Halawany et al., 2015). These mechanisms are based on complex interactions between immunology, psychology, neurology, and endocrinology (Halawany et al., 2015). The set of mechanisms induced by the stress reactions should be considered for understanding the impact of chronic stress on periodontal health.

As a physiological response to stress, the HPA axis is activated, resulting in the secretion of CRH and vasopressin by the hypothalamus, which act on the pituitary gland. In response, the pituitary gland secretes pituitary corticotropic hormones to act on the adrenal cortex and increase the production and release of cortisol and glucocorticoid hormones, which are necessary for a long-term stress response (Papathanasiou et al., 2013). Glucocorticoids induce a decrease in immunocompetence by modifying the behavior of lymphocytes, macrophages, and monocytes. These changes, when they occur over a long period, contribute to the risk of cardiovascular disease, diabetes mellitus, rheumatoid arthritis, and other diseases (Deinzer et al., 2005; Goval et al., 2013; Ishira et al., 2008; Johannsen et al., 2006;).

This decrease in immunocompetence occurs because of the following (Goval et al., 2013):

- changes to the inflammatory response;
- inhibition of IgA, IgG, and neutrophil function that leads to an increase in bacterial colonization of the biofilm and a decrease in the ability to prevent connective tissue invasion;
- changes to the initial cytokine profile in place of interleukin-1 and TNF α;
- elevated blood glucose levels;
- a change in the rates of certain growth factors.

Therefore, periods of chronic cortisol elevation and the immune dysfunction they induce, lead to the deregulation of the inflammatory inhibitory abilities of cortisol, promoting chronic inflammatory damage within the periodontium (Goval et al., 2013; Refulio et al., 2013).

ANS stimulation when exposed to stress results in the release of catecholamines by the adrenal gland (adrenaline/noradrenaline), Chromogranin A (CgA), and various neuropeptides, such as substance P, by sensitive nerve fibers (Hironako et al., 2008). The production of epinephrine and norepinephrine results in elevated blood glucose levels and alterations in the immune response that increase susceptibility to periodontal disease (Goval et al., 2013; Johannsen et al., 2006). Catecholamines regulate the immune response by stimulating the activity and spread of the immune cells whereas CgA has an antimicrobial effect (Helle, 2010). ANS also acts on the

salivary glands during periods of stress by secreting enzymes such as salivary alpha-amylase (sAA) that acts by neutralizing and preventing pathogens from entering the body via mucous membranes and inhibiting adhesion and bacterial growth in the oral cavity (Rohlender & Nater, 2009).

Psychological stress leads to a transient decrease in salivary flux that promotes plaque and calculus formation which results in periodontal disease. Stress also generates a change in salivary composition. (Rohleder & Nater, 2009)

3.10.3.3 Immunological reaction

Increasing studies suggest that psychological stress has an important effect on the immune system (Hall et al., 2012; Segerstrom & Miller, 2004), while researches showing that components of immune system such as interleukin-1β (IL-1β), IL-6, soluble IL-2 receptors and TNF-α were elevated in depressive patients (Lin et al., 2012) indicate that the immune system is closely associated with depression. Peripheral inducers of immune cytokines may generate symptoms of depression (Reichenberg et al., 2001) and in the brain, these inducers may decrease monoamine levels (Karrenbauer, 2011) that most current antidepressants aim to increase.

As an important regulator of brain-body interaction, immune mediators such as cytokines affect diverse central nervous system (CNS) functions involved in depression such as cognition, sleep and reward (Wong & Licinio, 2001).

The immune cell response plays a crucial role in the healing of periodontal tissues, both by preventing infection of the injured site and by preparing and regulating the repair mechanisms (Fentogluu et al., 2012). Some cytokines, interleukins (IL-1β, IL-6, IL-8) and TNF-α are involved in the production of phagocytic cells, which are needed to repair the injured site and to regulate the production of fibroblasts and epithelial cells (Fentoglu et al., 2012). In the case of a normal healing process, the production of cytokines, interleukins (IL-1β, IL-6, IL-8), and TNF-α decreased significantly. In a stressed subject with periodontitis, the production rate is high, resulting in an increase in the severity of periodontal damage (Zhao et al., 2012). Stress can also burden some aspects of the immune response such as mitogen stimulation, antibody and cytokine production, and NK cell activity (Bosch et al., 2007). By deregulating the inflammatory and immune response, stress can alter the tissue-healing process and promote the development of some oral pathologies such as periodontitis (Bakri et al., 2013).

Studies have also shown that some hormones released under stress cause a proliferation of certain bacteria such as Fusobacterium nucleatum, therefore aggravating the severity of periodontal damage (Jentsch et al., 2013).

Individuals with an inadequate stress response also have a decreased response to nonsurgical periodontal treatments than other patients and therefore more severe periodontal diseases (Bakri et al., 2014). The 5-year clinical and microbiological follow-up of patients treated for early-stage periodontitis showed that periodontal disease evolves more rapidly in stressed patients (Hilbert et al., 2006). For Lu et al., 2014 this rapid evolution is because of the stimulation of the stress-induced ANS stimulation, which results in the release of neurotransmitters (catecholamine neurotransmitter, epinephrine). These neurotransmitters are capable of binding to α1-adrenergic (α1-AR) receptors present on the surface of periodontal cells, thus decreasing their biological activity and causing a massive release of inflammatory factors.

Psychological stress is a risk factor for periodontal disease. Stress can also increase the severity of periodontal disease and decrease the effectiveness of treatments. When only the indirect action of stress on the periodontium was known (appearance of risk behaviors for periodontal-induced stress: smoking, poor food and oral hygiene), care of patients could be limited to educating patients about the consequences of these behaviors. Now, advances in biomedical research show that stress also has a direct effect on the periodontium by the implementation of neuro–immunoendocrinological mechanisms. These results suggest the multidisciplinary management (physician, dentist, psychologist) of patients to identify subjects with chronic stress and depressive symptoms and to put in place countermeasures to decrease the deleterious effect stress has on the periodontium. (Mathieu et al., 2018)

Although much attention has been focused on this multifactorial and heterogeneous disorder, the aetiologies of depression remain poorly understood. While risk loci for many other common diseases have been identified by genetic analysis, the true “depression genes” which are responsible for the onset and the cure of depression and could be manipulated to produce models of depression in rodents, have not been identified (Berton and Nestler, 2006; Krishnan & Nestler, 2008). Even so, genetic factors (Krishnan & Nestler, 2008), together with external environmental factors (stressful events in particular such as losing jobs and beloved ones), are considered to be involved in the onset of depression. The environmental risk factors associated with depression and depressive symptoms include endocrine abnormalities (hyper- or hypo-thyroidism), cancers (for example, pancreatic adenocarcinoma and breast cancers), adverse effects of drugs (Laftis & Hauser, 2004) and stressful events and other factors.

Psychological stress has been increasingly featured in scientific works as well as in popular media such as internet, newspapers and TV due to terrorism, war (Human, 2007), divorce and unemployment (Hall et al., 2012).

Signals from environmental stressors such as danger to life, social stressors and responses to injuries in the body are firstly transduced by sensory nervous systems, and then the sequent information is processed by so-called emotional circuits in the brain (Hyman, 2007). Although so far we have no clear understanding of the neural loops underlying the pathology of depression, the diverse symptoms of depression imply that many brain regions could be involved in the affection disorders (Berton & Nestler, 2006).

3.11 Stress and depressive symptoms during Covid-19 pandemic

Tere are a variety of stressful events that people have to face in their lives. If the intensity of stress exceeds the individual's ability to deal with, it may cause psychological or physical damage to the individual (Liang, 2006). The SARS-CoV-2, which has the characteristics of rapid transmission and high infection rate, was identifed at the end of December 2019 in Wuhan, China, but it took only a few months before it was declared as a global pandemic by the World Health Organization in 2020. Unfortunately, it is still rampant in some parts of the world and has negatively infuenced daily activities and mental health and wellbeing of the general population (Islam et al., 2021). Such extremely serious event may be regarded as a serious threat (stressor) to the majority of people.

So far, there has no consistent research conclusion on the mechanism of psychological stress reaction induced by stressors. Lazarus & Folkman, 1984 put forward a theory of cognitive appraisals and coping, which assumes that the individual's appraisal of stressors infuences his or her coping strategies and then afects the consequences of the stressors (Lardier Jr et al., 2020). In this theory, coping is described as continuous cognitive and behavioral eforts to manage demands that exceed individuals' resources (Lazarus & Folkman, 1984). Coping style refers to the coping strategy that an individual takes to protect himself or herself from the deleterious efects of stressors. According to this theory, individuals can adjust to the emotions activated by the stress through coping strategies, and manage the problems caused by the stress (Chou et al., 2011). Given the importance in managing stress, coping has received much attention, and various models of coping have been developed. In spite of the type varieties, it has been widely accepted that coping is an important mediator between stress and psychological stress reactions. Previous studies have revealed that coping mediated the association between stress and depression and depressive symptoms, and could predict the its severity.

On the other hand, social support is an important factor considered benefcial to individual's psychological health. It is defned as the psychological and/or physical assistance provided by family, friends and others to an individual facing difculties (Zhang and He, 2015). A large number of researches worldwide have focused on social support as a mechanism that protects people from the deleterious efects of stress. Tere are two hypotheses on the mechanism. One is the main-efect model, in which social support provides benefcial efects on mental health independent of stressors. The other is the bufering model, which posits that social support alleviates the impact of stressors on mental health only in times of high stress. Cohen believed that social support may act on the link between stressful events and individuals' appraisal, and play a moderating role in the relationship between the subjective experience and psychological

damage (Cohenn & Wills, 1985). However, Stroebe et al. in 1996 proposes another way that social support may help individuals' recovery from the stress reaction more easily. In general, benefcial bufering efects of social support have been considered to enhance the individual's sense of mastery in coping with stress and to diminish helpless feelings (Cheng, 1997). Social support is most often categorized into two basic types: received social support and perceived social support. Received social support is the objective or actual support, including assistance of materials and direct services. Perceived social support refers to the cognitive perception of availability and adequacy of support from others (Thoits, 1995). Although social support theory emphasizes the role of actual support, most evidence shows that perceived social support plays the essential function, especially under the condition of stress (Heller and Lakey, 1985). In relation to depression, it is reported that perceived social support is an important predictor of depression and depressive symptoms (Denton et al., 2015) as well as a bufer of depression and depressive symptoms in response to life events and chronic strains Cheng, 1997). In a four-year prospective model of cardiac patients, Holahan et al., 1997 found that the ongoing social support enhanced coping eforts, whereas the social stressors eroded coping eforts. Tus, there might be a moderating efect of perceived social support on the relationship between coping and depressive symptoms.

The Covid-19 pandemic brought the world to a halt. Since early 2020, social life has changed for many people around the world. Government restrictions and new social norms led to a reduction in mobility (Google, 2020), avoidance of public transport, cancellation of the majority of large events such as concerts, festivals, religious and sports events, and the temporary closing down of meeting places such as cafes, restaurants, museums or theatres. The Covid-19 outbreak and measures undertaken by almost all the countries around the world pose numerous threats to people's psychological well-being; thus, it is believed that focusing on our closest social environment is greatly needed. Both relative lack of social relations (Tay et al., 2013) and negative emotions (Huppert, 2009) strongly predict overall mortality and disease outcomes, and the threat of SARS-CoV-2 may increase anxiety levels (Karwowski et al., 2020) and prejudice toward other nationalities (Sorokowski et al., 2020), rendering any effort to understand stress in isolated or quarantined individuals during the Covid-19 pandemic even more important. Moreover, to understand possible negative effects, it is important to unpick the pre-existing factors that can predict the stress levels of people in quarantine or isolation.

Other people

One such factor is the presence (or absence) of other people. To date, most of the existing studies on human isolation and confinement are naturalistic observational studies, such as the

Taylor SEALAB project (Radloff & Helmreich, 1968), or the South African National Research station (SANAE) in Antarctica (Vermeulen, 1977). Under these difficult circumstances of a physically and socially restricted environment, participants reported high indices of severe hostility, depression, insomnia, and anxiety. Studies on prisoner populations suggest that social factors can significantly boost prisoner's well-being, which can otherwise be disrupted by jail isolation (Kyprianides & Easterbrook, 2020). The conditions in which participants of the afore-mentioned studies were put are far from what people are experiencing now. Although being relatively isolated from the outside world, many of us remain within the comfort of our own homes, usually surrounded by friends or relatives. However, there are also people who are getting through this time alone. Living alone has been previously linked to higher indices of depression and anxiety, and other common mental disorders (Jacob et al., 2019). Therefore, those who live alone might experience more stress due to the Covid-19 situation than those living with people who may be a source of potential support (Cohen & Wills, 1985). On the other hand, being around others might be stress-enhancing. Studies suggest that this type of chronic stress is often accompanied by a lack of privacy, a higher number of unwanted social interactions, possible deterioration of relationships with the family or flatmates, and so forth (Fuller et al., 1996). Considering the above, it could be hypothesised that the relationship between the number of people one is stuck with during isolation is somewhat U-shaped—those who live alone and those who are subjected to overcrowding experience the highest levels of stress.

Intimate relationships

Despite numerous advantages, being in a romantic relationship also carries a number of risks, for instance, contagion of negative emotions (Roberts & Levenson, 2001). Moreover, when couples encounter difficulties, such as financial hardship, or a lack of support from the spouse, they may experience a pronounced decrease in marital satisfaction, which can lead to an increase in stress levels (Archuleta et al., 2011).

On the other hand, intimate relationships allow for dyadic coping (Bodenmann, 2005), and often serve as a buffer against difficult situations (Gottlieb & Wagner, 1991), which may in turn translate into lower levels of stress (Chin et al., 2017).

Number of children

Also of interest is how having and living with children relates to the experiences of adults during the period of relative isolation. Having children is quite a positive experience, as it has been generally related to greater life satisfaction, especially amongst married couples in contrast to

individuals who are separated, cohabiting or never-married singles (Angeles, 2010). Nevertheless, having children may also foster elevated stress levels. Parental stress is the result of the gap between the challenges of being a parent and the parent's perceived ability to cope with those challenges (Abidin, 1995). This kind of stress may be even more pronounced during the Covid-19 outbreak, as most parents now must home-school their children. It could be hypothesised that having children at home may be associated with higher levels of stress in adults.

Gender

Gender seems to be related to well-being (Mroczek & Kolarz, 1998) and stress levels (Taylor et al., 2008). Previous studies have found that women report greater sadness, anxiety, and stress than men (Bergdahl & Bergdahl, 2002; Gao et al, 2019).

A recent study by Limcaoco et al. in 2020 in 25 countries on susceptibility to stress during the Covid-19 situation indicated that women report greater levels of stress. Similar gender differences for stress, anxiety, and depression symptoms were found by Wang et al. in 2020 in a Chinese sample during the initial stage of the Covid-19 outbreak, although only a minority of the participants reported being confined. In sum, while the evidence suggests that women in normal circumstances experience more stress, support for the link between gender and stress under quarantine is inconclusive.

Age

Generally, stress levels tend to decrease with age and although older adults report poorer perceived health, they have lower stress levels and higher well-being than young adults (Archer et al., 2015). Bergdahl and Bergdahl in 2002 found that self-reported stress levels increase from the age of 20 to a peak in the 40s, and then decrease to the lowest level in the 60s. Studies generally support the notion that older people are less affected by stressors than younger people (Feizi et al., 2012).

Few studies have investigated the relationship between age and stress levels during quarantine. The objective consequences of being infected by SARS-CoV-2 are higher for the older population (WHO, 2020a; 2020b). However, while the perceptions of a highly transmitted illness threat among the elderly may prompt stress, the empirical evidence is mixed. For instance, Taylor et al. in 2008 found that the negative psychological impact of quarantine is more pronounced among younger people. Investigating psychosocial responses towards a national outbreak of SARS in Singapore, Sim et al. in 2010 found that psychiatric morbidities are associated with younger age and higher posttraumatic stress symptoms. Most recently, an

online survey in the early stages of the Covid-19 outbreak in China found no association between age and stress (Wang et al., 2020).

As such, although older adults face higher risks of severe disease and death due to Covid-19 (WHO, 2020b), the evidence suggests that older people are less stressed and less affected by psychological consequences of quarantine and social isolation, while younger ones exhibit the highest levels of stress.

Individualism - collectivism dimension

The role of culture has been widely studied for decades, with researchers debating how cultural factors may act as a buffer to the environmental stressors or, on the contrary, exacerbate stress levels (Dar, 2017). One of the main focuses of research in this area, the individualism–collectivism dimension (Hofstede, 2001), has been linked to stress processing (Chun et al., 2006). During the current quarantine, people have been forced to renounce their personal enjoyment (e.g. sports, concerts, shopping, travel, social gatherings) for the sake of group needs. Since individualistic, rather than collectivistic, cultures put a higher value on pleasure and hedonism (Schwartz, 2009), it might be reasonable to think that the emotional cost of this quarantine period would be greater in individualistic cultures. In fact, collectivistic (vs. individualistic) cultures put more emphasis on group harmony over personal interests and enjoyment (Triandis et al., 1990). Overall, under the prevailing quarantine, the level of stress is expected to be higher for individualistic cultures compared to the collectivistic ones.

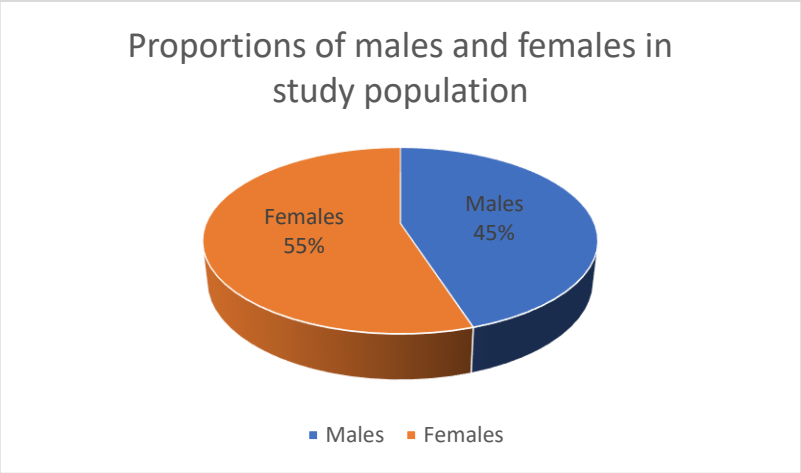
As witnesses to history and living in the shadow of the psychological and economic problems caused by the Coivid-19 pandemic, it is necessary to understand as the pathophysiological as well as the psychological effects of this disease – Covid-19. The human body functions as a subtle mechanism where one event triggers another in both health and illness.

Living in an urban world in the 21st century, stress has become commonplace. However, it is often forgotten that stress affects every function of our body. The effects of stress on mental well-being and the possible development of depressive symptoms should also be emphasized.

Therefore, understanding the impact of stress and depressive symptoms to oral health can give us valuable information what could improve dentist’s everyday work and communication with patient.

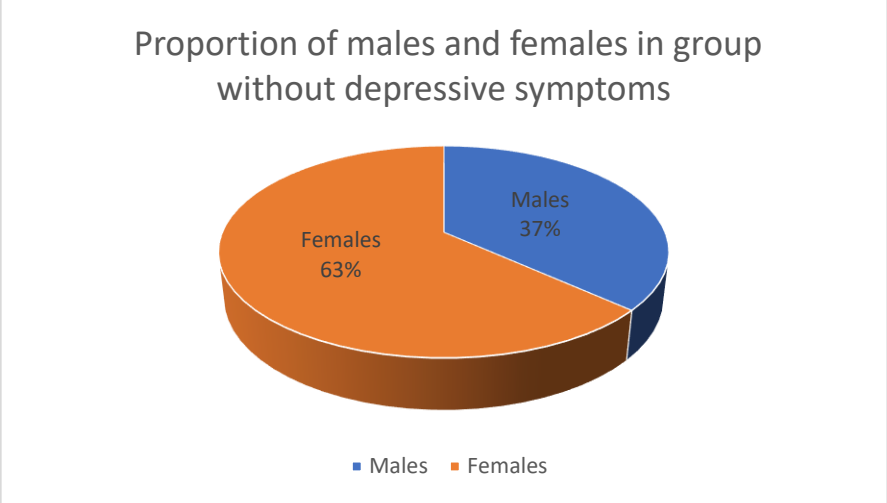
4 RESULTS

60 subjects were assessed in this survey. 30 subjects were in group without depressive symptoms and 30 subjects were in group with depressive symptoms. 33 females (55%) and 27 males (45%) were assessed in total (Pic. 4.1.).

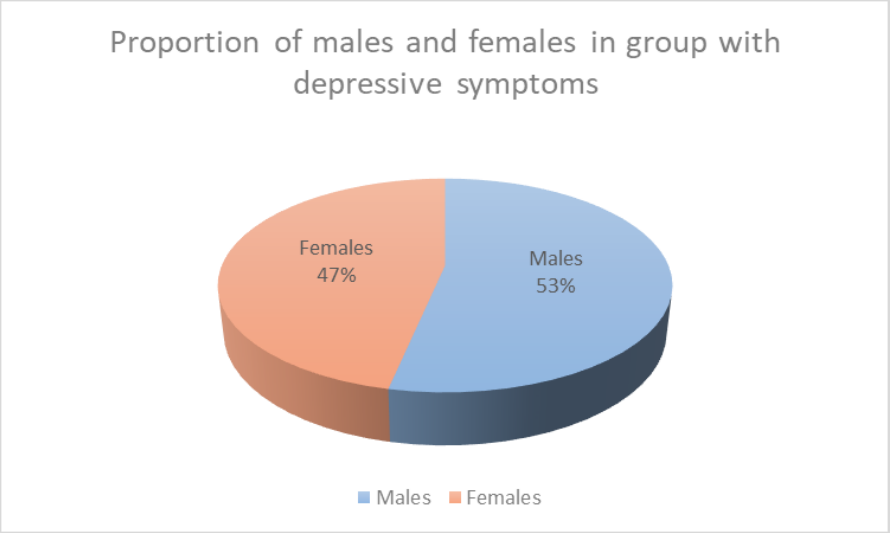


Picture 4.1 **Proportion of males and females in study population**

19 females and 11 males were assessed in the group without depressive symptoms (Pic. 4.2) and 14 females and 16 males were assessed in the group with depressive symptoms (Pic. 4.3).

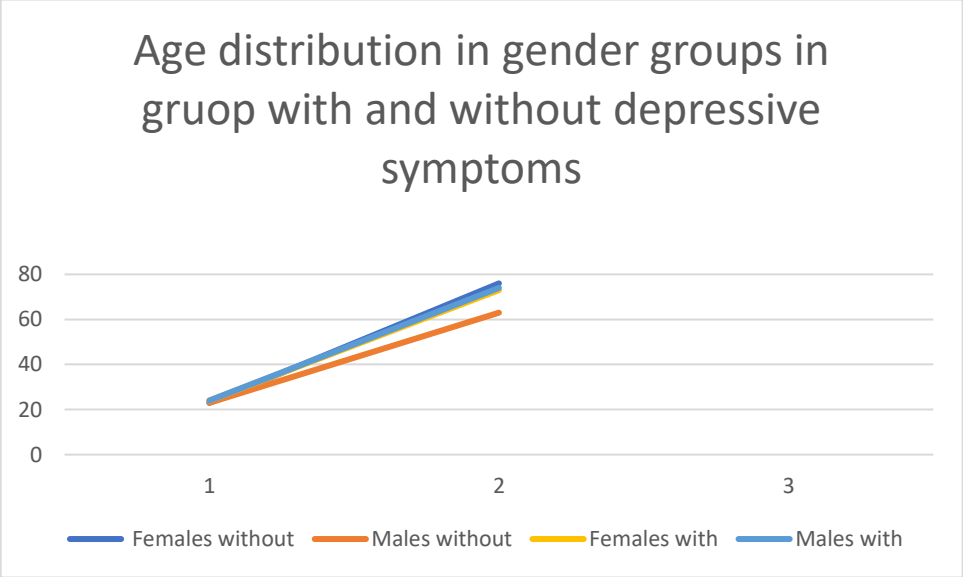


Picture 4.2 **Proportion of males and females in group without depressive symptoms**



Picture 4.3 **Proportion of males and females in group with depressive symptoms**

Age distribution in group without depressive symptoms was 23-76 years for females and 23-63 years for males. Age distribution in group with depressive symptoms was 24-73 years for females and 24-74 years in males. (Pic. 4.4)

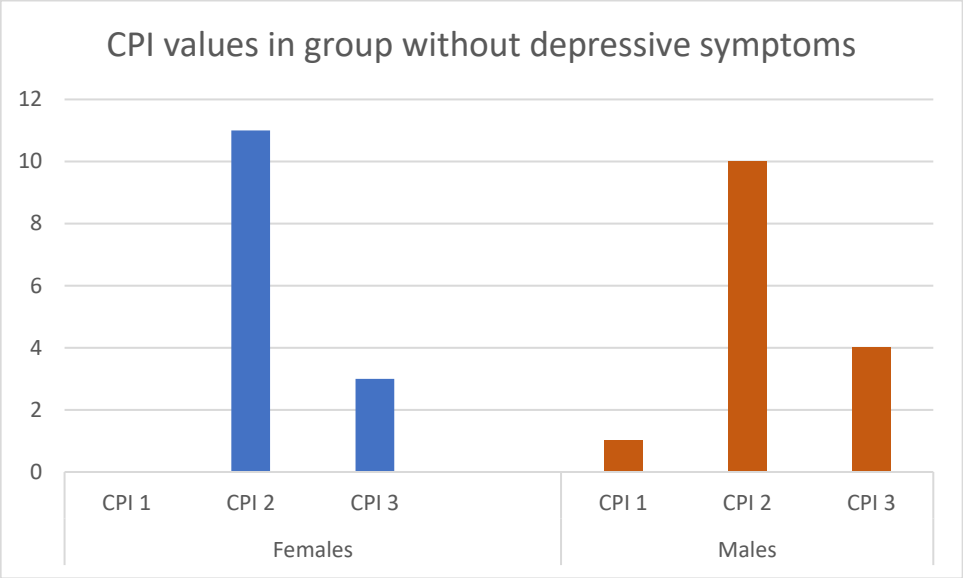


Picture 4.4 **Age distribution in gender groups in group with and without depressive symptoms**

We can see that age distribution in groups was rather similar.

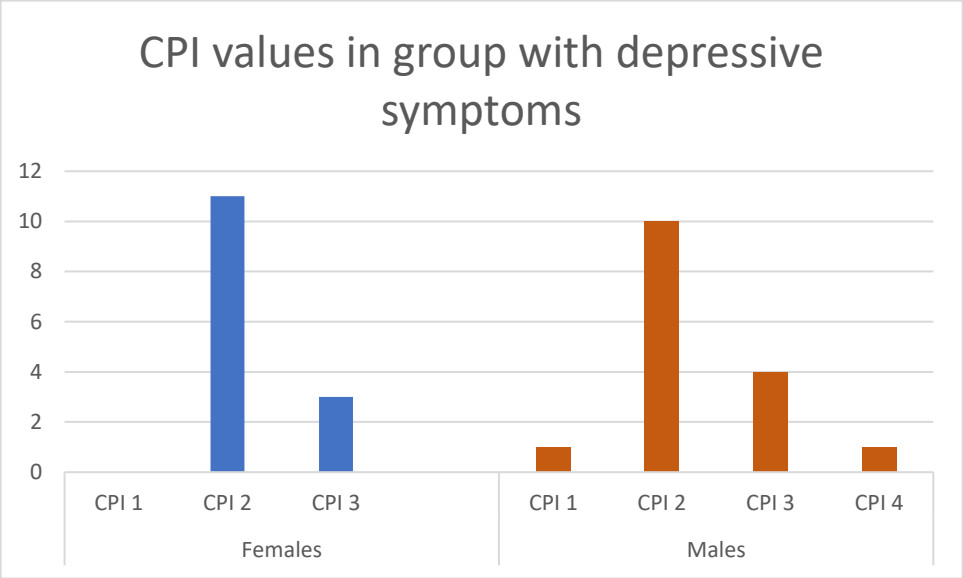
CPITN index consists of 2 parts – CPI is Community Periodontal Index and TN is treatment needs.

The highest value of CPI as for females as well males of group without depressive symptoms was 3 (Tab. 4.1.). In female group the highest CPI value was observed in 4 subject in 48, 68, 71 and 74 years of age, but in male group in 1 subject in 37 years of age (Pic. 4.5).



Picture 4.6 **CPI values in group without depressive symptoms**

The highest value of CPI for females of group with depressive symptoms was 3, but for males – 4 (Tab. 4.1.). In female group the highest CPI value was observed in 3 subject in 34, 51 and 73 years of age, but in male group in 1 subject in 74 years of age. CPI value 3 was observed in 4 male subjects in 25, 53, 57 and 61 years of age (Pic. 4.7.).

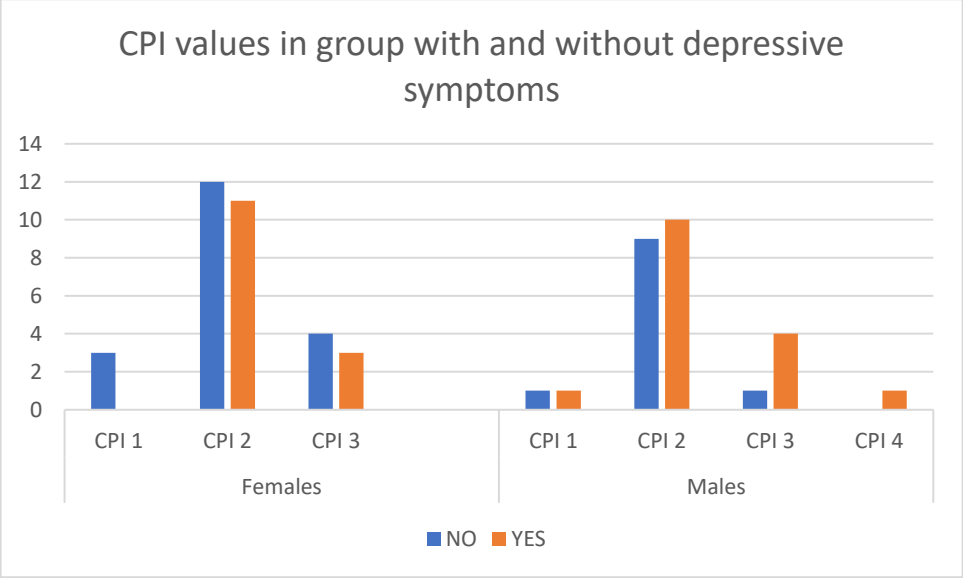


Picture 4.7 **CPI values in group with depressive symptoms**

Table 4.1 **The distribution of CPI values in study groups divided by genders**

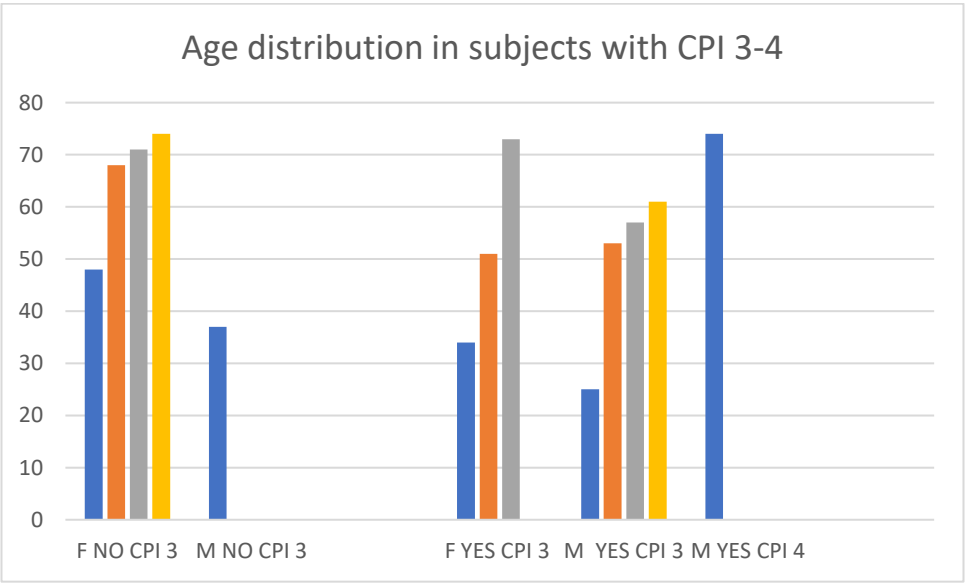
Study population group	CPI 1	CPI 2	CPI 3	CPI 4
Females without depressive symptoms	3	12	4	0
Males without depressive symptoms	1	9	1	0
Total in group without depressive symptoms	4	21	5	0
Females with depressive symptoms	0	11	3	0
Males with depressive symptoms	1	10	4	1
Total in group with depressive symptoms	1	21	7	1

We can see that there is no significant difference between the distribution of CPI 3 value in the study groups, CPI 2 values are the same, but CPI 1 value is significantly predominant in the group without depressive symptoms, and CPI 4 value was observed only in the group with depressive symptoms (Pic. 4.8).



Picture 4.8 **CPI values in group with and without depressive symptoms**

CPI 2 value means that subject had presence of supragingival or subgingival calculus with or without bleeding and no pathological pockets. CPI 3 - pathological pockets of 4-5 mm with or without calculus or bleeding. CPI 4 - pathological pockets of 6 mm with or without calculus or bleeding. CPI 3 was observed mainly in subjects in age over 45 years, what could relate to increase of periodontal disease risk increasing patient's age. But fact that CPI 3 was observed in subjects 25 and 34 years of age in group with depressive symptoms, could lead to conclusion that it could be explained by connection between depressive symptoms and neglecting attitude toward oral health. (Pic. 4.9.)



Picture 4.9 **Age distribution in subjects with CPI 3-4**

CPI 1 value, what means that subject had bleeding on probing, no calculus, no pathological pockets, was found only in group without depressive symptoms. CPI 1 means that subject has quite fair oral hygiene. Fact that CPI 1 was found only in subjects from group without depressive symptoms again could lead to conclusion that it could be explained by connection between depressive symptoms and neglecting attitude toward oral health.

As well one more important finding should be highlighted – no subject of both groups had CPI value 0, what means that subject had no bleeding, no calculus and no pathological pockets.

CPI value determines TN value (Tab. 4.2).

Patient with CPI 1 has TN value 1 and patient needs oral hygiene education as oral hygiene should be improved.

Patient with CPI 2 and 3 has TN value 2 and patient needs oral hygiene education as oral hygiene should be improved. Phase I periodontal treatment is needed as well.

Patient with CPI 4 has TN value 3 and patient needs oral hygiene education as oral hygiene should be improved. Phase I periodontal treatment with future possible Phase II periodontal treatment planning is needed as well.

Table 4.2 **The distribution of CPITN values in study groups divided by genders**

Study population group	CPI 1	TN CPI 1	CPI 2	TN CPI 2	CPI 3	TN CPI 3	CPI 4	TN CPI 4
Females without depressive symptoms	3	1	12	2	4	2	0	-
Males without depressive symptoms	1	1	9	2	1	2	0	-
Total in group without	4	1	21	-	5	-	0	-

depressive symptoms								
Females with depressive symptoms	0	-	11	2	3	2	0	-
Males with depressive symptoms	1	1	10	2	4	2	1	3
Total in group with depressive symptoms	1	-	21	-	7	-	1	-

The first part of questionnaire contained 13 open ended questions about how patient feels the influence of Covid-19 pandemics on his/her life (Annex No.8.).

Consumption of junk food was mentioned as increased in male subjects with depressive symptoms.

Household ability to meet financial obligations during Covid-19 pandemic was mentioned as not influenced in subjects without depressive symptoms and not influenced or strongly influenced in subjects with depressive symptoms.

Oral health was assessed as good in subjects without depressive symptoms and fair to bad in male subjects with depressive symptoms, and fair in female subjects with depressive symptoms.

Nonmaterial help opportunities from others were assessed as possible in subjects without depressive symptoms, but in subjects with depressive symptoms answers divided quite equally in “yes” and “no” in subjects with depressive symptoms.

Down episodes were described as none in subjects without depressive symptoms, and in subjects of group with depressive symptoms it was described as “some”. Nervousness, lonely feeling were described as none in subjects without depressive symptoms and as some in subjects with depressive symptoms.

Own health was described as not influenced in subjects without depressive symptoms and influenced in some level in subjects with depressive symptoms.

Social ties were described as not at all influenced in subjects without depressive symptoms and influenced in some level in subjects with depressive symptoms.

Work and education were described as not at all influenced in subjects without depressive symptoms and not at all influences or influenced in some level, or very influenced in subjects with depressive symptoms.

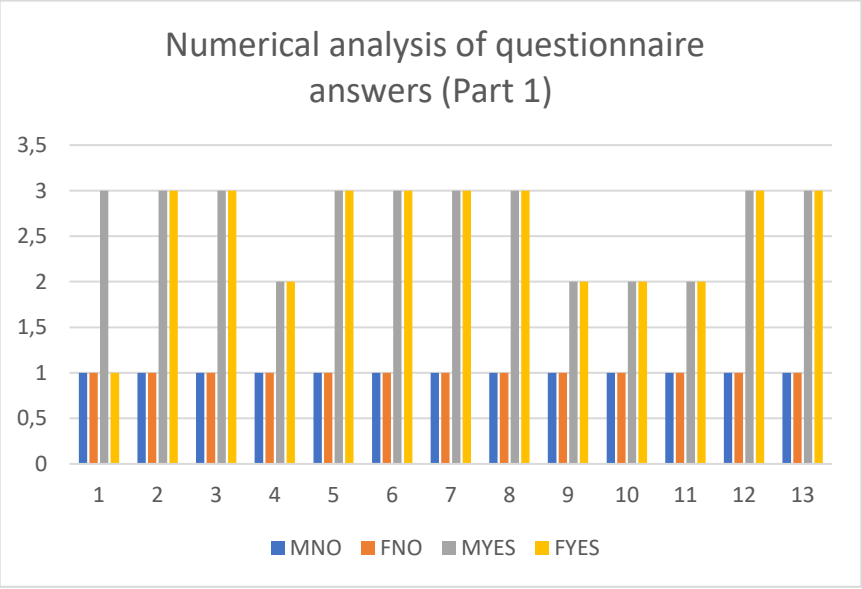
Household stress was described as none in subjects without depressive symptoms and existing in some level in subjects of group with depressive symptoms.

Answering the question about thoughts, if life was worth living subjects without depressive symptoms answered that they had no such a thought at all, but subjects with depressive symptoms answered that they had no such a thought or they had such a thoughts sometimes.

Asked to describe possible neglecting toward general an oral health subjects without depressive symptoms answered that they had no negligence, but male subjects of group with depressive symptoms answered that they had such situation sometimes, but females of this group answered that they had such situation rarely or very often.

Asked to answer if they went to family doctor with depressive kind of complaints subjects of group without depressive symptoms 100% answered that they did not, but subjects of group with depressive symptoms 100% answered that they went to family doctor with such kind of complaints.

Analyzing the answers provided by the subjects, it is visualized that the influence of Covid-19 pandemics on his/her (Pic. 4.10). life had been more significantly felt by subjects in the group with depressive symptoms. No significant difference was observed between genders.



Picture 4.10 **Numerical analysis of questionnaire answers (Part I)**

MNO – males without depressive symptoms

FNO – females without depressive symptoms

MYES – males with depressive symptoms

FYES – females with depressive symptoms

Value 1 – the reply provided shows that there has been no impact

Value 2 - the reply provided shows that there has been some impact

Value 3 - the reply provided shows that there has been impact

The second part of questionnaire contained 10 open ended questions about, how patient feels the influence of Covid-19 pandemics on society (Annex No. 9).

To question, how Covid-19 pandemic influenced health of friends and relatives, subject of both genders without depressive symptoms gave answers that there was no influence, or some influence presented.

Male subjects with depressive symptoms said that there was some influence, or it very influenced health of friends and relatives. Female subjects of group with depressive symptoms predominantly gave three answers – there was no influence, it was influenced in some level or very influenced.

Answering question about low interest in doing things, subjects without depressive symptoms of both genders said, that it was rarely observed in friends and relatives. The same answer was one of predominant in subjects with depressive symptoms, but another predominant answers were given as well – male subjects said that low interest in doing things was observed often, but female subjects assessed fact as happening sometimes.

Question about friends and relatives trouble falling or staying asleep or sleeping too much in subjects without depressive symptoms was answered as this problem was never noticed. Different answers predominated in subjects with depressive symptoms. Male subjects here gave three predominant answers – rarely, sometimes and very often. Female subjects answered this question predominantly choosing answers as sometimes and often.

When analyzing whether friends and relatives had a problem such as loss of appetite or overeating, subjects without depressive symptoms predominantly gave the answer that the situation was never noticed. Subjects of both genders with depressive symptoms provided a number of predominant answers, where a “never noticed” was one of them. However, male subjects gave two more predominant answers as that the situation happened rarely or sometimes, while the second dominant answer for females was that the situation happened rarely.

Subjects of both genders without depressive symptoms never noticed that their friend or relatives had no thoughts to be better off dead during Covid-19 pandemic. This answer was one of predominant in male subjects with depressive symptoms as well, but another answer was

observed as dominant and it was that situation was rarely observed. Female subjects with depressive symptoms predominantly answered that this situation was rarely observed.

Subjects of both genders without depressive symptoms never noticed some thought of hurting themselves in some way in their friend and relatives. This was one of predominant answer in subjects of both genders with depressive symptoms, but another answer was given by both genders as well, that situation was rarely noticed.

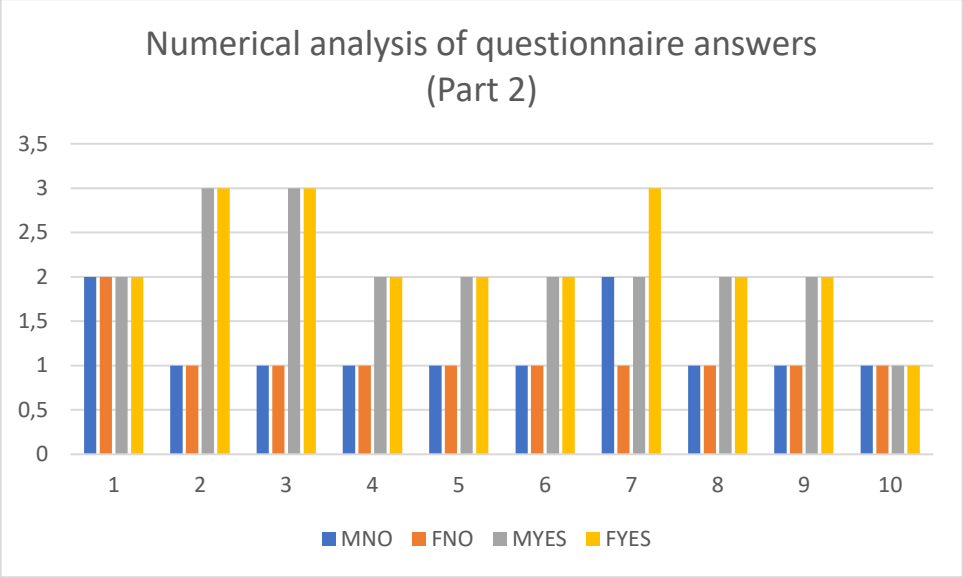
Changes of speech in friends and relatives were predominantly rarely or never noticed by male subjects without depressive symptoms and never noticed by female subjects without depressive symptoms. Changes mentioned above were predominantly rarely noticed by male subjects with depressive symptoms and often noticed by female subjects with depressive symptoms.

More aggressive reaction to insignificant problems of their friends and relatives during Covid-19 pandemic were predominantly never noticed by subjects of both genders without depressive symptoms, but sometimes it was noticed by male subjects with depressive symptoms and rarely or sometimes by female subjects with depressive symptoms.

Subjects of both genders without depressive symptoms never noticed that their friends and relatives started to unfollow hygiene during Covid – 19 pandemic. Different answers were observed in subjects with depressive symptoms, where male subjects observed the situation sometimes, but female subjects observed it rarely or sometimes.

All subjects without and with depressive symptoms never noticed some suicide attempt in their friends and relatives during Covid – 19 pandemic.

Analyzing the answers provided by the subjects, it is visualized that the influence of Covid-19 pandemic on society more significantly was felt by subjects in the group with depressive symptoms and rather insignificant differences were noticed between genders (Pic. 4.11).



Picture 4.11 **Numerical analysis of questionnaire answers (Part 2)**

MNO – males without depressive symptoms

FNO – females without depressive symptoms

MYES – males with depressive symptoms

FYES – females with depressive symptoms

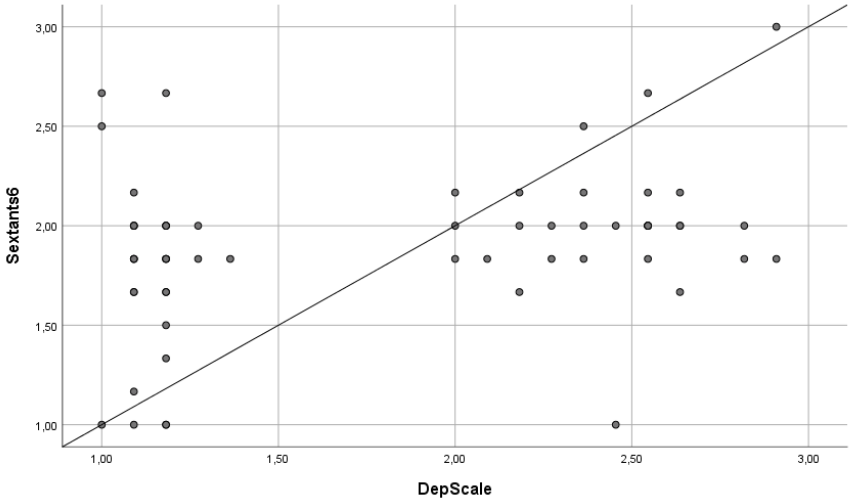
Value 1 – the reply provided shows that there has been no impact

Value 2 - the reply provided shows that there has been some impact

Value 3 - the reply provided shows that there has been impact

Statistical analysis was done using Spearman test and Manna -Whitney U test.

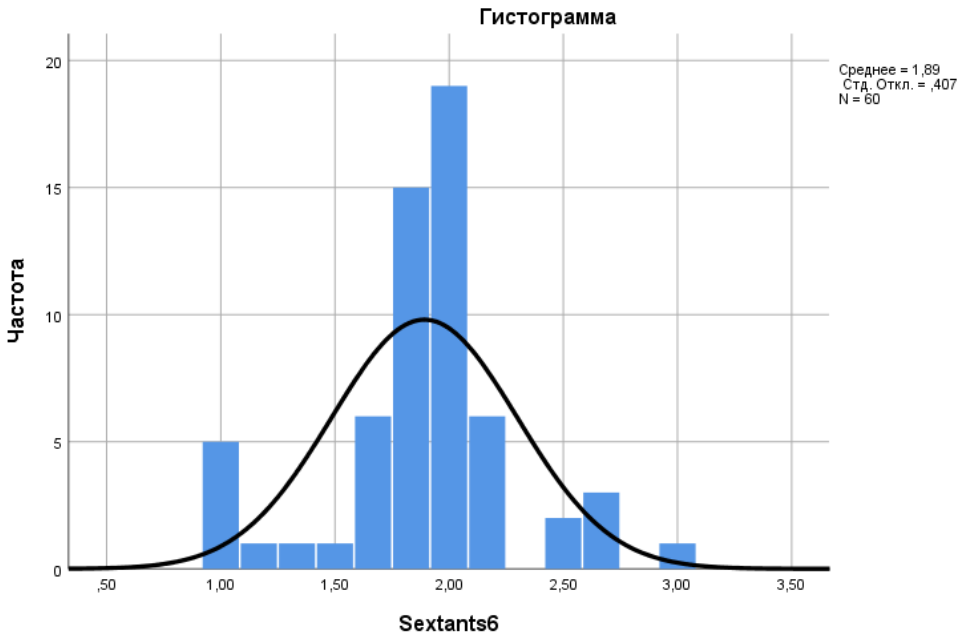
The distribution of the overall worst CPI in the study group was analyzed, showing a fairly dense scatter without critical ups or downs (Pic. 4.12.).



Picture 4.12 **CPI destribution in all study group**

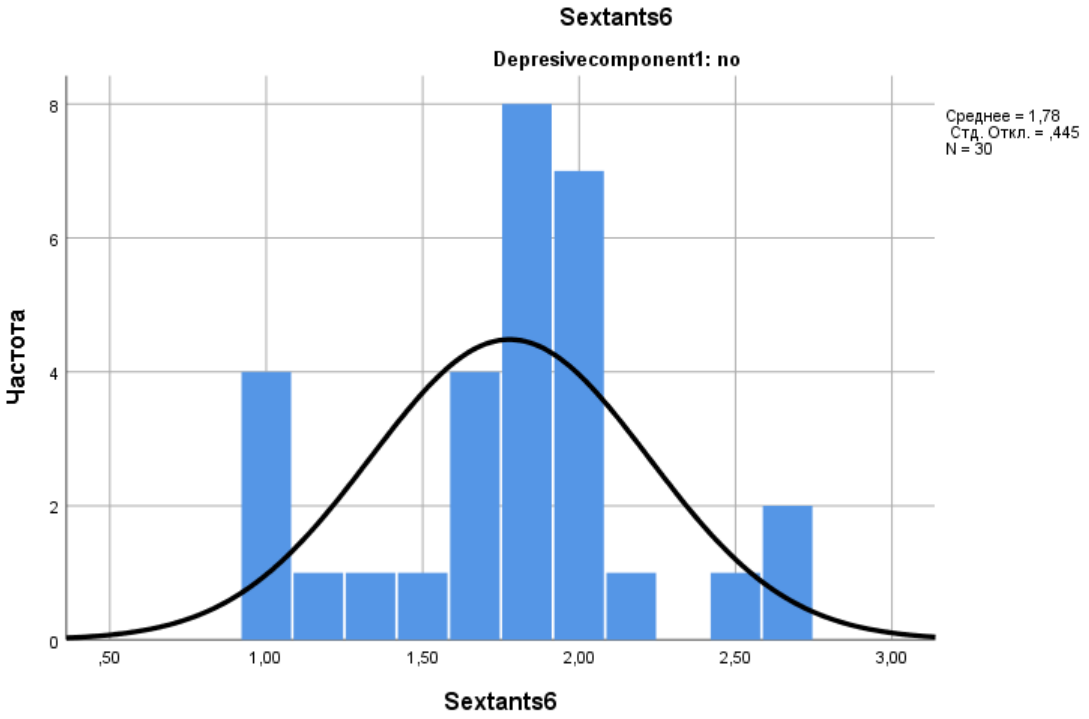
The worst CPI values were analyzed for whole study population and separately for the study group with and without depressive symptoms.

Analyzing the worst CPI for the whole study population, the mean CPIT was 1.98 with SD = 0.407 (Pic. 4.13).



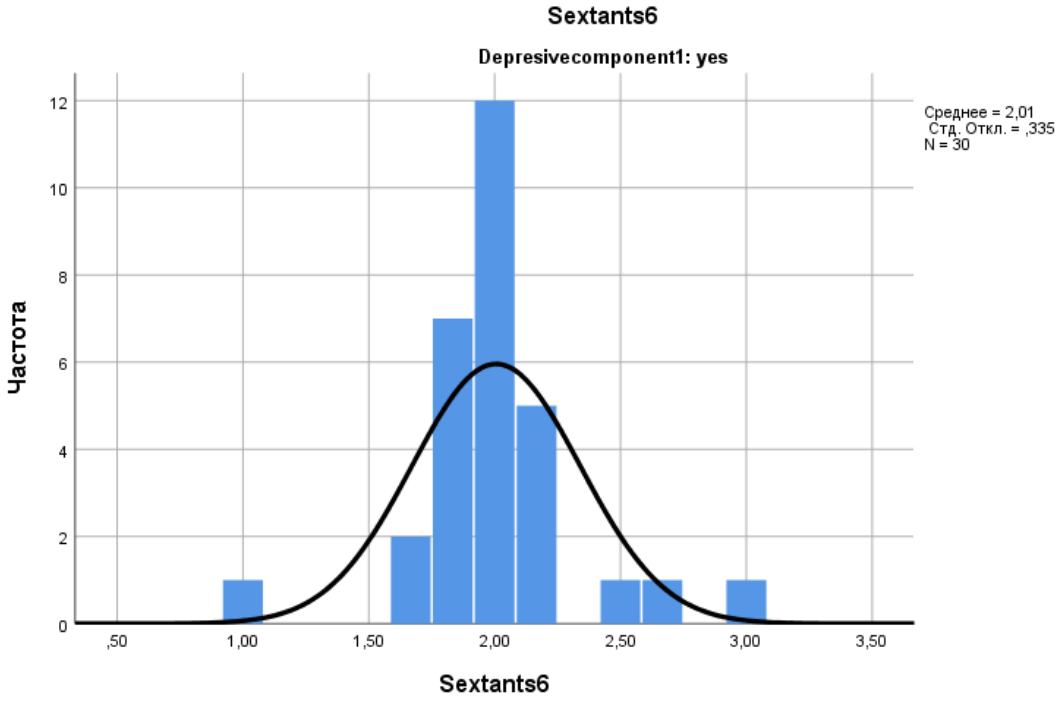
Picture 4.13 **Mean value of CPI in whole study population**

Analyzing the worst CPITN for the group without depressive symptoms, the mean CPITN was 1.78 with SD = 0.445 (Pic. 4.14).



Picture 4.14 **The worst CPI value in group without depressive symptoms**

Analyzing the worst CPITN for the group with depressive symptoms, the mean CPITN was 2.01 with SD = 0.335 (Pic. 4.15).

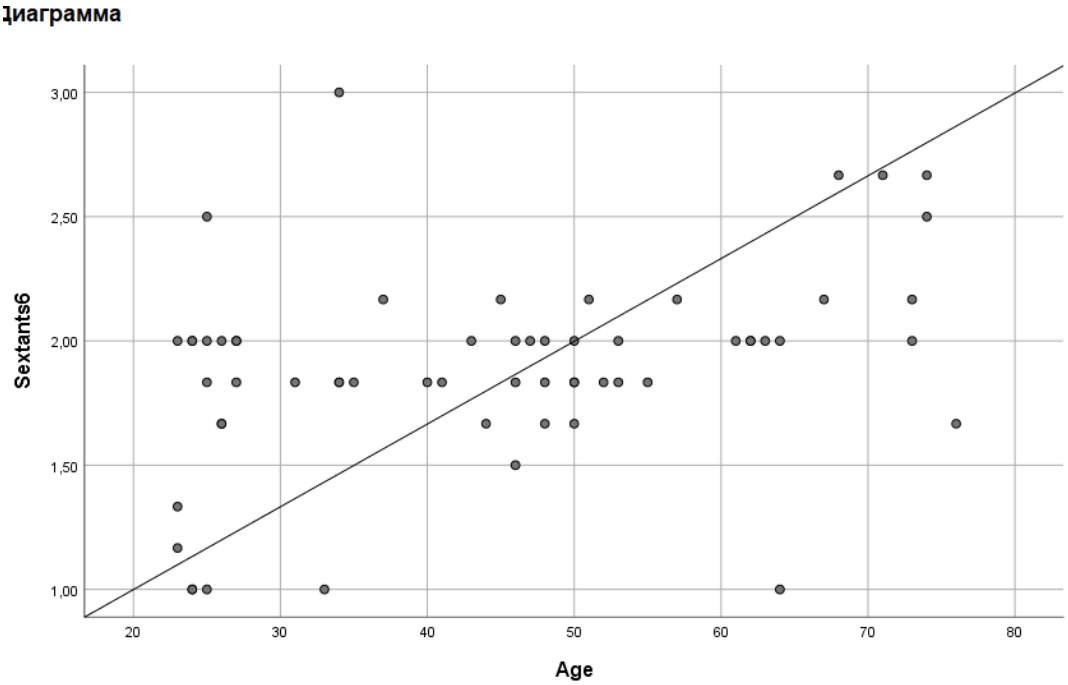


Picture 4.15 **The worst CPI value in group with depressive symptoms**

Analyzing descriptive statistics using the Spearman test and determining the correlation between worsening periodontal health (CPI) and the depressive component, it was concluded that in the group with the depressive component this relationship is statistically significant with a p = 0.042 and Z value for Manna -Whitney U test = -0.282.

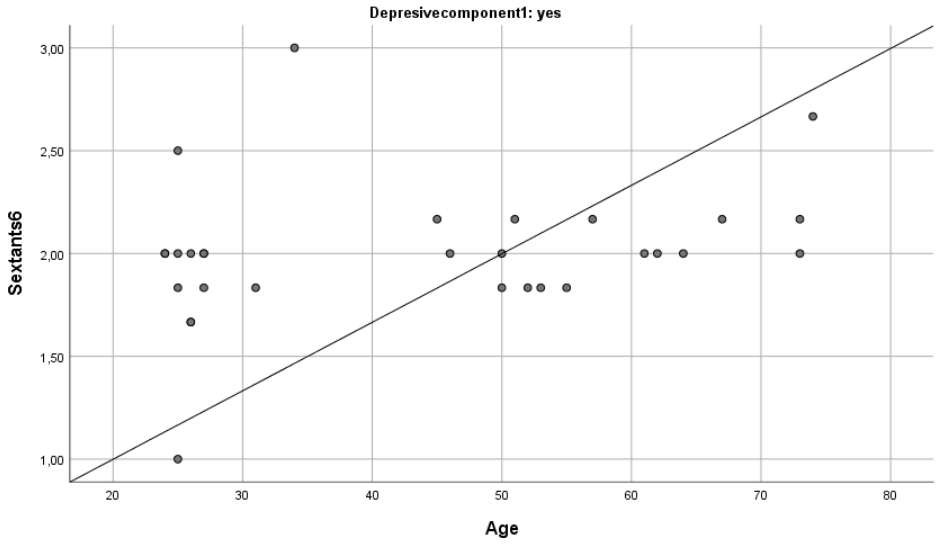
Total CPITN and age distribution was analysed in whole study population.

The overall age correlation with CPI worsening showed a statistical reliability of p= 0.373 with SD=0.40689 (Pic. 4.16).



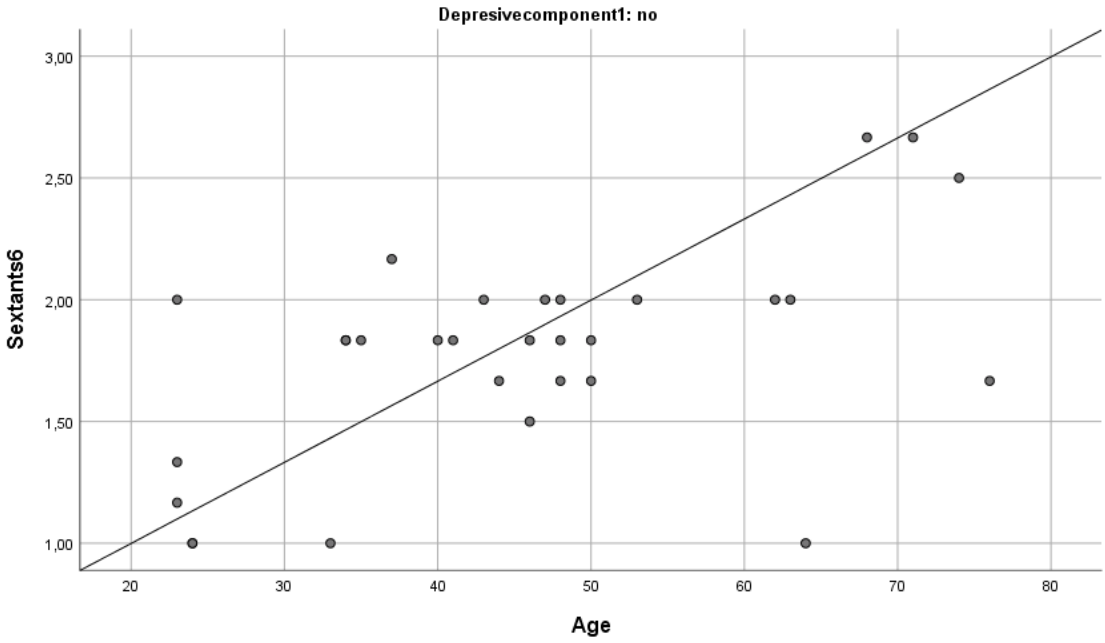
Picture 4.16 **Correlation between CPI and age in whole study population**

Descriptive statistics using Spearman test showed a statistically significant correlation between the age-related association of CPI worsening in the group with depressive symptoms with p=0.435 with SD = 0.33478 (Pic. 4.17).



Picture 4.17 **Correlation between CPI and age in group with depressive symptoms**

No statistically significant correlation was found in group without depressive symptoms with p=1.000 with SD = 0.44492 (Pic. 4.18).



Picture 4.18 **Correlation between CPI and age in group without depressive symptoms**

No statistically significant data were obtained about correlation between gender and worsening of CPITN index.

The null hypothesis - patient with depressive component could have more pronounced signs of periodontal disease than those without depressive component during Covid-19 pandemic – was proved with p = 0.042.

In addition to the hypothesis, the results of the study shows similar results to other evidence-based studies that the health of the periodontal worsens with age.

5 DISCUSSION

Periodontal diseases are defined as inflammatory diseases caused by pathogenic microflora organised in biofilms surrounding the teeth. Aetiology of periodontal diseases is highly related to bacteria. These bacteria induce the destruction of periodontal tissues with their numerous virulence factors. Many pathological processes are involved in periodontal destruction in terms of the inflammatory and immune host response. (Newman, 2015)

Studies showed the essential role of bacteria in periodontitis, but bacteria alone seem to be insufficient to explain occurrence or progression of the disease. Age, tobacco use, systemic diseases and psychological stress have been identified as important risk factors for periodontitis. Psychological stress is related to periodontitis by several studies. Psychological stress can directly affect periodontal health by various biological mechanisms, and also, it can have indirect effects through the changes in lifestyle such as ignoring oral-hygiene measures, smoking more heavily and consuming more fat and sugar in diet. Periodontitis patients with inadequate stress behaviours strategies (defensive coping) were suggested to be at higher risk for severe periodontal diseases. Furthermore, increased production of interleukin-6 was reported in response to psychological stress. Despite numerous clinical and epidemiological studies that confirmed an association between psychological stress and periodontitis, biological mechanisms involved are not fully understood. (Akcali et al., 2013; Bindushree et al., 2014) On the one hand, stress can influence the immune response and is generally associated with inflammation. On the other hand, health-related behaviour as preventive oral hygiene can be negatively influenced by psychosocial factors, which in return can lead to increased infection or may aggravate existing inflammation.

Periodontitis is a silent disease in which pathological changes take a long time before pain, discomfort, and functional disability occur. Therefore, people often underestimate the presence and severity of periodontal disease and seek treatment when advanced attachment loss has already occurred. The perception of “health” or “disease” is not only related to the severity of signs and symptoms, but it is a reflection of multidimensional sociodemographic and cultural backgrounds at both the population and individual level. Self-awareness of periodontal health status influences oral health-seeking behaviour and is related to the utilization of dental services for early detection and prevention of periodontal disease.

Therefore, at the time when periodontitis is diagnosed, it may be difficult to identify and evaluate what co-factors had contributed to the development of the disease. A number of bio-behavioural factors are key in periodontitis risk and disease development. Thus, smoking habits,

being overweight as defined by body mass index, and medications such as hormonal replacement therapy, or anti-inflammatory treatments (i.e. statins) have a significant impact on systemic inflammatory reaction. In addition, bio-behavioural research has confirmed that behavioural and social factors are important co-factors in the development of a pathogenic microbiota in the interaction with a challenged host. (Persson, 2018) Oral health and the ability to retain a functional dentition throughout life can have a significant impact on the quality of life for the individual. It is well known that poor oral health and tooth loss have negative impacts on speech functions and the ability to consume healthy foods. Furthermore, it limits people's interest in social contacts. The prevalence of systemic diseases increases with age. Several studies have demonstrated an association between oral (periodontal) infection and general health. This includes the risks for cardiovascular diseases, stroke, aspiration pneumonia, and depression. Biological evidence is mounting to explain how periodontitis may have an impact on systemic health. Therefore, successful ageing in general may also be dependent on good oral health. In the present review, the current scientific evidence that periodontal health and disease may be directly linked to successful ageing, and that people 50 years plus should be aware of the fact that periodontal health matters is presented. (Persson et al., 2003; Romano et al., 2020)
In 1993, the concept of microbial endocrinology has been proposed. This theory argues that several bacteria could use hormones produced by host to promote bacterial growth and infectious diseases. Considering periodontal diseases, studies mainly investigate effects of CAs such as noradrenaline on periodontal pathogens. It has been demonstrated that this hormone has different effects on bacterial growth depending on the bacterial species. These observations indicate that stress-induced hormones may have specific effects depending on species of bacteria. Periodontal destruction is the result of an imbalance between bacterial aggression and host response. (Aleksejunienė et al., 2002) Stress-related hormones are likely to favour the infection by increasing bacterial growth, thereby inducing a breakdown in oral biofilms. Specific mechanisms underlying these effects on periodontal microbiota remain unknown, and further studies are required to evaluate possible effects of these hormones, especially on triggering of virulence factors or quorum-sensing development. (Akcali et al., 2013; Bindushree et al., 2014)
Stress is a part of the human being that is present universally with varying degrees and has different effects on individual's health.
Standardised psychological analysis for the quantification and definition of stress, biological markers could be more objective to monitor the psychosocial status. In questionnaires, people may give false responses with or without intention. Furthermore, the particular person's character, that is, being an optimistic or pessimistic person strongly affects his attitudes, and

this issue can neither be verified nor controlled. This fact may eventually lead unreliable questionnaire data and false diagnosis of stress. Determining patients under chronic stress could develop specific multidisciplinary treatment strategies for ultimate outcome of coping with stress factors. There is no doubt stress has important clinical implications in periodontal disease development and also influences treatment outcomes. We know psychological factors influence susceptibility to periodontitis by affecting the lifestyle such as poor oral hygiene, poor compliance, high-fat diet and smoking and environmental changes in terms of oral microbiota and finally host response modulation that is also correlated with genetics and epigenetics. These effects suggest a need for the development of preventive treatment strategies and maintenance care for patients under stress. Investigations into stress markers in saliva, blood and GCF may become a routine for screening the response to treatment in the near future but could also be used to quantify patient's stress. (Akcali et al., 2013)

Worldwide public and private life has been restricted by lockdown and lack of contacts due to the Covid-19 pandemic and it became factor of psychosocial stress. Stressors included longer quarantine duration, infection fear, frustration, boredom, inadequate supplies, inadequate information, financial loss and stigma. The study design does not allow the detection of causal relationships, but the results might indicate an association between a stated Covid-19 pandemic and increased anxiety and depression level as well as stress, and changes (worsening) in oral health – specifically periodontal health.

Results of this study shows that there is statistically significant correlation between stress related depressive symptoms and some level of deterioration of oral health – specifically periodontal health, determining CPITN index.

As well results obtained by questionnaires show that answers according to aspects of life perception, personal hygiene, oral hygiene etc. differ between respondents from group with and without depressive symptoms, answers from respondents with depressive symptoms to be pointing to a subjective assessment of the above aspects as deterioration in some level.

Due to different incidence rates on regional and national levels as well as varying socio-political circumstances and reactions, the effects on social, professional and personal life may be diverse. Therefore, generalization of the present results should only be transferred to similar circumstances and conditions.

Limitation of this study is that there is rather small number of study population. Due to the localization of the study centre – Students Dental Clinic of University of Latvia - participants are from Riga (Latvia) this study cohort is not representative for the overall Latvian population. The selection bias needs to be taken into consideration, when interpreting oral hygiene-related parameters as no information was gathered about overall oral care habits.

As the COVID-19 pandemic and its implications progress and in context of future pandemics, psychosocial consequences and their association to oral health should be considered and further investigated.

Dental plaque is still considered the main etiological factor for periodontal diseases. Our understanding of periodontal disease has advanced from the previous concepts where gingivitis slowly progressed to periodontitis to a more complex scenario that correlates several risk factors in the pathogenesis of periodontal disease. Among these factors, age has been associated with increased rates of periodontal disease as the population gets older. Present study shows the statistically significant correlation between increase in CPITN index and age, what supports results from different previous studies. The importance of identifying the risk factors that participate in the pathogenesis of periodontal disease at an early phase, both of the individual and the disease, as well as evaluating the capacity of the individual to control dental plaque will enable the implementation of an adequate preventive program. (Akcali et al., 2013; da Silva et al., 1995; Goval et al., 2013).

Susceptibility to periodontitis varies greatly between individuals who harbour the same pathogenic bacteria. Evidence points to the host response to bacterial challenge as a major determinant of susceptibility.

6 CONCLUSION

Despite the relatively small research group, the aim of the work - to investigate oral health in patients with and without depressive component during Covid - 19 pandemic - was fully achieved, and the null hypothesis - that patient with depressive component could have more pronounced signs of periodontal disease than those without depressive component during Covid-19 pandemic – was statistically proved.

Statistical analysis also showed a correlation between the deterioration of CPI with age, and a statistically significant result was seen in the depressive symptom group.

Because the study has several limiting factors - a small study group, no information on the patient's daily oral care habits and no information on other contributing factors to periodontal disease, such as smoking, and the population is highly selective, the study data cannot be generalized to all Latvian population, however, the study shows a statistically significant association between stress and deteriorating of oral health.

Subjects might be unconcerned about their periodontal health condition or lack enough knowledge to be aware of it. This points to the need for planning strategies to improve education and knowledge about periodontal health, which, enhancing self-perception of symptoms, could help everyone to seek treatment in the initial stage of the disease.

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ANNEXES

Annex No. 1. Consent form

Dear Participant,

My name is Vladlen Kruglak and I am a fifth-year Dentistry program student at the University of Latvia. As part of my diploma research I am examining oral health in patients with and without depressive components using survey and CPITN among visitors of LU dental clinic. It will generate statistic information about patients oral and mental condition. Because you are a dental patient, I am inviting you to participate in this research by completing the attached questionary.

The questionnaire consists of 23 questions and will take approximately 5 minutes to complete. There is no compensation for responding nor is there any known risk, In order to ensure you that all information will remain confidential, please do not include your name. Copies of the research will be provided to my supervisor Dr. Baiba Krauze. If you choose to participate in this study, please answer all of the questions as honestly as possible. Participation in this study is voluntarily.

Completion and return of the questionnaire will indicate you willingness to participate in this study. If you require and additional information or have any questions, please contact me be the e-mail listed below.

Thank you for taking your time to assist me in my educational endeavors!

Sincerely,

Vladlen Kruglak

devostatoran@mail.ru

Annex No. 2. Questionnaire Part 1 – How patient feels the influence of Covid – 19 pandemics on his/her life?

1) Has your consumption of junk food and sweets changed?

a. Increased
b. Decreased
c. No change
d. I don't consume junk food and sweets

2) How the pandemics of Covid-19 influenced on your household's ability to meet financial obligations like loan repayments, household bills etc.? (If you have problems with money, you will postpone dental treatment as well)

a. Did not influenced
b. Slightly influenced
c. Strongly influenced

3) How do you assess your oral health during Covid-19 pandemics?

a. Very good
b. Good
c. Fair
d. Bad
e. Very bad

4) Do you feel that if you needed non-material help (somebody to talk to, help with doing something or collecting something) you could receive it from relatives, friends, neighbors, or other persons that you know?

a. Yes
b. No

5) How much of the time, during the past 1 year, have you felt downhearted or depressed?

a. All/Most
b. Some
c. Little
d. None of the time

6) How much of the time, during the past 1 year, have you been very nervous, lonely or suffering from anxiety?

a. All/Most
b. Some
c. Little

d. None of the time

7) How Covid-19 pandemics influenced your own health? (Please explain)

a. Not at all
b. Somewhat
c. Very
d. Extremely

_____

_____

_____

_____

_____

_____

8) How Covid-19 pandemics influenced your social ties? (Please explain)

a. Not at all
b. Somewhat
c. Very
d. Extremely

_____

_____

_____

_____

_____

_____

9) Did the Covid-19 pandemics influenced your work/education? (Please explain)

a. Not at all
b. Somewhat
c. Very
d. Extremely

_____

_____

_____

_____

_____

_____

10) Do you experience household stress from confinement?

a. Not at all
b. Somewhat
c. Very
d. Extremely

11) During Covid-19 pandemics have you felt that life wasn't worth living?

a. Not at all
b. Rarely
c. Sometimes
d. Often
e. Very often

12) Have you or your relatives noticed that you become neglecting to general/oral hygiene?

a. Not at all
b. Rarely
c. Sometimes
d. Often
e. Very often

13)Have you visited your family doctor with complaints of depression/anxiety?

a. Not at all
b. Yes

Annex No. 3. Questionnaire Part 2 – How patient feels the influence of Covid-19 pandemics on society?

1) How Covid-19 pandemics influenced health of friends or relatives?
   a. Not at all
   b. Somewhat
   c. Very
   d. Extremely
2) Do your friends/relatives started to have little interest in doing things?
   a. Rarely
   b. Sometimes
   c. Often
   d. Very often
3) Are your friends/family trouble falling or staying asleep, or sleeping too much?
   a. Never noticed
   b. Rarely
   c. Sometimes
   d. Often
   e. Very often
4) Do your friends/relatives started to have poor appetite or overeating?
   a. Never noticed
   b. Rarely
   c. Sometimes
   d. Often
   e. Very often
5) Do your friends/relatives started to have thoughts that they would be better off dead?
   a. Never noticed
   b. Rarely
   c. Sometimes
   d. Often
   e. Very often

6) Do your friends/relatives started to have thoughts of hurting themselves in some way?
   a. Never noticed
   b. Rarely

c. Sometimes
d. Often
e. Very often

7) Have you noticed any changes of speech in your friends/relatives?

a. Never noticed
b. Rarely
c. Sometimes
d. Often
e. Very often

8) Have your friends/relatives started to act more aggressively to insignificant problems?

a. Never noticed
b. Rarely
c. Sometimes
d. Often
e. Very often

9) Have you noticed any that your friends/relatives started to unfollow hygiene?

a. Never noticed
b. Rarely
c. Sometimes
d. Often
e. Very often

10) Have you noticed any that your friends/relatives were trying to hurt themselves? (suicide attempt)

a. Never noticed
b. Rarely
c. Sometimes
d. Often
e. Very often

Annex No. 4. Piekrišanas veidlapa

Cienījamais dalībniek!

Mani sauc Vladlens Krugļaks un es esmu Latvijas Universitātes Zobārstniecības programmas 5. kursa students. Diplomdarba pētījuma ietvaros es veicu pētījumu Mutes veselība pacientiem ar un bez depresīvās komponentes Covid-19 pandēmijas laikā. Pētījuma ietvaros pacientiem tiek lūgts aizpildīt anketu un tiek veikta mutes dobuma izmeklēšana un CPITN indeksa (indekss, kas novērtē periodonta veselības stāvokli un ārstēšanas nepieciešamību periodonta saslimšanas gadījumā) aprēķināšana. Pētījuma rezultāti ļaus apkopot informāciju par pacienta emocionālā stāvokļa saistību ar mutes dobuma veselības stāvokli.

Anketa sastāv no 23 jautājumiem, un tās aizpildīšana aizņems aptuveni 5 minūtes. Anketas aizpildīšana neprasa finansiālus ieguldījumus un nerada nekādus personīgos riskus. Lai nodrošinātu, ka visa Jūsu sniegtā informācija ir konfidenciāla, lūdzu nenorādiet savu vārdu, bet norādiet savu dzimumu un vecumu. Pētījuma informācija būs pieejama man un manai diplomdarba vadītājai dr. Baibai Krauzei. Ja piekrītat piedalīties šajā pētījumā, lūdzu atbildiet uz visiem jautājumiem pēc iespējas godīgāk. Dalība šajā pētījumā ir brīvprātīga.

Anketas aizpildīšana un atgriešana norāda uz Jūsu vēlēšanos piedalīties šajā pētījumā. Ja jums nepieciešama papildu informācija vai ir kādi papildus jautājumi, lūdzu, sazinieties ar mani.

Paldies, ka veltījāt laiku, lai palīdzētu man manos izglītības centienos!

Ar cieņu,

Vladlens Krugļaks

devostatoran@mail.ru

Annex No. 5. Anketa, 1. daļa – Kā pacients izjūt Covid – 19 pandēmijas ietekmi uz viņas/a dzīvi?

1) Vai izmainījās jūsu neveselīgās pārtikas un saldumu patēriņš?
    a. Tas pieauga
    b. Tas samazinājās
    c. Tas palika nemainīgs
    d. Es nelietoju neveselīgu pārtiku un saldumus
2) Kā Covid-19 pandēmija ietekmēja Jūsu mājsaimniecības finansiālās iespējas, kā piemēram, kredītsaistību, mājsaimniecības rēķinu utml. nomaksu? (Ja Jums ir fiansiālas problēmas, Jūs atliksiet arī zobu ārstēšanu to iespējamo izmaksu dēļ)
    a. Neietekmēja
    b. Mazliet ietekmēja
    c. Ietekmēja būtiski
3) Kā Jūs novērtējat savu mutes dobuma veselību Covid-19 pandēmijas laikā?
    a. Kā ļoti labu
    b. Kā labu
    c. Kā sliktu
    d. Kā ļoti sliktu
4) Ja Jums būtu vajadzīga jebkāda nemateriāla palīdzība (kāds, ar ko aprunāties, kāds, kas kaut ko varētu izdarīt vai saņemt Jūsu vietā), vai Jūs to varētu saņemt no tuviniekiem, draugiem, kaimiņiem vai kādām citām Jums pazīstamām personām?
    a. Jā
    b. Nē
5) Cik bieži pēdējā gada laikā Jūs esat juties/- usies nomākts/-a vai depresīvs/-a?
    a. Visu laiku/lielāko daļu laika
    b. Dažreiz
    c. Mazliet

d. Nemaz

6) Cik bieži pēdējā gada laikā Jūs esat juties/-usies nervozs/-a, vientuļš/-a vai cietis/-usi no trauksmes?

   a. Visu laiku/lielāko daļu laika

   b. Dažreiz

   c. Mazliet

   d. Nemaz

7) Kā Covid-19 pandēmija ir ietekmējusi Jūsu veselību? (Lūdzu paskaidrojiet)

   a. Nav ietekmējusi

   b. Savā ziņā ir ietekmējusi

   c. Ietekmējusi ļoti

   d. Ietekmējusi dramatiski

   _____

   _____

   _____

   _____

   _____

   _____

8) Kā Covoid-19 pandēmija ir ietekmējusi Jūsu sociālos kontaktus? (Lūdzu paskaidrojiet)

   a. Nav ietekmējusi

   b. Savā ziņā ir ietekmējusi

   c. Ietekmējusi ļoti

   d. Ietekmējusi dramatiski

_____

_____

_____

_____

_____

_____

9) Vai Covid-19 pandēmija ir ietekmējusi Jūsu darba/studiju procesu? (Lūdzu paskaidrojiet)

   a. Nav ietekmējusi

   b. Savā ziņā ir ietekmējusi

   c. Ietekmējusi ļoti

   d. Ietekmējusi dramatiski

_____

_____

_____

_____

_____

_____

_____

10) Vai Jūs izjutāt stresu mājsēdes laikā?

   a. Nemaz neizjutu

   b. Izjutu nedaudz

   c. Izjutu izteikti

   d. Izjutu dramatiski

11) Vai Covid-19 pandēmijas laikā Jūs jutāties tā it kā nav vērts dzīvot?

   a. Nemaz tā nejutos

   b. Tā jutos ļoti reti

   c. Tā jutos reizēm

   d. Tā jutos bieži

   e. Tā jutos ļoti bieži

12) Vai Jūs vai Jūsu tuvinieki pamanīja, ka kļūvat nolaidīgs/-a attiecībā pret vispārējo/mutes dobuma veselību?

    a. Tas nemaz netika manīts

    b. Tas tika manīts ļoti reti

    c. Tas tika manīts reizēm

    d. Tas tika manīts bieži

    e. Tas tika manīts ļoti bieži

13) Vai Jūs apmeklējāt Jūsu ģimenes ārstu ar sūdzībām par depresiju/trauksmi?

    a. Nē

    b. Jā

Annex No. 6. Anketa, 2. daļa – Kā pacients izjūt Covid – 19 pandēmijas ietekmi sabiedrībā?

1) Kā Covid-19 pandēmija ietekmējusi Jūsu draugu un tuvinieku veselību?

   a. Nemaz nav ietekmējusi
   b. Ietekmējusi nelielā mērā
   c. Ietekmējusi ļoti
   d. Ietekmējusi dramatiski

2) Vai Jūsu draugi/tuvinieki sāka mazāk interesēties par jebkādām dzīves aktivitātēm?

   a. To novēroju retos gadījumos
   b. To novēroju vidēji bieži
   c. To novēroju bieži
   d. To novēroju ļoti bieži

3) Vai Jūsu draugi/tuvinieki izjuta miega traucējumus vai vēlmi gulēt ļoti daudz?

   a. Nekad
   b. Ļoti reti
   c. Dažreiz
   d. Bieži
   e. Ļoti bieži

4) Vai Jūsu draugi/tuvinieki zaudēja apetīti vai sāka pārēsties?

   a. Nekad
   b. Ļoti reti
   c. Dažreiz
   d. Bieži
   e. Ļoti bieži

5) Vai Jūsu draugiem/tuviniekiem parādījās domas, ka labāk ir nomirt?

   a. Tādas domas nekad neparādījās

b. Tādas domas parādījās reti
c. Tādas domas parādījās dažreiz
d. Tādas domas parādījās bieži
e. Tādas domas parādījās ļoti bieži

6) Vai Jūsu draugiem/tuviniekiem parādījās domas par paškaitējumu?
a. Tādas domas nekad neparādījās
b. Tādas domas parādījās reti
c. Tādas domas parādījās dažreiz
d. Tādas domas parādījās bieži
e. Tādas domas parādījās ļoti bieži

7) Vai Jūs pamanījāt jebkādas izmaiņas Jūsu draugu/tuvinieku runas veidā?
a. Nē, nekad
b. Reti
c. Dažreiz
d. Bieži
e. Ļoti bieži

8) Vai Jūsu draugi/tuvinieki sāka reaģēt agresīvāk uz nenozīmīgām problēmām?
a. Nē, nekad
b. Reti
c. Dažreiz
d. Bieži
e. Ļoti bieži

9) Vai Jūs pamanījāt, ka kāds no Jūsu draugiem/tuviniekiem vairs neseko līdzi personīgai higiēnai?
a. Nē, nekad
b. Retos gadījumos
c. Dažreiz
d. Bieži
e. Ļoti bieži

10) Vai Jūs pamanījāt, ka kāds no Jūsu draugiem/tuviniekiem cenšas sev apzināti nodarīt pāri? (Suicīda mēģinājums)
    a. Nē, nekad
    b. Retos gadījumos
    c. Dažreiz
    d. Bieži
    e. Ļoti bieži

Annex. No. 7. Patient Health Questionnaire (PHQ – 9)

PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

NAME:_____ DATE:_____

Over the last *2 weeks*, how often have you been bothered by any of the following problems?
(use "✓" to indicate your answer)

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself—or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or the opposite – being so figety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead, or of hurting yourself	0	1	2	3

Annex No.8. Analysis of answers to questionnaire "How patient feels the influence of Covid-19 pandemic on his/her life"

Question	Predominant answer of males without depressive symptoms	Predominant answer of females without depressive symptoms	Predominant answer of males with depressive symptoms	Predominant answer of females with depressive symptoms
1) Has your consumption of junk food and sweets changed? e. Increased f. Decreased g. No change h. I don't consume junk food and sweets	Predominant answers were d - I don' t consume junk food and sweets	Predominant answers were C - No ch ange	Predominant answers were a - Increased c - No change	Predominant answers were c - No change
2) How the pandemics of Covid-19 influenced on your household's ability to meet financial obligations like loan repayments, household bills etc.? (If you have problems with money, you will postpone dental treatment as well)	Predominant answers were a - Did not influenced	Predominant answers were a - Did not influenced	Predominant answers were a - Did not influenced c - Strongly influenced	Predominant answers were a - Did not influenced c - Strongly influenced

a. Did not influenced b. Slightly influenced c. Strongly influenced				
3) How do you assess your oral health during covid-19 pandemics? a. Very good b. Good c. Fair d. Bad e. Very bad	Predominant answers were b - Good	Predominant answers were b – Good	Predominant answers were c – Fair d – Bad	Predominant answers were c – Fair
4) Do you feel that if you needed non-material help (somebody to talk to, help with doing something or collecting something) you could receive it from relatives, friends, neighbors, or other persons that you know? a. Yes	Predominant answers were a - Yes	Predominant answers were a – Yes	Predominant answers were a – Yes b - No	Predominant answers were a – Yes b - No

b. No				
5) How much of the time, during the past 1 year, have you felt downhearted or depressed? a. All/Most b. Some c. Little d. None of the time	Predominant answers were d – None of the time	Predominant answers were d – None of the time	Predominant answers were b – Some	Predominant answers were b – Some
6) How much of the time, during the past 1 year, have you been very nervous, lonely or suffering from anxiety? a. All/Most b. Some c. Little d. None of the time	Predominant answers were d – None of the time	Predominant answers were d – None of the time	Predominant answers were b - Some	Predominant answers were b – some
7) How Covid-19 pandemics influenced your own health? (Please explain) a. Not at all	Predominant answers were a – Not at all	Predominant answers were a – Not at all	Predominant answers were b – Somewhat c - Very	Predominant answers were b – Somewhat

b. Somewhat c. Very d. Extremely				
8) How Covid-19 pandemics influenced your social ties? (Please explain) a. Not at all b. Somewhat c. Very d. Extremely	Predominant answers were a – Not at all	Predominant answers were a – Not at all	Predominant answers were b - Somewhat	Predominant answers were b – Somewhat
9) Did the Covid-19 pandemics influenced your work/education? (Please explain) a. Not at all b. Somewhat c. Very d. Extremely	Predominant answers were a – Not at all	Predominant answers were a – Not at all	Predominant answers were a – Not at all b – Somewhat c – Very	Predominant answers were a – Not at all
10) Do you experience household stress from confinement? e. Not at all f. Somewhat g. Very	Predominant answers were a – Not at all	Predominant answers were a – Not at all	Predominant answers were c – Very	Predominant answers were b – Somewhat c – Very

h. Extremely				
11) During Covid-19 pandemics have you felt that life wasn't worth living? a. Not at all b. Rarely c. Sometimes d. Often e. Very often	Predominant answers were a – Not at all	Predominant answers were a – Not at all	Predominant answers were c – Sometimes	Predominant answers were c - Sometimes
12) Have you or your relatives noticed that you become neglecting to general/oral hygiene? a. Not at all b. Rarely c. Sometimes d. Often e. Very often	Predominant answers were a – Not at all	Predominant answers were a – Not at all	Predominant answers were c - Sometimes	Predominant answers were b – Rarely e – Very often
13) Have you visited your family doctor with complaints of depression/anxiety? a. Not at all b. Yes	Predominant answers were a – Not at all	Predominant answers were a – Not at all	Predominant answers were b – Yes	Predominant answers were b – Yes

Annex No. 9. **Analysis of answers to questionnaire "How patient feels the influence of Covid-19 pandemics on society"**

Question	Predominant answer of males without depressive symptoms	Predominant answer of females without depressive symptoms	Predominant answer of males with depressive symptoms	Predominant answer of females with depressive symptoms
1) How Covid-19 pandemics influenced health of friends or relatives? a. Not at all b. Somewhat c. Very d. Extremely	Predominant answer of males without depressive symptoms a - Not at all b – Somewhat	Predominant answer of females without depressive symptoms a - Not at all b – Somewhat	Predominant answer of males with depressive symptoms b – Somewhat c – Very	Predominant answer of females with depressive symptoms a - Not at all b – Somewhat c – Very
2) Do your friends/relatives started to have little interest in doing things? a. Rarely b. Sometimes c. Often d. Very often	Predominant answers were a - rarely	Predominant answers were a – rarely	Predominant answers were a – rarely c - often	Predominant answers were a – rarely b – sometimes
3) Are your friends/family	Predominant answers were	Predominant answers were	Predominant answers were	Predominant answers were

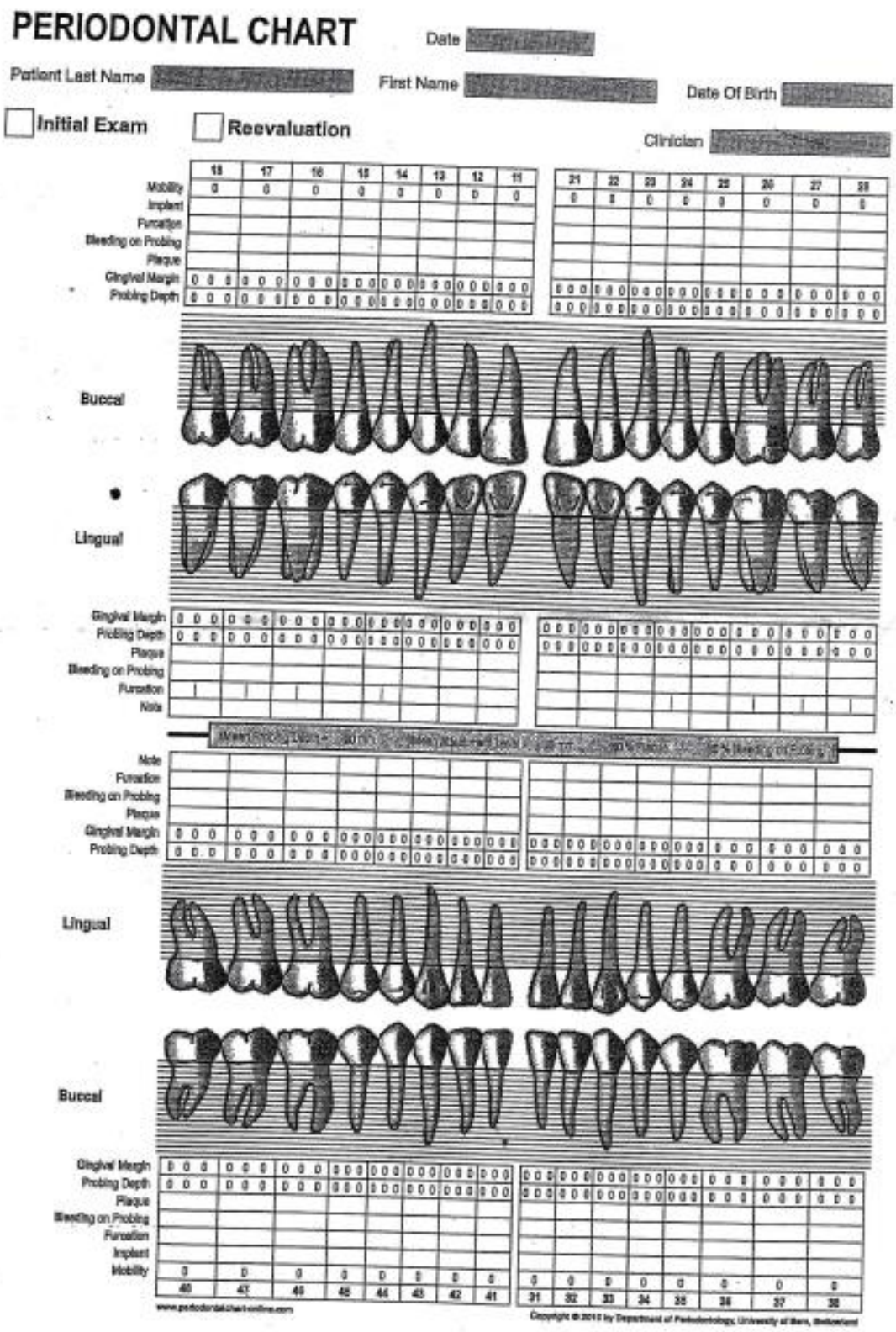
trouble falling or staying asleep, or sleeping too much? a. Never noticed b. Rarely c. Sometimes d. Often e. Very often	a – never noticed	a – never noticed	b – rarely c – sometimes e – very often	c – sometimes d – often
4) Do your friends/relatives started to have poor appetite or overeating? a. Never noticed b. Rarely c. Sometimes d. Often e. Very often	Predominant answers were a – never noticed	Predominant answers were a – never noticed	Predominant answers were a – never noticed b – rarely c - sometimes	Predominant answers were a – never noticed b – rarely
5) Do your friends/relatives started to have thoughts that they would be better off dead?	Predominant answers were a – never noticed	Predominant answers were a – never noticed	Predominant answers were a – never noticed b - rarely	Predominant answers were b – rarely

a. Never noticed b. Rarely c. Sometimes d. Often e. Very often				
6) Do your friends/relatives started to have thoughts of hurting themselves in some way? a. Never noticed b. Rarely c. Sometimes d. Often e. Very often	Predominant answers were a – never noticed	Predominant answers were a – never noticed	Predominant answers were a – never noticed b – rarely	Predominant answers were a – never noticed b – rarely
7) Have you noticed any changes of speech in your friends/relatives? a. Never noticed b. Rarely	Predominant answers were a – never noticed b - rarely	Predominant answers were a – never noticed	Predominant answers were b - rarely	Predominant answers were d – often

c. Sometimes d. Often e. Very often				
8) Have your friends/relatives started to act more aggressively to insignificant problems? a. Never noticed b. Rarely c. Sometimes d. Often e. Very often	Predominant answers were a – never noticed	Predominant answers were a – never noticed	Predominant answers were c – sometimes	Predominant answers were b – rarely c – sometimes
9) Have you noticed any that your friends/relatives started to unfollow hygiene? a. Never noticed b. Rarely c. Sometimes d. Often e. Very often	Predominant answers were a – never noticed	Predominant answers were a – never noticed	Predominant answers were c - sometimes	Predominant answers were b – rarely c – sometimes

10) Have you noticed any that your friends/relatives were trying to hurt themselves? (suicide attempt) a. Never noticed b. Rarely c. Sometimes d. Often e. Very often	Predominant answers were a – never noticed	Predominant answers were a – never noticed	Predominant answers were a – never noticed	Predominant answers were a – never noticed

Annex No. 10. Periodontal chart



DOCUMENTATION PAGE

This Diploma Thesis

„ORAL HEALTH IN PATIENTS WITH AND WITHOUT DEPRESSIVE COMPONENT DURING COVID-19 PANDEMICS"

was developed at the Faculty of Medicine of the University of Latvia.

With my signature, I attest, that this research has been carried out without aid or assistance. Used information was obtained only from indicated sources and the electronically submitted copy of this diploma work complies with printout.

Author: VLADLEN KRUGLAK _____

(name, surname) *(signature)*

I recommend the work for presentation.

Supervisor: LECTURER D.D.S BAIBA KRAUZE _____ 20.05.2022.

(position, name, surname, degree) *(siganture)* *(date)*

Reviewer: LECTURER, MARINA LOSEVIČA _____ _____

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(date)

International students' coordinator, _____

(signature)

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