Assessing the Relationship between Occupational Stress and Periodontitis in Industrial Workers

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I dedicate this thesis work to the lotus feet of

Lord Lakshmi Narasimha

“Sarvendriyairapi vinaasarvam sarvatra sarvadaa jaanaati yo namaamyadyam tamaham sarvatomukham”

( To that form of the Lord, which is half man and half lion, with mane, and fearful canine teeth, to such a divine Lord Narsimha, I offer my salutations.)
Abstract

**Background:** According to the World Health Organization (WHO), periodontal disease is one of the two most common oral diseases in the world. Periodontitis is a multifactorial disease, commonly associated with most chronic diseases. In the recent years the association between periodontitis with occupational stress has evolved in various studies in many developed settings.

**Objectives:** This study aims at studying the prevalence of periodontal disease and its relationship with job stress among industrial labor workers in South India.

**Methods:** The study included 198 subjects between the age of 18-64 years, 130 from a small scale sector (SS) and 68 from a large scale sector (LS) in Chennai city in South India. The subjects were informed about the research goals, and also requested to sign consents. The questionnaire included parts from the generic job stress questionnaire from the National Institute of Job Stress and Health. Dental examinations based on Community Periodontal Index and Treatment Needs protocol was done using WHO probe. Participants with moderate to severe periodontitis were informed about the salivary cortisol test. The saliva samples were collected and transported to the lab. Data was entered in Epiinfo 3.1.1 and analyzed in Stata 10. The Chi-square analysis was done to measure association and logistic regression analysis was done to identify the independent association of job stress to periodontitis.

**Results:** The study shows that 48% of the participants reported to have job stress and 42% had periodontitis. Further analysis also shows that the prevalence of job stress was twice as much in SS, compared to LS. The mean salivary cortisol level was 3.42ng/dl. The results also indicated a higher odds of having low levels of salivary cortisol amongst those who reported job stress. Bi-variate regression analysis show the relationship of periodontitis with job stress to be much higher on controlling for other risk factors. The odds of having periodontitis in relation to positive job stress were 6 times higher than those who did not have positive job stress.

**Conclusions:** This study shows high prevalence of job stress related periodontitis amongst industrial workers in India. This research recommends the health ministry to improve access to dental care especially in rural areas and include psychiatric units and oral health care as a part of primary health care. Promoting health education to remove stigma against visiting psychiatrist. The factory admins were recommended to have counselors to help their employees.

**Key Words:** Periodontitis, CPITN (Community Periodontal Index and Treatment Needs), psychosocial disorders, Cortisol, Oral Hygiene, Smoking, Alcoholism, India.
List of Abbreviations

- **WHO**  --  World Health Organization
- **CPITN**  --  Community Periodontal Index & Treatment Needs
- **NIOSH**  --  National Institute of Occupational Safety & Health
- **SS**  --  Small Scale Industry
- **LS**  --  Large Scale Industry
- **AAP**  --  American Academy of Periodontitis
- **RIA**  --  Radio-immuno assay
- **EIA**  --  Enzyme-immuno assay
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Rathi Ramji
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1. Introduction

1.1 Overview of Periodontitis and its progression

Periodontitis is a multifactorial disease affecting the tooth and its supporting tissues which includes the gingiva, the periodontal fibers and the alveolar bone (Figure 1). It causes detachment of tooth structure from its position in the oral cavity and destruction of tissue fibers. It is a disease of both hard and soft tissue of the oral cavity. The American Academy of Periodontics (AAP) defines periodontitis as an inflammation of the supporting tissues of the teeth characterized by a progressively destructive change leading to loss of bone and periodontal ligament (i.e. an extension of inflammation from gingiva into the adjacent bone and periodontal ligament).

![Figure 1. Structure of tooth and its supporting tissues](image)

1.1.1 Risk factors for Periodontitis

Risk factors are defined as factors whose presence increases the probability to have disease. The occurrence of periodontitis is greatly determined by the presence of such risk factors. The risk factors are classified as modifiable and fixed (or non-modifiable) risk factors based on their support for treatment and prognosis (Beck 1994). Modifiable risk factors are those factors which can be modified or treated so as to prevent the occurrence or progression of periodontal disease. Fixed or Non Modifiable Risk factors are those risk factors for periodontitis that cannot be intervened or modified to prevent periodontal disease (Burt 2001)
1.1.1.1 Improper Oral Hygiene Practice

AAP defines good oral hygiene as the complete absence of bacterial plaque which can be removed using tooth brushes, dental floss, and other devices. Further, the AAP defines dental plaque as an organized mass consisting mainly of microorganisms that adheres to teeth, prostheses, and oral surfaces and is also found in the gingival crevice and periodontal pockets. Other components in the plaque include an organic polysaccharide-protein matrix consisting of bacterial by-products such as enzymes, food debris, desquamated cells, and inorganic components such as calcium and phosphate. The formation of plaque can seldom be prevented, but effective and periodic removal of plaque is achievable and is necessary.

Calculus is yet another local factor which initiates periodontitis. They can be effectively removed by professional cleaning of the tooth (Figure 2). Studies show that bacteria in the plaque produce toxins, which cause inflammation of the gingiva, initiating the first stage of periodontal disease. If it is not treated at this time, the disease progresses into the periodontium to cause destruction of the fibers and mobility of tooth. If it is still left untreated, it may lead to loss of tooth structure (Fenesy 1998). Effective removal of dental plaque can be achieved by brushing, flossing and use of mouth rinses. Thus plaque is considered as a modifiable risk factor. In addition, periodic dental checkups and scaling (AAP defines scaling as instrumentation of the crown and root surfaces of the teeth to remove plaque, calculus, and stains from these surfaces) also help in plaque control.

Figure 2. Calculus and Periodontitis
1.1.1.2 Microbial Risk factors

Microorganisms have been largely identified in all types of periodontal diseases. Research shows that they are considered as risk factors as their presence alone is not accepted as their primary cause for disease occurrence. However, they play an important role in disease progression (Ljiljana Kesic 2008). Pathogens like Porphyromonas gingivalis, Treponema denticola and Tannerella forsythia have been identified in advanced periodontitis. The importance of Actinobacillus actinomycetemcomitans (Aggerigatibacter) in aggressive periodontitis has also been documented. These bacteria reside within the supragingival (the part of the gingiva that covers the crown portion of the tooth) and subgingival (the part of the gingiva which covers the root of the tooth) deposits, which in turn reflects on improper oral hygiene practice (Figure 2). Microbial risk factors are modifiable and most of the antimicrobial mouth rinses are useful in eliminating them.

1.1.1.3 Behavioral Risk factors

The most important and most commonly regarded behavioral risk factor which is also considered as environmental risk factor is smoking. Prolonged smoking renders reduction in the blood vessels in the gingiva, leading to low response or no response in case of inflammation, thereby resulting in periodontal involvement and periodontal disease. Studies also show the reduction in bone levels and bone density in smokers which facilitates disease progression. In addition to smoking, studies have identified that the use of other forms of tobacco are also considered as risk factors for periodontitis (Rivera-Hidalgo 2003). Previous research has included alcoholism as a behavioral risk factor as it decreases the immune response (inhibits neutrophils, macrophages and T cell functions) thereby making the individual more susceptible to infections (Pitiphat, Merchant et al. 2003).

Another important behavioral risk factor is an individual’s acceptance and practice of oral hygiene maintenance. In addition to this the individual should be aware of the importance of regular visits to dentist for periodic cleaning and checkups. This has rather been considered behavioral risk as most people tend to neglect dental checkups and cleaning. Other risk factors under this category include bruxism (clenching teeth during sleep), nail biting and finger sucking. Behavioural risk factors are controllable and thus considered as modifiable.
1.1.1.4 Systemic Diseases

The prevalence of chronic diseases related to social factors and habits is also considered to have an impact on periodontal health (Petersen 2009). Systemic diseases are grouped into two based on their involvement in periodontal disease development and progression (Andrija Bosnjak 2001). The first group is considered as the systemic risk factors as they influence disease development, progression, as well as treatment plan. Numerous epidemiological studies both longitudinal and cross sectional have identified Diabetes Mellitus as the most common systemic risk factor related to periodontal disease. Hyperglycemia leads to breakdown of gingival tissue and inhibits immune system defense against pathogenic bacteria and also reduces the host ability to promote healing (Soskolne and Klinger 2001). Recent studies have also shown that respiratory diseases (pneumonia, emphysema, and chronic obstructive pulmonary disease), coronary heart disease, atherosclerosis and ischemic stroke to be included under systemic risk factors for periodontal disease.

The second group is regarded as risk indicators as they are related to the early stage of development of the disease. These include osteopenia and osteoporosis; stress, distress, and coping. This group also includes immune system diseases such as AIDS; primary and secondary neutrophil disorders (congenital neutropenia and drug-related agranulocytosis); and diseases affecting host response like Papillon-Lefevre syndrome, Ehlers-Danlos syndrome and hypophosphatasia (Andrija Bosnjak 2001).

1.1.1.5 Local Risk factors

Local risk factors include malocclusion, faulty dental restorations or fractured teeth, tooth deformities, traumatic occlusion and pulpal infection with periapical involvement. Some of these factors enhance plaque accumulation. Local risk factors are modifiable (Geiger 2001). Treating the specific problem followed by professional oral care can improve prognosis.

1.1.1.6 Drugs and Medications

Phenytoin, a drug used to treat epilepsy has long been a major risk factor in the development of periodontal disease as it causes (as an adverse effect) gingival connective tissue over proliferation leading to gingival over growth and inflammation, finally precipitating periodontitis. This is certainly a modifiable condition as the gingival overgrowth is fibrous and not hypertrophic. Hence can be surgically managed thereby preventing progression of gingivitis into periodontal
disease. The medication can also be changed to prevent further overgrowth with equally effective drugs (Hassell 1981). Cyclosporine, a drug used for treatment of various conditions like type 2 diabetes, arthritis, etc. causes suppression of T lymphocytes and interferes with production of interleukin 1. This causes fibrous enlargement of gingiva by causing a rapid proliferation of collagen fibers, epithelial thickening and secondary inflammation. Fortunately, cyclosporine substitutes recently introduced have proved to be equally effective and less alarming to the gingival tissues (Adams and Davies 1984). Drug used in treatment of angina pectoris is Nifedipine, a well-known calcium channel blocker that has been identified to cause fibrous enlargement of gingiva. The condition can be reversed by replacing Nifedipine with an equally potent drug Verapamil hydrochloride along with effective dental cleaning, and oral hygiene procedures and periodontal surgery if necessary (Lucas, Howell et al. 1985). Some drugs and dental filling materials containing metallic substances have been proved to have allergic reactions on gingiva which there by affects the periodontium. Discontinuation of such drugs and dental materials, and provision of proper oral care and follow up to dentist periodically for cleaning and specialized treatments reverses this condition (Finne K et al., 1982).

1.1.1.7 Dietary Factors

Calcium levels in the serum have been shown to play a role in periodontitis. Several studies have shown that younger age groups with low serum calcium, woman with low serum calcium and middle aged men with low serum calcium levels have high risk of periodontitis. This could be explained by the fact that low serum calcium reflects on compromised bone support which promotes disease progression. Calcium supplementation and dietary regulation could certainly improve this condition (Nishida, Grossi et al. 2000).

Vitamin C is another dietary factor whose deficiency causes inflammation of gingiva, a condition termed as scorbutic gums. Longitudinal studies have also shown high prevalence of periodontitis amongst vitamin C deficient individuals, especially amongst smokers. Studies also indicate that low dietary intake of vitamin C initiates development of periodontal disease. Vitamin C supplements and diet rich in vitamin C can reverse this condition (Nishida, Grossi et al. 2000). The active form of Vitamin D is mainly involved in maintaining the levels of serum calcium and phosphorus. Thereby mediating bone metabolism. A reduction in the levels of Vitamin D may lead to osteoporosis by altering the bone mineral density. Osteoporosis may in turn lead to periodontal disease. Vitamin D receptors also play a role in the immune system activity by promoting cell proliferation and destruction. Vitamin D mediated inflammatory (cytokines) function also plays a role in progression of periodontal disease. Thus both hypervitaminosis and hypovitaminosis of Vitamin D play a role in periodontal disease occurrence (Amano, Komiyama et al. 2009).
1.1.1.8 Age

The relationship of age to periodontitis has been known for long years. Studies comparing young population and older age groups show higher prevalence of periodontitis in aged, with more plaque accumulation and poor oral hygiene. This could be due to age related health impairment which reduces manual dexterity leading to poor oral hygiene practice. Aged populations have also been recognized with higher prevalence of severe forms of periodontitis. Studies clarify that this was due to untreated disease since adulthood that leads to cumulative destruction throughout life time and is not purely age related (Schei O 1959).

1.1.1.9 Gender

Several studies on gender related prevalence of periodontitis indicate male predominance. This has been related to the improper maintenance of oral hygiene and purposive ignorance of dental checkups. In addition, males lack hormonal balance that controls directly or indirectly the periodontal attachment loss and bone resorption in comparison to females. Though these are not totally non modifiable factors, hormonal control and other unexplained factors related to genetic influences are certainly non modifiable (Grossi, Genco et al. 1995).

In contrast to males, females have periods of increased risk of periodontal disease. Evidences have shown increased risk of hormone (estrogen and progesterone) related gingivitis during puberty. During menstrual cycle, swollen gums, lesions, canker sores, swollen salivary glands or bleeding gums in the days before the period begins. These could precipitate periodontal involvement in some woman if left untreated. During pregnancy and in case of intake of oral contraceptives, an increase in the body secretion of progesterone causes painful gingivitis accompanied by bleeding. This can normally be treated but mostly neglected leading to periodontal involvement. Menopause is another stage in a woman’s life when there is increased susceptibility of periodontal disease. This is often due to menopause induced hormonal changes causing severe dryness of mouth. The self-cleansing capacity of saliva is dramatically reduced leading to large plaque accumulation and periodontitis (2002).
1.1.1.10 Socioeconomic Status

Studies show a higher prevalence of periodontal disease amongst blacks and whites who live in a low socioeconomic environment with minimum or no educational background. Socioeconomic status can also relate to nutritional deficiency and untreated chronic diseases which may cause or increase the risk of periodontal diseases. These are termed as non-modifiable factors as improving individual or populations’ social status is difficult to achieve (Borrell, Beck et al. 2006).

1.1.1.11 Race

Earlier studies show a wide difference in prevalence of periodontitis amongst Africans followed by Hispanics and Asians in comparison to the Northern Europeans and Americans. Further, a comparative study between Norwegians (Scandinavians) and Sri Lankans (Asian) show a higher prevalence of periodontal disease amongst Sri Lankans (Baelum, Chen et al. 1996). The higher prevalence of periodontal disease is noticed amongst immigrant Africans in North America, as in native Africans.

Studies based on racial differences in the prevalence of periodontitis shows a higher prevalence amongst blacks. The difference is described to be due to the presence of high melanin pigmentation in the skin and soft tissues of the blacks, which prevents absorption of Vitamin D from the Ultra violet rays of sunlight. Milk and dairy products are richest sources of Vitamin D in the diet. Glucose intolerance is common problem amongst blacks, making them avoid dairy products. Thus they are considered to be more prone to hypovitaminosis D, leading to osteoporosis thereby leading to periodontitis. The presence of high melanin staining in the gingiva makes it more vulnerable to inflammation and thereby leads to periodontal disease. Immigrants from sub-Saharan Africa in Sweden and other Scandinavian countries have a higher prevalence of Hypovitaminosis D related periodontitis, due to long winters with less light in these countries (Amano, Komiyama et al. 2009). The effects of racial differences on the occurrence and progression of periodontal disease can be modified and prevented by Vitamin D supplementation and gingival pigmentation correction surgeries.
1.1.2 Classification of Periodontal Diseases

1.1.2.1 American Dental Associations Classification of Periodontitis

The ADA Classification (Table 1) was based on severity of attachment loss. Periodontitis is classified by clinical and radiographic examination into four case types. It was useful for easy choice of treatment and to describe disease for insurance claims (Armitage 1999).

Table 1. ADA classification of periodontitis

<table>
<thead>
<tr>
<th>Case Type I</th>
<th>Gingivitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Type II</td>
<td>Early Periodontitis</td>
</tr>
<tr>
<td>Case Type III</td>
<td>Moderate Periodontitis</td>
</tr>
<tr>
<td>Case Type IV</td>
<td>Advanced Periodontitis</td>
</tr>
</tbody>
</table>

1.1.2.2 The AAP Classification of Periodontal Diseases

This classification was based on factors influencing periodontal disease occurrence such as age of onset, clinical appearance, rate of disease progression, pathogenic microbial flora and systemic influences. Two main categories were described with sub-divisions under each of them. The former classification was modified and updated in 1999 and the current classification was described (Table 2 and 3). Gingivitis is a condition characterized by inflammation of the gingiva (gums). As in any inflammatory condition, the gingiva is reddish, swollen, bleeding and tender. There may or may not be plaque accumulation. It is considered as the primary form of periodontal disease. Gingivitis is classified based on its etiology and onset (Table 2).

Table 2. AAP classification of gingivitis

<table>
<thead>
<tr>
<th>GINGIVITIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>i Chronic Gingivitis</td>
</tr>
<tr>
<td>ii Acute Necrotizing Ulcerative Gingivitis</td>
</tr>
<tr>
<td>iii Gingivitis Associated with Systemic Conditions or Medications</td>
</tr>
<tr>
<td>iv Hormone-Induced Gingival Inflammation</td>
</tr>
<tr>
<td>v Drug-Influenced Gingivitis</td>
</tr>
<tr>
<td>vi Linear Gingival Erythema (LGE)</td>
</tr>
<tr>
<td>vii Gingival Manifestations of Systemic Diseases and Mucocutaneous Lesions</td>
</tr>
<tr>
<td>viii Bacterial, Viral or Fungal</td>
</tr>
<tr>
<td>ix Blood Dyscrasias (for example Acute Monocytic Leukemia)</td>
</tr>
<tr>
<td>x Mucocutaneous Diseases (Lichen Planus, Cicatricial Pemphigoid)</td>
</tr>
</tbody>
</table>
1.1.3 Etiopathogenesis of Periodontitis

Periodontal disease is a multifactorial disease with various factors which presents them together or act individually to initiate disease or to promote progression. But evidence indicates that periodontal disease can be considered both as infectious and inflammatory. This makes the etiological definition of periodontitis more complicated. Research has identified that a reduced host response initiates inflammation and accumulation of plaque. The improper removal of plaque due to poor oral hygiene practice increases the possibility of plaque to form a more complex structure called a biofilm which is composed of bacterial cells, destroyed epithelial cells, food debris and some inflammatory response cells (Listgarten 1996). The biofilm adheres to the tooth surface and is not easily identified with naked eyes. Until this time the disease remains inflammatory. The biofilm formed as a result of improper oral care acts as a structured matrix with surface receptors for pathogenic bacterial adhesion initiating infection. On invasion and adherence, the anaerobic species (considered the most common etiological agents) produce toxins that promote destruction of periodontal structures. This in turn causes loss of attachment of tooth structure and may result in detachment of tooth from its socket.
1.1.4 Clinical Appearance of Periodontal Disease

The AAP defines certain criterion as signs to identify periodontal disease, and to facilitate good treatment plan (Table 4). Recording the patient’s history including the enumeration of symptoms in patients owns words are important. The examination of the gingiva and periodontium using scientifically approved instruments as periodontal probes and explorers is primary in the diagnostic procedure. The most commonly recognized signs are inflammation of the gingiva with or without bleeding and periodontal pocket formation. Plaque and calculus is yet another common finding. In addition to the clinical examination and history taking, radiographic examination indicates bone loss or resorption.

Table 4. Clinical features of periodontal disease

<table>
<thead>
<tr>
<th>S.No</th>
<th>SYMPTOMS</th>
<th>SIGNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bad Breathe</td>
<td>Inflamed Gingiva</td>
</tr>
<tr>
<td>2</td>
<td>Swelling and painful gums</td>
<td>Bleeding on Probing</td>
</tr>
<tr>
<td>3</td>
<td>Bleeding gums</td>
<td>Increased Pocket Depth</td>
</tr>
<tr>
<td>4</td>
<td>Pain during Chewing</td>
<td>Clinical attachment loss</td>
</tr>
<tr>
<td>5</td>
<td>Loose teeth</td>
<td>Tooth Mobility</td>
</tr>
</tbody>
</table>
1.2 Global burden of Periodontitis

The WHO reports that 5-70% of the populations in various countries around the world belonging to the older age groups suffer from severe periodontitis (Petersen and Yamamoto 2005). The wide difference in the global prevalence is owing to the differences in the prevalence of periodontal disease in the different countries of the world. This may be due to distinguishing factors amongst the different countries like economic development and prevalence of chronic diseases. Periodontal disease is considered more common in developing settings of Asia and Africa than in Europe and America (Petersen and Yamamoto 2005). Cigarette smoking may account for one-half of the cases of advanced periodontitis in the United States. Further, the WHO also classifies four main factors associated to periodontitis as the local, iatrogenic, behavioral and systemic factors as main risk indicators of periodontitis across nations.

High prevalence of periodontal disease in the world motivated the introduction and use of Community Periodontal Index and Treatment Needs, using WHO probe (Dini and Guimaraes 1994). Local factors and iatrogenic factors have much been spoken of in the past. More recently much studies report association of chronic diseases like diabetes and cardiovascular diseases to periodontitis (Janket, Jones et al. 2008). The global increase in the prevalence of chronic diseases increases the need for attention in controlling and treating periodontitis.

1.3 Overview of Occupational Stress

Stress refers to a psycho physiological response of a living organism to a perspective challenge, change or threat (Dhabhar 2009). The main features of stress include mood swings, changes in personality characteristics and feeling of helplessness. Occupational stress (job stress) is a psychosocial disorder which is an impact of the interaction between the worker and his work environment on the worker themselves. If left unidentified it can cause serious physical and physiological illness to the individual, which affects both the individual and the organization. Occupational stress may occur due to stress factors at the individual level, or at the organization level or at the interface of the two (van der Hek and Plomp 1997). Occupational stress is regarded to be influenced by factors like type of work environment, especially for industrial workers.

The industrial companies are of two major categories namely heavy industry or large scale industry (LS) and light industry or small scale industry (SS). Large scale industries are those which either manufacture heavy products or the process of manufacturing certain products that may be heavy. The workers in such factories are considered to have excessive work load, which may precipitate stress. Small scale
industries are manufacturers of products to be finally sent to dealers or finishing of existing products. Here workers are more relaxed in comparison to large scale industry. According to the authors of “Ergonomics of India” (Kumar, Dagli et al. 2008), the difference in work load amongst large scale industrial workers is known to be four times more than in small scale industrial workers. Thus job stress is anticipated to be lower in workers working in small scale industry.

1.3.1  Factors relating to occurrence of Occupational Stress

L. Cooper (1983) summarized and categorized into 6 groups of organizational variables outlined below that may cause stress in the workplace. These are:

- Factors intrinsic to the job (e.g. heat, noise, chemical fumes, shift work)
- Relationships at work (e.g. conflict with coworkers/supervisors, lack of social support)
- Role in the organization (e.g. role ambiguity)
- Career development (e.g. lack of status, lack of prospects for promotion, lack of a career path, job insecurity)
- Organizational structure and climate (e.g. lack of autonomy, lack of opportunity to participate in decision making, lack of control over the pace of work)
- Home and work interface. (e.g. conflict between domestic and work roles; lack of spousal support for remaining in the workforce)

1.3.2  Prevalence of Occupational Stress

Recent studies show that the blue collar workers or the industrial labor workers are those mainly affected by this disorder (Primm 2005). Perhaps the variety of stressful working conditions is the sources of stress, e.g. repetitive work and shift work. Blue collar workers have more complaints about their physical work environment, more physical and mental symptoms, and less pleasure in work, when compared to white collar workers. In addition to this blue collar workers are more affected with changes in market status, layoffs, industrial shutdown, production loss and financial crisis.

1.3.3  Assessment and Laboratorial Measurement of Occupational Stress
Three important criteria to consider regarding assessment of job stress based on previous studies made (Hansen Jo Ida et al 2003) are:

1. What the main stressors in the environment of study subjects are in.
2. How these affect the subjects psychologically or physiologically.
3. How the situation is perceived and interpreted by the subject.

Measuring main stressors and perception of the situation by the individual is conveniently accomplished using standardized questionnaires. The physiological and psychological changes can be monitored and evaluated using various laboratorial tests. The adrenal gland is the center that acts immediately during stressful periods. Physiological effects of stress are commonly measured by testing samples of blood or saliva to check for levels of adrenal hormones, like Dehydroepiandrosterone and cortisol or Chromogranin A (an acidic glycoprotein released from the adrenal medulla).

1.3.3.1 Dehydroepiandrosterone Test

Dehydroepiandrosterone (DHEA) is a steroid hormone synthesized in the adrenal gland. DHEA is synthesized from its steroid precursor Pregnenolone which is in turn synthesized from cholesterol. The stability of DHEA is maintained and its half-life is prolonged by storage of the hormone in sulfated form in blood. DHEA is the primary precursor of the two predominant sex hormones estradiol and testosterone. Thus maintaining the stability of DHEA in the blood stream is considered important for the process of hormonogenesis within the adrenal glands, testes and ovaries.

According to research studies, reduction in the level of DHEA is related to adrenal dysfunction due to various pathological conditions including psychosocial stress (Gallagher, Leitch et al. 2006). Recent advancements in this test included identification of salivary cortisol as well. The test involves collection of two sets of salivary samples from subjects at four different times of the day. The samples are stored carefully and transported later to the lab for further analysis of enzyme immunoassays. But this test is not practiced as it is time consuming.

1.3.3.2 Test for levels of Chromogranin A

Chromogranin A adrenal glycoprotein is co-released along with catecholamine from the adrenal medulla. The sympatho medullary system is a key component that regulates stress related activities in the brain. Chromogranin A is considered as a sensitive and reliable indicator of the functioning sympatho medullary system.
Recent studies have indicated release of Chromogranin A from the submandibular salivary gland (Hironaka, Ansai et al. 2008). Hence, salivary test for Chromogranin A is considered as a stress indicator. This test is not suggested as the best test for evaluating stress in relation to periodontitis.

1.3.3.3 Salivary Cortisol Test

Cortisol is a glucocorticoid synthesized in the zona fasiculata of the adrenal cortex. It is regarded as the stress hormone as it controls the responses to anxiety and stress. The activity of the cortisol hormone is controlled by a pituitary peptide which is in turn controlled by hypothalamic peptide corticotrophin releasing hormone. Cortisol is known to be released in an irregular manner with the highest levels in the morning which decreases through the day. The mechanism of cortisol response to stress is based on fight, flight and defeat principle. When an individual is subjected to a challenge, the control hormone non-epinephrine is on action. If the stress or challenge prolongs, the individuals stress path moves towards the flight or anxiety zone which is controlled by the hormone epinephrine.

The third stage is when the individual reaches a stage of inability or defeat, the hypothalamus is activated and a cascade of hormonal pathways is initiated, resulting in the release of cortisol from the adrenal cortex. This results in increased fat production, leading to visceral obesity, breakdown of tissues and suppression of the immune system, by acting as an anti-inflammatory agent. During stressful situations, cortisol also regulates and mobilizes energy to various parts of the body to enable coping to stressful situation. Thus, cortisol is considered as a marker for clinically identifying stress.

The salivary cortisol test is performed by a lab assistant on the saliva samples of selected cases and controls. The use of saliva as a diagnostic fluid is a relatively recent trend. This is not surprising considering its many advantages and the fact that saliva contains a wide array of constituents. Collection of salivary samples is easy and can be done by the participant himself, based on simple instructions. This procedure needs no trained staff. Moreover, it does not carry the risk of needle-stick injuries. Saliva collection is also less likely to cause stress compared with other invasive procedures such as phlebotomy (the act of drawing blood either for testing or transfusion). Salivary cortisol test can be useful to measure cortisol levels in all kinds of people including infants and bed ridden.

The levels of salivary cortisol vary from time to time based on the environment and human activities. During the day the level gradually depresses and reaches normal by midnight. Studies show a standard normal value for mornings 8am onwards to be between 3.5-27 nmol/l and at 10pm >6 nmol/l. These values may vary slightly based on the laboratory settings and also the salivary cortisol test kit used.
The cortisol level in saliva samples collected during early mornings (just after awakening) is normally high. The afternoon values are a bit uncertain as they may be low and night values are expected to be within normal range. The conventional procedure for saliva collection indicates the need to collect three samples per participant. Considering limitations in research, single sampling is also popular. The most appropriate time advised for a single sample collection is the midnight. Recent research on self -perceived stress indicates that a single morning sample, not early morning but till or before lunch could be ideal for the test. This method is more convenient than midnight sampling to the participant and researcher and is also cost effective and time saving.

A higher basal level of cortisol indicates the presence of acute stress. Rise in cortisol levels for a prolonged period indicates the presence of Cushing's disease and persistent low levels in the presence of type 1 diabetes indicates the presence of Adisson's disease. Prolonged stress may also result in a condition indicated by low levels of salivary cortisol, resulting in a condition called chronic fatigue syndrome or chronic stress. This condition occurs due to failure of the adrenal gland to produce enough cortisol as a result of hyper activity of the adrenal gland in response to high stress (Rosania et al., 2009).

The relationship between stress and periodontitis is mediated by psychoneuroimmunologic changes. When an individual is stressed, polypeptides are released from the sympathetic noradrenaline nerve fibers and from some of the endocrine glands. These hormones mimic bacterial antigens thereby stimulating immune response. The hypothalamus releases corticotrophin releasing hormone, which in turn stimulates the pituitary glands to release the adrenocorticotrophic hormone. The entire reaction initiates the adrenal cortex to produce cortisol. Cortisol regulates the lymphocytic and inflammatory responses. High cortisol levels for prolonged periods decreases the immune competency by inhibiting immunoglobulins IgG and IgA. IgA and IgG are immunoglobulins which plays a role in control of periodontitis. The initial colonization of periodontal pathogens is inhibited by IgA, while IgG enhances the chances of phagocytosis of periodontal pathogens by the neutrophils (Jones, Bridges et al. 1970).

Thus it is easy to conclude that elevated cortisol levels had a co-relation with the progression of periodontitis. Recent studies have distinguished the difference in cortisol levels in acute and chronic periodontal diseases. Elevated cortisol levels are regarded to be associated with loss of tooth attachment, while depressed levels of cortisol were related to chronic periodontal diseases (Rosania et al., 2009). Thus salivary cortisol is considered as a valuable measure in identifying the co-relation between stress and periodontal disease (Miller G E et al., 2007).

Though a number of cross sectional studies identify the relationship between stress and periodontal disease only three studies have assessed the salivary cortisol levels. This test has been recently accepted by the Food and Drug Association as validated for its accuracy, ease of performance and time effectiveness. Unlike DHEA test, this
test requires one test sample of saliva collected during the middle of the day for accurate results. There are two types of salivary cortisol test, the classical test using modified radioimmunoassay (RIA) and the newer test using enzyme immunoassay (EIA).

According to the researchers who have used this study the advantages of this method is that it is non-invasive and allows random sampling (Hironaka, Anai et al. 2008). The disadvantages include interference by diurnal rhythm; and contamination by food, artificial agents and blood.

### 1.4 Global Burden of Occupational Stress

According to the WHO report, “Raising Awareness of Stress at Work in Developing Countries” in 2007, occupational stress is one of the most common forms of stress in developing countries as the socioeconomic states, social inequalities and overpopulation forces employees to work based on job availability without a choice. Based on mortality data from the United States and other developed countries, occupational stress seems to be an increasing issue especially after the economic recession.

Job stress accounts for 85% of the stress reported throughout the world. Longitudinal studies from 1997 to 2002 have indicated a constant increase in prevalence of occupational stress globally. According to studies, occupational stress is more common among men than in woman. Thus, blue collar workers have significantly higher prevalence of occupational stress than people at higher levels and executives. Studies have shown that blue collar workers are highly vulnerable to occupational stress, both in developed and developing world (Primm 2005). The influence of power and decision making is an important factor and is one of the main causes of occupational stress.

### 1.5 Co-Relation between Periodontitis and Occupational Stress

Recent studies around the world show that change in the psychosocial state also effects periodontal health. The association between psychosocial stress and periodontitis has shown some evidence (Borges, Moreira et al. 2007), studying stress markers in gingival tissue of periodontitis cases (Beck 1994). This field demands more research as psychosocial stress is widely prevalent. The WHO in collaboration with the European Union has reported stress as one of the main social determinant of health and the most common chronic diseases in the world (Noone P, 2009).
According to the American Institute of Stress and WHO, the most common form of stress in the world is occupational stress. 37% of subjects who visited physicians and psychiatrist had occupation related stress related problems in a study conducted in United Kingdom (Cherry, Chen et al. 2006).

Measuring the levels of stress factors such as Chromogramin A (Hironaka, Ansai et al. 2008) and salivary cortisolin Japanese adults has improved in understanding the association between periodontitis and stress. Earlier studies in industrial workers in Norway (Lie, Due et al. 1988) and in India (Kumar, Dagli et al. 2008) have related periodontitis primarily to smoking as risk factor. But the long known relationship between smoking and stress, especially occupational stress (Cherry, Chen et al. 2006), brings us more closely to associate between periodontitis and occupational stress.

1.6 India

1.6.1 Geography, Population and Economy

India is a country in South Asia. It is the seventh-largest country by geographical area, the second-most populated country, and the biggest democracy in the world. The south of the country is bounded by the Indian Ocean. Along the western coast of the country lies the Arabian Sea, and along the eastern coast lies the Bay of Bengal. The Indian coastline is 7,517 kilometers in length (Figure 4). The neighboring countries lie at the borders: in the west lies Pakistan; China, Nepal and Bhutan in the north; and Myanmar (Burma) lies to the east. India lies close to Sri Lanka and the Maldives in the Indian Ocean.

It is a republic consisting of 28 states and seven union territories with a parliamentary system of democracy. It has the world’s twelfth largest economy at market exchange rates and the fourth largest in purchasing power. Economic reforms since 1991 have transformed it into one of the fastest growing economies. Being a pluralistic, multilingual, and multi-ethnic society, India is also home to a diversity of wildlife in a variety of protected habitats.

The Constitution of India, the longest and the most exhaustive constitution of any independent nation in the world, came into force on 26 January 1950. The preamble of the constitution defines India as a sovereign, socialist, secular, and democratic republic. India has a bicameral parliament operating under a Westminster-style parliamentary system. Its form of government was traditionally described as being 'quasi-federal' with a strong centre and weaker states, but it has grown increasingly
federal since the late 1990s as a result of political, economic and social changes (www.india.gov.in).

**Figure 4.** Map of India

1.6.2 Dental health care in India

In India health care system is controlled and managed by governmental hospitals in the urban, and primary health centers in the rural areas (Tandon 2004). There are over twenty thousand health centers in India. Each of these has ten sub centers. Each primary health care centre is responsible for health provision for a population of thirty thousand in that locality. Indian government included dental care in these primary health centers in 1986. About 1000 in-house dentist were employed to provide basic preventive care and emergency services. Thus only 20% of the health centers have dental care facility. This condition has not changed till date. Private dental care is becoming increasingly expensive, leaving 75% of the population without access to dental health support.

According to studies, the situation in India regarding dental care provision is similar to most of the developing countries in the Asia-Pacific region. The two most prevalent diseases are dental caries and periodontal diseases, followed by malocclusion and oral cancers. The potential disease levels have remained high over the years. Moreover, about 40-50 percent of children have malocclusion, and 40 percent of all cancers reported in India are oral cancers. Thus lack of dental care could clearly be a cause for continuing prevalence and incidence of periodontal diseases. A higher
prevalence of periodontal disease in low socioeconomic sector is clear as most of the rural population belongs to this class. A high prevalence of periodontal disease demands more time to treatment needs and thus prevention methods are totally neglected. This is the current state of dental care in the country (Tandon 2004).

1.6.3 Periodontitis in India

Studies conducted in India shows that every second person above the age of 35 years has periodontal pockets and 35% of total teeth extracted after the age of 35 years are due to periodontal disease. The disease process is enhanced under the effect of smoking/tobacco and predisposes to coronary heart disease due to an increased risk of thrombo-embolic phenomena. Studies identify high prevalence of periodontal disease amongst 94% of the rural population (Greene 1960). Periodontitis in rural population was commonly associated with high accumulation of plaque and other oral factors. Further studies showed that most rural population use fingers to clean their teeth. Though there were significant differences in the prevalence of disease in rural and urban India, socioeconomic class diet and systemic diseases were equally distributed in both, hence periodontal disease prevalence was high in urban areas as well.

1.6.4 Occupational Stress in India

The Indian Council for Research on International Economic Relations is projecting a possible 20-fold increase in lost productivity due to health issues such as heart disease and diabetes over the next decade owing to increasing stress disorders amongst employees especially in the industrial sector. Those predominantly affected belong to the labor class as in other developing countries. Work-related stress and mental fatigue are mainly blamed on expectations of better performance, deadlines and competition over the last few years. The WHO reports 35% of cardiac disease related deaths in India by 2030 will be due to occupational stress. According to the WHO, 30% of suicidal deaths in India are due to occupational stress. A recent study in South India indicated the prevalence of over 25% of job related stress in industrial workers, owing to severe working conditions (Mohan, Elangovan et al. 2008).

1.7 Relevance of Study

Periodontal disease is a multifactorial disease; hence research promoting the identification of risk factors is gaining importance for improving the treatment and
prevention (Beck 1994). Over the years the association of systemic diseases to periodontitis is well established. The control of systemic diseases associated with periodontitis has had an impact on reducing the global prevalence of periodontal disease (Andrija Bosnjak 2001). The relationship between stress and periodontal disease has been discussed for over sixty years (Arnold 1954).

Pathogenesis of stress as a risk factor for periodontitis is understood from recent studies (Strooker, de Geus et al. 2010). Various studies have been done in different parts of the world including, United States, Japan, Norway, United Kingdom and Italy to identify stress related periodontitis. Recent cross sectional studies made in the United States has introduced the use of salivary cortisol test as a parameter to measure the levels of stress in periodontitis cases (Rosania, Low et al. 2009). Earlier studies in United Kingdom have shown that occupational stress as the commonest type of stress in both high and low income countries, and also that blue collar workers are most prone to occupational stress (Cherry, Chen et al. 2006).

The current study is the first of its kind as it involves studying the association of periodontitis and occupational stress in Indian blue collar workers with salivary cortisol test as its key parameter.

### 1.8 Objectives of Study

**General:** The aim of this study is to explore the relationship between periodontitis and occupational stress (job stress) in industrial workers in South India.

**Specific Objectives:**

- To identify the association between periodontitis and self-reported job stress amongst industrial workers.
- To co-relate the between self-reported job stress and the salivary cortisol levels, to identify positive job stress.
- To explain the association between periodontitis and positive job stress.
2. Materials and Methods

2.1 Setting

This study was done in South India in Chennai, the capital of Tamil Nadu. Chennai is the fourth largest city in India with a population of 8.4 million. It is a broad industrial based city and it accounts for 60% of the country’s industry-based revenue. Blue collar employees from two leading manufacturing industries were selected from the northern (rural area) and southern (urban area) parts of the city to conduct research studies. Earlier studies done in the same region reveal the prevalence of reported 37% cases of gingivitis and 7.4% periodontitis among those who visited various dental care providers (Thavarajah, Rao et al. 2006). The selected factories are categorized as manufacturing industries, a common type among the industrial sector worldwide. Thus this work is comparable to studies with similar setup worldwide.

Appeal to conduct research studies was submitted to 4 factories in the city considering if they were large scale industry or small scale industry. Based on ease to approach, permission was obtained from only two of the four factories. In this study, SS represents a small scale industry and LS represents a large scale industry. The classification is based on differences in the type of workload and the product manufactured.

2.1.1 Small Scale Industry (SS)

The Small Scale Industry (SS) selected for the study are a key abrasive manufacturing group of companies in India. The company pioneered the manufacture of coated abrasives and bonded abrasives in India in addition to the manufacture of super refractories, electro minerals, industrial ceramics and ceramic fibers. Today, the company manufactures a range of over 20,000 different varieties of abrasives, refractory products and electro-minerals in ten different locations across various parts of the country.

2.1.2 Large Scale Industry (LS)

The large scale industry (LS) selected for this study is a dominant supplier of cylinder liners of international quality to original equipment manufacturers and after markets. They have been leaders in this market since their start up in 1973. Their main motto
has been to produce high quality automotive cylinder liners at an affordable cost through superior technology, continuous innovation and constant focus on quality.

### 2.2 Study Instrument

#### 2.2.1 Study Protocol

This study aims at understanding the relationship between occupational stress and periodontitis in industrial workers in India. The target population is selected based on duration of exposure, which is the duration of employment in the particular industry. The prevalence of periodontitis and occupational stress is first measured by appropriate methods. Periodontitis is measured by dental examination under sufficient illumination. The Community Periodontal Index and Treatment Needs (CPITN) score is measured using a special probe known as CPITN probe or WHO probe. This method has been selected as it is standardized by the WHO for measuring periodontal disease.

Occupational Stress is measured in two ways. The administration of a standardized questionnaire from the National Institute of Job Stress and Health (NIOSH) was done to measure occupational stress amongst all subjects in the study. The second measure is restricted to those subjects diagnosed with periodontitis by the CPITN method. This measure includes collection of salivary samples from positive cases of periodontitis. The samples are later subjected to assay tests in the laboratory to identify levels of stress marker namely cortisol to assess stress. The prevalence and co-relation of occupational stress and periodontitis is to be evaluated after data analysis.

#### 2.2.2 Questionnaire Based Measures

The questionnaire was formulated and adapted so that it is suitable for the industrial workers. Based on the information gathered from the factory administration, the questionnaires were constructed in English and later translated to the native language Tamil by the researcher with the help of a high school Tamil teacher. The questions from the generic job stress questionnaire were selected based on the relevance to the industrial labor workers omitting questions for white collar workers. The researcher and the administration agreed prior that each participant would spend no more than ten minutes on the questionnaire. The time was considered critical as the absence of participant from work would mean production delay. Considering the time and research goals, questions chosen were all close ended. The
appropriateness of each section of the questionnaire was analyzed and reconsidered for inclusion and exclusion.

In addition to the use of generic job stress questionnaire, questions relating to self-reported job stress, demographic details and questions on habits were also included. The subjects were enquired about being stressed or not. Further, if they reported to be stressed they were asked about the reason for their stress, if it was related to family issues, financial status, job, health related or child care related. In addition question regarding how they react to this stressful condition was also included. The key segments used in this study and their descriptions are shown in the Table 6.

Validity and reliability of the generic job stress questionnaire was verified by the NIOSH by doing independent content analysis and recommendations concerning candidate scale inclusion. A schematic view of the theoretical approach to job stress was constructed which guided the final selection of specific constructs included in the questionnaire. This model developed by NIOSH builds upon frameworks proposed by Caplan, Cobb, French, Harrison, and Pinneau (1975); Cooper and Marshall (1976); and House (1974). In this scheme, job stressors refer to working conditions that may lead to acute reactions, or strains in the worker. Further, the questionnaire has been used as key tool in various other studies concerning job stress (Nakata, Takahashi et al. 2008).

Table 6. Sections and brief details of the questionnaire contents

<table>
<thead>
<tr>
<th>S. No</th>
<th>Information type</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Demographic Details</td>
<td>Name, age, gender, marital status, and children</td>
</tr>
<tr>
<td>2</td>
<td>Health related Behaviors and Habits</td>
<td>Smoking, Alcoholism</td>
</tr>
<tr>
<td>3</td>
<td>Job description</td>
<td>Employment status, current position, length of service, hours per week</td>
</tr>
<tr>
<td>4</td>
<td>About the workplace</td>
<td>Physical environment, working hours</td>
</tr>
<tr>
<td>5</td>
<td>Work characteristics</td>
<td>Demand, discretion, initiative, position, consistence and clarity, involvement, support, satisfaction, and attitudes</td>
</tr>
<tr>
<td>6</td>
<td>Family and work</td>
<td>Life outside work and job performance; job responsibilities and interference with family life</td>
</tr>
<tr>
<td>7</td>
<td>Self assessed stress</td>
<td>If stressed or not, causes and reactions</td>
</tr>
<tr>
<td>8</td>
<td>Recent health conditions and Chronic illness</td>
<td>Cardiovascular disease, cancer, diabetes, asthma, arthritis, eczema, indigestion, persistent, and depression</td>
</tr>
</tbody>
</table>

Demographic details form the first part of this questionnaire. The subject is asked to fill in their name for identification if required during the time of analysis. The age and sex of the subjects are also important factors that may be related to both job stress and periodontitis and may act as an effect modifier. Marital status was also asked in order to differentiate the two study groups. The second part of the demographic
details included questions on habits as smoking and alcoholism as they could also be related to both job stress and periodontitis. The next division of the questionnaire includes questions on job description. It is important to know the type of job and duration of working in the job to assess the level of exposure and its association to the outcome variable job stress and in turn to periodontitis.

The other important segments are the self-assessment questions on the presence or absence of stress. It also includes questions on what type of stress is perceived and how the subject reacts in a stressful situation. The last division reports self-assessed questions on prevalence of various diseases and health conditions.

2.3 Dental Examination

The examination is done under sufficient illumination with artificial light. The CPITN Index is the preliminary part after examining the subjects for inclusion criteria for Case selection. Depending on the presence of teeth, a partial or complete CPITN indexing is performed. And the scores are analyzed to determine severity of periodontitis.

2.3.1 CPITN (Community Periodontal Index and Treatment Needs)

The Community Periodontal Index and Treatment Needs (CPITN) is an epidemiologic tool developed by the World Health Organization (WHO) for the evaluation of periodontal disease in population surveys. It is used to recommend the kind of treatment needed to prevent periodontal disease. A partial CPITN involves examination of 5 teeth each in the maxilla and mandible. A complete CPITN involves examining all teeth present. Partial CPITN indices are commonly used in epidemiological studies as it is convenient and time saving. The WHO indicates representation of CPITN scores based on rearranging subjects into four age groups, 15-19 years, 20-29 years, 30-44 years and 45-64 years.

2.3.1.1 Intra Oral Examination

A special probe introduced by the WHO known as the CPITN probe is used. This probe was used to evaluate the depth of the dental sulcus. The teeth were examined for supragingival or subgingival calculus. The presence of bleeding gums was elicited by probing the gingival margins. The CPITN probe has a head, needle end and handle as in any other probe. The end of the needle is small and ball-like. Above the ball is the first marking indicating 1mm pocket depth. The second mark is slightly thicker
and indicates 2mm pocket depth. The third is a thick band little away from the second marking indicating 4mm pocket depth (Figure 7).

![Figure 7. The CPITN Probe showing the various markings and the ball shaped end](image)

2.3.1.2 Selection of Tooth for Examination

The six surfaces of the tooth to be examined are mesiobuccal, mesiopalatal, distobuccal, distopalatal, midbuccal, and midpalatal. The upper right central incisor; the upper right first and second molars; upper left first and second molars; lower left central incisors; lower left first and second molars; and lower right first and second molars are the ten teeth to be examined.

- Incase any of these teeth are missing certain criteria were followed.
- Central incisors were replaced by examining the opposite side central incisors.
- First molars were replaced by examining adjacent second or first premolars.
- Second molars cannot be replaced by third molars and are left unaccounted.

2.3.1.3 Findings, Code and Treatment Recommendation

The CPITN Probe is designed with special markings on its measuring needle with a ball- ended tip. When inserted into the gingival margin and run along, the gingiva
bleeding and presence of local factors can be evaluated. Pocket depth is measured by inserting the probe into the gingiva towards the periodontium. It is advised to hold the probe parallel to the tooth surface to avoid tissue injury.

The pocket depth is 2mm or below if the gingival margin lies at the second mark on the probe needle from the ball end. If the gingival margin is almost touching the thick band, it indicates 3mm pocket depth. If the band is covered by the gingival margin, the pocket depth is 4mm and above. This indexing also relates treatment suggestions based on the stage of disease. Having a pocket depth of over 2mm or score 3 and 4 in any one of the examined tooth by CPITN index indicates the presence of periodontitis (Table 7).

Table 7. CPITN scores and treatment needs

<table>
<thead>
<tr>
<th>FINDINGS</th>
<th>Score</th>
<th>Treatment need</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathologic pockets &gt;= 6 mm deep</td>
<td>4</td>
<td>Need for more complex treatment to remove infected tissue</td>
</tr>
<tr>
<td>Pathologic pockets 4-5 mm deep</td>
<td>3</td>
<td>Need for professional cleaning of teeth, plus improvement in personal oral hygiene</td>
</tr>
<tr>
<td>Supragingival or subgingival calculus</td>
<td>2</td>
<td>Need for professional cleaning of teeth, plus improvement in personal oral hygiene</td>
</tr>
<tr>
<td>Gingival bleeding after gentle probing</td>
<td>1</td>
<td>Need to improve personal oral hygiene</td>
</tr>
<tr>
<td>No signs of periodontal disease</td>
<td>0</td>
<td>No need for treatment.</td>
</tr>
</tbody>
</table>

2.4 Salivary Cortisol Test

Subjects who were found to have one or more teeth with attachment loss or have tooth loss due to periodontitis determined by CPITN indexing were selected as case samples. Subjects who had no signs of periodontal disease or bleeding of gums were selected as controls or non-cases for salivary cortisol test. The selection based on presence and absence of periodontitis was considered as the relationship of occupational stress to periodontitis is measured in this study. Salivary cortisol test is considered a valuable tool in measuring stress of all types.

In SS, 25 persons were selected from the category of cases, and 21 as non-cases. The non-cases were much lesser in number as most of the subjects had bleeding gums (a very early sign of periodontitis). Samples were collected by the company health officer. Final number of samples was from 20 cases and 20 non-cases. Refusal to give salivary samples was due to:
• Generalized fear of identification of new diseases.
• Undergoing periodontal or orthodontic treatments
• Disinterest to participate in research study claiming that the test was not beneficial to them.

This reduced the initial sample size for the salivary cortisol test.

In LS, 20 cases that were diagnosed with periodontitis by dental examination were selected to participate. Based on further examination, 20 subjects with no periodontitis were selected as non-cases. The research team collected saliva on the same day after dental examination.

Samples were collected in a salivette tube containing a cotton plug (Figure 8). The subjects were asked to chew the cotton long enough to soak it with saliva. Without touching, the cotton was spit into the tube and refrigerated until transportation to the lab. The sample was analyzed and test was performed at the Lister Metropolis Laboratory & Research Centre, Chennai. Transportation was done on the same day of the sample collection. Sample collection was done for three days based on the subjects’ availability and appropriateness of time of collection. The laboratory provides normal range for salivary cortisol level for a morning to early noon (before lunch) to be from 5ng/ml to 21.6 ng/ml. Values lower than 5 ng/ml were considered as low levels and those values falling within the normal range were considered as normal. Values above 21 ng/ml were regarded as high values. Morning salivary samples are considered second best after midnight ones samples, especially for research purposes, as it provides accurate results with single samples and is more convenient for the participant and cost effective for the researcher.

The EIA salivary cortisol test is based on the competition between cortisol and Acetyl Choline (AChE) esterase conjugate (cortisol tracer) for selected binding sites of specific rabbit antiserum. The amount of cortisol tracer binding with the rabbit antiserum is inversely proportional to the concentration of cortisol in the wells. As the amount of cortisol varies, the amount of cortisol tracer is kept constant. The 96 well EIA plate is filled initially with mouse monoclonal anti rabbit IgG, which later binds with the added rabbit antiserum cortisol, both free or tracer. The plates are then washed and Elman’s reagent (AChE substrate) is added into the well. The final reaction shows yellow color in the wells on the plate which is read under a spectrophotometer at 412nm. The intensity of the color is directly proportional to the level of cortisol tracer and inversely proportional to the free cortisol levels (Salimetrics Cortisol EIA kit Manual).
2.5 Participants

Blue collar employees in the two factories were target population for this study. But all blue collar employees were not included into the study. Certain criteria were followed in selecting participating groups.

2.5.1 Exclusion Criterion for subjects in study

All permanent workers in the factory were invited for the study. Some subjects were excluded for certain reasons as enlisted in Table 5.

Table 5. Exclusion criteria for subject selection

<table>
<thead>
<tr>
<th>S. No</th>
<th>Criteria for Exclusion</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Those having less than 6 teeth in their oral cavity.</td>
<td>CPITN index involves measurement of periodontal pocket depth and bleeding of gums. For complete representation of the oral cavity at least 6 teeth are to be evaluated.</td>
</tr>
<tr>
<td>2</td>
<td>Those who are under immunosupressor therapy.</td>
<td>The periodontal tissue is vulnerable in those under immunosupressor therapy. It is a condition that last till therapy is continued. Hence they are avoided.</td>
</tr>
<tr>
<td>3</td>
<td>Those who are on treatment for periodontal disease.</td>
<td>Those undergoing periodontal therapy are not included to prevent the chance of disturbing the actual healing process or disturbing on going therapy. This is also for ethical reasons.</td>
</tr>
<tr>
<td>4</td>
<td>Those freshers working less than a year in the industry.</td>
<td>The exposure variable in this study in working in the factory and experiencing job stress. It is difficult to equalize</td>
</tr>
</tbody>
</table>
2.5.2 Criteria for selection as Cases with Periodontitis

- They should have clinical attachment loss of more than 2mm. Clinical attachment loss is defined as the depth of loss of attachment of periodontal fibers to the tooth and or the supporting bone. This signifies the severity of periodontitis.
- In case of bone loss with radiographic evidence.

2.6 Data Collection

2.6.1 Data collection in SS

Based on the company records, the total number of permanent workers working on shift basis (morning, evening and night) was 298. Like in any other setting each shift lasts for 8 hours. The shift changes happen once a month. In addition, there were 125 temporary workers. But this study included only permanent workers (Figure 5).

The screening camp and data collection was done for 2 days as permitted by the factory administration. The data collection was done for around 8 hours so as to cover all those in the day shift. The researcher and the dental team were active participants in the camp. The idea of research was clearly explained to the participants in a common gathering by the researcher herself. The participants were allowed to interact and clarify the concepts explained. Following this the participants who were willing to participate were asked to sign the informed consent forms. The subjects filled the questionnaire with the help of the researcher regarding understanding of questions, followed by dental examination by the dental team.

The total number of workers who were available at the time of data collection was 149. Of the 149 workers available, 9 persons refused to participate. In this way 140 informed consent forms were signed (Figure 5). After reviewing all the questionnaires to check for completeness, 10 were sent back to the participants, to fill out the left out parts. The remaining ten had to be dropped out as those participants had not filled out their names or initials, which helps to identify them.
2.6.2  Data Collection in LS

The screening camp and data collection was done for 1 day as permitted by the factory administration. The data collection was done for around 5 hours so as to cover all those in the day shift. The researcher and a dentist were active participants in the camp. The idea of research was clearly explained to the participants in a common gathering by the researcher herself. The participants were allowed to interact with the researcher and clarify the concepts explained. Following this the participants who were willing to participate were asked to sign the informed consent forms. The subjects filled the questionnaire with the help of the researcher regarding understanding of questions, followed by dental examination by the dentist and researcher herself.
At the start of this research project, the LS reported the presence of 120 technical or labor workers and around 200 management staff. Most workers were working in 2 shifts, one in the morning and other in the night. As in SS the shifts lasted for 8 hours and change of shifts was monthly. All of them were permanent workers. At the time of data collection the factory had only a total of 90 employees. This was because of termination of 30 members to compensate the loss to the management due to recession. The removal of members was also said to improve effective production with best employees. The final number of participants who accepted to participate was 70. This study had only 2 female participants at the end, from LS; hence they were dropped from the study to control for any possible bias (Figure 6).

2.7 Definitions

American Academy of Periodontics (AAP) defines periodontitis as an inflammation of the supporting tissues of the teeth characterized by a progressively destructive change leading to loss of bone and periodontal ligament (i.e. an extension of inflammation from gingiva into the adjacent bone and periodontal ligament). Stress refers to a psycho physiological response of a living organism to a perspective challenge, change
Occupational stress is a psychosocial disorder which is an impact of the interaction between the worker and his work environment on the worker himself (van der Hek and Plomp 1997). The laboratory provides normal range for salivary cortisol level for a mid-day (before lunch) to be from 5ng/ml to 21.6 ng/ml. Values lower than 5 ng/ml were considered as low levels and those values falling within the normal range were considered as normal. Values above 21 ng/ml were regarded as high values.

The presence and absence of periodontitis is measured by using CPITN probe based on the CPITN index. CPITN is defined as the community periodontal index and treatment needs. It is a WHO accepted and validated method of evaluating periodontal health. A tooth scored 3 or 4 indicating increased pocket depth over 2mm indicates presence of periodontitis. The occurrence of periodontitis is known to be influenced by certain factors in addition to job stress. These factors, considered as explanatory variables are also accounted in this study. Improper maintenance of oral health allowing accumulation of plaque and calculus may also initiate bacterial activity which is defined as poor oral hygiene.

Poor oral hygiene is also one of the risk factors for periodontitis measured using the CPITN probe. A CPITN score of 2 indicates the presence of plaque and calculus which implies poor oral hygiene. Records with score 2 for one or more tooth are counted to have poor oral hygiene. Smoking is another explanatory variable related to periodontitis. The questionnaire includes questions on self-reported smoking habit along with the number of cigarettes smoked per day. Subjects smoking one or more cigarettes are considered as smokers.

Similarly, questions about consumption of alcohol are also included in the questionnaire. Those who reported to consume alcohol were considered as alcoholics. Unlike in a developed country setting, the very consumption of alcohol is considered as alcoholism in India. This is due to the unavailability of quality alcoholic beverages, especially at an affordable price to the financial affordability of the workers. The type of alcohol readily and cheaply available is of poor quality and consumption even once a month could be considered harmful. Diabetes and hypertension are also self-reported health conditions in the questionnaire addressed to be marked present or absent.

### 2.8 Statistical Analysis

The collected data was systematically checked for its completeness. Incomplete questionnaires were initially sent back to the factories for finding those individuals to complete the missing parts. The data entry was done using Epiinfo 3.5.1 and 200 records were available for analysis. The data was cleaned and checked for coherence. Analysis of 200 records was done in STATA 10. The outcome variable measured in
this study is periodontal disease and the exposure variable was occupational stress. The dependent variable, periodontal disease was defined as a dichotomous variable based on clinical examination. Subjects with mean clinical attachment loss $\geq 2$ mm were assigned as periodontitis cases and those with mean clinical attachment loss $< 2$ mm were assigned as controls. The presence and absence of occupational stress was based on self-reported data obtained from the questionnaire and the salivary cortisol test results. Job stress and periodontitis amongst various age groups in the presence and absence of other factors was assessed using Chi-square testing. Logistic regression analysis was used to identify the co-relation of self-reported job stress to periodontal disease by controlling other possible risk factors. Probability levels at $P<0.05$ were considered statistically significant. The odds ratios were presented with 95% confidence intervals.

### 2.9 Ethical Considerations

An appeal was sent to the district collector regarding this study. But the appeal was returned as working on subjects from private organizations required consent from the specific organization and subjects themselves. The factory administration was informed about the research goal and study. Prior permission was taken from the head of the two organizations before the start of the study. A written consent was obtained from those interested in participating after providing them with a complete explanation about the purpose of research and procedures to be done. Free dental examination was done for all participants and some basic treatment was provided immediately and free of cost. The subjects were allowed to leave the study in case of discomfort at any point of time.
3. Results

3.1 Demographic Characteristics

The study included 210 subjects from two factories in South India with more subjects in SS (140) than in LS (70), which was explained by the size of the two factories. The completed responses were from 200 full time employees. Of this 200, 94% of the subject’s questionnaires were selected for the analysis. About 82% of the subjects were from the age group between 20 years to 44 years in both factories. Further differentiating participants from the two factories, three - fourths of them were married in both settings (p value 0.005). Almost 72% of those in SS were never smokers and, nearly one half of those in SS (48%) smoked. It was noted that three – fourths of the participants in LS consumed alcohol at least once in a week and 31% did so in SS (Table 8).

3.2 Prevalence of Occupational Stress (Job Stress)

3.2.1 Prevalence of Self-Reported Job Stress

The current study shows that 82% of the total of 198 subjects, self-reported to be stressed. On further inquiry, 39% reported that the stressful state was due to financial troubles and their current job conditions. Data also shows that 48% of those reporting to be stressed are stressed because of their occupation or current job. The percentage of subjects who reported job stress in SS(45%) was almost twice as much of those in LS (28%). The prevalence of self- reported job stress increases with increase in age (p- value 0.0002). On referring to the data on smoking, 45% of those who reported to have job stress were smokers. In addition to this, 74% of those who smoke reported to smoke more when they were stressed due to their work (Table 9).
3.2.2 Prevalence of Positive Job Stress

Of the 80 participants who submitted salivary samples, 60% had self-reported job stress. The odd of having low morning cortisol levels was 6.9 times higher among those who had reported job stress than who had not. Data also infers that 41% of those participants who submitted saliva samples had positive job stress (Table 10). The mean salivary cortisol levels measured amongst 80 participants was 3.42 ng/dl.

3.3 Prevalence of Periodontitis

Of the 198 industrial workers who underwent complete dental examination, 42% had periodontitis. On stratifying results based on the subjects from the two factories, one half of the subjects from LS had periodontitis when compared to SS where the prevalence of periodontitis was 36% (p value 0.01). When accounted for periodontitis amongst smokers, 59% of them had periodontitis with a significant p value of 0.001.
Similarly, almost half of those who consumed alcohol had periodontitis (p value 0.003). It was noticed that 88% (p value 0.009) of the total number under this study had a poor oral hygiene of which nearly half of them had developed moderate to severe periodontitis of them had developed periodontitis (Table 11).

3.3.1 CPITN scores for the Study Subjects

CPITN scores were evaluated from records of 200 subjects. The results of the CPITN index indicate a high prevalence of poor oral hygiene among most of the age groups with score 2. The index also indicates an increase in periodontal diseases with age, showing increasing occurrence of score of 3 or 4. Score 3 or 4 indicates the presence of periodontal pockets (Figure 7).

![Figure 7. CPITN scores recorded for subjects based on age groups represented as indicated by the WHO](image)

3.4 Periodontitis and Job Stress

On studying the association between periodontitis and self-reported job stress, 71% of those who reported to experience job stress were diagnosed to have periodontitis on dental examination. The odds of having periodontitis amongst those who reported to experience job stress were 7.5 times higher than those without job stress (95% CI 3.7 – 15.02) and results show statistical significance (Table 12).
On comparing the occurrence of self-reported job stress related periodontitis amongst the participants from the two settings, the odds of having periodontitis amongst those who reported job stress was 8.3 times higher among those from SS than LS, with a significant confidence interval (Table 13).

Of those 80 participants who submitted saliva samples, nearly half of them had positive job stress. The odds of having periodontitis amongst those participants who had positive job stress was 6.13 times higher than those who did not have positive job stress (Table 14).

### 3.5 Explanatory factors related to periodontitis

Bivariate logistic analysis was carried out to identify the individual effect of the exposure variable on the outcome variable by controlling the external factors. In this study the outcome variable periodontitis had a known relationship with having a poor oral hygiene, smoking, alcoholism and systemic diseases like diabetes and hypertension. The odds ratio was calculated along with 95% confidence intervals.

Those individuals who had poor oral hygiene had 3.8 times higher chance of having periodontitis when compared to those who had good oral hygiene, by controlling
other influential factors. Similarly, the odds of having periodontitis among those who smoked were 2.1 times higher when compared to non-smokers, by controlling other associated variables. Also, those who consumed alcohol had 3.1 times higher chance of having periodontitis after controlling other factors. On controlling other dependent variables in associating diabetes to periodontitis, those with diabetes have 2.9 times more chances of having periodontitis.

On controlling for all other dependent variables to associate periodontitis with exposure variable self-reported job stress, the chance of having periodontitis amongst those with job stress was 9.1 times higher than those who did not report of having job stress (Table 15).

### Table 14. Relating the association between positive job stress and periodontitis using odds ratio.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Odds Ratio (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodontitis</td>
<td>Positive Job stress</td>
</tr>
<tr>
<td>No Periodontitis</td>
<td>21</td>
</tr>
<tr>
<td>Periodontitis</td>
<td>12</td>
</tr>
</tbody>
</table>

In Table 15, a) Poor oral hygiene is measured using a WHO/CPITN probe to identify local factors like plaque and calculus. b) Smoking is accounted from the self-reported answers of the questionnaire. c) Alcoholism is also accounted from self-reported answers regarding alcohol consumption in the questionnaire. Consumption of alcohol at least once a day or week or even a month is considered as alcoholism. d) Diabetes is a self-reported health condition recorded from the questionnaire. e) Self-reported job stress is also accounted from the self-reported answers in the questionnaire. The dependent variable periodontitis is measured using the CPITN probe based on CPITN scores 3 and 4 indicating a pocket depth of over 3mm in one or more tooth.

### Table 15. Explanatory factors for the presence of periodontitis amongst factory workers in India

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Odds Ratio</th>
<th>95%Confidence-Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor Oral Hygiene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair = 4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Poor = 81</td>
<td>2.59</td>
<td>1.71 – 9.46</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No = 42</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes = 43</td>
<td>1.90</td>
<td>1.89 – 4.03</td>
</tr>
<tr>
<td>Alcoholism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No = 41</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes = 44</td>
<td>2.70</td>
<td>1.24 – 5.85</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No = 74</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes = 11</td>
<td>2.92</td>
<td>1.76 – 11.25</td>
</tr>
<tr>
<td>Self Reported Job stress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No = 30</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes = 55</td>
<td>12.72</td>
<td>5.76 - 29.02</td>
</tr>
</tbody>
</table>
4. Discussion

4.1 Key results of the study

This study was conducted in Chennai, the Capital of Tamil Nadu in Southern India. The two settings selected for this study were from the Northern and Southern zones of Chennai. The small scale industry (SS) was located in a rural area while the large scale industry (LS) was chosen from the urban area. Analysis was done using questionnaires filled by 198 subjects of which 130 were from the SS and 68 from the LS. Previous studies comparing rural and urban population was conducted in the Western part of India (Mumbai) shows 94% higher prevalence of periodontitis amongst rural populations than urban (Greene 1960).

The two groups under study were widely distributed among various age groups and were also classified based on marital status. The information on marital status indicates the importance of the subject being in job in a setting like India as woman in the lower socio economic classes are usually not educated and some are not allowed to work as part of their culture and traditional beliefs. Hence, the importance for a man to work in order to support his family becomes crucial. This study shows that 74% of the subjects are married and have a family to support, and they need a job. Smoking is a common habit in Indian men from the lower socio economic classes. It is more likely due to the readily available and affordable local smokable tobacco products. This study shows 35% of study subjects to be smokers. The higher prevalence of 48% in LS in comparison to 28% in SS can be related to the easier availability of newer tobacco products to those working in LS, which is within the city limits.

The SS factory administration has rules prohibiting smoking in their premises. The government has also prohibited public place smoking nationwide. Thus the possibility to smoke for the SS industrial workers is much lesser in comparison to the LS industrial workers. This could be the reason for lower prevalence of smoking in the SS industry. The study also reports a high prevalence of alcohol consumption amongst the study population. Results indicated that there was no difference in the prevalence of alcohol consumption amongst subjects from the two settings. The high prevalence of alcohol consumption could be an effect of generalised high prevalence in all parts of India.

This study shows a 61% prevalence of self-reported job stress amongst the 200 study subjects. On stratifying results based on the two factories, a higher prevalence (45%) was accounted in the subjects from the SS industry in comparison to the LS industry (27%). The results signify that there could be a co-relation between the occurrence of job stress and the work environment. On studying the results from the age-wise prevalence of self-reported job stress, the prevalence is seen to increase with age. This
could be because of increasing financial burden to support families; health disorders neglected due to job conditions; and work conflicts. Of those who reported to have job stress, 74% of current smokers reported that they smoke when stressed and 16% of those who usually consume alcohol reported that they consume alcohol during stress. A high prevalence of poor oral hygiene maintenance was noted among those who reported job stress. The higher prevalence may be due to neglecting oral health during stressful states.

On assessing the hormonal effects of stress, the higher prevalence of low-levels of salivary cortisol was found among the selected 80 subjects. The mean levels of morning salivary cortisol was 3.42 ng/dl. The extended study on prevalence of type 1 diabetes amongst the 80 subjects indicated the absence of the disease amongst all the participants. Thus, the possibility to have Addison’s disease amongst those with low salivary cortisol levels was ruled out. Low cortisol levels indicate chronic fatigue syndrome due to excessive stress. Thus a low level of salivary cortisol was also considered as a marker for high levels of stress as inferred in previous studies. Co-relating the results of salivary cortisol test to self reported job stress, 69% of those who reported to have job stress had low cortisol levels. The 69% were thus considered to have positive job stress. This result is considered a critical finding unique to this study as previous studies have not compared self-reported stress to salivary cortisol levels (Rosania, Low et al. 2009).

This study shows a 42% prevalence of periodontitis amongst the 198b participants from the two factories. A higher prevalence of periodontitis in the LS workers indicates the possible co-relation of periodontal disease to the work environment and the working conditions. A high prevalence of periodontitis is also seen to increase with increasing age as in self reported job stress. This could be due to the effects of other health problems or exposure to risk factors related to periodontitis that are common in the setting and problems related to ageing (Andrija Bosnjak 2001). This identifies the known co-relation between periodontitis and smoking habit that was in par with previous studies that indicate a higher prevalence of periodontitis amongst smokers than non-smokers (Rivera-Hidalgo 2003). Similar co-relation between periodontitis and alcoholism has also been shown in this study. This study also reports that maintenance of oral hygiene plays a significant role in the development of periodontitis.

The prevalence of periodontitis amongst those who reported job stress was as high as 71% amongst the study population. The odds of having periodontitis amongst those who reported job stress was 7.5 times higher than those who did not report job stress. The study included a small group of subjects owing to which the confidence intervals(3.7 – 15.02) though significant (p value < 0.05) are wide. The results of this study are considered important as it is the only reported study done to associate self-reported job stress to periodontal disease in the chosen region. On stratifying results from the two factories, participants from SS had higher odds of having self-reported job stress related to periodontitis in comparison to the LS. As in previous research the higher prevalence of periodontitis in rural areas and also that urbanisation is related to better financial state than in populations in rural areas, could be a reason for the results in the current study.

Regression analysis results show that exposures to self-reported job stress indicated a higher risk of developing periodontitis on controlling other risk factors amongst the 198 study participants. Also, the results indicate a higher odds ratio for self-reported job stress as an
exposure variable than other factors. Thus the co relation between self reported job stress and periodontitis is certain.

The prevalence of periodontitis among those who had positive job stress was 8.3 times higher than those who did not have positive job stress. This indicates a strong relation between the exposure variable positive job stress to the dependent variable periodontitis. This is yet another crucial finding unique to this study.

4.2 Strengths of the study

The key objective of this study was to identify the relationship between job stress and periodontitis in Indian industrial workers, a first of its kind in this setting. The use of salivary cortisol test as a parameter to study hormonal response to job stress is yet another new approach, even though prior studies of serum cortisol levels in relation to general stress has been done. Also, previous studies done in the United States on stress related periodontitis using salivary cortisol test have included only 40 cases of periodontitis for the salivary cortisol test (Rosania, Low et al. 2009). This study has had twice the sample size, which included 40 cases and 40 controls making the results comparable. Further, the results from the salivary cortisol test were also correlated with results from self reported job stress to identify positive job stress which is also unique to this study.

Studying the prevalence of job stress in large scale and small scale industries is novel, and is not yet reported. Though this study was initially a cross sectional study, an internal case control study (salivary cortisol test) was also done. A high response rate was recorded in the two settings (SS - 94% and LS -100%).

4.3 Limitations of the study

Factories chosen for this study are chosen based on ease to approach the administration. Even though this could be considered as a limitation, the factories themselves are in par with international standards and represent a typical Indian industrial setup. The results from this study might be limited to the state of Tamil Nadu and cannot be directly compared with results from other parts of India considering the diversity in culture and other factors within the country. However, a major part of this study deals with factors that are common to the individual states within India.
Though the questionnaire used in this study included questions from the generic job stress questionnaire, only the self-reported questions on job stress has been included for the analysis considering time limitations. The remaining data are to be analyzed in future. Another key limitation of this study is the number of study subjects. All statistical results are significant but certainly have a wide confidence interval. This clearly indicates a small sample size. Moreover this subject size is too less to represent populations from a densely populated country like India.

The difference in the number of subjects in the two factories may also influence the prevalence of periodontitis. The study was done within the factory premises, in the presence of a few staff from the administration to help in organizing the data collection and the dental camp. This could certainly introduce a bias, as the workers may not answer all questions regarding job stress and work as confidently as they would in the absence of the administrative staffs leading to an underestimation of prevalence of job stress. However, the presence of administrative staffs as a limitation for this study is mitigated by the fact that such staffs were not allowed to be near the subjects thereby allowing a sense of personal space for the subjects.

The dental examination was done by a team of ten dental surgeons in SS and only three of them in LS. This was because of the differences in the number of employees in the two factories. Though all dentists followed the same protocol for dental examination prepared by the researcher, there could be a certain difference expected in their scoring of CPITN and dental examination skills. This may cause a bias in the results.

The salivary cortisol test should have been done for all study subjects for better results. Subjects selected for salivary cortisol test were chosen based on presence and absence of periodontitis. Self-reported job stress was not considered as a factor for selection during the selection of subjects for salivary cortisol test. Thus, the distribution of subjects having self-reported job stress among those who submitted salivary samples may not be proportional. Considering the duration for this thesis work and the resources available, salivary cortisol test for all subjects has been left for future work.

### 4.4 Comparisons with existing studies

This study is in par with previous studies with the fact that oral hygiene status has a major role is periodontitis occurrence (Greene 1960). The results of this study indicate a high prevalence of periodontitis amongst factory workers in India who normally belong to low socio economical sector and in addition report to have financial stress. The unavailability of free dental treatment and problems with affordability of private dental care which is expensive can force them to neglect early
periodontal problems. Thus, this study is comparable to previous studies which relate the limited availability of resources and social status as a key factor for high prevalence of periodontitis in India (Tandon 2004).

The current study is also in line with past studies showing the relationship between smoking and periodontal disease, and clearly relates smoking as a risk factor for the disease (Kumar, Dagli et al. 2008). Studies conducted earlier to relate job stress and periodontitis have had similar results to the one reported here (Cherry, Chen et al. 2006). Most important of all was the salivary cortisol results which were certainly in par with recent studies which concluded that low cortisol levels in the absence of type 1 diabetes and hypertension is related to Chronic fatigue syndrome, which occurs as a result of excessive stress is also related to periodontal disease (Rosania, Low et al. 2009).

4.4 Future work

The relationship between periodontitis and psychosocial stress has been long identified. But the exact mechanism behind the occurrence is still largely unexplored. A closer relationship of periodontitis to job stress has been shown in this study. But analysis of the NIOSH questions in the questionnaire is expected to be addressed in the future. Moreover, the salivary cortisol test can be done to all subjects in the study in near future so as to improve the quality of results obtained. The author intends to continue further research in this field. This study is planned to be enlarged by including more subjects from both the existing factories and newer factories in India, which falls under similar groups as large scale and small scale industries.
5. Conclusion

A high prevalence of occupational stress and periodontitis and the inter relationship between them is clearly understood through this study. This study is intended to be a baseline research that informs authorities both in the government and private sectors in the country about the increasing threat of psychosocial disorders that are neglected due to social stigma and unavailability of treatments. The research results also recommend the health ministry to improve the accessibility to free dental care especially in rural areas and include psycho-therapists services in the public health care systems. Health education campaigns promoting the availability of such services and also educating populations on the need for approaching such services is recommended. The private sector employers and factory administrations are recommended to have in office counseling services in addition to the medical services provided within their campus.
References


Appendix -1

INFORMED CONSENT FORM

Epidemiology and Public Health Sciences
Umeå International School of Public Health

Informed Consent Form for Master Thesis Research

Informed Consent Form Number: ____________________

Informed Consent Form for: _________________________

Name of Organization: ____________________________

Name of Principal Investigator: Rathi Ramji

Name of Supervision: Fredrik Norström

Name of Collaborating Hospital: SRM Dental College & Hospital

This Informed Consent Form has two parts:

• Information Sheet (to share information about the research with you)
• Certificate of Consent (for signatures if you agree to take part)
PART I: Information Sheet

Introduction: I am Rathi Ramji, basically a Dentist from India, doing my Masters in Public Health in Umeå University. My area of research is on Periodontal Disease (Gum Disease), which is very common in our country, and its association to Job stress. I will give you information and an invitation to be part of this research. You do not have to decide today whether or not you will participate in the research. Before you decide, you can talk to anyone you feel comfortable with about the research. There may be some words that you do not understand. Please ask your co-staffs to stop as you go through the information and they will take time to explain. If you have questions later, you can ask them to me as well.

Purpose of the research: The WHO reports Periodontal disease as one of the two most common oral diseases of global burden. Periodontitis is a multifactorial disease affecting the tooth and its supporting tissues. The most important factors related to Periodontitis are improper oral hygiene practice, age, sex, socioeconomic status, drugs, smoking and other forms of tobacco use. Occupational stress is a psychosocial disorder which is an impact of the interaction between the worker and his work environment on the worker himself. Various studies have reported the association between occupational stress and periodontal disease. This study is to confirm this association and improve preventive therapy and treatment modalities for the disease.

Type of Research Intervention: The process includes a thorough oral examination under light with a mouth mirror and a probing device followed by a selected group of individuals to give a sample of saliva. There will be no injections given into the mouth. Treatment will later be provided free of cost at the Dental Hospital.

Subject selection: We invite workers in the industrial sector as machinery or blue-collar workers to participate in the study.

Voluntary Participation: Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you agree to participate in this research project, you will be offered the treatment that is routinely offered in this clinic/hospital for free, and we will tell you more about it later. You may change your mind later and stop participating even if you agreed earlier.

Procedures and Protocol: A team of over ten Dental Surgeons first perform the general oral examination. This is done using regular Diagnostic Instruments along with a CPITN/WHO probe (a thin instrument that could be used on the gums). The CPITN
index is recorded and subjects with moderate to severe Periodontitis are selected. The subjects that have severe Periodontitis are categorized as positive Periodontitis cases and enlisted separately. The others are advised other forms of dental treatment provided for free at the Dental Hospital later. The next step is the General Health questionnaire distribution, which includes some short questions on occupational stress for all subjects.

A list of positive Periodontitis cases is maintained by the Human Resource Department or Social Welfare Department of industry and the research team and is useful in randomly selecting a group of subjects for the Salivary Cortisol test. Finally, the Salivary Cortisol Test (or saliva sample collection) is done within 24 hours time. The Salivary Cortisol Test detects the stress related factors present at time of high stress in the saliva which may cause the destruction of periodontal fibers (gums). It involves the collection of saliva by just asking the person to spit into a small tube. The samples are stored at –30 degree centigrade and transported to the laboratory. This saliva sample is later analyzed in the laboratory and a result on level of stress cortisol in the saliva is calculated. The test is purely for research purpose and is of no use to the subjects. This is a highly advanced method specially made available for this study as it has yet to be introduced in India.

**Description of the Process:** The initial dental examination happens for 3 to 5 days depending on the availability of the subjects based on their shifts. The subjects are also asked to fill up their questionnaire at this time. A week later a selected group of individuals with Chronic Periodontitis and a high Community Periodontal Index and Treatment Needs score are subjected to Salivary Cortisol Test on a single day. All subjects are later offered free dental care.

**Duration:** The initial dental examination takes 5-7 minutes. Following this, 10 minutes is allotted to fill up the questionnaires. Those selected for the Salivary Cortisol test will have to spend around 2 to 3 minutes to submit their saliva samples.

**Benefits:** You will be checked completely on dental related health and provided free treatment for your current illness and future dental ailments for free. Your participation is likely to help us find the answer to the research question. There may not be any benefit to the society at this stage of the research, but future generations are likely to benefit.

**Risks and Side Effects:** There will be no risk or side effects if you participate in this study.
Pros and Cons

- This study accounts for Periodontitis occurrence in a representative sample from South India, which indicates the needs to expand dental care system in this part of the country.
- It also aims at clarifying the association of Periodontitis and Occupational stress. This helps in improving prevention strategies and treatment modalities.
- This study is restricted to two not randomly chosen factories. They are supposed to be representative but might not be so.

Confidentiality: With this research, something out of the ordinary is being done in your community. It is possible that if others in the community are aware that you are participating, they may ask you questions. We will not be sharing the identity of those participating in the research.

The information that we collect from this research project will be kept confidential. Information about you that will be collected during the research shall kept hidden and no-one but the researchers will be able to see it. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will lock that information up with a lock and key.

Right to Refuse or Withdraw: You have the right to withdraw from the study at any stage. The treatment for current illness may be continued. Future treatment for free may not be available.

Who to contact:

Research Related Queries: Dr. Rath Ramji
+91 9884028118 (Mobile)
ratirimji@gmail.com (Email)

Treatment Related Questions: SRM Dental College & Hospital
Ramapuram, Chennai 600089
Tamil Nadu, India
PART II: Certificate of Consent

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a subject in this research.

Name of Subject: __________________
Signature of Subject: __________________
Date (day/month/year): __________________

If illiterate, a literate witness must sign. Subjects who are illiterate should include their thumb-print as well.

I have witnessed the accurate reading of the consent form to the potential subject, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness: __________________ AND Thumb print of subject
Signature of witness: __________________
Date (day/month/year): __________________

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential subject, and to the best of my ability made sure that the subject understands that the following will be done:

1. Dental Examination
2. Filling up the Stress Questionnaire
3. Salivary Cortisol Test (For selected Subjects)

I confirm that the subject was given an opportunity to ask questions about the study, and all the questions asked by the subject have been answered correctly and to the best of my ability. I confirm that the individual has not been forced into giving consent, and the consent has been given freely and voluntarily.

Print name of researcher/person taking the consent: ____________________________
Signature of researcher/person taking the consent: ____________________________
Date (day/month/year): ____________________________
Appendix – 2

QUESTIONNAIRE
A study on Periodontitis and Job stress in Industrial Workers in India

Epidemiology and Public Health Sciences
Umeå International School of Public Health

Questionnaire for Master Thesis Research

Questionnaire Number: 

Questionnaire for: 

Name of Organization: 

Name of Principal Investigator: Rathí Ramji

Under the Supervision of: Fredrik Norström

Name of Collaborating Hospital: SRM Dental College & Hospital
PART I

We want to know about your work environment and how it in turn affects your gums. This information is not available anywhere else. Your answers on the enclosed forms are only evidences to support our research. The information which you provide will be combined with other answers only in statistical summaries. You shall not be identified through any results presented from this study. Thank you for your cooperation and support.

(Please indicate your answers using a tick mark wherever applicable)

PERSONAL INFORMATION

1. Name: ______________________
2. What is your gender? □ Male □ Female
3. How old were you on your last birthday? ______ years
4. What is your marital status? □ Married □ Single, Never Married
   □ Single, Divorced □ Single, Widowed
5. Do you have children living at home? □ Yes □ No

QUESTIONS RELATED TO HABITS

6. Do you smoke? □ Yes □ No
   If Yes, how many per day? □ 0-5 □ 5-10 □ Over 10
7. Do you drink alcohol? □ Yes □ No
   If Yes, how often? □ Everyday □ Once in 2 days
   □ Weekends □ Once a month
JOB RELATED INFORMATION

8. How long have you worked in this job?  

9. Select the most appropriate description of your JOB SITUATION:
   - Full-time permanent employee
   - Part-time permanent employee
   - Full-time temporary employee
   - Casual, how many hours in average per week ________________
   - Other (specify), ______________

   How many hours in average per week ________________

10. a. How many hours per shift? hours
    b. When?  Day  Evening  Night  Mixture

11. How long have you worked the shift you indicated above?  

12. How many hours do you normally work per week in your job? ________________

13. How many hours overtime do you work in your job in an average week? ________________

14. How many hours per week do you work on any other job? ________________

PART II – JOB SATISFACTION

We would like you to think about the type of work you do in your job.

1. Knowing what you know now, if you had to decide all over again whether to take the type of job you now have, what would you decide? I would...
   - [1] Decide without hesitation to take the same job
   - [2] Have some second thoughts
   - [3] Decide definitely NOT to take this type of job

Q.No. 1

2. If you were free right now to go into any type of job you wanted, what would your choice be? I would...
   - [1] Take the same job
   - [2] Take a different job
   - [3] Not want to work

Q.No. 2

3. If a friend of yours told you he/she was interested in working in a job like yours, what would you tell him/her? I would...
   - [1] Strongly recommend it
   - [2] Have doubts about recommending it
   - [3] Advise against it

Q.No. 3

4. All in all, how satisfied would you say you are with your job? I am...
   - [1] Very satisfied
   - [2] Somewhat satisfied
   - [3] Not too satisfied
   - [4] Not at all satisfied

Q.No. 4

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PART III – CONFLICTS AT WORK

Please indicate the degree to which you agree or disagree with the following statements about your team work

1. There is harmony amongst me and my team members.
   - [1] Strongly disagree
   - [3] Neither agree nor disagree
   - [5] Strongly agree

2. We have lots of arguments over who should do what job.
   - [1] Strongly disagree
   - [3] Neither agree nor disagree
   - [5] Strongly agree

3. There are clashes between subgroups within our team.
   - [1] Strongly disagree
   - [3] Neither agree nor disagree
   - [5] Strongly agree

4. There is agreement between my team and other teams.
   - [1] Strongly disagree
   - [3] Neither agree nor disagree
   - [5] Strongly agree

5. There is lack of mutual assistance between my team and other teams.
   - [1] Strongly disagree
   - [3] Neither agree nor disagree
   - [5] Strongly agree
PART IV – WORK DEMAND

Now we would like you to indicate how often certain things happen at your job. Please write the number for your response in the box to the right of each question.

1. How often does your job require you to work very fast?
   - [1] Rarely
   - [2] Occasionally
   - [3] Sometimes
   - [4] Fairly often
   - [5] Very often

2. How often does your job require you to work very hard?
   - [1] Rarely
   - [2] Occasionally
   - [3] Sometimes
   - [4] Fairly often
   - [5] Very often

3. How often does your job leave you with little time to get things done?
   - [1] Rarely
   - [2] Occasionally
   - [3] Sometimes
   - [4] Fairly often
   - [5] Very often

4. How often is there a great deal to be done?
   - [1] Rarely
   - [2] Occasionally
   - [3] Sometimes
   - [4] Fairly often
   - [5] Very often

5. How often is there a marked increase in the workload?
   - [1] Rarely
   - [2] Occasionally
   - [3] Sometimes
   - [4] Fairly often
   - [5] Very often

6. How often is there a marked increase in the amount of concentration required on your job?
   - [1] Rarely
   - [2] Occasionally
   - [3] Sometimes
   - [4] Fairly often
   - [5] Very often

7. How often is there a marked increase in how fast you have to think?
   - [1] Rarely
   - [2] Occasionally
   - [3] Sometimes
   - [4] Fairly often
   - [5] Very often
8. How often does your job let you use the skills and knowledge you learned in school?


Q.No. 12

9. How often are you given a chance to do the things you do best?


Q.No. 13

10. How often can you use the skills from your previous experience and training?


Q.No. 14

PART V – MENTAL DEMAND

Please indicate the degree to which you agree or disagree with the following statements about your job.

1. My job requires a great deal of concentration.


Q.No. 15

2. My job requires me to remember many different things.


Q.No. 16

3. I must keep my mind on my work at all times.


Q.No. 17

4. I can take it easy and still get my work done.


Q.No. 18

5. I can let my mind wander and still do the work.


Q.No. 19
PART VI – SELF ACCESSED STRESS

1. Do you think you get stressed?  □ Yes  □ No

2. Do you experience any of the following? Kindly give your responses using a tick mark.
   □ Job stress  □ Self-health related  □ Family related
   □ Child care stress  □ Financial stress

3. How do you react when you are stressed?
   □ I clench my teeth  □ I drink alcohol
   □ I bite my nails  □ I smoke when I get stressed

PART VII – WORKLOAD & RESPONSIBILITY

The following questions are concerned with various aspects of your work activities. Please indicate how much of each aspect you have on your job by writing a number in the box provided.

1. How much slowdown in the workload do you experience?


   Q.No. 25

2. How much time do you have to think and contemplate?


   Q.No. 26

3. How much workload do you have?


   Q.No. 27
4. What quantity of work do others expect you to do?

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5. How much time do you have to do all your work?

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6. How many projects, assignments, or tasks do you have?

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7. How many breaks do you have between heavy work load periods?

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8. How much responsibility do you have for the future of others?

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9. How much responsibility do you have for the job security of others?

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10. How much responsibility do you have for the morale of others?

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11. How much responsibility do you have for the welfare and lives of others?

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HEALTH CONDITIONS

Within the past twelve months, has a doctor ever treated you for, or told you that you had any of the following: Please put a tick if yes in the box at the right side of the page.

1. Diabetes
2. Cancer
3. Hernia or rupture
4. Tuberculosis
5. Asthma
6. “High” blood pressure
7. Heart disease
8. Arthritis
9. Epilepsy
10. Glaucoma
11. Paralysis, tremor, or shaking
12. Kidney or bladder trouble
13. Lung or breathing problems
14. Stroke
15. Anemia
16. Gall bladder, liver or pancreas trouble
17. Thyroid trouble or goiter
18. Insomnia
19. Gastritis
20. Colitis
21. Stomach ulcer
22. Alcoholism
23. Emotional problems

Thank you for your valuable time and effort! Your responses will be kept confidential.

DENTAL EXAMINATION INCLUDING CPITN INDEXING
(FOR RESEARCHERS USE ONLY)
For more information and clarifications

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Telephone: +46 90 785 29 33
Telefax: +46 90 13 89 77
http://www.umu.se/phmed/epidemi/
LETTER TO THE ADMINISTRATION OF SS

From,
Rathi Ramji,
Master Student in Public Health,
Dept. of Public Health and Clinical Medicine,
Umeå International School of Public Health,
Umeå, Sweden

To,
Mr. K.Srinivasan (Managing Director)/ Dr. J John Sukumaran (Medical Officer),
Carborundum Universal Limited,
Thiruvottiyur, Chennai 600019, India

Respected Sir,

Subject: Permission to conduct dental camp and research studies in your premises.

I am Rathi Ramji, a Dentist from India. At the moment I am pursuing my Master studies in Public Health from Umeå University, Sweden. As a part of my study, I am supposed to do a research thesis on Occupational Stress amongst Industrial workers as a cause for Periodontitis (Gum disease).

As you are probably aware, India is gradually improving in the field of research. In order to fasten this process, I am intending to work on Indian Industrial Workers to understand the relationship between work stress and the occurrence of gum disease. It would be kind if you permit me to do this study on workers from your factory. I am intending to be in India by 10th November 2009 and consider starting my study on the 12th November 2009.

I plan to do this study in two settings based on work routine and work load. I am also taking subjects for study from a factory in South Chennai district. I also would like to inform you that the identity of the subjects and the factory
will be kept away from the publications and research results, and is purely confidential. I will shortly send you the Informed consent form to be read thoroughly and signed by your workers. It is their right to decide to participate or not. But more the subjects are, it will be helpful for our research. I will also send you the questionnaire that I will distribute to your workers during the study for your reference alone. So that you could go through it and check if it does not affect your company policy in any way (which we hope it will not). Kindly do not let out the questionnaire to the workers as it will disturb the study.

It will be kind if you could get the informed consent readout to them and signed. This will help you in informing us about the number of subjects ahead of the study commencement. This also helps in arranging number of doctors for doing the dental examination. The informed consent form also includes the procedures that are going to be followed during the Dental camp and study.

Awaiting for your kind reply,

Yours Sincerely,

Rathi Ramji
LETTER TO THE ADMINISTRATION OF LS

From,

Rathi Ramji,
Master Student in Public Health,
Dept. of Public Health & Clinical Medicine,
Umeå International School of Public Health,
Umeå, Sweden

To,

Mr. R. Prakash Kumar,
Cylinder Liners Agencies Pvt Ltd. (CLAP),
Thandalam, Chennai 602101, India

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