

From the Department of Periodontology and Cariology,
Institute of Odontology,
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ABSENCE OF TOOTH ACHE SYNDROME

Oral Health and Treatment needs among
urban Pakistanis

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*This thesis is dedicated to my loving
parents, **Abuji and Mama**, for their love,
patience and support, who means a world
to me and occupy a big place in my heart*

The greatest gift I ever had came from GOD;
I call them Parents

A token of Immence Gratitude to my Loving parents

*I can't equal all the love you have given me,
But surely, I can keep trying all my life.....
To live upto your expectations.....and all your love*

PREFACE

I am privileged to be the first Pakistani dentist to present a thesis at the Department of Periodontology and Cariology, Institute of Odontology, Karolinska Institutet.

These years of postgraduate study have been richly rewarding. It has been a period of growth, self knowledge and warm friendships.

Oliver Smithies, the Nobel Laureate in Medicine 2007, said;

“Find something that you enjoy - because if you don’t, you won’t do well. And there is no substitute for hard work - I haven’t found one yet.”

As an ambassador for my country, I have been aware of my responsibility to project the true essence of Pakistan.

The collaborative project between the Odontological Institute of Karolinska Institutet (KI) and The Altamash Institute of Dental Medicine (AIDM) was formalized by an Instrument of Agreement in May 2002. I was the first beneficiary of this educational co-operative project, visiting KI as one of the teachers of AIDM, from February 10 to March 23, 2003, on a scholarship from the Linnaeus-Palme International Exchange Programme. During my visit the research project was finalized and my application as a PhD student was approved by KI.

The project was awarded a planning grant from SASNET (Swedish South Asian Studies Network) in 2005, and I was also awarded a scholarship from The Swedish Institute for the year 2007-2008.

To my knowledge, this thesis is the first of its kind: there has been little previous research into the oral health status of adult Pakistanis. The project is intended to highlight the periodontal and cariological status of the underprivileged population of Pakistan. It will provide initial information about the nature and severity of dental disease in Pakistani adults: an essential basis for the planning and provision of appropriate dental care facilities and personnel resources.

This project is intended to provide oral health statistics to aid in planning oral health care in Pakistan. It is hoped that this will be a stepping-stone to further research, eventually improving the lot of the people of Pakistan.

My goal as a doctor is also to serve mankind and to provide benefits for the people of my country. The participants in this project will benefit directly from my research, as they will be offered dental treatment at minimal cost at the Altamash Dental Hospital. This is indeed a privilege in a country where is no dental insurance system and private treatment is expensive.

This project is also intended to attract the attention of the government of Pakistan and WHO, to allocate resources and funds for the improvement of the oral health of the people, by providing for their dental treatment needs through the dental health sector. In our view, we anticipate that this research will have a great impact on the overall infrastructure of Community Dentistry in Pakistan.

I hope you will enjoy reading this thesis as much as I enjoyed writing it.

Happy reading!

A.G.OGSTON, 1911-1996

“For science is more than the search for truth, more than a challenging game, more than a profession. It is a life that a diversity of people leads together, in the closest proximity, a school for social living. We are members one of another.”

A.G.Ogston,
Australian Biochem. Soc. Annual Lecture,
Search, Vol.1, No.2, August, 1970.

ABSTRACT

Dental caries and periodontal disease are among the most common diseases affecting mankind. Oral diseases have a negative impact on an individual's quality of life and also represent a burden for health care systems worldwide. Populations in the developing nations are afflicted by a panorama of oral diseases similar to that of the developed nations: dental caries, periodontal diseases and oral mucosal diseases. In both developed and developing countries, the burden of oral disease is particularly high in underprivileged groups.

Pakistan, a developing nation, is excessively burdened by oral diseases, particularly dental caries and periodontal disease. The oral health status of adult Pakistanis is poorly documented.

The **general aim** of this thesis was to survey oral health and oral treatment needs among an adult population from a deprived area in Karachi, acquiring baseline data for future treatment strategies and research. The **specific aims** of the thesis were to describe perceived oral health and perceived treatment needs among adult Pakistanis; to survey oral health with special reference to habits, knowledge and attitudes; to investigate the influence of betel quid (pan) and betel nut (chalia) chewing on oral health; to relate objectively assessed dental treatment needs to perceived treatment needs; to relate objectively determined oral health status to risk factors such as betel nut habits; and finally, to determine whether - in this population with relatively poor oral health and poor oral hygiene - diabetes is associated with any specific oral problems. **Study I** disclosed that over half the population in this sample of underprivileged adults perceived oral health problems, predominantly esthetics, followed by pain and dental caries. **Study II** demonstrated that in this typical population of a deprived urban area, betel nut habits and frequency of oral hygiene had a strong influence on perceived oral health, while cleaning method and sugar intake did not. **Study III** showed that this population had poor oral health with a high prevalence of plaque, calculus and bleeding on probing. Moreover, they did not perceive oral health to be a major concern. A further finding was that while there was little need for major restorative work, the oral health of the community would benefit considerably from preventive measures such as scaling, minor restorative treatment and improvement in oral hygiene habits. In **Study IV**, diabetes was found to have a strongly negative influence on the oral health of this population with poor oral hygiene: compared to non-diabetics, those diagnosed with diabetes had fewer remaining teeth, more plaque and a higher prevalence of moderate to severe periodontal disease.

In conclusion, the results of the studies on which this thesis is based show that among urban adult Pakistanis, oral health is not perceived as a major concern and has low priority. No association was found between poor oral health and educational levels or socio-economic status. In general, major restorative treatment is not required: the primary unmet treatment need is for minor restorative work or preventive measures

such as scaling. Improving oral hygiene habits and dental health education could achieve major improvements in oral health.

In this population with poor oral hygiene, diabetics have more missing teeth and a higher prevalence of periodontitis.

Key words: betel nuts, bone loss, calculus, caries, dental care, oral health, oral hygiene, plaque, Pakistan, periodontal disease, questionnaire, treatment needs.

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LIST OF ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
BDJ	British Dental Journal
CAL	Clinical attachment loss
CPITN	Community Periodontal Index Treatment need
CP	Chronic Periodontitis
DMFT	Decayed missing filled teeth
DMFS	Decayed missing filled surfaces
EMRO	Eastern Mediterranean Region
FDI	World Dental Federation
GBI	Gingival Bleeding Index
GCF	Gingival crevicular fluid
GI	Gingival Index
GING	Gingivitis
GNP	Gross National Product
HIV	Human Immunodeficiency Virus
IARC	International agency for research on cancer
IDDM	Insulin Dependent Diabetes Mellitus
NCD	Non- communicable diseases
NDS	National Dental Service
NHANES	National Health and Nutritional Examination survey
NSAID	Non-Steroidal Anti-inflammatory drug
PD	Pocket depth
PI	Plaque Index
PNT	Post and Telegraph colony
ppm	Parts per million
PTDC	Pakistan Tourism Development Cooperation
SD	Standard deviation
Sci Dev Net	Science and Development Network
Sludge Syndrome	Salivation, Lacrimation, Urinary incontinence, diarrhea, GI-upset and hypermolality and emesis
WHO	World Health Organization
WHO- CAPP	The WHO Oral Health country/Area Profile Programme

INTRODUCTION

Oral health means much more than healthy teeth
Oral health is integral to general health
(WHO)

Global Oral health

The promotion of general health, with oral health as an integral component, has been recognized as one of the key factors for a successful and productive society. Health directly correlates with quality of life of both individuals and society, and also with economic and social development of countries as a whole (FDI)

ORAL HEALTH

Oral health is Global Health

Health status is not determined solely by biology: social, economic, environmental and other factors may also be important.

Oral health, an integral part of general health, is subject to these determinants.

Growing disparities between the rich and poor countries and between different population groups within the same nation are important characteristics of economic globalization in the late 20th and early 21st century. These differences are reflected in the growing disparity in oral health between the rich and the poor throughout the world (The Commonwealth Oral Health Statement- BDJ 2001).

Populations in the developing nations are afflicted by the same oral diseases as in those in the developed nations: dental caries, periodontal disease and oral cancers. In poorer nations, oral diseases are superimposed on poverty and lack of education. A major obstacle is the lack of commitment by national leaders in developing countries in providing cost-effective approaches to the prevention and treatment of oral diseases (Greenspan 2007).

HEALTH PROMOTION

The process of enabling individuals and communities to increase control over the determinants of Health, and thereby improve their health. Health promotion represents a mediating strategy between people and their environment, combining personal choice and social responsibility for health to create a healthier future

(WHO 1984)

HEALTH EDUCATION

Any planned combination of learning experiences designed to predispose, enable, and reinforce voluntary behavior conducive to health in individuals and groups or communities

(Green and Kreuter 1991)

Global burden of oral diseases

Global perspective of oral disease

Despite great improvements in the oral health of populations in many countries, problems still persist on a global scale. The burden of oral disease is particularly high in underprivileged groups in both developing and developed countries. Oral diseases such as dental caries, periodontal disease, tooth loss, oral mucosal lesions and oropharyngeal cancers, HIV/AIDS- related oral disease and orodental trauma are major public health problems worldwide.

Poor oral health has a profound effect on general health and quality of life. Poor living conditions, major risk factors related to unhealthy lifestyles (poor diet, nutrition and oral hygiene and use of tobacco and alcohol), and limited availability and accessibility of oral health services are all contributing factors. Several chronic systemic diseases of global importance, such as diabetes, have a negative impact on oral health. Thus, the challenge of improving oral health is particularly great in developing countries (Petersen et al. 2005).

BURDEN OF DENTAL DISEASE

Oral diseases have a great impact on quality of life and represent a substantial burden for health care systems world wide (FDI).

The burden of oral disease among older people is high and this has a negative effect on their quality of life. Dental caries and periodontal disease have historically been considered the most important global oral health burdens (Petersen et al. 2005). They are also the most common oral diseases affecting mankind (WHO 2007).

Dental caries

Background

Caries is an ancient disease that continues to afflict millions of people today. It is a chronic, infectious disease initiated through a series of complex chemical and microbial reactions that result in the destruction of the calcified tissues of teeth (enamel, dentine and cementum). It develops insidiously over a long period of time, progressing from the surface of the tooth to the interior. In theory, dental caries is a continuum that begins with the loss of calcium ions from hydroxyapatite crystals and ends with destruction of the tooth surface. Between the two events, there occurs a fluctuating process of demineralization and remineralization, resulting first in a subclinical lesion and eventually in the production of a white spot lesion (Antonio 2003). White spot lesions then progress to incipient, cavitated lesions which in turn enlarge to become clinically discernible cavities.

Archeological evidence shows that caries has afflicted humans at least from the time that agriculture replaced hunting and gathering as the principal source of food. Evidence from skulls in Britain suggests that caries prevalence changed little in nearly a thousand years from the 5th century (Burt and Eklund 2005).

Dietary changes during the 17th century, principally the refinement and greater use of sucrose as sugars became more available, are considered chiefly responsible for the development of the modern pattern of caries. In Britain, there was a marked increase in the severity of caries following the removal of import duties on sugar in 1875. By the end of the 19th century, dental caries was well established as an endemic disease of massive proportions in most developed countries (Burt and Eklund 2005).

Global Burden

Dental caries is still a major health problem in most industrialized countries: it affects 60-90% of school aged children and the vast majority of adults (WHO 2007). Dental caries experience in children is relatively high in America (DMFT=3.0) and in Europe (DMFT= 2.6), but lower in most African countries (DMFT= 1.7) (Petersen et al. 2005). In Pakistan, the DMFT is quite low 1.38 (WHO 2004).

In 1980, the WHO Oral Health Data Bank had DMFT values at age 12 for 107 out of 173 countries: in 51%, DMFT was ≤ 3 and higher in the remaining 49% of countries. In the year 2000, data from 84 countries were recorded in the WHO Oral Health Country/Area Profile Programme. Of these, 68% had $DMFT \leq 3$ (Petersen 2003).

In most developing countries, the level of dental caries has been historically low but a trend towards increasing prevalence is emerging. This is largely due to increasing consumption of sugars and inadequate exposure to fluorides.

In contrast, a decline in caries experience has been observed in most industrialized countries over the past 20 years. This is attributable to a number of successful public health measures, including effective use of fluorides, together with improved living conditions, lifestyles and improved self-care practices. It must be emphasized that dental caries as a disease of children has not been eradicated, but only controlled to a certain degree (Petersen 2003; Petersen et al. 2005). Of particular concern is the fact that in low- income countries, 90% of the caries remains untreated (FDI-World Dental Federation).

Worldwide, the prevalence of dental caries among adults (35-44 year olds) is high, affecting nearly 100% of the population in most countries (Petersen 2003; Petersen et al. 2005).

Most industrialized countries and some countries of Latin America have high DMFT values (≥ 14), whereas levels of dental caries experience are much lower in the developing countries of Africa and Asia, including Pakistan (Petersen et al. 2005).

Periodontal diseases

Background

Like caries, periodontal diseases (gingivitis and periodontitis) are infectious diseases involving the tissues supporting the teeth. Gingivitis is defined as an inflammatory

process in which the junctional epithelium, although altered by disease, remains attached to the tooth at its original level whereas periodontitis is a chronic, tissue-destructive condition where the collagen fibers of the tooth-supporting ligament and bone are destroyed, primarily by the host's immune inflammatory response to the Gram – negative bacterial challenge in the gingival crevice (Kinane and Lowe 2000). If untreated, the disease will lead to loss of teeth (Hugoson et al. 1998a).

Epidemiological surveys from the 1950's and 60's disclosed a high prevalence of periodontal breakdown in 35-60% of the adult population. The prevalence and severity are higher in low-income countries, probably because of the higher prevalence of gingivitis and calculus deposits (Burt and Eklund 2005). However, epidemiological data from the 1980's and 90's indicate that severe periodontal breakdown affects only a minority (5-8%) of otherwise healthy individuals in the industrialized countries (Hugoson and Jordan 1982; Oliver et al. 1998; Papapanou 1996). Recent trends and prevalence of periodontitis in USA: the NHANES, 1988-2000, indicated a decrease in the prevalence of periodontitis between the NHANES III and the NHANES 1999-2000, from 7.3% to 4.2%, for all racial groups in USA ($p < 0.001$). In the NHANES III, 11.4% of blacks, 6.9% of Mexican-Americans and 6.7 % of whites had periodontitis, whereas the corresponding values recorded in NHANES 1999-2000 were 6.8% for blacks, 4.6% for Mexican-Americans and 3.8% for whites ($p < 0.001$) (Borrell et al. 2005).

Global burden

As with caries, periodontal disease is also a major global public health problem. Severe periodontitis which may result in tooth loss is found in 5-20% of most adult populations worldwide (WHO 2007). The data available from the WHO Global Oral Health Data Bank (WHO 2004) indicate that symptoms of periodontal disease are highly prevalent among adults (35-44years) in all regions. Almost all children and adolescents have signs of gingivitis whereas aggressive periodontitis, a severe periodontal condition affecting individuals during puberty and which may lead to premature tooth loss, affects about 2% of youth (Petersen 2003; Petersen et al. 2005).

IMPACT OF ORAL DISEASE

Since oral health is integral to general health, oral diseases directly affect quality of life and may have a serious impact on an individual's well being, self-esteem, social interaction and financial status (FDI).

Although oral diseases are rarely life-threatening conditions, a healthy mouth undoubtedly improves the quality of life, whereas compromised oral health results in diminished overall health and productivity (Pack 1998).

In developing countries, including Pakistan, oral health services are usually provided at the regional or central hospitals in urban centers. Little if any preventive or restorative dental care is available. Many countries in Africa, Asia, and Latin America have a shortage of oral health personnel and dental services are generally limited to pain relief or emergency care.

In Africa, the dentist to population ratio is approximately 1:150 000, compared with about 1:2000 in most industrialized countries. In children and adults suffering from

severe tooth decay, the teeth are often left untreated or extracted to relieve pain or discomfort. Public health problems related to tooth loss and impaired oral function are therefore expected to increase in many developing countries (Petersen et al. 2005). In Pakistan, a survey conducted in 2001 disclosed that there were only 4343 qualified dentists, giving a dentist to population ratio of 1:34, 351 (Pakistan.doc 2003).

ECONOMIC GLOBALIZATION AND ORAL HEALTH

The economic impact of oral disease

The major determinants of a number of oral conditions appear to have a socio-economic basis in which economic globalization could be playing a part. These conditions include cancer, cancrum oris (noma), dental caries and periodontal diseases (Hobdell 2000).

In most industrialized countries, oral diseases are among the most expensive to treat. The burden of oral disease has been addressed by the establishment of advanced oral health systems which primarily offer curative services to patients. Most systems are based on demand for care and oral health care is provided by private dental practitioners to patients, with or without insurance schemes (Petersen et al. 2005). Conventional curative dental care is a significant economic burden for many industrialized countries: 5-10% of public health expenditure relates to oral health (Petersen et al. 2005). In most developing countries, expenditure on oral health care is low: resources are allocated primarily to emergency care and pain relief. In Pakistan, only 3.5% of GNP is spent on health care, with public expenditure being <1% of GNP. In developing countries the average is about 3.5% of GNP (Pakistan.doc. 2003; WHO 2004). By contrast, the corresponding value for Sweden in 2002 was 8.7% (WHO 2005).

Epidemiology

Epidemiology has been a central issue within oral health care and must be considered a vital instrument for the analysis of a populations treatment needs, the planning of suitable measures, and the evaluation of the care received. Furthermore, it is a tool for the development of quality in dental care. If properly used, information from epidemiological investigations is the most natural and important source of data for the prospective analysis of the development of oral health and the care that will be needed in a population

(Hugoson et al. 2005b)

ORAL HEALTH IN DEVELOPED COUNTRIES

The decline in dental caries in industrialized countries is attributed primarily to the widespread use of fluoride toothpastes, a change in diet and infant feeding patterns, and an improvement in oral hygiene as well as socio-economic factors (FDI).

Some countries, including the Scandinavian countries and the United Kingdom, have organized public health services, providing oral health care, particularly to children and disadvantaged population groups (Petersen et al. 2005).

SWEDEN AS A MODEL FOR POPULATIONS WITH BETTER ORAL HEALTH

Oral health in Sweden

Many epidemiological studies have shown improvement of dental health in Sweden (Hugoson et al. 2005a, b; Hugoson et al. 1998a) due to better living conditions. Periodontal diseases such as gingivitis and periodontitis affect many people in Sweden. An improvement in oral hygiene between 1973 and 1983 led to a decrease in the frequency of plaque and gingivitis (Hugoson et al. 1998b). This is probably associated with the introduction in 1974 of a national dental insurance plan which included preventive dentistry (Osterberg et al. 2000).

A prospective longitudinal study on periodontal bone height changes in a Swedish population over a period of 17 years showed all age groups except the youngest had very good oral hygiene, with $\geq 50\%$ having plaque and gingivitis scores below 20% (Hugoson and Laurell 2000).

Health care is provided by a national social insurance system, which also provides sick pay child benefits, disability allowances and pensions. 8% of the total government spending on health care is spent on dentistry. The public dental service provides free treatment to children and adolescents up to the age of 19 years, and adults and the elderly can receive subsidized dental care from the NDS or even dentists in private practice. A recall is done every 2 years (WHO 2005).

A recent review (Hugoson et al. 2005a, b) of dental care habits and knowledge of oral health among individuals aged 3-80 years in Jonkoping, Sweden from 1973 to 2003 also showed great overall improvement in oral health during this 30 year period. In 2003, approximately 90-95% of all individuals were regular dental attenders, with recall appointments every two years. About 70-80% of all adults in 2003 were enrolled in a recall system, set up on the dentist's initiative. More than 90% brushed their teeth once or twice a day and all used fluoride toothpaste (Hugoson et al. 2005a). The clinical and radiographic findings showed an increase in the mean number of teeth. Nearly all 60 year-olds had almost complete dentitions. Generally the number of carious lesions decreased with a corresponding increase in the number of restored surfaces, showing an increase number of remaining teeth. Oral hygiene had improved markedly: in 2003 there was a 50% reduction in plaque and gingivitis (Hugoson et al. 2005b). The dental insurance system made dental care cheaper and thus affordable to most of the population.

The Swiss Health Survey conducted 5 yr cross-sectional studies. The results for 1992 and 2002, showed an increase over the 10 year period in the retention of natural teeth and a consequent increase in the mean number of teeth by 1.3, showing evidence of improvement in oral health of this population (Zitzmann et al. 2008).

ORAL HEALTH IN DEVELOPING COUNTRIES

Caries prevalence, high rates of periodontal disease and widespread oral mucosal disease constitute the major oral health problems in the developing countries (Saparamadu 1984).

People in developing countries are excessively burdened by oral diseases, particularly dental caries and periodontal diseases. These are aggravated by poverty, poor living conditions, lack of education about health and disease and failure of governments to fund sufficient oral health care workers (Pack 1998).

It is noteworthy that in less developed countries, dental caries is increasing in prevalence and severity. The most rapid increases are occurring in the urbanized, higher socio-economic groups, reflecting economic and cultural trends associated with the change of traditional lifestyles, i.e from starchy foods to greater consumption of refined sugars, and lack of oral hygiene. Of particular concern is the fact that 90% of the caries in developing countries remains untreated (FDI).

In developing nations, greater proportions of the population fall into the 'disadvantaged' category because of crowding, poverty, poor educational opportunities and malnutrition (Pack 1998).

Individual attitudes and knowledge related to health beliefs and values may also influence oral health outcomes. Related to this is poor self esteem, a bleak future outlook and a more pessimistic view of health matters in general. In turn these attitudes can affect oral health behavior, people in deprived circumstances are reluctant to assume personal responsibility for their oral health care (Pack 1998).

Studies on cariological and periodontal status of populations with poor oral health

People in developing countries usually have limited access to dental care, more extensive gingivitis and higher levels of plaque and calculus than people in more economically developed countries.

Many epidemiological studies have confirmed the generally poor oral health of adults in developing countries. (Ronderos et al. 2001) reported periodontal disease among indigenous people in the Amazon rainforest: high levels of plaque, calculus, and BOP. The subjects had gingival recession, but despite poor oral hygiene and extensive gingival inflammation, they did not have very severe periodontal destruction.

Studies on Chinese populations show a high prevalence of age-dependent dental caries, indicating that when oral hygiene is poor, carious lesions continue to develop and progress throughout life (Luan et al. 1989). Another study, of a Chinese agricultural community, disclosed poor oral health expressed as an increased prevalence of periodontal variables, calculus and gingivitis, but low mean DMFT (2-6) among those aged 35-44 years (Lin and Schwarz 2001). Poorer periodontal condition was also recorded in an urban population in Shanghai: all the elderly in the study had calculus (Hu et al. 1990).

An epidemiological survey of a population of rural Chinese adults demonstrated that a large number suffer loss of teeth over a 10 year period and its incidence increases with age. At subject level, caries and periodontal variables seem to be equally important

predictors of tooth loss, but at tooth level, caries seem to predominate (Baelum et al. 1997).

There is relatively little epidemiological information on dental status and prevalence and severity of dental caries among adults of the Indian subcontinent. A comprehensive review of dental caries among different Southeast Asian populations indicates high caries prevalence (45% to 98%), but the DMFT levels are much lower than for US adults (Tewari et al. 1991). High caries prevalence (91%) was reported for 30-39 year olds in Thailand, but the mean number of teeth present was high, 29.4 (Baelum et al. 2002).

In Poland, part of the developing world, studies indicate unsatisfactory oral status: both rural and urban populations are characterized by poor periodontal status and high prevalence of dental caries. This indicates that oral health is influenced by individual attitudes and behavior with respect to dental treatment on the one hand and social and living conditions and the organization of dental care on the other (Szymanska and Fetkowska-Mielnik 1998).

Studies on elderly Indians have also shown high caries experience (72.4%), with little evidence of previous restorative treatment and a significant unmet treatment need (Shah and Sundaram 2004). Another study in India also showed high caries prevalence (77.6%) and poor periodontal health in all the participants (Rao et al. 1999). A study of 300 southern Indians by Thomas et al (1994) also showed a high mean DMFT (13.51): the average number of teeth was 18.42 but not one subject had a filled tooth.

A study of Singaporean adults disclosed poor oral hygiene: 96.6% were dentate and 79.2% had calculus. The mean DMFT was 10.7 (Loh et al. 1996).

Dental caries was also highly prevalent among Vietnamese villagers and 87% had periodontal problems, highlighting the need for oral health promotion (Uetani et al. 2006).

In 1984, the ratio of dentists to the inhabitants was greater in Japan than in many other countries: one dentist to 1905 inhabitants. In addition Japan has a medical insurance system. However, periodontal disease is prevalent. This is attributable to the restrictions of the medical insurance system, which reimburses only treatment. Thus, the fee for medical treatment is low while preventive care is costly (Miyazaki et al. 1989; Miyazaki et al. 1995).

Studies in UK on Bangladeshi female adults showed lower caries experience and less tooth loss than the indigenous population. Traditional oral hygiene practices were common, but demand for dental services was low, suggesting low dental awareness (Williams et al. 1996).

Other studies on ethnic groups living in UK showed that Indians and Bangladeshi adults had mean DMFT of 9.9 and 2.8 respectively. Most were dentate, with 18 or more sound teeth (Robinson et al. 2000). Another study on Asians living in Southampton, UK, also reported that most of the participants were dentate (70%), but the majority was in need of periodontal treatment (Mattin and Smith 1991). A study on Bangladeshi medical service users in UK showed low caries experience and tooth loss and a high level of periodontal diseases: 98% of all the individuals examined had calculus, indicating very high unmet periodontal treatment need and poor oral health (Pearson et al. 2001).

The subjects of the present series of studies comprise a group of adults with poor oral hygiene, from one of the colonies of the city of Karachi, Pakistan, as representative of the underprivileged people of the developing nations.

PAKISTAN AS A MODEL FOR POPULATIONS WITH POOR ORAL HEALTH

Pakistan

Background

Pakistan is part of the Indian subcontinent, in Southern Asia, (EMRO, Eastern Mediterranean region- WHO CAPP) bordering the Arabian Sea, between India on the east and Iran and Afghanistan on the west and China in the north. It has a population of 164,741,924 (CIA-July 2007 est.). The age categories are:

0-14 years: 36.9% (male 31,264,576/female 29, 507,174)

15-64 years: 58.8% (male 49,592,033/female 47,327,161)

65 years and over: 4.3% (male 3,342,650/female 3,708,330) (CIA-2007 est.)

The population growth rate is 1.828% (CIA-2007 est.), with total fertility rate as 3.71 children born/woman (CIA-2007 est.). Only 34% of the people live in the urban areas. It is the ninth most populous country in the world.

Like many other developing countries, Pakistan is becoming increasingly urbanized. The associated changes in social structures are accompanied by changes in disease patterns and treatment needs.

WHO has statistics for children only, and there is little information about the oral health of Pakistani adults. According to the 2003 WHO report, the DMFT value for children 12-15yrs is 1.38. The periodontal profile of 15-19 year olds in 1991 is based on examination of 561 subjects, of whom 26% had no disease, 20% had bleeding on probing, 5% had calculus, 2% had pocketing of 4-5mm, and none had pocketing \geq 6mm (WHO- CAPP).

At public dental clinics run by the national health system under the social welfare department, treatment is rudimentary, primarily alleviation of pain by medication and extraction. Private insurance is almost non-existent: only 2% in 2001 (Pakistan.doc 2003). The number of registered dentists in Pakistan is 5108. There are only 327 dental specialists (WHO 2004).



Fig 1: With permission from Pakistan Tourism development Cooperation (PTDC).

Oral health in Pakistan

Oral diseases, particularly caries and periodontal disease, are an excessive and unnecessary burden on the people of Pakistan. Although oral diseases are preventable, inadequate application of preventive measures and inappropriate oral health care delivery systems have resulted in ineffective control of these problems (WHO 2004). Very little information is available about the oral health and dental treatment needs of adult urban Pakistanis. The only data are from a national pathfinder study, a pilot study conducted on a sample equally distributed in four provinces of Pakistan, comprising 13 urban and rural areas. Dental caries was reported in 78 per cent of adults. The DMFT index was 4.6 in the 35-44 year-olds, increasing to 18.3 in 45-54 year-olds. The percentage of periodontally healthy subjects was 32 per cent at age 12, decreasing to 10.4 per cent at age 50. Calculus was the most frequently observed condition in all age groups (Maher 1991).

There are several published studies on the oral health of Pakistani children. Haleem and Khan (2001) reported the prevalence of dental caries and oral hygiene status in a survey of 3157 12 year-old children in 15 cities throughout Pakistan. Prior to this, no national survey had been undertaken since 1998 (WHO 1988). Haleem and Khan reported an improvement in the oral status of urban schoolchildren since 1988. The proportion of caries-free children had increased from 50 % in 1988 to 63.75 % in 1999, with a marginal decline in mean DMFT score from 1.0 to 0.9. The percentage of children with calculus had decreased from 51 to 34 %. However, despite the overall improvement, there was a considerable unmet treatment need, particularly for professional scaling and restoration of carious teeth. Treatment need was noted in a higher proportion of children attending public schools, with almost no access to dental services, than in children at private schools. The survey highlighted the need for school-based dental health services (Haleem and Khan 2001).

Unmet treatment need had also been disclosed in an earlier study of the prevalence of dental disease and oral hygiene habits of schoolchildren in Lahore. Alarming, 95 % of the total score for caries comprised decayed teeth, i.e. untreated disease. Although 93 % of the subjects in the sample practiced some form of oral hygiene, only 27 % were assessed as periodontally healthy (Khan et al. 1991).

Another survey of 12 and 15 yr old Pakistani children by Khan (Khan 1992) disclosed no gender-related difference in caries prevalence and caries experience was the same in the two age groups, DMFT 1.2. 98.5% of all carious teeth needed treatment but 50% of these children were caries free.

A study on 12 -15 yr-old children in a remote area of Pakistan also disclosed a low DMFT score (1.19), but the decayed component was 3.70, indicating poor awareness of oral health and lack of dental facilities. The results also showed that 60% of the participants needed periodontal treatment (Iqbal and Ram 2004).



Fig 2: Typical patient male (45 years) showing extensive amount of characteristic plaque and calculus.

Burden of oral disease (Dental caries and Periodontal disease) in Pakistan

Oral health has had low priority in the health services of Pakistan. There are large unmet dental treatment needs in the population: over 90% of all oral diseases remain untreated (WHO 2004). From young adults to 50 year olds, lack of perceived dental treatment needs appears to be the most frequent reason for not going to the dentist (WHO 2004). This lack of perception of needs, or '*absence of toothache*', causes delays in seeking treatment until an acute condition arises. Thus, many patients present with teeth irreparably damaged by advanced caries and extractions comprise 90% of all treatment in public dental clinics (WHO 2004). Moreover, preventive measures comprise less than 3% of services at the public dental clinics and are testimony to the abysmal lack of oral health education, preventive practices and the lack of dental health programs in the country (WHO 2004).

The 2004 situation analysis of the oral health sector in Pakistan was undertaken in order to collect baseline data at a national level. This survey examined almost 9000 individuals in 21 districts of the country. Based on the findings of this survey, Pakistan may be classified as a low caries country. For the 35-44 year-old group, half the lesions are untreated while more than 90% of the treatment offered is extraction. An increase in the sugar consumption of Pakistan may explain the observed rise in caries experience (WHO 2004).

The higher prevalence of caries in the rural areas was of particular importance. . This survey also showed that caries is very strongly age-related and the average number of affected teeth rises to almost 18 per individual over the age of 65. Table 1 presents the DMFT score for 35-44 year-olds at national, urban and rural levels (WHO 2004).

Table 1: Mean Decayed Missing Filled (DMFT) scores at national, urban and rural levels.

	Age (years)	Decayed(D)	Filled(F)	Missing(M)	DMFT
National	35-44	4.64	0.45	2.93	8.02
Urban	35-44	4.60	0.58	2.64	7.82
Rural	35-44	4.71	0.27	3.35	8.33

The prevalence of periodontal disease was around 80%. However, it was concluded that severity was moderate and hence its effect on the longevity of the dentition is also moderate. These results indicate that periodontal disease, including inflammation of gums and the presence of calculus, is endemic in Pakistan (WHO 2004).

In this survey, periodontal status was expressed as the Community Periodontal index (CPI) using three indicators: gingival bleeding, calculus, and periodontal pockets 4-

5mm and \geq 6mm. The results for the 35-44 age groups are shown in Table 2 (WHO 2004).

Table 2: Percentages of individuals with CPITN scores at national, urban and rural levels.

	Age (years)	Healthy	Bleeding	Calculus	Periodontal Pocket 4- 5mm	Periodontal Pocket >6mm	Excluded
National	35-44	16.80%	22.50%	33.90%	10.20%	6.70%	9.90%
Urban	35-44	11.90%	17.50%	47.80%	6.20%	6.70%	9.90%
Rural	35-44	21.70%	27.50%	40.00%	14.20%	6.70%	9.90%

Both caries and periodontal disease were more common in rural districts. The survey showed that one-third of the population requires scaling or complex periodontal surgery. It is also an indication of the enormity of unmet treatment needs, which are more pronounced in the rural population (WHO 2004). Dental caries and treatment experience of Pakistani adults from minority ethnic communities living in South Thames Region, UK also showed that most of the Pakistani adults were dentate but had a mean DMFT score of 8.1 (Robinson et al. 2000).

Oral hygiene habits in Pakistan

The importance of oral hygiene is not a new concept for the Muslims of the country, as the religion strongly advocates clean teeth.

Little is known about the oral hygiene habits of Pakistanis. A study of school children 12 and 15 years old was conducted by Khan in 1991: 93% of the total sample claimed to maintain oral hygiene. Brushing was the most popular technique, followed by miswaq/dandassa use and then a locally produced dentifrice (manjan). Less than 27% of the sample was in good periodontal health and this percentage decreased with increasing age. Almost 50% had visible calculus deposits (Khan 1991).

Similar results were found in another study on children in Pakistan (Ishaque and Khan 2001): more than 80% claimed that they used a toothbrush, 15% used a finger for cleaning their teeth, 7% used a miswaq and 10% used none of these methods. A recent study by Iqbal and Ram (2004) on children in a remote area of Pakistan disclosed very poor oral hygiene habits, only 30% on average stating they brush their teeth daily. Gingival condition was compromised in 60% of the sample. The overall DMFT was 1.19.

There are few studies of the oral hygiene habits of adult Pakistanis. A question about oral hygiene habits was included in a health survey of patients, mostly young married men, attending The Family Practice Centre, Agha Khan University. 88% claimed to clean their teeth daily (Qidwai et al. 2003).

The oral health survey in 2004 in Pakistan showed that 90% of the population cleans their teeth. The means varied: toothbrush and toothpaste, toothpowder, local mixtures of salt, bark of various trees (dandassa) and a chewing stick or 'miswaq': 50% used a miswaq, followed by toothpowder (WHO 2004). Although 90 % claimed that they cleaned their teeth, the survey also disclosed that >80% had some form of periodontal disease and >40% had calculus deposits.

These few studies highlight the poor oral hygiene status of Pakistani children and adults and clearly indicate the need for more detailed documentation of oral hygiene habits, especially in the adult population.

Need for more epidemiological studies in Pakistan

The oral health of adult urban Pakistanis is poorly documented. There is a need for baseline information about their knowledge, attitudes and practices with respect to oral health and the factors affecting it. On the basis of this information, dental health education could be tailored to their specific needs and circumstances. It is believed that a better understanding of the etiology of oral diseases would in turn motivate changes which would improve oral health status, and ultimately quality of life. The information from such studies would also find a broader application in providing a basis for future oral health strategies and research.

“HEALTH FOR ALL”

This concept as applied to the people of Pakistan still remains a distant dream and the task of providing primary Oral health care appears to be enormous and challenging indeed. Strategies should therefore be considered to meet the oral health needs of Pakistani people by providing the best quality care for the lowest possible cost, maximizing treatment effectiveness and reaching those in greatest need of our services. These programs can be a foundation upon which can be built a comprehensive oral health care system

(Adapted from Rao et al. 1999)

BETEL NUT (CHALIA) AND BETEL QUID (PAN) CHEWING HABIT

Background

Betel nut (Chalia), also known as Pinang, or Areca nut, is the seed of the Betel Palm (Areca Catechu). This tree grows in much of the tropical Pacific, Asia, and parts of east Africa. Betel nuts contain alkaloids like arecaine and arecoline, which, like nicotine, have stimulating, mildly intoxicating and appetite suppressant effects. Chewing betel nut is a widespread and popular cultural activity in many Asian countries (WHO 2003). Millions of people across Asia chew betel-quid for its stimulant effect, to satisfy hunger, and to freshen the breath (Sci Dev Net 2007). It is also slightly addictive. It has psychoactive and cholinergic effects. High doses of betel nut can induce cholinergic toxicity with the SLUDGE syndrome (salivation/ sweating, lacrimation, urinary incontinence, diarrhea, gastrointestinal upset, emesis) (Nelson and Heischouer 1999). Betel nut chewing has been shown to have a deleterious effect on the gums. The nut may cause red staining of the teeth, mouth, lips and stools and burning and dryness of mouth may also occur. It is reported that ingestion of 8 to 30 grams of areca nut may be fatal. (Medline Plus)



Fig 3: Betel nuts (www.goldenagro.com/betelnut.)

Botanical Classification

Family: Arecaceae (Palmaceae)

Genus: Areca

Species: Catechu

(Erowid Betel Vault)

Betel quid (Pan), generally has three components: betel leaf (from the Piper betel vine), betel nut (from the Areca catechu tree), and slaked lime (calcium hydroxide), to which tobacco is often added. Other ingredients and flavoring agents like catechu gum, cardamom, cloves, aniseed, cinnamon, nutmeg, sugar syrup, water and gold or silver metal may be included according to local preferences and practices (WHO 2003 & Medline Plus).



Fig 4: Betel quid (www.goldenagro.com/betelnut.)

A Widespread habit

Betel quid (Pan) and Betel nut (Chalia) chewing are widely practised in many parts of the Asia and also in Asian-migrant communities elsewhere in the world. Betel-nut is the fourth most common substance of abuse in the world and is used by 600 million people worldwide (Nelson and Heischouer 1999). Traditional and commercially packaged products are freely available in pan shops in many cities outside Asia.

The United Kingdom is the major non-Asian importing country and imports have doubled since the early 1980's. It is also popular among immigrants resident in other parts of Europe, North America and Australia (WHO 2003).

Pakistan imports over 100,000 tonnes of betel nut from Indonesia and India annually. The total industry is valued at Rs.160 million for 2,000 tonnes of white variety of betel nut, which is endemic to Dakshina Kannada and Northern Kerala and the rest from Indonesia. The value of imports of betel nut from Indonesia to Pakistan amounted to US \$ 7.03 million in 2000, fell to US\$ 6.48 million in 2001 and increased to US\$ 7.44 million in 2002 (Bhurgri 2005) and Jakarta Business News 2003)

Young children start using sweetened betel nut products, often adding tobacco when they reach adolescence (WHO 2003).

In recent years, the introduction to the world market of a variety of commercial betel-quid and betel-nut products (pan masala and betel quid mixture, gutka) - combined with aggressive marketing campaigns - has resulted in a huge increase in consumption (Sci Dev Net 2007). Within a short period of about two decades, this industry has risen in value to several hundred million US dollars (Gupta and Ray 2004).

A Cancer causing habit

The IARC, International Agency for Research on Cancer, an agency of the World Health Organization, reported in 1985 that chewing betel quid with tobacco is carcinogenic to humans. According to a recent report from WHO, betel quid and betel nut chewing are carcinogenic even when consumed without tobacco (Trivedy et al. 2002; Warnakulasuriya et al. 2002). Recent epidemiological studies in South Asia have been able to separate the effects of betel quid use with and without tobacco (WHO 2003). Betel quid with tobacco causes oral, pharyngeal and oesophageal cancers in humans. Betel nut has been observed to cause oral sub mucous fibrosis (a premalignant condition that can undergo malignant transformation to oral cancer).

Global Burden

The incidence of oral cancer ranges from 1 to 10 cases per 100,000 populations in most countries (WHO 2007). Oral cancer is the eighth most common cancer worldwide. In some Asian countries, oral cancer accounts for up to 50% of all cancers. Three quarters of oral cancer cases occur in developing countries (FDI). Prevalence is particularly high in men. In Asia, the age standardized incidence rate of oral cancer per 100 000 population ranges from 0.7 in China to 4.6 in Thailand and 12.6 in India. In south-central Asia, cancer of the oral cavity ranks amongst the three most common types of cancer. However, in recent years, sharp increases in the incidence rates of oro/pharyngeal cancers have been reported in Denmark, Germany, Scotland, central and eastern Europe and to a lesser extent, Australia, Japan, New Zealand and the USA (Petersen 2003; Petersen et al. 2005). It has been shown that Asian immigrant communities have a significantly higher risk for oral cancer than natives of countries where they have settled: a major contributing factor is betel nut use.

Global prevalence of oral cancer

Oral cancers are more common in parts of the world where betel quid is chewed. Of the 390,000 oral and oropharyngeal cancers estimated to occur annually, 228,000 (58%) occur in South and South-East Asia (Ferlay et al. 2004 & WHO 2003). In some parts of India, oral cancer is the most common cancer. In parts of Taiwan and China, the incidence of oral cancer in men has tripled since the early 1980's, coinciding with a steep rise in the number chewing betel nut. Tobacco is generally not added in these regions. In India, one in three children and teenagers occasionally or regularly chews these products (WHO 2003).

Studies on Betel-nut (Chalia) and Betel quid (Pan) including Pakistan

The National Health Survey of Pakistan (1990-94) found that almost 10% of the country's population habitually chews betel nut in one form or another. Betel-nut (supari/pan masala) is served on many occasions, especially at weddings. A situation analysis survey of Pakistan in 2004 indicated that tobacco use is also very common: approximately 34% of men and 12.5% of women regularly use tobacco in some form (WHO 2004).

In Pakistan, oral cancer is the second most common cancer in women and the third most common in men. The following study by Merchant et al (2000) identified the independent effect of betel quid without tobacco as a cause of oral cancer. Between 1996 and 1998, primary cases of oral squamous cell carcinoma, confirmed by biopsy, were recruited from 3 tertiary teaching centers in Pakistan, with controls matched for age, gender, hospital, and date of onset. There were 79 cases (68% men) and 149 controls. The results showed that people with oral sub mucous fibrosis were 19.1 times more likely to develop oral cancer. Compared to non-users, those using betel quid without tobacco were 9.9 times and those using betel quid with tobacco 8.4 times more likely to develop oral cancer.

The incidence of oral cancers in the Karachi South district is the highest in the world. The most common site is the buccal mucosa (55.9%), followed by the tongue (28.4%), palate (6.8%), gingiva (4.4%), lip (3.1%), and floor of the mouth (1.4%). About 30% of cases occur in patients aged ≤ 40 years and 23% in those aged ≥ 65 years (Bhurgri 2005). Betel quid is associated not only with oral cancer but also with increased risk of pharyngeal and oesophageal cancer.

Besides cancer, betel nut chewing is also associated with a high frequency of other oral soft tissue lesions. Betel nut induced lichenoid lesions, mainly on the buccal mucosa or the tongue, develop at the sites at which the quid is retained. In chronic chewers, a condition known as betel chewer's mucosa, a discolored, betel nut -encrusted change, is often found at quid retention sites (Reichart and Phillipsen 1998; Trivedy et al. 2002). Betel nut stains the oral mucosa to a deep red color. It also causes "betel chewer's perleche", consisting of fissures at the angles of the mouth produced by constant moistness and maceration. These improve with the cessation of betel quid usage (Nelson and Heischober 1999). Betel nut chewing is implicated in oral leukoplakia and submucous fibrosis, both potentially malignant conditions. In Asia, oral cancers often arise from such precancerous lesions (Trivedy et al. 2002).

Some epidemiological studies conducted in South-eastern Asia have shown that betel nut chewers have less caries than non-chewers (Moller et al. 1977; Nigam and Srivastava 1990; Schamschula et al. 1977). Betel nut chewers have been shown to have more calculus than non-chewers (Anerud et al. 1991) and *in vitro* studies have shown that both betel quid and betel nut extract inhibit keratinocyte and fibroblast growth (Chang et al. 1998; Jeng et al. 1999).

Need for more studies on the deleterious effects of betel quid and betel nut chewing on caries and periodontal status

Much has been written about the association between betel products and the development of precancerous and cancerous lesions, but there are few reports in the literature of the effects of the habit on the two major oral diseases, dental caries and periodontal disease (Reichart and Phillipsen 1998; Trivedy et al. 2002). This topic warrants further investigation and is of particular relevance to the population of the Karachi South District. As stated previously, this district has the world's highest incidence of oral cancer (Bhurgri 2005) but little is known of the influence of pan and betel nut chewing habits on the overall oral health of this population.

DIABETES AND ORAL HEALTH

Introduction

Considerable changes in disease pattern are occurring in developing countries. While the prevalence of infectious diseases and nutritional deficiencies is progressively declining, a concomitant increase is noted in the prevalence of chronic non-communicable diseases (NCD), such as cardiovascular diseases, diabetes mellitus and cancer. Factors contributing to the speed of this change include lifestyle characteristics. Obesity has become more prevalent; food energy availability has generally risen beyond requirements, with a trend towards increased sugar consumption in most countries (National Workshop on Diabetes, Pakistan, 1995).

Global Burden

Diabetes Mellitus is a global problem as its prevalence is increasing worldwide. The number of affected adults will increase up to 300 million by the year 2025. Worldwide adult prevalence was 4.0% in 1995 and is expected to increase up to 5.4% by the year 2025 (King et al. 1998). According to the World Health Organization, 366 million people are projected to have diabetes by the year 2030 (Wild et al. 2004). In 2000, 31.7 million people in India were afflicted with diabetes and this figure is estimated to increase to 79.4 million by the year 2030 (Wild et al. 2004). The condition is highly prevalent in Asian communities. Hong Kong, Pakistan and Singapore are among the countries with the highest prevalence of diabetes in the adult population (Tan et al. 2006). Pakistan has an adult diabetic prevalence of 18%, compared with 2% in Sweden and 25% in Saudi Arabia 25% (WHO).

Common risk factors for oral diseases and chronic diseases

A core group of modifiable risk factors is common to many chronic diseases. The four most prominent non communicable diseases- cardiovascular diseases, diabetes, cancer and chronic obstructive pulmonary diseases- share some common risk factors with oral diseases, some of which, related to lifestyle, are preventable. Dietary habits are important in the development of chronic diseases and also influence the development of dental caries. The strong correlation between several oral diseases and chronic diseases is primarily attributable to the common risk factors (Petersen 2003; Petersen et al. 2005). Severe periodontal disease is associated with diabetes mellitus, and has been considered a sixth complication of diabetes (Loe 1993).

Diabetes Mellitus as a systemic risk factor for Oral diseases

Diabetes mellitus is one of the strongest systemic risk factors for periodontal disease, for review see (Nunn 2003). Both type I and type II diabetes increase the risk for periodontitis (Position paper 1996). Periodontitis can also be considered a complication

of both types of diabetes. Poor diabetic control exacerbates the risk even further (Position paper 1996; Nunn 2003).

Metabolic control of diabetes

The association between diabetes mellitus and periodontitis has long been discussed, with conflicting conclusions. The severity and extent of periodontitis in the diabetic patient appears to be related to control of the diabetes. Among patients of similar age with long duration IDDM and similar plaque levels, those with poor metabolic control had greater clinical attachment loss and alveolar bone loss than those with better control (Seppälä and Ainamo 1994; Seppälä et al. 1993). Periodontitis also progresses more rapidly in poorly controlled diabetes and early age of onset of diabetes also is seen as a risk factor for more severe disease (Seppälä and Ainamo 1994; Seppälä et al. 1993).

Poor metabolic control, calculus, and having had diabetes for many years may increase the risk of periodontitis. Conversely diabetics who control their diabetes and oral health through self care and regular professional care are at a much lower risk for periodontitis and tooth loss (Oliver and Tervonen 1993).

It has been suggested that poorly controlled type 2 diabetes is associated with greater prevalence of severe periodontitis. In a US adult population, individuals with poorly control diabetes mellitus had a significantly higher prevalence of severe periodontitis than non-diabetics (odds ratio=2.90; 95% CI: 1.40, 6.03), while the association was less pronounced for those with well-controlled diabetes (odds ratio=1.56; CI: 0.90, 2.68) (Tsai et al. 2002).

Both chronic gingivitis and periodontitis are common inflammatory conditions of the periodontal tissues. Given the 'right' concurrence of risk factors, a person with periodontitis can experience significant destruction of tooth-supporting bone, ultimately resulting in tooth loss. Poorly controlled diabetes is an important risk factor for periodontitis and gingivitis and periodontitis is sometimes the first indication of the diabetic condition. As severe periodontitis can lead to tooth loss, it is important that patients with diabetes understand the importance of good daily oral hygiene and regular dental checkups (Hirsh 2004).

Periodontitis is a recognized complication of diabetes; people with well-controlled diabetes who have good oral hygiene are not considered to be at increased risk of periodontitis. However, susceptibility to periodontitis is significantly increased when diabetes is poorly controlled, particularly in smokers. Recent epidemiological evidence shows that the prevalence of diabetes in patients with periodontitis is significantly greater (twofold) than in those without periodontitis (Soskolne and Klinger 2001). Diabetes mellitus, as a metabolic disorder, affects oral health in general. A review of the studies on diabetes mellitus and oral health was done in 2006 by Khalid Bin Abdul Rahman. The epidemiological literature suggested that the most frequently reported oral symptoms in diabetic patients are: poor oral hygiene, inflammation of gums (gingivitis), oral candidiasis, calculus and pocket formation, dental caries, non-carious tooth surface loss, periapical abscess, taste impairment, burning mouth syndrome, rhomboid glossitis, denture stomatitis, angular cheilitis, hyposalivation, halitosis and oro-antral fistula (Rahman 2006).

These findings were supported in a study by Sandberg in 2000, which showed that diabetics suffered from xerostomia (dry mouth), had sites of advanced periodontitis and more initial caries lesions than non-diabetics. Diabetics showed a greater need of periodontal treatment, caries prevention and prosthetic corrections (Sandberg et al. 2000).

Diabetes and Oral hygiene

Regarding oral health and diabetes, a large number of studies have shown an association between periodontitis and diabetes. The meta analysis by Khader showed that patients with diabetes had significantly poorer oral hygiene, expressed as higher average plaque index (PI), higher average gingival index (GI), and more clinical attachment loss, but they exhibited the same extent of periodontal disease (Khader et al. 2006).

Studies conducted on populations with high standards of oral hygiene have not disclosed dramatic differences in clinical attachment level and alveolar bone height for diabetics and non-diabetics (Kawamura et al. 1998; Seppälä and Ainamo 1994; Seppälä et al. 1993). On the other hand, studies on populations with poor oral health have shown a strongly negative impact of diabetes on periodontal status (Almas et al. 2001; Bahru and Abdu 1992; Ngakinya et al. 1997).

Diabetes and periodontal therapy

It has also been suggested that effective periodontal therapy can have a positive effect on the control of diabetes. A substantial body of evidence has begun to emerge suggesting a bidirectional relationship between both types of diabetes and periodontal disease (Taylor et al. 2004). A meta-analysis of intervention studies also showed a beneficial effect of periodontal therapy on blood sugar control in persons with type 2 diabetes. Overall, this meta- analysis of 10 interventional studies found a non-significant 0.38% reduction in actual value of HbA1c, and 0.71% among 5 studies conducted in patients with type 2 diabetes (Janket et al. 2005).

Diabetes mechanism of action on periodontium

While the mechanism by which diabetes exacerbates periodontal destruction is still not fully understood, numerous mechanisms have been elucidated to explain the impact of diabetes on the periodontium. Inflammation plays an important role in periodontal diseases and also is the major component in the pathogenesis of diabetes. Research suggests that periodontal disease, as an infectious process with a prominent inflammatory component, can adversely affect the metabolic control of diabetes (Mealey 2006). Another study also confirms that diabetes increases the risk of periodontal diseases and inflammatory periodontal disease may increase insulin resistance in a similar way to obesity, aggravating glycemic control (see review (Mealey and Oates 2006).

Diabetes and Caries

There seems to be an increase in the prevalence of caries in patients with diabetes but the association is not as clear as with periodontal disease: for review see (Taylor et al. 2004). Studies showing higher DMFT in diabetics than in non-diabetics include (Albrecht et al. 1988; Bahru and Abdu 1992; Bakhshandeh et al. 2008; Sandberg et al. 2000).

Diabetes in Pakistan

The prevalence of diabetes in Pakistan is high, afflicting 12% of people over 25 years of age. When one considers the associated risk factors present in Pakistani society, the large number of people with diabetes is no surprise. Obesity tops the list (Jawad 2003). In 2000 the prevalence of diabetes in Pakistan was 5.2 million, with a predicted increase to 13.9 million by the year 2030 (Wild et al. 2004).

A population based survey conducted in the rural town of Shikarpur in Sindh Province, Pakistan in 1994 recorded the prevalence of diabetes mellitus and estimated its relationship to age and obesity. The reported prevalence was 16.2% in men and 11.7% in women. There was a strong association with obesity, positive family history of diabetes and hypertension (Shera et al. 1995).

According to the Pakistani National Diabetic Prevalence Survey, conducted in collaboration with WHO from 1994 to 1998, the prevalence of type II diabetes is 13.9% in rural Sindh compared to 16.5% in urban Sindh, of which the city of Karachi is a part (WHO 1998). Similarly, in our first questionnaire study (Tanwir et al. 2006), 17% of the population reported being diabetic.

A recent study in Lahore, Pakistan concerning oral health knowledge, attitudes, and practices and sources of information for diabetic patients disclosed ignorance of the relationship between diabetes and oral complications. Moreover, oral hygiene practices were inadequate, with only 2% brushing three times a day and 22% twice daily (Masood et al. 2007).

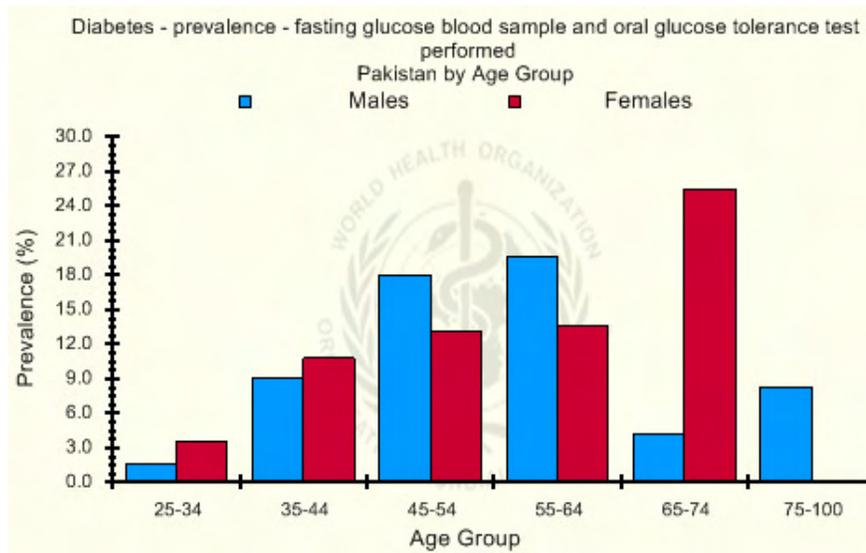


Fig 5: WHO Global Information Base (infobase.who.int)

Self- efficacy and daily oral care for diabetics

Successful treatment of dental caries, periodontal diseases and diabetes requires consistent daily self care. Two Finnish studies concluded that perceived self-efficacy determines oral health behavior and is also associated with level of oral hygiene. Associations between poor metabolic control of diabetes and low dental self-efficacy, low frequency of tooth-brushing and high plaque levels, suggest that dental health education, including enhancement of self-efficacy is important, especially in diabetic patients with poor metabolic control. The results suggested that perception of self-efficacy is important in relation to dental health education.

Dental personnel can enhance dental self- efficacy by providing models of oral health behavior, by verbal persuasion, including encouragement and positive feedback (Knecht et al. 1999; Syrjälä et al. 1999). A recent study on diabetics in Pakistan also suggested an association between counseling by physicians and patients' motivation to improve their oral hygiene: after counseling, 53.4% of patients were brushing two to three times a day, compared to only 22.3% of those who received no counseling (Masood et al. 2007).

Screening for undiagnosed diabetes

In the past 15 years the incidence of diabetes mellitus has increased dramatically, resulting in a major public health challenge. However, there is evidence that around one-third of diabetes cases remain undiagnosed. It is generally acknowledged that early diagnosis and appropriate metabolic management of the condition can significantly delay the onset of most complications of diabetes.

A recent American study revealed that in individuals with a self-reported family history of diabetes, hypertension, high cholesterol levels and clinical evidence of periodontal disease the probability of undiagnosed diabetes is 27-53%: highest for Mexican-American men (53%) and lowest for white women (27%). As the presence of reported risk factors increased, so did the probability of having undiagnosed diabetes. Moreover, when periodontal disease, expressed in terms of clinical attachment loss and pocket depth, was included in the model, the probability increased further. For example, in a 45 year-old individual with a family history of diabetes positively diagnosed with hypertension and high cholesterol level, the probability of undiagnosed diabetes is 13% to 32%. When periodontal disease is included as a risk factor, the probability almost doubles: 27% to 53% among the different races/ethnic groups. Patient data collected by the dentist through conscientious history taking and clinical oral examination should disclose patients with the above-mentioned combination of risk indicators for diabetes. Thus dental examination presents an opportunity to identify patients likely to have undiagnosed diabetes (Borrell et al. 2007).

Need for more research on the effect of diabetes mellitus on oral health

The prevalence of type II diabetes mellitus in Pakistan is among the highest in the world and the poor standard of oral hygiene in the population reflects the low priority accorded to oral health. Studies in industrialized countries have shown that improved oral hygiene, combined with good metabolic control of diabetes, results in improved oral health, which in turn leads to better general health. The association between diabetes and oral status in deprived populations warrants further investigation. In such populations, particularly where the prevalence of diabetes is high, measures which raise patient awareness of the importance of oral health in management of diabetes may prove to be a cost-effective means of reducing the overall burden of the disease in the community.

FLUORIDE EXPOSURE IN PAKISTAN

Appropriate use of fluorides is one of the most effective measures for controlling dental caries. For maximum benefits, 0.5 to 1ppm of fluoride is recommended as the optimal range (WHO 1994).

The benefit of using fluoride to prevent caries has been known for many years. Fluoride in drinking water and in fluoride-containing products reduces caries, mainly through its topical effect. Fluoride in low doses has been shown to inhibit demineralization and enhance remineralization and has also been shown to be effective in inhibition of bacterial enzymes. The use of fluorides in various forms thus remains the cornerstone of most caries prevention programmes (Ayyaz et al. 2002).

Fluoride prophylaxis programmes at community or individual level need to be adjusted to allow for the level of fluoride in the domestic water supplies. However, the natural fluoride content of drinking water in Pakistan is poorly documented (Ayyaz et al. 2002).

According to the fluoride map of Pakistan (Ayyaz et al. 2002), most water supplies are low in fluoride content. Analysis of 987 water supplies showed a fluoride content < 0.7 ppm in 84%: in 64%, the levels were <0.3 ppm and 20% ranged from 0.3-0.7 ppm. In 6% of the samples, the range was 0.7 to 1.0 ppm and in a further 6% the range was 1.0-2.0 ppm. In 1.5% of the samples the fluoride levels were in the 2.01 to 3.0 ppm range, and levels > 3ppm was found in 2%. In general, high levels of fluoride (>1.5ppm) were found in 4-6% of water supplies of Punjab, Sind, and Baluchistan provinces, while in the North West Frontier Province 91% of samples had fluoride levels < 0.3ppm (WHO-CAPP, WHO 2004 & (Ayyaz et al. 2002). For the city of Karachi, the following levels were recorded: Karachi Central 0.6-1.46 ppm, Karachi East 0.1-0.15 ppm, Karachi South 0.1-0.14 ppm, Karachi West 0.1-0.15 ppm and Malir area 0.27-0.36 ppm (WHO- CAPP and Ayyaz et al. 2002).

Fluoride content of water supply to PNT colony, Karachi is **0.19ppm**

In 1994, a WHO expert committee reviewed the use of fluorides for caries prevention and concluded that community water fluoridation is safe and cost-effective and should be introduced and maintained wherever socially acceptable and feasible. The optimum fluoride concentration will normally be within the range 0.5-1.0mg/l, depending on the mean annual maximum temperature. It was recommended the technical operation of water fluoridation systems be monitored and recorded regularly (WHO 1994).

At present, a community based water fluoridation system is not feasible for Pakistan. Only 20% of the population has access to reticulated water. There are neither technical nor financial resources to implement such a scheme (Ayyaz et al. 2002).

Thus for most of the population in Pakistan, to ensure optimal intake of fluoride necessary for the control of dental caries, alternate sources of fluoride are indicated (Ayyaz et al. 2002).

ABSENCE OF TOOTHACHE SYNDROME

This thesis is entitled “*Absence of toothache syndrome*”, which clearly reflects the behavior and attitudes of the study population to diseases of the oral cavity. Oral health is not a priority of this group of people and they seek dental care only for acute problems, in most cases emergency treatment for relief of pain.

Oral health is of low priority in the Pakistani health services and this has resulted in large unmet dental treatment needs: >90% of all oral diseases remain untreated. From young adults to the 50 year olds, failure to perceive their dental treatment needs appears to be the greatest barrier to dental attendance. This lack of perception of dental needs, or “*absence of toothache*”, causes postponement of treatment to the stage where the teeth are in such an advanced stage of decay that they are irreparable and extraction is necessary: extractions comprise >90% of treatment at public dental clinics. Preventive services (scaling, prophylaxis, and minor fillings etc) comprise <3% of services. There is an urgent need for greater priority of oral health in Pakistan (WHO 2004).

Studies from other developing countries also support these findings. A Polish study from 1998 investigated individual attitudes and behavior with respect to dental treatment. The study participants sought professional medical advice only for acute discomfort, or for symptoms which they regarded as life-threatening. Less acute conditions were generally treated by household remedies (Szymanska and Fetkowska-Mielnik 1998).

A study on Asians of Pakistani, Indian and Bangladeshi origin living in Southampton, UK concluded that despite the fact that many subjects held positive attitudes towards oral health; fewer than 15% were regular dental attenders. The remainder went to the dentist for relief of pain or for new dentures (Mattin and Smith 1991).

Studies on Japanese adults also revealed that they visit the doctor when their disease takes a turn for the worse. It is more likely in this case because of the Japanese medical insurance system, which reimburses only treatment fees. Thus the fee for medical treatment is low while preventive care is costly. From the patients' point of view, treatment is cheaper if sought after symptoms appear and it is difficult for doctors to charge for prevention. Thus the insurance structure steers the provision of services and is a barrier to the provision of preventive measures (Miyazaki et al. 1989).

VALUE OF SELF- REPORTED QUESTIONNAIRES

Epidemiological studies are essential for predicting, planning and provision of dental care facilities and in such studies, questionnaires have been used to acquire data about the dental and general status of the population (Palmqvist et al. 1991a, b). Some studies of self reported oral-health have been undertaken in Sweden (Buhlin et al. 2002; Buhlin et al. 2003): the responses to the questionnaires proved valid for oral status with respect to bleeding gums and number of teeth, but less reliable for periodontal variables.

The first two studies in this thesis are based on self-reported oral health data, which was subsequently validated. In accordance with the above-reported studies by Buhlin et al., the results of our first study also disclosed that while the participants had estimated bleeding gums and number of teeth correctly, self-assessment of calculus and periodontitis was less reliable (Tanwir et al. 2006). Thus questionnaires may be regarded as a cost-effective means of accessing some health information, albeit limited (Gooch et al. 1989).

HYPOTHESIS

Collecting and processing information about the nature and severity of dental disease in a population is the first step towards constructing a frame of reference on which to base the planning and delivery of dental services tailored to the specific needs of the target population. However, in deprived communities beset by lack of education, poverty and poor general health, it is also important to explore and identify entrenched (negative) attitudes to oral health, dental disease and dental care i.e. factors likely to act as barriers to successful implementation of new measures.

This thesis tested a number of hypotheses about adult Pakistanis from a deprived urban district:

- that they have poor and insufficient knowledge about oral health and that the standard of oral health is influenced by income and education
- that chewing betel quid and betel nut has deleterious effects on the oral tissues and enhances the risk of caries and periodontal disease
- that inadequate oral hygiene practices influence oral status in this population and finally,
- that in this deprived population, poor oral hygiene exacerbates the negative influence of diabetes on their oral health.

AIMS OF THE THESIS

GENERAL AIM

The general aim of this thesis was to survey the oral health and oral treatment needs among the adult population of the city of Karachi and thus create a basis for future treatment strategies and research.

Specific Aims

- To describe perceived oral health and perceived treatment needs among adult Pakistanis
- To survey the oral health of a Pakistani adult population, with special reference to habits, knowledge and attitudes to oral health and perceived treatment needs
- To investigate the influence of betel quid (pan) and betel nut (chalia) chewing on perceived oral health
- To record the oral health status of adult Pakistanis by clinical and radiographic examination and to relate this objective assessment to their perceived treatment needs
- To relate the objectively determined oral health status to risk factors such as betel nut habits
- To determine whether - in this population with relatively poor oral health and poor oral hygiene - diabetes is associated with any specific oral problems.

SIGNIFICANCE OF THE PROJECT

This project is intended to highlight the oral health status of underprivileged urban Pakistani adults, documenting not only the prevalence, nature and severity of dental disease (caries and periodontal disease) but also the unmet treatment needs in this population. The population is representative of deprived urban adults in many Asian cities. Thus the results and conclusions may be extrapolated to other countries of the region, providing a relevant frame of reference for similar studies.

This project will also provide oral health statistics as a basis for planning strategies for oral health care in Pakistan. Thus this project will be a foundation for further research, intended to improve the lot of the people of Pakistan.

The project is also intended to draw the attention of the government of Pakistan and WHO to the plight of underprivileged urban adults, beset by a heavy burden of - largely preventable - oral disease. Although rarely life-threatening, poor oral health has a negative effect on the individual's general health and quality of life. Oral health services warrant higher priority within the health sector. Manpower resources and funds need to be allocated for improved dental services, designed to meet the needs of the target population, as documented in this project.

MATERIAL AND METHODS

This section is a brief summary of the material and methods employed. Additional and detailed information can be found in each individual paper.

ETHICAL CONSIDERATIONS

The study was approved by the local ethics committee at Karolinska University Hospital, Huddinge, Sweden and at the Altamash Institute of Dental Medicine in Karachi, Pakistan. All studies were conducted in accordance with the Helsinki Declaration and all volunteers gave written informed consent to participate.

MATERIALS

Karachi

Karachi is the provincial capital of Sindh Province and the most populous city in Pakistan. It is also one of the largest cities in the world and is located on the northern shores of the Arabian Sea, west of Indus River Delta. It was the original capital of Pakistan and remains the cultural and economic hub, as well as being the nation's largest sea port. Spread over 3, 530 square kilometers (1,363 sq mi), the city and suburbs comprise the world's twentieth largest metropolitan area. The city attributes its growth to the mixed populations of economic and political migrants and refugees with diverse national, provincial, linguistic and religious origins.

In 2008, the estimated population of Karachi city is **12,461,423** and is currently growing at about 5% per year, mainly due to domestic rural to urban migration (Helders 2006, 2007 & 2008).

PNT Colony (Post and Telegraph Colony)

The population in the present project was selected from the P & T colony of Karachi. P & T is located in the vicinity of Altamash Dental Hospital, Karachi, Pakistan. The colony has a population of 6000-10,000 people. All age groups are represented, but children and young adults predominate. The socio-economic status is mediocre, many people being poor and underprivileged, many with a yearly household income of less than 50,000 rupees (USD800). The educational level is mostly moderate; men are better educated than women. It is our assumption that P & T colony is representative of most low-income areas in the city of Karachi, and also for Pakistan in general.

Selection of participants

The participants were selected from the current electoral rolls, obtained from the local council. The electoral rolls were organized according to the random selection of the houses in the colony. All electors belonging to each of our required age groups, <35 years, 36-<40 years, 40-<45 years, and 45-50 years, were selected. Starting at the beginning of the list, questionnaires were allotted to the participants until we reached the required 1000 participants. This method of selection represents a form of randomization as the layout of the houses in the colony is random - there is no systematic pattern of house numbers in the colony, nor on the electoral rolls. The questionnaires were distributed to the participants' homes by a dental auxiliary, who also explained the questions thoroughly. After a week the questionnaires were collected by the same dental auxiliary. The participants underwent clinical and radiographic examination at Altamash Dental Hospital.



Fig 6: PNT colony showing haphazard, non-systemic layout of the houses.

Papers I and II

Study I and II are questionnaire-based. The participants comprised 1000 adult males and females, residents of PNT colony, stratified according to age as described above. There were 6 non-respondents, leaving in all 994 (510 men and 484 women) who answered the questionnaire. Twenty participants were randomly selected for radiographic examination and history taking by the principal investigator (FT), to evaluate and validate oral status in relation to the information supplied in response to the questionnaires.

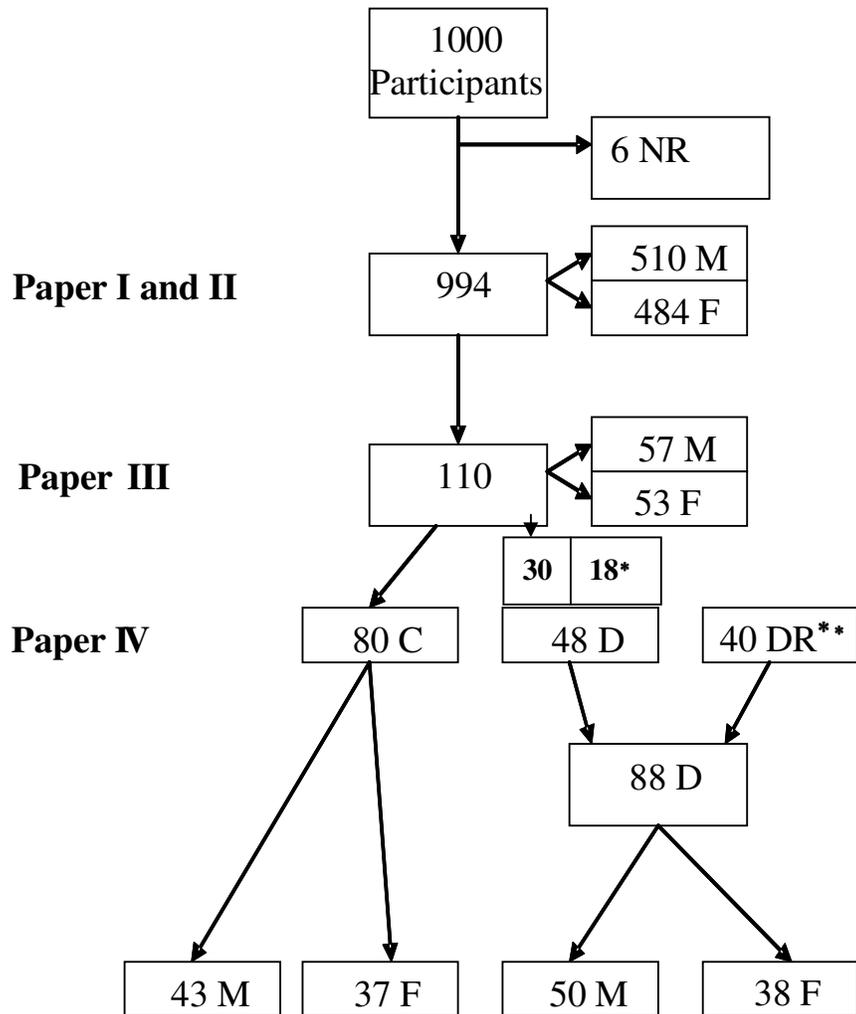
Paper III

The participants of study III were selected from the 994 who had answered the questionnaire in our earlier studies. Every tenth participant was offered clinical and radiographic examination. In order to meet the criteria for random selection, if the tenth person declined, then the offer was extended to the eleventh, twelfth person and so on. In total, 110 participants, 57 men and 53 women accepted and underwent examination. The responses in the questionnaire were confirmed at the time of the clinical examination.

Paper IV

The participants in study IV comprised all those in our earlier questionnaire study who reported having diabetes (17%). All were offered dental examination: 48 accepted and underwent clinical and radiographic examination. The answers in the earlier questionnaire were confirmed at the time of the clinical examination.

In order to increase the test group, an additional 40 diabetics of similar age were recruited from the same colony, through an open invitation to join the study. These people were then asked to complete the questionnaire when they presented for clinical and radiographic examination. Of the 88 diabetics, 50 were males and 38 females. The diagnosis of diabetes was confirmed by a recent blood report from a recognized laboratory, or by the medications stated in the questionnaire and confirmed at the time of clinical examination. The control group for this study comprised 80 subjects: the 43 male and 37 female non-diabetics in the randomly selected 110 participants in Study III, as described above.



*From Questionnaires

**Diabetics recruited from the PNT colony

Fig 7: **Stratification of the study population in studies I –IV**

METHODS

Questionnaire

In studies I and II, the participants answered a questionnaire comprising in all 57 questions (36 questions for each study), covering personal and demographic data, medical history, dental history, dietary history, habits and oral hygiene history.

Personal history included questions such as age, marital status, number of children in the family and educational level. Information about socio-economic variables was sought in questions about monthly and annual household income. Income was stratified as <50,000 rupees, 50,000-100,000 rupees, and >100,000 rupees.

Most questions were multiple choice but some were open. The question about educational level was open and the participants described their standard of education as primary schooling, secondary schooling, intermediate, or university education to graduate or postgraduate level.

Medical history included questions on heart disease: participants could choose from 'angina', 'high blood pressure', 'low blood pressure', 'suffered a heart attack or stroke'. Questions about *diabetes* included; 'yes', 'no', and 'if yes, since when', with the following options for age of onset: 5-10 years of age, 11-20, 21-30 and over 30 years. Mode of treatment for diabetes included such options as 'Diet', 'Drugs, which one, and 'Insulin injections, dosage'. Family history of diabetes was sought by asking: "Does anyone in your family have diabetes"? and the options to choose from included; 'Yes', 'No', and 'if yes, who'.

Oral health questions covered primarily such topics as oral problems (pain, difficulty chewing, cavities, esthetics, sensitivity and halitosis, tooth mobility, missing teeth, gum recession and others).

Dental history included questions on dental status (number of teeth), wearing dentures, and calculus, bleeding gums, gingival pockets, dryness of mouth, dental care habits including dental attendance and oral habits like pan, chalia, smoking and alcohol consumption.

Dietary history included questions on intake of meals, type of water, snacking between meals, consumption of sweets, tea with or without sugar, soft drinks, fruits and chewing gum.

Oral hygiene history included questions about frequency and mode of cleaning, time of day for cleaning and also the use of a dentrifice, with or without fluoride, paste or powder.

Table 3: Variables of interest in the questionnaire.

VARIABLES OF INTEREST QUESTIONNAIRE

Demographic data	Medical conditions	Dental history	Diet history	Oral hygiene	Habits
Age	Heart	Cavities	Number of	Cleaning of teeth	Smoking
Gender	diseases	Pain	meals	Cleaning	Alcohol
Profession	Hyper-tension	Gum	Snacks	technique	Betel quid
Education	Hepatitis B	recession	Sweets	Cleaning aids	Betel nut
Address	HIV (AIDS)	Mobility	Soft Drinks		
Salary	Diabetes	Sensitivity	Fruits		
Marital Status	Bleeding	Calculus			
Number of children	disorders	Bleeding gums			
		Dryness of mouth			

Clinical examination

In studies III and IV, the participants underwent clinical examination by the principal investigator (FT). The radiographic examination was conducted by a trained radiologist at the Altamash Dental Hospital, Karachi, Pakistan.

Periodontal evaluation

For studies III and IV, Periodontal health was assessed at six sites on each tooth, excluding the third molars. The following periodontal data were recorded: supragingival calculus when clearly visible and subgingival calculus when clearly felt with the probe; visible plaque expressed as the Visible Plaque Index (PI %); marginal bleeding, expressed as Bleeding on Probing Index (BOP %); furcations and mobility (Grade I, II, or III) and Pocket Depth: for pocketing ≥ 4 mm, the distance between the gingival margin and the apical limit of probing.

Periodontal diagnosis

In studies III and IV, the periodontal diagnosis was determined by the clinical and radiographic evidence as: gingivitis, chronic periodontitis (mild, moderate or severe) or aggressive periodontitis.

Cariological examination

In both studies III and IV, DMFT and DMFS Indices were used to express the DMF scores of each individual. Caries of enamel and dentine were registered by visio-tactile examination (mirror and probe) and from bitewing radiographs. All 28 teeth, excluding third molars, were examined in normal, direct operational light.

The oral mucosa of the participants was examined and any changes found were registered.

Radiographic Examination and evaluation of Alveolar bone loss

In studies III and IV, radiographic examination of all the participants comprised panoramic radiographs and four bitewings.

Alveolar bone loss was measured with a digital caliper from the cemento- enamel junction to the crest of alveolar bone on the approximal surfaces of the premolars and molars using bitewing radiographs, or panoramic radiographs for those participants who declined to undergo bitewing examination.

STATISTICAL ANALYSIS

The statistical analyses for studies I–IV were carried out using Statistica 6.1 (Stat Soft, Tulsa, OK, USA) or Statistica 7.0 software programmes.

Parametric data (normally distributed) were presented by means and standard deviations. Non-parametric data (non-normally distributed) were analyzed using the Student-t-test or Mann-Whitney U-test respectively.

In general, the unit of analysis was established as the individual. The level of significance (α) was set at $p \leq 0.05$ and the confidence interval at 95%.

In study I, the Chi-square test was applied to bivariate comparisons. Correlations between age and number of teeth were calculated using the Spearman rank correlation test. The association between oral problems and different variables was tested with a logistic regression model, adjusting for age, gender, education, income, smoking and diabetes.

In study II, frequency differences among various groups were calculated with the chi-square test. The odd ratios were calculated with univariate logistic regression.

In study III, univariate comparisons between groups were made with unpaired t-tests or the Mann-Whitney U test where applicable. The odds ratios for bone height and all decay were calculated with a stepwise multi-variate logistic regression model, adjusting for age, gender, education, smoking, betel quid (pan), betel nut (chalia), cleaning frequency, and cleaning regime.

In study IV, univariate comparisons between groups were made with unpaired t-test or the Mann-Whitney U test where applicable. Frequency differences among various groups were calculated with the chi-square test. The odds ratios for plaque and teeth were calculated with a stepwise multi-variate logistic regression model, adjusting for age and education.

RESULTS

STUDIES I AND II

Perceived Oral health

This section presents the perceived oral health of the participants in studies I and II.

Questionnaire-based studies I and II

The response rate to the questionnaires was very high: of the 1000 questionnaires distributed, 994 were completed and returned by 510 men and 484 women. 82 per cent of the men and 87 per cent of the women were married. The mean ages for males and females were 42(SD 5) and 41(SD 5) respectively (Table 4). The mean number of children per family was 4.0 (SD 2.0).

The *educational levels* of the participants are shown in figure 8. More than half had been educated to grade 10 or higher, with no significant age-related differences in educational level. Most of the women (83%) were housewives and of the men, 65% were employed as public servants. There were significant age related differences with respect to *occupation*, significantly higher numbers of public servants belonged to the older two age groups than to the younger two groups ($p= 0.01$).

Study I

More than half the participants (54 %) perceived that they had *oral health problems*. The most frequent problem was esthetics (33 %) but pain (17 %), cavities (15 %) and difficulty chewing (8 %) were also common (Table 5). Occupation seemed to have a minor influence on oral health, except among the unemployed, who reported significantly more missing teeth ($p<0.001$) than those in employment.

Most participants (94 %) had more than 20 teeth. There was a weak but significant negative correlation between age and number of teeth ($r^2=0.03$, $p<0.001$). Age was also significantly associated with pain, bleeding gums and periodontitis. Women also reported significantly more pain, bleeding gums and periodontitis. Poorly educated subjects reported pain more frequently than those with higher education (Table 6).

Diabetes was reported by 166 subjects (17%) (Table 4). The prevalence increased with age: 25% of those over 44 years of age were diabetic. However, statistical analysis disclosed no associations between diabetes and the variables gender, income, occupation or educational level. The mean age of subjects with diabetes was 43.3 years, compared to 41.2 years for the non-diabetic subjects ($p<0.001$). The diabetics tended to report more dental problems, more bleeding gums, more calculus and fewer teeth. However, after compensation for age, gender, smoking, educational level and income, no significant associations between diabetes and oral problems were disclosed.

Smoking was reported by 30% of all subjects and showed a significant association with pain, bleeding gums and periodontitis. Smokers reported significantly fewer cavities (Table 6).

Of the 20 subjects randomly selected for professional validation, 18 were examined and evaluated. Verbal questioning affirmed that all the selected participants had understood the questions. Radiographic examination confirmed that all participants had correctly estimated their number of teeth. The responses in the questionnaire with respect to calculus and periodontitis were less reliable: objective examination disclosed that only 10 out of the 18 subjects had correctly answered the question about calculus and 5 out of 16 subjects had correctly assessed their periodontal condition.

Education of the participants (%)

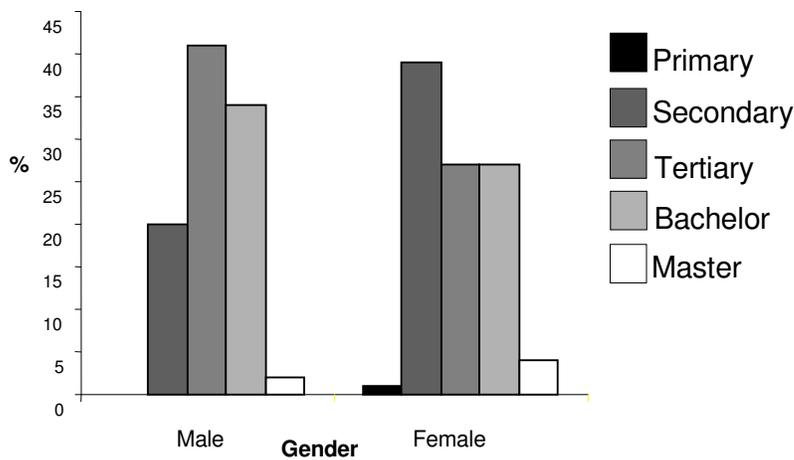


Figure 8: Mean % of educational level of the participants.

Table 4: Mean age (SD), marital status (%), Diabetes (%), Smoking (%), of the participants. Almost one third (32%) of the subjects failed to answer the question about smoking.

	Number	Age	Married	Diabetes	Smoking
All subjects	994	42 (5)	85%	16.8%	29.5%
Male	510	42 (5)	82%	16.0%	39.2%
Female	484	41 (5)	87%	17.6%	0.6%
Age groups (yrs)					
≤35	87		68%	4.7%	16.4%
36-39	325		77%	11.5%	27.3%
40-44	260		92%	16.9%	33.0%
≥45	322		95%	25.3%	31.9%

Table 5: Percentage of the respondents answering that they had oral problems. n indicates number of participants answering the question “Do you have any oral problems –Yes or No?”

Categories	n	Any oral Problem	Pain	Chewing difficulties	Cavities	Esthetic	Sensitive	Missing
All participants	994	54	17	8	15	33	10	1
Gender								
Women	484	55	18	7	18	37	10	1
Men	510	53	15	9	12	37	10	1
Income *								
<50,000	148	55	18	8	18	38	10	1
50,000-100,000	275	51	16	8	10	33	11	1
>100,000	128	54	15	7	11	38	9	1
Education								
Primary	5	60	20	0	20	40	0	0
Secondary	290	55	20	10	19	35	11	2
Tertiary	342	52	17	7	11	34	10	1
Bachelor	304	57	14	6	15	42	9	1
Master	30	47	13	10	17	40	7	0

* Housewives are excluded

Table 6: Odds ratio (95% confidence interval) for self reported oral problems. Bleeding gums includes the answers “Yes” and “Yes, when brushing”. Age refers to yearly increase, gender compares females to males, education compares the lowest two categories (primary and secondary schooling) with the highest two levels (bachelor and master). Salary compares the lowest income (< 50,000 rupees) with the highest (>100,000).Smoking and diabetes refer the alternative response “No” to the questions “Do you smoke?” and “Do you have diabetes?” respectively.

Oral problems	Pain	Bleeding gums	Cavities	Periodontitis
Variable				
Age	1.08 (1.03-1.13)	1.05 (1.01-1.09)	1.00 (0.96-1.05)	1.05 (1.01-1.09)
Gender	1.94 (1.06-3.58)	2.13 (1.32-3.45)	1.08 (0.60-1.94)	2.13 (1.31-3.45)
Education	2.05 (1.15-3.65)	0.87 (0.55-1.37)	1.36 (0.75-2.48)	0.87 (0.55-1.37)
Salary	0.85 (0.42-1.73)	1.29 (0.74-2.25)	1.30 (0.62-2.75)	1.29 (0.74-2.25)
Smoking	2.26 (1.36-3.76)	2.92 (1.96-4.33)	0.45 (0.24-0.85)	2.92 (1.96-4.33)
Diabetes	0.67 (0.38-1.25)	0.76 (0.48-1.20)	0.88 (0.48-1.62)	0.76 (0.48-1.20)

Study II

Factors influencing Oral Health

Dental Attendance Habits

Regular *dental attendance* was the exception among the participants: 3% responded that they visited a dentist annually and over 80% seldom or never visited a dentist (Table 7). Women visited the dentist less frequently than men ($p < 0.02$). There was no association between frequency of dental attendance and age or income. Those with higher education visited a dentist less frequently than the others. Those who seldom saw a dentist had fewer oral problems than those who visited a dentist once a year or more, odds ratio 0.35.

Oral Hygiene Habits (method and frequency)

With respect to *oral hygiene frequency*, there were no significant differences associated with gender, age, income or education. Most participants cleaned their teeth at least once daily and more than 70 % used a toothbrush. The second most common method was finger cleaning (27%) while only a few used a miswaq (Table 7). Those who cleaned their teeth only occasionally (less than daily) reported significantly more oral problems than those who cleaned once or more daily (odds ratio 6.11) (Table 10). The cleaning method showed no influence on perceived oral health.

Consumption of sweets and tea with/ without sugar

Over 75 % of the respondents consumed *sweets and/or tea with sugar* at least once a day: this was unrelated to age, gender, income or education. Sweets and tea with sugar showed no association with oral problems in general. 91 % of respondents considered consumption of sweets to be potentially deleterious to oral health.

Smoking Habits

Regarding *smoking*, 39% of the men smoked, but none of the women (Table 8). Consumption was higher in the older age groups. Those in the middle-income group 50,000 – 100,000 rupees tended to be heavier smokers than those in either the lower or higher income groups. Smoking was considered dangerous to oral health by 87% of all participants (94% of men and 80 % of women). Of the smokers, 42 % had smoked for ≤ 5 years, 19 % for 6-10 years, 21 % for 11-15 years and 17 % for more than 15 years.

Betel quid (pan) chewing

Almost one third (32%) of the participants chewed *betel quid (pan)*, with significantly greater consumption in the older age groups (>39 yrs) ($p<0.001$) (Table 8). Moreover, consumption was higher in the low income group (<50,000) than in the high income group (>100,000), 38% vs. 27%, $p=0.07$. Pan chewers ran a significantly higher risk of oral problems, odds ratio 3.63: this was most pronounced for esthetic problems but also with respect to pain, difficulty chewing and halitosis. However, dental caries was significantly less frequent among pan chewers (odds ratio 0.63), (Table 10). Pan chewers reported more bleeding gums (<0.001) and more pockets ($p<0.001$).

Twenty-four per cent of the pan users had been chewing for ≤ 5 yrs, 15 % for 6-10 years, 31 % for 11-15 years and 30 % for >15 years.

In response to the question as to whether pan chewing was a threat to oral health, 97% (98% of males and 95% of females) of all subjects considered this habit to be dangerous.

Betel nut (chalia) chewing habit

Betel nut chewing was more frequent in women than in men ($p<0.001$) and more common in the younger (<40 yrs.) than the older age groups, $p<0.001$ (Table 8). As was the case with pan chewing, betel nut chewing was a more common habit in the low-income than in the higher income group (27% and 16% respectively). The habit was almost equally distributed with respect to educational levels. Betel nut chewing was not considered to have as profound an influence on perceived oral health as pan chewing. The only statistically significant factor was a higher risk for dental caries, odds ratio 4.51 and somewhat more gingival bleeding ($p<0.01$), (Table 10). Almost all participants (95%, 98% of males and 93% of females) considered betel nut chewing to be bad for oral health.

The duration of betel nut (chalia) chewing was somewhat less than for pan- chewing: 36 % had chewed for ≤ 5 years, 26 % for 6-10 years, 21 % for 11-15 years and 18 % more than 15 years.

More than half the participants either chewed betel quid (pan) or betel nut (chalia) (Table 9).

Table 7: Percentage of individuals answering the questionnaire in indicated groups.

Variable	Gender			Education				
	All subjects	F	M	Primary	Secondary	Intermediate	Bachelor	Master
N	994	484	510	5	290	342	304	30
Dental visits %								
<i>Never/Seldom</i>	83	87	81	100	81	84	83	93
<i>Once in 5 years</i>	13	11	15	0	14	13	13	7
<i>Yearly</i>	3	2	3	0	2	3	3	0
Oral hygiene								
Cleaning frequency								
<i>Never/seldom</i>	1	1	1	0	2	1	0.7	0
<i>Occasionally</i>	11	10	12	0	12	10	11	3
<i>Daily</i>	87	88	86	100	84	88	89	93
Cleaning regime								
<i>Toothbrush</i>	72	68	75	40	67	75	72	77
<i>Miswaq</i>	1	1	1	0	2	0	1	0
<i>Finger</i>	27	30	24	60	30	24	27	23

Table 8: Percentage of individuals answering the questionnaire in indicated groups.

VARIABLE	Gender		Age				Income			Education					
	All subjects	F	M	≤35	36-39	40-44	≥45	<50 000	50 000-100 000	>100 000	Primary	Secondary	Intermediate	Bachelor	Master
N	994	484	510	89	325	260	320	148	273	130	5	290	342	304	30
Betel quid chewing %	32	31	34	27	25	37	37	38	32	27	0	36	32	31	10
≤5/day	4	3	4	2	3	4	5	5	5	2	0	4	3	6	0
6-10/day	17	18	16	18	12	14	21	18	15	13	0	19	17	16	7
11-15/day	11	9	13	7	10	14	12	14	11	11	0	13	11	10	3
Betel nut %	28	37	18	33	34	21	25	27	21	16	20	34	22	29	30
≤5/day	11	13	9	13	16	7	9	16	11	10	0	12	10	12	17
6-10/day	11	16	6	11	12	9	11	10	6	5	0	13	10	12	10
>10/day	5	7	2	7	5	4	4	1	2	1	20	8	2	4	3
Smoking %	20	0	39	10	17	24	23	28	42	27	0	13	26	22	10
≤5/day	2	0	4	0	3	2	2	4	5	2	0	1	3	2	0
6-10/day	11	0	20	6	9	13	12	16	21	16	0	6	12	13	10
>10/day	8	0	15	4	6	9	9	9	17	10	0	6	11	7	0

Table 9: Number of participants using Betel quid and betel nut.

	Betel nut(Chalia)	No Betel nut(Chalia)	
Betel quid(Pan)	68	253	321
No Betel quid (Pan)	203	462	665
	271	715	986

Table 10: Influence of betel quid (pan) or betel nut (chalia) chewing and cleaning frequency on perceived oral health. Percentage of indicated groups who perceive various oral health problems.

Variable	Any oral problem	Pain	Chewing difficulties	Cavities	Esthetic	Halitosis
Betel quid(Pan)						
All non-users	44	15	7	17	14	7
All users	74	21	12	11	46	20
Odds ratio	3.63	1.57	2.22	0.63	5.38	3.32
	(2.69-4.82)	(1.12-2.22)	(1.38-3.55)	(0.42-0.94)	(3.94-7.34)	(2.23-4.96)
≤ 5/day	52	18	15	8	18	3
6-10/day	71	24	6	11	44	21
>10/day	83	17	20	12	58	22
Betel nut(Chalia)						
All non-users	53	16	8	9	25	12
All users	55	19	7	31	21	11
Odds ratio	1.10	1.22	0.81	4.51	0.79	0.94
	(0.83-1.46)	(0.85-1.76)	(0.47-1.41)	(3.14-6.49)	(0.56-1.10)	(0.60-1.46)
≤ 5/day	44	23	4	12	6	8
6-10/day	56	17	6	34	27	9
>10/day	76	11	13	63	43	24
Cleaning frequency						
Daily	48	15	6	13	19	9
Less than daily	85	21	21	26	51	26
Odds ratio	6.11	2.31	2.41	4.38	4.84	3.54
	(3.64-10.25)	(1.49-3.58)	(1.54-3.39)	(2.59-7.43)	(3.26-7.19)	(2.22-5.64)

STUDIES III AND IV

Study III

In study III, 110 participants (53 females and 57 males) were randomly selected for clinical examination,.

Periodontal findings (Study III)

The participants had an average number of 26 teeth (Table 11).

Plaque and bleeding on probing were prevalent (Table 11). Calculus and gingival recession were common findings in all the participants.

Men had significantly more bone loss than women (odds ratio 3.4, CI 1.4-8.6) and older subjects, ≥ 45 years, had lost more bone than the younger subjects, ≤ 35 years (odds ratio 10., CI 2.5-46.3) No association was found between bone height and income and educational levels.

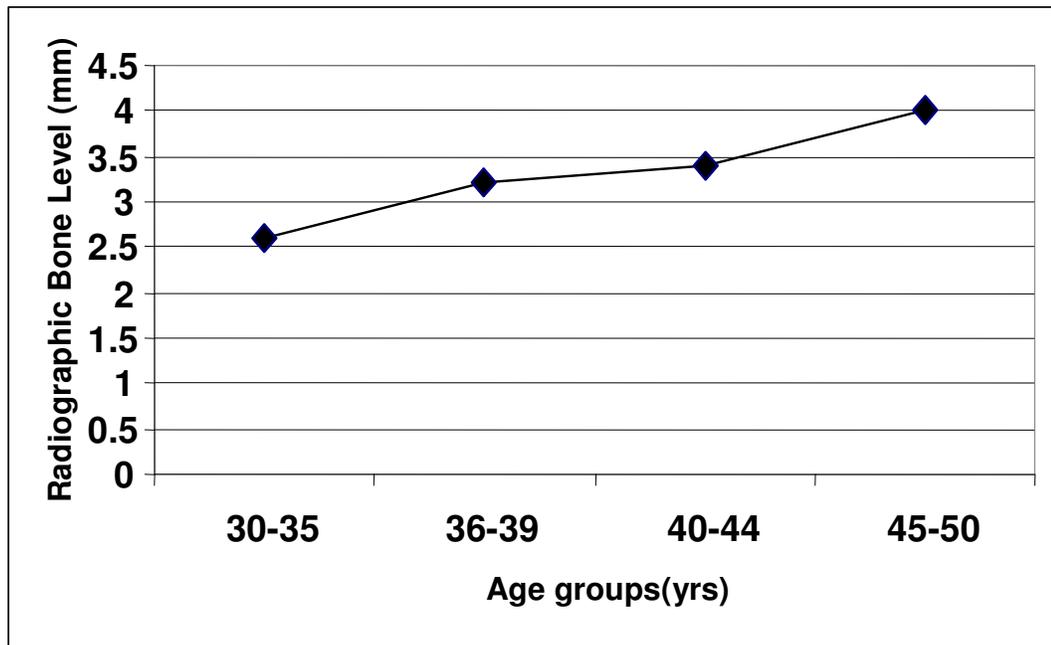
Smokers, betel quid (pan) and betel nut (chalia) users tended to have more bleeding on probing, while smokers and pan users also had more bone loss than non-users (Table 11). However, no significant associations were disclosed between smoking, betel quid (pan) and betel nut (chalia) habits and plaque, bleeding on probing or bone height (Table 11).

Individuals using a toothbrush for oral hygiene had a tendency to less bleeding on probing, mean and standard deviation (69.8 ± 30.7 vs 80.9 ± 22.1), and less bone loss (3.4 ± 1.1 vs 4.0 ± 1.6) than those who cleaned their teeth with a finger ($p < 0.15$ and $p < 0.02$).

Those who visited the dentist occasionally had a tendency to bleed less than those who seldom or never visited the dentist (Table 11).

Table 11: Periodontal findings.
Participants mean and SD values in the indicated groups

Categories	n	Teeth	Plaque %	BOP%	Bone Height
All participant	110	26.3(2.0)	87.4(20.7)	71.9(29.2)	3.5(1.3)
Gender					
Women	53	26.5(1.8)	87.5(19.7)	71.0(27.9)	3.1(1.0)
Men	57	26(2.2)	87.4(21.8)	72.8(30.6)	3.8(1.4)
Age groups					
<=35	15	27.7(0.6)	86.0(22.6)	74.7(22.2)	2.6(0.8)
36-39	35	26.7(1.8)	86.2(24.2)	67.7(32.2)	3.2(1.0)
40-44	17	26.7(1.3)	89.7(17.8)	74.4(26.0)	3.4(0.9)
>=45	43	25.3(2.3)	88.8(19.6)	73.5(30.5)	4.0(1.4)
Smoking					
Yes	24	26(2.2)	86.6(22.1)	72.9(29.4)	3.8(1.3)
No	86	26.4(2.0)	87.7(20.5)	71.7(29.4)	3.4(1.2)
Betel quid					
Yes	27	26.1(2.2)	89.1(18.5)	75.9(26.9)	3.6(1.1)
No	83	26.4(1.9)	86.9(21.5)	70.7(29.9)	3.5(1.3)
Betel nut					
Yes	33	26.6(1.9)	86.2(19.5)	73.0(27.3)	3.4(1.3)
No	77	26.2(2.1)	87.9(21.3)	71.5(30.2)	3.5(1.3)
Clean. freq					
Daily	98	26.3(2.0)	88.5(19.7)	73.3(28.8)	3.6(1.3)
Occasionally	11	26.2(2.1)	76.4(27.8)	61.8(32.7)	3.2(0.8)
Clean.regime					
Toothbrush	81	26.3(2.1)	86.3(21.5)	69.8(30.7)	3.4(1.1)
Finger	27	26.2(1.9)	89.8(18.7)	80.9(22.1)	4.0(1.6)
Dental Visit					
Never/seldom	84	26.2(2.2)	89.4(19.3)	74.7(28.7)	3.5(1.2)
Sometimes	23	26.2(1.5)	82.8(23.4)	62.6(30.5)	3.5(1.6)



Odds ratio 10.8

Fig 9: Radiographic bone level (alveolar bone loss) with increasing age.

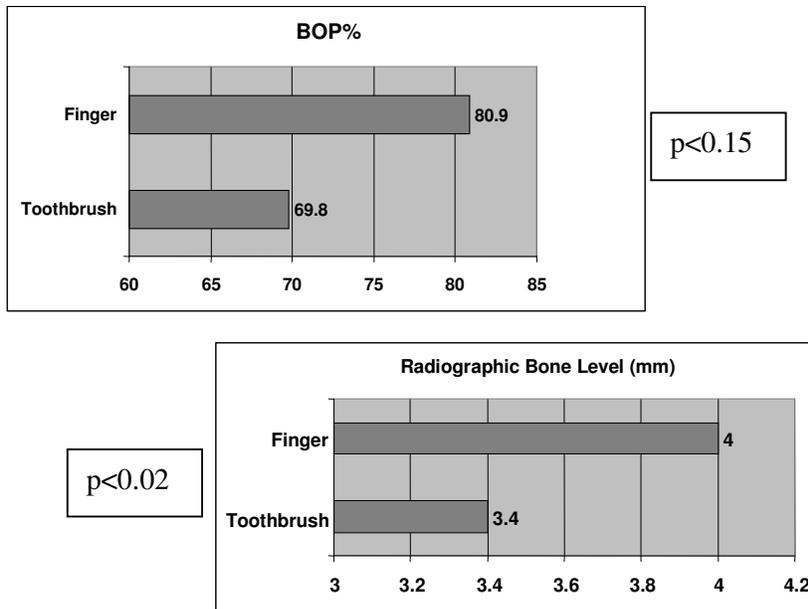


Fig 10: BOP (Bleeding on probing %) and radiographic bone level in finger- cleaners and toothbrush users.

Periodontal diagnosis (Study III)

Periodontal diagnoses for all participants and males and females separately, are shown in Fig11.

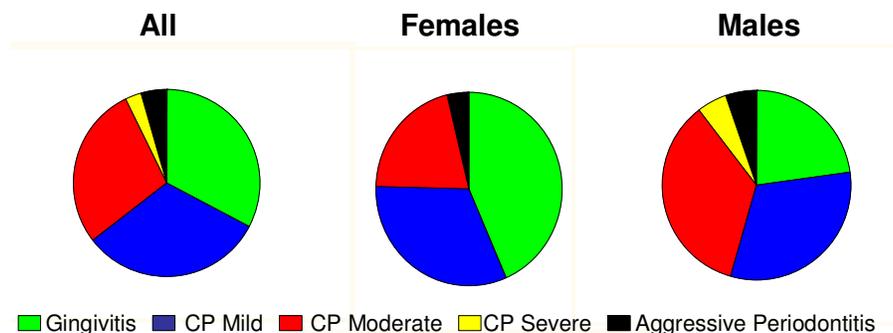


Fig 11: Periodontal Diagnosis as gingivitis, chronic periodontitis (mild, moderate or severe), or aggressive periodontitis in all participants, in females and in males.

Cariological findings (Study III)

With respect to caries status, the number of lesions was low (2.1 ± 2.7) (Table 12). Females had more decay than men. The odds ratio for women to have 5 caries lesions or more was 7.8 (CI 1.5- 4.0). Caries experience declined with increasing age. More decay was recorded in the age group 36-39 years than in the older age group (2.6 ± 3.8 and 1.7 ± 1.5 respectively) (Table 12). No significant associations were disclosed between dental status and income or educational level.

Chalia users had somewhat more decay than non-users, while pan users had somewhat less decay (Table 12). Those who consumed sweets more than once or twice a day had more decay than those who never or only occasionally ate sweets (Table 12). However, the differences did not reach significance.

Subjects who cleaned their teeth daily had fewer fillings than those who cleaned their teeth only occasionally (0.6 ± 1.2 vs 1.5 ± 2.1). Those using a toothbrush had more decay than those who used a finger to clean their teeth (2.3 ± 2.9 vs 1.9 ± 1.4), (Table 12). The subjects who never visited the dentist had more carious teeth (2.2 ± 2.9 vs 1.4 ± 1.6) than those who occasionally visited the dentist (Table 12). These differences were not significant.

Table12: Cariological findings
Participants mean and SD values in the indicated groups

Categories	n	All Decay	Fillings	DMFT	DMFS
All participants	110	2.1(2.7)	0.7(1.3)	4.6(4.4)	13.7(15.4)
Gender					
Women	53	2.7(3.3)	0.5(1.2)	4.9(5.3)	13.5(17.9)
Men	57	1.4(1.6)	0.7(1.4)	4.2(3.5)	14.0(12.8)
Age Groups					
<=35	15	2.1(2.4)	0.5(0.9)	3.0(2.9)	5.1(5.0)
36-39	35	2.6(3.8)	0.7(1.5)	4.6(5.8)	12.2(18.8)
40-44	17	1.8(2.3)	0.5(1.5)	3.5(3.1)	9.9(8.8)
>=45	43	1.7(1.5)	0.7(1.2)	5.5(3.8)	19.4(14.9)
Smoking					
Yes	24	1.2(1.4)	0.7(1.2)	4.0(3.0)	14.0(12.2)
No	86	2.3(2.9)	0.6(1.4)	4.8(4.8)	13.6(16.2)
Betel quid					
Yes	27	1.5(1.9)	0.7(1.1)	4.4(4.1)	14.6(15.9)
No	83	2.2(2.9)	0.6(1.4)	4.6(4.5)	13.4(15.3)
Betel nut					
Yes	33	2.6(3.3)	0.6(1.1)	4.7(4.9)	12.0(14.0)
No	77	1.9(2.3)	0.6(1.4)	4.5(4.2)	14.2(15.9)
Clean. freq					
Daily	98	2.0(2.6)	0.6(1.2)	4.4(4.1)	13.2(13.7)
Occasional	11	2.1(2.5)	1.5(2.1)	6.2(6.7)	19.1(26.9)
Clean. regime					
Toothbrush	81	2.3(2.9)	0.8(1.5)	4.9(4.9)	14.4(16.9)
Finger	27	1.9(1.4)	0.3(0.7)	3.6(2.6)	12.3(10.1)
Sweets					
Never/Occas	34	1.6(2.1)	0.7(1.4)	3.7(3.4)	10.1(10.2)
Once/Twice	68	2.2(2.9)	0.6(1.3)	5.0(4.9)	15.8(17.4)
Tea with sugar					
Never/Occas	26	1.9(3.1)	0.9(1.6)	4.8(6.5)	14.3(22.5)
Once/Twice	82	2.0(2.5)	0.5(1.2)	4.5(3.6)	13.6(12.7)
Dental Visit					
Never	84	2.2(2.9)	0.8(1.4)	5.0(4.8)	15.0(16.9)
Sometimes	23	1.4(1.6)	0.2(0.5)	3.1(2.2)	9.6(8.2)

Diabetes

Study IV

Comparison of diabetics and non-diabetics

Study IV was a comparative study of clinical and oral health status in 88 diabetics (50 males and 38 females) and a control group of 80 non-diabetics (43 males and 37 females).

Periodontal findings (Study IV)

The average number of teeth was 24 in diabetics and 26 in the non-diabetics. The odds ratio for “fewer teeth” was 2.3 times higher for the diabetics than for the non-diabetics (CI 1.32-4.14, $p < 0.001$) (Table 13).

With respect to periodontal status, plaque and bleeding on probing were prevalent among both diabetics and non-diabetics. Diabetics had a higher percentage of sites with plaque than non-diabetics (odds ratio 1.96, CI 0.99-3.88, $p < 0.056$) (Table 13). Calculus and gingival recession were also common findings in both groups.

Diabetics had more bone loss than non-diabetics (3.8 ± 1.3 vs. 3.5 ± 1.3) (Table 13). No association was found between bone height and income or educational standard.

Moderate to severe periodontitis was significantly more common in the diabetes group ($p < 0.007$).

The periodontal diagnosis for both groups are presented in Fig12.

Cariological findings (Study IV)

Diabetics tended to have more decay than non-diabetics (2.0 ± 4.0 vs. 1.0 ± 3.0).

However, the difference did not reach significance. The DMFT and DMFS scores were significantly higher for diabetics than for non-diabetics ($p < 0.001$) (Table 13). No significant associations were disclosed between caries status and income or educational level.

Oral hygiene habits (Study IV)

Most of the participants (87% of the diabetics and 89% of the non-diabetics) cleaned their teeth daily. More diabetics than non-diabetics were toothbrush users (85% vs. 75%) and fewer diabetics were finger cleaners (13% vs. 20%). However, the differences did not reach significance.

Consumption of sweets and tea with sugar (Study IV)

Fewer diabetics than controls consumed sweets more than twice a day, 53% and 70% respectively ($p < 0.02$). Similarly 81 % of the non-diabetics consumed tea with sugar once or twice a day or more, compared to 50% of the diabetics ($p < 0.001$) (Table 13).

Table 13:

Mean (\pm standard deviation) values for number of teeth, % of sites with plaque, % of sites with bleeding on probing (BOP) and bone height. Median and Interquartile range for all decay, fillings, DMFT and DMFS. Number and (%), dental attendance and oral hygiene routines, consumption of sweets and tea with sugar.

Variables	Diabetics	Non- Diabetics	P-value
Number of Teeth	24.6(4.4)	26.5(1.9)	< 0.001
Periodontal Data			
Plaque %	92.1(17.1)	86.9(21.3)	< 0.056
Bleeding on Probing%	75.5(30.4)	75.3(27.2)	NS
Bone Height	3.8(1.3)	3.5(1.3)	NS
Cariological Data			
All Decay	2.0(4.0)	1.0(3.0)	NS
Fillings	0(6.0)	0(1.0)	NS
DMFT	6.0(8.0)	3.5(5.5)	0.001
DMFS	18.5(26.5)	8.0(14.0)	< 0.001
Dental History and Oral hygiene history			
Dental visits	Never/seldom	62(70)	63(79)
	Sometime	26(30)	17(21)
Cleaning frequency	Daily	77(87)	71(89)
	Occasional	11(12)	9(11)
Cleaning regime	Finger	13(15)	20(25)
	Toothbrush	75(85)	60(75)
Dietary habits			
Sweets	Never/seldom	41(47)	24(30)
	Once/twice	47(53)	56(70)
Tea with sugar	Never/seldom	44(50)	15(19)
	Once/twice	44(50)	65(81)

Perio- diagnosis

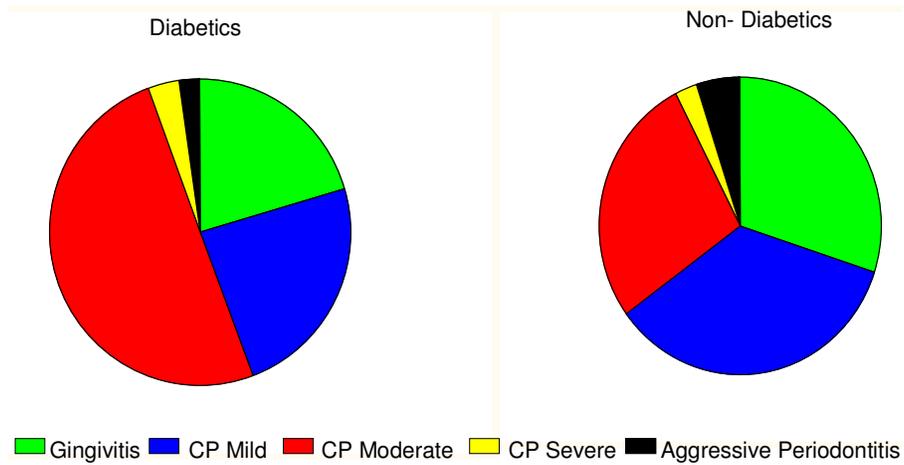


Figure12: Periodontal Diagnosis: gingivitis, chronic periodontitis (mild, moderate or severe) or aggressive periodontitis in diabetics and non-diabetics.

Mucosal findings (Studies III and IV)

The mucosal lesions recorded among the randomly selected participants in Study III and also among the diabetics and non-diabetics (Study IV) were limited to buccal staining only.

DISCUSSION

With high prevalence and incidence, oral diseases are a major public health problem and the burden is greatest on disadvantaged and socially marginalized populations (WHO 2004).

Study I disclosed that more than half the adults surveyed had *dental problems*. The most frequent problem was esthetic, but 17% also reported pain.

Only 5 per cent of the population reported having fewer than 20 teeth. Similar findings are reported from Beijing, China (Luan et al. 1989), southern Thailand (Baelum et al. 2002), USA (Marcus et al. 1996) and from Stockholm, Sweden (Buhlin et al. 2003). Bleeding gums, including bleeding when brushing, were reported by 30 per cent of the subjects. This is in accordance with a similar study conducted in Sweden (Buhlin et al. 2002).

Most of the participants were educated, with more than half of them reporting *education* to tenth grade or higher. The study disclosed no association between reported cavities and age, gender, or education. This is in contrast with an earlier study that showed a strong univariate relationship between low educational level and severe caries (Hadden et al. 2003).

Smoking showed a strong correlation with periodontal disease, which is in agreement with many studies (for review see Nunn 2003). On the other hand, there was a significantly negative association between smoking and caries, which is in contrast to a number of previous studies (Axelsson et al. 1998; Hirsch et al. 1991; Soetiarto 1999; Zitterbart et al. 1990) It is possible that caries is unsuitable for self-assessment and that clinical and radiological examination are prerequisites for any conclusions to be drawn.

In the questionnaire, *diabetes* showed no association with oral problems. This finding was somewhat unexpected because several earlier studies have demonstrated greater susceptibility to periodontitis in diabetics and some studies have shown a higher prevalence of caries and tooth loss (for review see Taylor et al. 2004). The reason for this is unclear, but it might be attributable to the design of the study, with other factors masking the influence of the disease, even though 17 per cent of the subjects were diabetics.

Study I disclosed that income had no real influence on the frequency of oral problems. This suggests that the cost of dental care is not a major barrier to dental treatment but is outweighed by such factors as ignorance of oral disease and poor attitudes to oral health.

Study II disclosed factors affecting perceived oral health. The findings in the study showed that betel nut chewing and oral hygiene frequency have an influence on perceived oral health, while cleaning method and sugar intake do not.

The participants reported that betel quid and betel nut chewing had a strongly negative influence on their perceived oral health. The reported use of betel quid (32%) and betel nut (28 %) is in agreement with earlier reports from Pakistan, Nepal and India (for review see Gupta and Ray 2004; Mazahir et al. 2006).

Betel quid chewers had significantly more oral problems. The risk was significantly more pronounced for esthetic problems, pain, difficulty chewing and halitosis. Gingival bleeding and pockets were also significantly more frequent among betel quid users while dental caries was reported less frequently. Study II revealed that the betel quid users reported having significantly fewer cavities while the betel nut users reported significantly more cavities. The reason for this discrepancy is unclear but it was not related to differences in income or education.

Some epidemiological studies conducted in South-Eastern Asia, have shown that **betel nut chewers** have less caries than non-chewers (Moller et al. 1977; Nigam and Srivastava 1990; Schamschula et al. 1977). Although the cariostatic mechanism is not clear, several possible explanations have been suggested, e.g., the betel nut stain could work as a protective varnish (Howden 1984) or the tannins in the betel nuts may have an antimicrobiological effect (de Miranda et al. 1996).

Regarding **gender differences**, betel nut chewing was more frequent among women ($p < 0.001$) while there were no gender-related differences in betel quid use. Betel nut chewing was more common in the younger half of the population and betel quid was more common among the older half. These results are in agreement with another study conducted in a Karachi squatter settlement (Mazahir et al. 2006). However, there was no correlation between perceived oral health problems and gender or age in this population (Tanwir et al. 2006).

To our knowledge, Study II was the first to indicate poorer **periodontal health** in people chewing betel quid and betel nuts than in non-users. Betel nut chewers have been shown to have more calculus than non-chewers (Anerud et al. 1991) and *in vitro* studies have shown that both betel quid and betel nut extract inhibit keratinocyte and fibroblast growth (Chang et al. 1998; Jeng et al. 1999).

Regarding **dental attendance habits**, 83% of all participants reported that they had never visited the dentist. These results are in agreement with those of a previous study in Pakistan (Ishaque and Khan 2001) but in contrast to a recent study in Saudi Arabia (Al-Bader et al. 2006). Our finding that subjects who reported more frequent dental attendance had more perceived dental problems than those visiting infrequently, indicates that most visits were for treatment of acute conditions rather than for regular check-ups. Regular check ups or recall examinations are highly unusual in this population, whereas the literature indicates that regular dental attenders have better oral health than those who attend for emergency treatment only.

Concerning **oral hygiene habits**, almost 87% of the total sample population surveyed reported daily oral hygiene habits. Brushing was the most frequent technique (72%). This is in accordance with studies in Pakistan (Khan et al. 1991; Ishaque and Khan 2001; Iqbal and Ram 2004) and in Saudi Arabia (Almas et al. 2003). Most of the

participants used a toothbrush for oral hygiene but a substantial minority (27%) used their fingers. There was no difference in perceived oral health between these two groups.

In contrast to cleaning method, cleaning frequency showed a significant association with oral health. Those who cleaned once or more daily had fewer oral problems, particularly with respect to cavities and esthetics.

Regarding *sugar intake*, more than half the study population consumed sweets once a day, with females being higher consumers, while more males drank tea with sugar twice or more a day. This is in agreement with an earlier study conducted in Pakistan (Qidwai et al. 2003).

Study II implies that this population had poor awareness of oral health, unrelated to income or education. Their lifestyle does not encompass meticulous oral hygiene and regular dental checkups.

In a randomly selected sample of participants, responses to the questions were validated by dental professionals, disclosing that while the participants had correctly estimated their number of teeth, self-assessments of calculus and periodontitis were less reliable. Comparable findings have been reported in a previous study conducted in Stockholm, Sweden, using similar questions (Buhlin et al. 2002). The validation affirmed that the respondents had understood the questions in the questionnaire.

It is important to emphasize that the studies I and II were based on a questionnaire and not on clinical examinations. The results do not provide information about the actual oral health status of this population but describe perceived oral health problems and hence, subjective treatment needs.

ORAL HEALTH IN AN ADULT PAKISTANI POPULATION

Study III was based on a clinical and radiographic evaluation of the periodontal and cariological status in a sample from an adult Pakistani population.

Study III revealed that the participants had more or less *functional dentition* with poor oral health, evidenced by a high prevalence of plaque, calculus and gingivitis. While caries experience was relatively low, the majority exhibited mild to moderate bone loss, and evidence of periodontal destruction.

The ultimate goal for oral health is a natural, functional dentition throughout life (Dowsett et al. 2001). It is very interesting to note that this population of Pakistani adults has more or less functional dentition similar to many industrialized countries. The population had on average 25 *teeth*. Similar findings are reported from China (Luan et al. 1989), Sweden (Buhlin et al. 2003), India (Shah and Sundaram 2004), Central America (Dowsett et al. 2001) and the United Kingdom (Robinson et al. 2000). The participants correctly assessed the number of teeth in their dentitions, as reported in Study I (Tanwir et al. 2006).

Many epidemiological studies have shown **poor oral health** among adults of the third world. One such study is of periodontal disease among indigenous people in the Amazon rain forest, disclosing high levels of plaque, calculus, and BOP. These people had gingival recession rather than deep pockets, similar to our study population, but despite poor oral hygiene and extensive gingival inflammation, they did not exhibit severe periodontal destruction (Ronderos et al. 2001). Similarly, a study on Chinese farmers showed poor oral health, high prevalence of periodontal variables, calculus and gingivitis, but low mean DMFT values (Lin and Schwarz 2001). A study on Asians living in Southampton also showed most of the participants to be dentate (70%), but a high unmet periodontal treatment need (Mattin and Smith 1991).

The poor oral health in this population was evidenced by the high prevalence of **plaque, calculus and gingivitis**. A very high prevalence of gingivitis was found among both sexes. Similar findings were reported in the situation analysis of Pakistan (WHO 2004). These findings are in agreement with our previous study of perceived oral problems in this population (Tanwir et al. 2006), the situation analysis in Pakistan (WHO 2004) and also a study from India (Howden 1984), in which none of the participants was found to have a completely healthy periodontium.

In agreement with earlier studies in Pakistan (WHO 2004 and Maher 1991), the presence of calculus is characteristic for this population. A study on a Bangladeshi population living in UK, also reported calculus in 98% of dentate participants (Pearson et al. 2001). Similar findings of calculus were also noted in Japan (Hu et al. 1990), in Guatemala, Central America (Dowsett et al. 2001) and in USA (Hanson and Persson 2003).

Overall, despite the presence of widespread calculus and plaque deposits, extensive and **advanced periodontitis** was not observed in this population. Most of the study population exhibited mild to moderate bone loss, while severe loss was unusual. Only 8 (7 %) out of 110 participants exhibited severe and aggressive periodontitis. That destructive periodontal disease is not an inevitable consequence of long standing gingival inflammation is in accordance with epidemiological data from the 1980's and 90's indicating that severe periodontal breakdown affects only a minority (5-8%) of otherwise healthy individuals in the industrialized countries (Hugoson and Jordan 1982; Oliver et al. 1998; Papapanou 1996). Similar findings were seen among tea workers in Sri Lanka (Loe et al. 1986; Loe et al. 1978), in the analysis of Pakistan (WHO 2004) and in a study of adults in Guatemala, Central America (Dowsett et al. 2001). The present results also support those from Japan (Miyazaki et al. 1989) and USA (Hanson and Persson 2003) on the prevalence of periodontal disease in low income populations.

Regarding **gender differences**, men tended to have more periodontal problems, bleeding on probing and bone loss than women. This is contrary to the findings by (Rao et al. 1999) in India, but in agreement with the Japanese study (Miyazaki et al. 1989) and also with a French study, in which men showed a significant greater percentage attachment loss than women (Bourgeois et al. 2007). The older age group exhibited more severe bone loss than the younger group, which is in accordance with many earlier studies from Pakistan and elsewhere (WHO 2004;1996; Bourgeois et al. 2007; Hanson and Persson 2003; Maher 1991; Miyazaki et al. 1989).

Smokers had more severe bone loss than non-smokers, but the other periodontal variables such as plaque, bleeding on probing, calculus and gingival recession were similar in smokers and non-smokers. This is in agreement with the study conducted in Navajo Indian adolescents (Wolfe and Carlos 1987). Several studies have shown strong evidence to suggest that smoking negatively interferes with healthy periodontal conditions. (For review see Bergstrom, 2006).

Betel habits had no significant effect on the periodontal health of the participants. This is in contrast to our earlier findings, probably because the participants' perception was that they had more periodontal problems because of the staining of teeth and mucosa and generalized pain (Tanwir et al. 2006). This is contrary to a UK study (Pearson et al. 2001).

Concerning their **cariological status**, the participants in our study had received very little restorative treatment. This is in agreement with a study conducted on a community of Indian elderly (Shah and Sundaram 2004). However, the level of decay was less than in earlier investigations in Pakistan, the survey of Pakistan (WHO 2004) and in the national pathfinder survey conducted in Pakistan (Maher 1991), in which dental caries was reported in 78 per cent of adults. The low level of caries in this population may be related to the maintenance of traditional dietary practices and the comparatively low levels of refined and fermentable sugars in the diet. Our findings are in accordance with studies conducted in the United Kingdom (Pearson et al. 2001; Robinson et al. 2000).

In our present study we found a trend for caries experience to decline with age. Similar findings were seen in a study on elderly in India (Shah and Sundaram 2004), who also found that with increasing age, the number of decayed teeth decreased and caries free teeth increased. However, the association between dental caries and age was not significant. This finding is similar to a study on an indigenous adult population in Central America (Dowsett et al. 2001). Females had more decay than men (2.7% and 1.4% respectively). This is similar to the study on adults in Poland (Szymanska and Fetkowska-Mielnik 1998). In contrast, an Indian study found no gender difference in caries prevalence (Shah and Sundaram 2004).

Poor oral hygiene was reported among adults in Singapore, but the mean DMFT value was higher than in the present study (Loh et al. 1996). A study of Vietnamese villagers disclosed a high prevalence of dental caries and 87% of subjects with periodontal problems (Uetani et al. 2006). In USA, a study on a low income adult population disclosed an increase in tooth decay needing urgent treatment (Hanson and Persson 2003).

Among the habits, **betel quid chewers** tended to have less decay and betel nut chewers more decay, which is in agreement with our previous study (Tanwir et al. 2008). The protective effect of betel quid chewing may be due to excessive salivation and the cariostatic action of lime (a component of betel quid, which contains calcium). The practice of regular betel quid chewing has been reported to impact on caries levels. Howden (Howden 1984) concluded that betel nut chewing in Papua New Guinea had a cariostatic effect.

A very interesting correlation was found between dental caries experience and *oral hygiene practices*. Those using a toothbrush and cleaning daily had more decay than those who used a finger to clean their teeth and those who cleaned their teeth only occasionally. Although daily cleaning with toothbrush and toothpaste is considered the hallmark of oral hygiene practice, it cannot totally prevent caries, which has a multifactorial aetiology. These findings are in agreement with study done in India (Shah and Sundaram 2004) but in contrast to study on people from South East Asia living in the UK (Robinson et al. 2000).

The clinical examination also revealed no association between oral health and socioeconomic status. This result is similar to our earlier studies (Tanwir et al. 2006; 2008) but contradicts the findings of a previous study (Shah and Sundaram 2004).

From the findings of Study III it may be speculated that the poor oral status disclosed in this population is not attributable to ignorance, low levels of education or the cost of dental treatment. The implications are that for this population, oral health is not a major concern but of low priority and that the participants have a poor attitude towards their oral health.

The study also leads to the conclusion that this population is not in need of major restorative treatment. Preventive measures such as scaling and minor restorative treatment, improvement in oral hygiene habits and dental health education would considerably improve the oral health of this population.

DIABETES EFFECT ON ORAL HEALTH

Study IV tested the hypothesis that diabetes has a strong influence on oral health in a population with poor oral hygiene. This study revealed that the patients with diabetes had fewer teeth, poorer oral hygiene, expressed as an increased number of sites with plaque and more periodontitis as compared to a control group without diabetes.

Fewer *teeth* among diabetics seem mainly to be a finding in populations with a poor oral hygiene. A Saudi study showed that 81 % of those in the diabetic group had from 9-20 missing teeth compared to 19% in the non- diabetic group (Almas et al. 2001). Kawamura and co-workers (Kawamura et al. 1998) showed that diabetics had 6.7 missing teeth compared to 4.3 in the control group. Studies conducted on populations with better oral hygiene have disclose no differences in the number teeth (Falk et al. 1989; Oliver and Tervonen 1993; Sandberg et al. 2000). A recent meta-analysis (Khader et al. 2006) does not report the number of missing teeth, but shows no difference in DMFT.

Moderate to severe *periodontitis* was more frequent in diabetics than in non-diabetics. This is in agreement with many previous studies which pose diabetes as a risk factor for periodontal disease (Khader et al. 2006; Leong et al. 2007). Compared to the non-diabetics, the diabetics in these studies had more plaque, even though the use of a tooth brush was more common in this group and the proportion of people cleaning their teeth daily was similar in both groups. The finding of poorer oral hygiene among patients

with diabetes is in agreement with a number of studies (Albrecht et al. 1988; Khader et al. 2006; Ngakinya et al. 1997; Sandberg et al. 2000).

While studying the periodontal condition of the diabetics it also emerged that diabetics had a tendency to more *decay* than non-diabetics, with significant DMFT and DMFS values, attributable to the “M” missing component and also that the diabetics had fewer teeth. These results are in accordance with many earlier studies (Albrecht et al. 1988; Bahru and Abdu 1992; Bakhshandeh et al. 2008; Sandberg et al. 2000).

Several studies have shown that diabetics have poorer *self-efficacy* with respect to oral health. Two Finnish studies concluded that perception of dental self-efficacy plays a decisive role in relation to oral health behavior in diabetic patients and has a positive influence on diabetes compliance (Knecht et al. 1999; Syrjälä et al. 1999). Study IV also showed a significant association between dietary history regarding sugar intake, with the diabetics consuming less than the non-diabetics. This was an expected finding.

The diabetics in the population sample were restricted to those already diagnosed with type 2 diabetes. Hence, any undiagnosed, asymptomatic, or misdiagnosed patient would not be included in the diabetic group but may have been included among the non-diabetics, as controls. Thus in future studies it would be worthwhile to screen for unidentified diabetes among the control group, as suggested by Borrell (Borrell et al. 2007). The results indicate that the dental surgery or dental clinic could serve as a health care centre for *screening of unidentified* cases, i.e. dental examination could offer an opportunity to identify individuals unaware of their diabetic status.

Thus, the results of study IV confirm that in this population with poor oral hygiene, diabetes has a strongly negative influence on oral health as evidenced by fewer teeth and a higher prevalence of moderate to severe periodontal disease among the diabetics than among the non-diabetics.

There are certain weaknesses in the studies. Sample size calculations and power calculations were not undertaken. It was considered that to describe the oral health status of this population, a sample size of 100, every tenth participant from the 1000 participants in the questionnaire study, was an adequate basis for evaluating the cariological and periodontal status by clinical and radiographic examination. There were also practical reasons. To request more participants for clinical examination was not practical or rather difficult, bearing in mind that research was being conducted among this group of adults for the first time. Extra diabetics were invited to join the clinical study in order to balance the number of non-diabetics and to increase the comparative power afforded by a larger study sample. These diabetics were from the same PNT colony and did not differ in age or education from the other participants. Another weakness was that in Study III the findings disclosed tendencies which did not reach statistical significance. Studies on a larger population sample are thus warranted in future.

A further weakness was that in Study IV, for practical reasons, plasma glucose or glycosylated hemoglobin (HbA_{1c}) was not measured. The results of the study would

have been enhanced by analysis of data on HbA_{1c} and glucose tolerance in both the diabetic and non-diabetic groups.

The **mucosal lesions** recorded among the participants in Study III and Study IV comprised buccal staining only. Oral premalignant and malignant conditions are highly prevalent in South East Asia and the Karachi South district has the highest incidence of oral cancers in the world (Bhurgri 2005). No such conditions were found in the study population, probably because people seek help elsewhere for mucosal lesions. There are established centers for screening and treatment of oral malignant and premalignant conditions.

ABSENCE OF TOOTH ACHE SYNDROME

This series of studies concerned the oral health behavior of this population and their attitude to oral health. Oral health is not a high priority and they seek dental treatment only when the need arises, for emergency conditions, usually for relief of pain. This finding emerged in the questionnaire studies I and II and was confirmed in the clinical studies III and IV.

The implication is that irregular dental attendance is attributable not to lack of resources, poor education or low income, but to the fact that oral health is not a major concern. Compared to general health, the attitude to oral health is poor.

Similar results were seen in the Oral health survey conducted in 2004 in Pakistan, which found that over 90% of all oral diseases remain untreated. Irregular dental attendance is attributable to poor perception of dental treatment needs, or “*absence of toothache*”: most dental patients present with teeth in an advanced stage of decay, damaged beyond repair.

One unfortunate consequence of irregular dental attendance is that extractions comprise more than 90% of treatment. Preventive services form less than 3% of services at the public dental clinics (WHO 2004).

Similar conditions apply in other developing countries. A Polish study showed that the subjects sought medical care only for severely debilitating conditions or diseases which they considered to be life-threatening: less acute conditions were usually treated with domestic remedies (Szymanska and Fetkowska-Mielnik 1998). Another study on Asians living in Southampton, including those of Pakistani, Indian and Bangladeshi origin, concluded that despite the fact that many subjects held positive attitudes towards oral health, fewer than 15% were regular dental attenders: the remainder felt that a dental appointment was necessary only if they were in pain or required new dentures (Mattin and Smith 1991). A study on Japanese adults also revealed that they visit the doctor when their disease takes a turn for the worse (Miyazaki et al. 1989). These results are consistent with those of a study on an indigenous population of Central America, where oral care was restricted to emergency treatment only and thus oral disease remained largely untreated (Dowsett et al. 2001). An investigation of primary barriers to utilization of dental services in a low income population in USA also disclosed that for financial reasons the subjects sought dental care only after a problem

had arisen: consequently tooth extraction was often the only available treatment (Hanson and Persson 2003)

Thus there is an urgent need to increase oral health awareness among Pakistani adults in general. However, because of the high prevalence of diabetes, it is suggested that initially, special effort should be made to improve the oral health of young diabetics.

MAIN FINDINGS

In study I, more than half of an adult population surveyed had perceived oral health problems: the most prevalent were esthetic problems, followed by pain and dental caries (cavities).

In study II, betel nut chewing was found to have deleterious effects on oral tissues and to increase the risk of caries and periodontal disease.

In study II, frequency of oral hygiene practice was shown to have a strong influence on oral health.

Studies I, II, and III disclosed no relationship between oral problems and socioeconomic status, income or educational level.

Study III disclosed that the oral health of Pakistani adults is poor, with a high prevalence of plaque, calculus and bleeding on probing. Moreover this population does not perceive oral health to be a major concern.

A further finding in study III was that while there is little need for major restorative treatment, the oral health of the population would benefit considerably from preventive measures such as scaling, minor restorative treatment and improvement in oral hygiene habits.

In study IV, Diabetes was found to have a strongly negative influence on the oral health of this population with poor oral hygiene, as evidenced by fewer teeth and a higher prevalence of moderate to severe periodontal disease among diabetics than among non-diabetics.

GENERAL CONCLUSIONS

The series of studies on which this thesis is based confirms the poor attitude towards oral health in this population: oral health is not a major concern and has low priority. No association has been found between poor oral health and ignorance, poor educational levels, or socio-economic status. This population does not require major restorative treatment. The main unmet treatment need is for minor restorative work or preventive measures such as scaling. Improving oral hygiene habits and dental health education could achieve major improvements in oral health. Diabetes is highly prevalent in Pakistan and in this population with poor oral hygiene, it was shown that diabetes is associated with poor oral health: diabetics have fewer teeth and a high prevalence of periodontitis.

FUTURE CONSIDERATIONS

Compilation of oral health data through large epidemiological studies and formulating oral health policies at a national level are pre-requisites for the implementation of effective preventive dental care programmes in Pakistan

(Adapted from Meshari Al-Otaibi PhD thesis, pg 63)

This thesis is the first step towards collecting oral health data about the cariological and periodontal status of an adult Pakistani population, as a basis for determining treatment needs. Among the developing countries, Pakistan, with 170 million people, has a relatively large and diverse population. Further studies are therefore warranted at both regional and national level. The data should be compared with those of the developed countries, in order to determine global differences in the prevalence and incidence of oral diseases. Longitudinal studies of untreated populations would improve our insight into the role of risk factors in the aetiology of oral diseases.

Antibiotic resistance is an increasing global problem. As antibiotics are available as over-the-counter products in Pakistan, it would be of relevance to study the use of antibiotics, both on prescription and over-the-counter, in the treatment of oral conditions.

Because of the high prevalence of periodontitis, more detailed investigation of the periodontal condition of the Pakistani population is warranted, for example collection of data on the microflora and the inflammatory markers in gingival crevicular fluid and plaque samples, for comparison with data from the developed countries.

Betel nut extract and alkaloids found in the betel nut are known carcinogens and have been studied in relation to lesions of the oral soft tissues, but little is known of the effect of betel habits on caries and periodontal status. Because these habits are so widespread and well-established in Pakistan, further studies are warranted.

Diabetes is extremely prevalent in Pakistan and seems to have a strongly negative impact on the oral health of this population with poor oral hygiene, as suggested in this thesis. It would therefore be interesting to conduct intervention studies on diabetics, comparing the effect of basic periodontal treatment, with and without antibiotics, to determine whether systemic antibiotics and local periodontal treatment improve glycemic control. As proposed in this thesis, the dental clinic could function as a location for screening for cases of undiagnosed diabetes.

As with diabetes, Pakistan has also a high prevalence of cardiovascular conditions. Similar studies could be conducted to study cardiovascular disease in the population, for instance to study the medications used and also to conduct intervention studies.

The ultimate goal for oral health is a natural, functional dentition throughout life (Dowsett et al. 2001). It is of interest to note that this population of Pakistani adults has more or less functional dentition similar to many industrialized countries, where the burden of oral disease has been managed through the establishment of highly technological dental delivery systems, based primarily on curative services to patients (Petersen et al. 2005). In these developed countries expenditure on oral care is much higher than in most developing countries and mostly constitutes major restorative treatment like bridgework and implants. Over the past years, savings in dental expenditure have been noted in industrialized countries which have invested in preventive oral care and where positive trends have been observed in terms of prevalence of oral disease (Petersen et al. 2005).

Pakistan does not have the resources of developed countries to provide major restorative work rather than preventive services. This thesis has shown that there is little need for major restorative treatment. Minor restorative intervention and positive changes in attitude to oral health care should achieve major improvements in overall health status.

Finally, as preventive oral health programmes are nonexistent in Pakistan (Ijaz and Khan 2005), primary health care approach strategies should be reinforced and improved oral hygiene practice and dental education should be established early in life. Awareness of oral health should be promoted and encouraged throughout life.

To achieve long term goals, all primary oral health care programmes should be based on disease prevention rather than the treatment of disease sequelae.

The implementation of field based, community-oriented oral health programmes, with emphasis on prevention and health education, maximizing the use of available community resources, seems to be a realistic approach to the prevention and control of oral diseases in the developing countries. The primary health care approach that would embrace all these activities will go a long way towards improving the oral health of communities in the developing countries (Saparamadu 1984, 1986).

In Pakistan, public health preventive measures, including oral health strategies, need to be tailored to the resources available. It is acknowledged that resources reserved for oral health are very limited. It is suggested therefore, that in view of the high prevalence of diabetes, young diabetics should be the first group to be targeted for preventive intervention intended to improve oral health.

PREVENTION IS BETTER THAN CURE

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