ORAL HEALTH PROMOTION PROGRAMME FOR DIABETICS IN SINGAPORE

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NATIONAL UNIVERSITY OF SINGAPORE

2006

ORAL HEALTH PROMOTION PROGRAMME FOR DIABETICS IN SINGAPORE

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(B.D.S.)(F.I.C.D.)

A THESIS SUBMITTED

FOR THE DEGREE OF DOCTOR OF PHILOSPHY

FACULTY OF DENTISTRY, PREVENTIVE DENTISTRY DEPARMENT

NATIONAL UNIVERSITY OF SINGAPORE

2006

THIS THESIS IS DEDICATED TO

MY FAMILY

MY DEAR WIFE *"Sanda"* & DAUGHTER *"Phyu"*

AND

IN MEMORY OF

MY DEAR PARENTS

"Col. Tan Yu Saing & Daw Hla Hla"

&

DAUGHTER

"Lynne"

DECLARATION

This thesis does not contain material that has been submitted for any degree or qualification, or published work by another person with the exception of citations acknowledged in the text.

HLA MYINT HTOON

DATE: 2**0.01.06**

ACKNOWLEDGEMENTS

I would like to extend my deepest appreciation, for the kind guidance and encouragement rendered by my supervisor Assoc. Professor Lim Lum Peng with her astute mentoring and unwavering perseverance to support my academic progress.

My deepest appreciation also goes to Dr Fidelia Tay for providing all the support in her capacity to conclude this research.

I would like to express my special thanks to Dr. Sum Chee Fang and Prof. Thai Ah Chuan for the multidisciplinary collaboration and support for the success of the study. I would like to express my special thanks to both the consultants for providing this immeasurable contribution.

Special appreciations are also extended to Dr. Chan Yiong Huak, for his special guidance in the statistical analysis of this complex study and to Dr. Roland Jureen for proofreading and invaluable suggestions provided.

Last but not the least, my colleagues Dr. Khurram Ataullah, Dr Tan Wah Ching, Dr Chee Hoe Kit and Dr.Tan Ching Ching deserve my special thanks for their help, encouragement and friendship.

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SUMMARY

Aim: The purpose of this study was to evaluate the periodontal status of a cohort of patients with diabetes in a longitudinal randomized controlled trial and to find out the factors affecting the treatment outcome in terms of clinical, laboratory and oral hygiene compliance behavioural responses.

Materials and methods: 161 subjects with diabetes were recruited from two diabetic centres in Singapore. These subjects were then randomized into three groups; oral hygiene with scaling group OH+Sc (59 subjects), oral hygiene alone group OH (52) and control group (50). At baseline, periodontal clinical parameters, Probing Pocket Depth (PPD), Plaque, Bleeding on Probing (BOP) and Calculus) were collected. Laboratory data (HbA1c, Total cholesterol) and self reported questionnaire data; Knowledge, Attitude and Practice (KAP), Hiroshima University Dental Behaviour Inventory (HU-DBI) and Oral Health Impact Profile 14 items (OHIP-14) were collected prior to the intervention. Oral hygiene instruction was delivered to the subjects belonging to OH+Sc & OH groups. Scaling was only provided to the OH+Sc group and the control group did not receive any form of therapy. The same parameters were evaluated at 3 months (155 subjects) and 9 months (132 subjects) with an additional questionnaire set on self-efficacy at 9 months. To determine a criterion for oral hygiene compliance (OHC), Receiver Operator Characteristic (ROC) curve analysis was carried out using a sequence of plaque and BOP scores in relation to a composite score of pocket depth, subgingival calculus and supragingival calculus at baseline. McNemar, logistic regression analysis and Pearson's

Chi Square test with Bonferroni correction was used to analyze the OHC criterion differences. ANOVA, ANCOVA and repeated measure analysis was used for analyzing clinical and laboratory data differences. Summation scores of Questionnaire data were analyzed by ANOVA and paired t tests. An " a priori' OHC model was analyzed for a path analysis (Structural Equation Modeling).

Results: The combination of ≥ 25% plaque scores and ≥ 15% gingival bleeding scores (unacceptable oral hygiene compliance criterion) obtained the highest Receiver Operator Characteristic (ROC) value (using a probability cutoff of 0.5) of 0.868 with Sensitivity 98.6%, Specificity 75.0%, Positive Predictive Value (PPV) 97.3% and Negative Predictive Value (NPV) 85.7%. After intervention, OHC for OH +Sc group showed significant improvements compared to control at 3 months ($p<0.001$) and 9 months ($p<0.01$). OH group showed a significant improvement compared to Control at 9 months ($p<0.01$) only. The OH+ Sc group was found to have significantly lower plaque, BOP and subgingival calculus levels as compared with Control group at 3 months ($p<0.01$) and at 9 months ($p<0.01$). OH group showed significant reductions in plaque and BOP scores at 3 months ($p<0.05$) and at 9months for plaque only ($p<0.05$). There were no significant change in PPD, HbA1c, total cholesterol and supragingival calculus variables at all time lines between groups. There were no marked change in knowledge of periodontal disease among the oral hygiene instructed groups, however, there were significant improvements in interdental cleaning practice for the OH+Sc group compared to control at 3 months ($p<0.05$). There was no marked change in oral health attitudes or the oral health impact profile following intervention. A logistic regression analysis showed self-efficacy as a potential explanatory theory for oral hygiene compliance behaviour among this cohort ($p<0.01$). Subgingival calculus and unacceptable HBA1c at baseline were factors found to

be associated with low oral hygiene compliance ($p<0.05$) using structural equation modeling (SEM).

Conclusion: In conclusion, the study confirms that scaling and oral hygiene education is an effective periodontal treatment modality to improve periodontal health of patients in the programme. The removal of subgingival calculus in combination with oral self-care is considered to be the treatment of choice for managing periodontal disease among subjects with diabetes. In addition, enhancing self-efficacy and effective control of HbA1c may have beneficial effects on oral hygiene compliance for diabetics in Singapore.

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CHAPTER ONE Introducing Background to the Research

Diabetes mellitus (DM) is one of the most common chronic medical conditions requiring continued life-long management that affects a significant proportion of the adult population in Singapore. Currently there are more than 300,000 people with diabetes in Singapore reflecting a high prevalence of the disease in global standing (Cockram, 2000). Poor glycaemic control in these patients have led to serious medical complications such as blindness, kidney failure, heart attacks, strokes, limb amputation, sexual difficulties and neurological complications. The increase in incidence of diabetes and its complications calls for more concerted efforts to reduce the risk factors associated with the disease. This includes maintenance of low blood glucose levels, control of cholesterol, hypertension, body weight management and smoking cessation as a holistic approach involving the various medical disciplines. With emerging emphasis on the link between periodontal disease and systemic health, periodontal disease has been identified as the sixth complication of diabetes (Löe, 1993). In Singapore, a pilot study conducted by Lim & co-workers (2002) demonstrated a higher prevalence of periodontal disease amongst diabetics as compared with the population at large. It is therefore timely to include periodontal health care as part of the integral component of health promotion among patients with diabetes.

Conventional measures used to control periodontal disease includes a combination of oral hygiene and non-surgical periodontal therapy such as scaling and root planing to remove plaque retention factors to prevent progression of periodontal disease (Jones & O'Leary, 1978; Axelsson & Lindhe, 1981; Nakib et al., 1982; Corbet et al., 1993). The

effectiveness of oral health programmes to improve the periodontal health of individuals in different settings has been well documented (Croxson, 1993; Lim et al., 1996; Redmond et al., 1999, Worthington et al., 2001). Similarly, a number of studies conducted in patients with diabetes have demonstrated promising clinical outcomes (Tervonen & Karjalainen, 1997; Rodrigues et al., 2003). Studies of such nature have not been documented in the local context.

The self-care component of oral hygiene maintenance is ubiquitous at all levels of periodontal disease management. However, patient motivation still remains one of the barriers in oral health education. An understanding of the health behaviour of individuals is therefore necessary particularly in a high-risk group like diabetes. This would require understanding of major behavioural phenomena such as self-efficacy and the impact on oral health using reliable units of evaluation. The use of non-standardised format has lead to difficulties in analyzing and interpreting the findings. The need for standardized format is exemplified by the development of various questionnaires such as the HU-DBI (Hiroshima University Dental Behaviour Inventory) and oral health quality of life (Kawamura et al., 1988, 2001a; Slade, 1997). The control of diabetes and periodontal disease share a common platform, as both conditions require long-term management and self-care. An insight into a possible link between oral health behaviour and diabetes control is therefore also needed.

In view of the high prevalence of diabetes in the local population and the possible pre-disposition to periodontal breakdown, there is a profound need to promote oral health

through oral self-care, and a need to better understand oral health behavior of individuals with diabetes in order to facilitate planning of appropriate oral health programmes.

The purposes of this study are therefore:

1. To find out the periodontal health status and oral health behaviour status of adult diabetics in Singapore.
2. To evaluate longitudinally the effects of a periodontal health programme on periodontal health status and oral health behaviour status of adult diabetics in Singapore.
3. To explore factors associated with oral hygiene compliance in adult diabetics in Singapore.

CHAPTER TWO LITERATURE REVIEW

2. 1 DIABETES – The size of the problem

Diabetes mellitus is one of the most common medical problems in Singapore and it was also reported as the sixth common cause of death in 2001 (Ministry of Health Singapore, 2002). It is estimated that there is currently 171 million diabetics worldwide; this figure is expected to double by the year 2030 (WHO, 2006) creating a potentially heavy burden on the health care services. There is also a rising prevalence of type 2 diabetics among the young (maturity onset diabetes of the young) due to changes in lifestyle (Cockram, 2000). The prevalence of diabetes mellitus in Singapore was found to increase from 2.5% in 1975, to 4.7% in 1984, to 8.6% in 1992, and 9.0% in 1998 (MOH Singapore 1999). Table 1 shows the age specific distribution of diabetes from the 1998 Ministry of Health report (MOH Singapore 1999). An increase in the prevalence of diabetes was found in the older age group. Over 20 % of adults aged 50 and above was found to have diabetes. This increasing trend is of public health concern, as it would have direct implications on the financial and manpower resources of the nation.

Table 1. AGE SPECIFIC PREVALENCE OF DIABETES (%) IN SINGAPORE
(National Health Survey , Ministry of Health 1998)

Age(n)	Male(%)	Female (%)	Total(%)
18-29(1205)	**0.6**	**1.0**	**0.8**
30-39(1509)	**3.7**	**2.9**	**3.3**
40-49(1161)	**9.6**	**9.7**	**9.6**
50-59(501)	**19.7**	**24.0**	**21.8**
60-69(347)	**29.4**	**35.2**	**32.4**
Total 18-69years	**8.5**	**9.6**	**9.0**

2.2 EPIDEMIOLOGY OF PERIODONTAL DISEASE

2.2.1 Assessment of Periodontal disease

Chronic inflammatory disease of the gums and its supporting structure is one of the commonest oral diseases in man.

Clinical assessments of plaque-induced periodontal diseases as stated by the position paper on Diagnosis of Periodontal Diseases (AAP, 2003) are based upon:

i) Presence or absence of inflammation

ii) Probing depth

iii) Clinical attachment loss (extent and pattern)

iv) Medical and dental history

v) Other contributing factors (e.g. plaque, calculus, pain and ulcers)

The difference between gingivitis and periodontitis is based on the presence or absence of attachment loss (Armitage, 1995). In gingivitis, gingival redness, edema, bleeding, changes in contour, loss of tissue adaptation to teeth, and increased GCF output (Greenstein, 1984; Cimasoni, 1983) are the main characteristic findings without the loss of attachment and bone loss.

Indices used to assess gingivitis include: Sulcus bleeding index (Ainamo & Bay, 1975) and Gingival Index (Löe & Silness, 1963). For periodontitis, various indices have been used based upon loss of periodontal support. The indices include Russell's Periodontal index (Russell, 1956), Periodontal disease index (Ramfjord, 1959) and Extent and Severity Index (Carlos et al., 1986). The CPI criterion is one of the most commonly used epidemiological tools used in oral health assessments (Ainamo et al., 1982). The CPI criterion requires the use of a WHO probe. The key elements of the probe include

i) a ball end of 0 .5mm in diameter

ii) a band extending from 3.5mm to 5.5mm(WHO-E probe)

iii) a second band from 8.5mm to 11.5mm(WHO-C probe)

iv) probing force not exceeding 0.2-0.25N

Recordings are done in sextants, including ten index teeth in the following sequence teeth number 17, 16, 11, 26, 27, 36, 37, 31, 46, 47. They are recorded for its worst score.

Six points on each tooth are examined: mesio-buccal, mid-buccal and disto-buccal and corresponding lingual sites with the following codes:

Code	Description
0	indicated for less than 3.5mm, without any bleeding on probing (BOP)
1	indicated at less than 3.5mm, with BOP but no calculus and plaque retentive defects.
2	indicated at less than 3.5mm, calculus, and plaque retentive defects present with BOP.
3	indicated when pocket is between 3.5mm and 5.5 mm.
4	indicated when pocket exceeds 5.5mm indicating a depth of ≥ 6mm.

No treatment is indicated if the Code is '0', oral hygiene instruction for Code '1', oral hygiene instruction plus calculus removal and/or correction of plaque retentive restorative margins for Code '2', oral hygiene instruction plus calculus removal and root surface debridement (RSD) as required for Code '3', Code '4" would include oral hygiene instruction plus calculus removal, root surface debridement and complex periodontal treatment which may require referral to periodontologist.

However, CPI criteria are not without its limitations. The index was not primarily designed for clinical trials. Users may assign a higher code for calculus of (code2)

which8can preclude the assessment of bleeding in the presence calculus. Sou (1988) found that CPI criteria might underestimate pocket depth by 20% compared to full mouth assessments. Since recession is not recorded for CPI criteria there is a limitation in recording clinical attachment loss (CAL).

2.2.2 Prevalence of periodontal disease - local and global trend

In the year 2000, Lo and co-workers reviewed the epidemiology of periodontal disease among school children in Singapore. The study showed incremental improvements in oral hygiene among school going children from 1970 to 1994. However, it was emphasized that there were only a third of the schoolchildren that were without periodontal disease and highlighted the need for a greater effort in promoting oral hygiene (Table 2).
The 1994 data on schoolchildren by Loh et al., (1995) showed that none of the subjects had CPI 4. In contrast, Ong et al., (1994) showed a prevalence of 5.7% for CPI 4 from a cohort of 774 subjects with an age range less than 30 years (Table 2). In a recent National Oral Health survey 2003, over 90% of the adult population was found to have some form of periodontal disease. Sixty percent presented with at least one tooth with probing depths of > 3.5mm. Of these, 13.8% had periodontal disease in the more severe category (Lim et al., 2005).

Table 2 Comparison of %CPI scores among children, adult and diabetics in Singapore

(n)	age	CPI 0	CPI 1	CPI 2	CPI 3	CPI4
Schoolchildren (2706) (Loh et al., 1995)	**12-18**$^{+}$	**30.0**	**16.6**	**53.0**	**0.5**	**0.0**
Adult (774) (Ong et al., 1994)	**<30**	**12.4**	**5.3**	**62.9**	**13.7**	**5.7**
Adult (1460) (Lim et al., 2005)	**20-65**	**1.9**	**2.6**	**32.7**	**46.7**	**13.8**
Adults (diabetes) (153) (Lim et al., 2002)	**20-83**	**0**	**0**	**15.0**	**56.9**	**28.1**

Global data showed that periodontitis in moderate to severe form affects the general population from 5 -20 %, by age 40 years and the proportion affected increases with age (Miyazaki et al., 1991;WHO Global Oral Data Bank, 2004). The findings from WHO oral data bank 1987 indicated a pattern of high bleeding and calculus scores from developing countries that did not necessarily show corresponding increase in pocketing (Pilot & Barmes, 1987). This evidence caused some rethinking of the traditional disease continuum model on the natural history of periodontal disease. These findings together with other accumulative scientific data from other diverse population studies (Sheiham, 1970; Hugoson et al., 1986; Loe et al., 1986; Jenkins et al., 1988; Lindhe et al., 1983 & 1989; Burt, 1994; Locker et al., 1998) raised the concept of a high-risk element for periodontal disease. Current evidence points towards a paradigm shift from the traditional continuous progressive model to an episodic model in which there is short burst of disease activity followed by longer periods of disease remission (Goodson et al., 1982; Socransky et al., 1984 & 1992; Page et al., 1997). The new paradigm of research therefore focuses on the population who are at risk as well as in identifying factors that may contribute to the risk

potential of these individuals eventually leading to periodontal breakdown. This new paradigm has provided the direction and impetus for research into high-risk association of environmental (e.g. smoking) and host factors (e.g. diabetes) with periodontal disease and other risk factors. Diabetes was one of the risk factors that intrigued researchers in the past few decades.

2.3 ASSOCIATION BETWEEN PERIODONTAL DISEASE AND DIABETES

2.3.1 Diabetes as a risk factor for periodontal disease

The paradigm shift in the natural history of periodontal disease has led to a risk focused research effort. The interrelationship between diabetes and periodontal disease has been studied extensively during the past few decades. The growing accumulative evidence has supported that periodontitis is indeed one of the six complications of diabetes mellitus (Löe, 1993). A summary is provided in Table 3.

The evidence: In some of the earlier studies, patients with diabetes were found to have poorer periodontal conditions (Glavind et al., 1968; Cohen et al., 1970). However, some researchers (Benveniste et al., 1967; Hove & Stallard, 1970; Barnett et al., 1984; Sastrowijoto et al., 1990a) could not demonstrate a close relationship between the two conditions partly due to the small sample size and short duration of study. Improvements of study designs in recent years have clearly shown that diabetics are indeed a high-risk group for periodontal disease (Nelson et al., 1990; Emrich et al., 1991; Grossi et al., 1994; Bridges et al., 1996; Firatli et al., 1997).

Table 3. Studies of diabetes as a risk factor for periodontal disease

Authors	Design	Sample size	age	Parameters	Remark
Williams &Mahan (1960)	case study	9DM		FBG, Insulin	Significant
Cohen et al., (1970)	2 years	21♀DM 18♀Non-DM	27±4.71 28.1±3.94	GI, LOA	Significant
Hove & Stallard (1970)	CS SES&age	28DM 16control Matched		Oral debris, pocket calculus, xrays	NS
Sastrowijoto (1990a)	case study diseased & control sites	6 Type 1 DM		PD, AL, BOP PI,microflora	NS
Nelson et al., (1990)	6 years	2237 Pima	≥ 15	Missing teeth ABL, DM	Significant 2.4(OR)
Emrich et al., (1991)	CS	1342 Pima	≥ 15	PD, LOA, plaque calculus,GI, PD	Significant 3.43(OR)DM
Tervonen &Oliver (1993)	retrospective	75DM	20-70	PD, LOA, plaque HbA1c subgroups	Significant
Grossi et al., (1994)	CS	1426 type 2DM New Yorkers	25-74	Perio-parameters, age, smoke status, systemic disease, Subgingival microflora	Significant 2.3(OR) 95% CI 1.17-4.6 for DM
Bridges et al., (1996)	prospective age matched	118 DM 115control	24-78	PI, GI, PD, CAL missing teeth	Significant
Firtali et al., (1997)	5 years	44 Type I DM 22 control	adolescent	CAL, FBG, HbA1c Fructosamine, DD	Significant(CAL)

PD,pocket depth;BOP,bleeding on probing;Al,attachment loss;ABL,alveolar bone loss;PI,plaque index;DM,diabetes mellitus;CS,cross sectional;SES,socio-economic status;LOA, loss of attachment;FBG,fasting blood glucose;DD=diabetic-duration;NS= not significant; OR= odds ratio; CI= confidence interval

Gingivitis was found to be more severe and prevalent among children with diabetes compared to children who did not have diabetes. (Ringelberg et al.,1977; Gusberti et al.,1983; Katz et al., 1991; de Pommereau et al.,1992). Bacic et al., (1988) in a cross sectional study of 222 diabetics (mean age 46.9years), and 189 controls (mean age 43.9 years) using CPITN criteria found that pocket depth of 6mm or more scored 1.3 sextants in diabetics and 0.3 sextants in controls ($P< 0.001$).

In 1993, Oliver & Tervonen showed that the prevalence of periodontal disease expressed as sites of pocket ≥ 4 mm among subjects with diabetes was 41% in comparison to 16% from a U.S. National Health Survey of 1985-1986. The same study also showed that subjects with diabetes had 5.2 sites exhibiting periodontal disease per person in comparison to 1.6 sites per person found for subjects without diabetes. Severity of periodontal disease as expressed in proportion of pockets with ≥ 4 mm pocket depth was 11.2% for diabetics and 2.5% for well-controlled diabetics (Ringelberg et al., 1977). However, a pilot study in Singapore by Lim et al., (2002) did not show statistical significance of this finding.

Firatli (1997) in their five-year longitudinal study on type 1 diabetics found a significant difference in clinical attachment loss between 44 type 1 DM and 20 controls in consistent agreement with these studies. In a study by Safkan-Seppäla & Ainamo (1992) 71 poorly controlled Type 1 DM (16.5 years DM duration) showed similar loss of proximal bone loss pattern. The findings indicate that periodontal parameters such as increased probing pocket depth (PPD), clinical attachment level (CAL) and alveolar bone loss (ABL) was associated with diabetes subjects compared to non-diabetics.

A series of studies conducted on Pima Indians who notably have a high prevalence of Type 2 DM have strongly supported the association between periodontitis and diabetes

(Emrich et al., 1991; Nelson et al., 1990; Taylor et al., 1996; Shlossman et al., 1990; Taylor et al., 1998). From the same study cohort, odds ratio for periodontal destruction ranging from 2.6 to 3.43 were reported (Nelson et al., 1990; Emrich et al., 1991). A study conducted in New York showed an odds ratio of 2.32 (95% CI 1.17-4.6) even after controlling for age and smoking (Grossi et al., 1994).

Those with poor metabolic control had significantly higher gingivitis scores (Gislen et al., 1980, Seppälä et al., 1993; Karjalainen and Knuuttila, 1996). Similarly, moderate and poorly controlled diabetics (both types) had more frequency of attachment loss and extensiveness (Shlossman et al., 1990; Tervonen & Oliver, 1993) that was also found to be true for type 1 diabetics (Safkan-Seppäla & Ainamo, 1992; Tervonen et al., 2000). Tervonen & Oliver (1993) also stated their finding that presence of calculus increased with poorer glycaemic control. At the same time, well-controlled diabetics who practice good oral hygiene and are well maintained without systemic complications appear not to be at high risk of developing periodontal disease (Tervonen & Knuutilla, 1986; Oliver & Tervonen, 1993; Yalda et al., 1994; Grossi et al., 1996).

The duration of diabetes also affected the frequency and extent of periodontal disease involvement among diabetics who had a longer duration of diabetes (Belting et al., 1964; Glavind et al., 1968; Hugoson 1989). The effect of the frequency and extent of periodontal disease with those presenting more advanced systemic complications and longer duration of diabetes was also noted by some researchers (Thorstensson et al., 1993; Karjalainen et al., 1994).

In a pilot study, Lim and co-workers (2003) investigated the periodontal status of adult diabetics using modified CPI criteria. The level of glycated hemoglobin level or fasting glucose was used to categorize subjects into two groups: good/ acceptable and

suboptimal/poor glycaemic control. One third of the subjects were found to have at least one sextant with probing depth of 5.5mm and above (CPI 4). Oral hygiene (Odds Ratio 2.7) with gender (Odds Ratio 3.1) was found to be associated with CPI 4 when analyzed by a logistic regression. The prevalence of CPI 4 amongst diabetics was found to be higher (28.1%) than the population based findings of 13.8 %. Due to the limitations of the pilot study and the lack of sensitivity of CPI criteria, glycaemic control did not appear to have significant effect on the prevalence of more severe periodontal breakdown. The results suggest a need for a longitudinal study and enquiry as to what kind of oral hygiene behavior may affect the severity of periodontal disease.

Other risk factors like smoking has been found to further increase the risk of periodontal disease in diabetics (Moore et al., 1999; Haber et al., 1993). Recent studies also highlight the influence of a low socioeconomic class, stress and lifestyle factors which can contribute to the severity of periodontal disease in the presence of drinking behavior and uncontrolled diabetes (Lalla et al., 2004; Negishi et al., 2004)

In summary, high risk profiling among diabetics for periodontal disease can aid in the planning of preventive strategies. There is currently a lack of such data highlighting the need of such information in the Singaporean context.

2.3.2 Pathogenic Mechanism (Figure 1)

Periodontitis and diabetes are two chronic diseases sharing many risk factors in their disease pathway. The pathways of periodontal disease and diabetes are associated with microbial challenge, the presence of a genetic risk factor, and environmental factors and in the case of diabetes an endocrine challenge. Therefore, the biologic plausibility of the

association between periodontitis and diabetes may best be explained by some of these possible shared disease mechanisms featured in Figure (1) (mechanism adapted from Tan, 2005; Soskolne & Klinger, 2001; Iacopino, 2001). Periodontal infections are infectious agent specific, where putative microorganisms such as; Aa (Actinobacillus actinomycetemcomitans), Pg (Porphyromonas gingivalis) has been strongly implicated in periodontal disease. The presence of these anaerobic Gram-negative bacteria was also found in the biofilm of subjects with or without diabetes (Sastrowijoto et al., 1989; Mashimo et al., 1983; Zambon et al., 1988; Mandell, 1992; Sbordone et al., 1998). These putative microorganisms are commonly considered to act as stressors and cause a chronic source of inflammation imposing an inflammatory burden at the local and systemic level. This would further trigger off inflammatory mediator expressions such as Prostaglandin E2 (PGE-2), cytokines interleukins IL-1b, IL-6 and tissue necrosis factor TNF-α and set into motion a series of catabolic events that eventually leads to periodontal tissue destruction (Offenbacher, 1996). Furthermore, these events may share disease pathways with some systemic medical conditions such as diabetes (Paquette et al., 1999).

Cellular response: It is also found that there is increased impairment in polymorphonuclear leukocytes (PMN) among subjects with diabetes compared to non-diabetics. The functions such as reduced PMN chemotaxis, defects in phagocytosis are also believed to cause impaired healing of periodontal tissues among diabetics (Smith et al., 1996). PMN related impairments such as elevated gingival crevicular fluid elastase and enzyme –glucoronidase are signals of PMN impairments that are evident in diabetic periodontal pathology (Oliver et al., 1993; Alpagot et al., 2001).

Insulin resistance: Sammalkorpi (1989) showed that there was 33% increase in insulin resistance during acute bacterial infection and 28% during the convalescence period. It is

still not clear why insulin resistance occurs but one of the factors such as TNF- α has been found to influence glucose uptake by cells and promotes insulin resistance (Paz et al., 1997; Stephens et al., 1997; Hansen et al., 1999). In periodontitis, the putative Gram-negative microorganisms harbour lipopolysaccharides (LPS) endotoxins and are considered to be potent producers of TNF- α. In some studies LPS was found to induce insulin resistance among rats (Lang et al., 1992; Ling et al., 1994). Salvi et al., (1998) found that diabetics as a group has a higher capacity to produce TNF- α in association with increasing Porphyromonas gingivalis (Pg) LPS concentrations. Grossi et al., (1996) also concurred with this finding in a study on smoking among diabetics. The researchers found that chronic Gram-negative infections with endotoxemia may lead to insulin resistance and impaired control of diabetes.

AGE (Advanced Glycated Endproducts) in diabetes and periodontal disease:

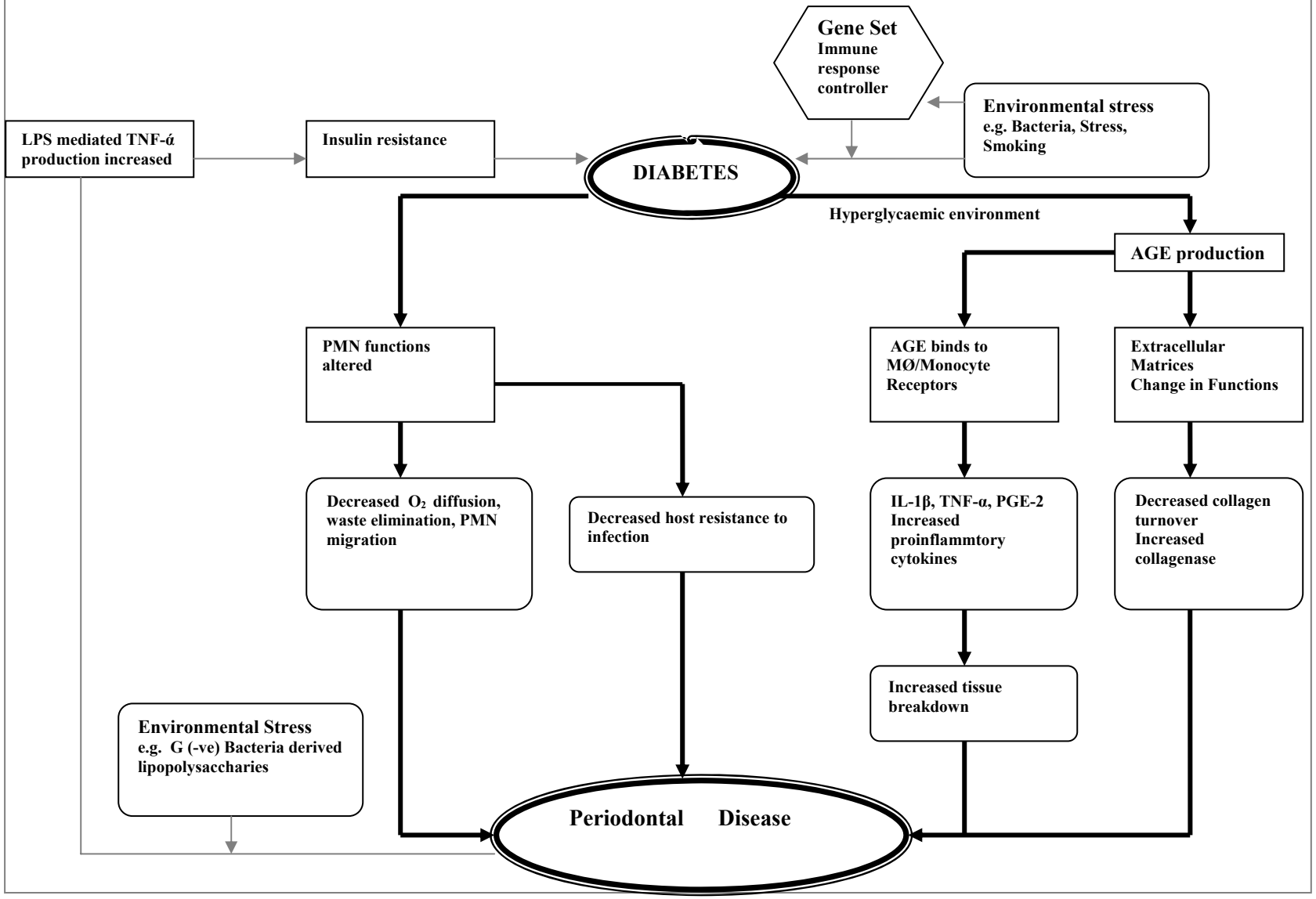
Diabetes is associated with accumulation of advanced glycated end products. AGE binds on surfaces of cells in the periodontium including monocytes and endothelial cells. The binding of AGE particularly in monocytes tends to increase chemotactic activity and levels of proinflammatory cytokines including TNF-α cytokine dysregulation (Goova et al., 2001; Salvi et al., 1997; Lalla et al., 2001; Schmidt et al., 1993; Lamster & Lalla, 2001; Naguib et al., 2004). The TNF- α dysregulation process is believed to start an inflammatory event, thereby impairing wound healing. In addition, AGE is also implicated for its role in greater collagen breakdown, contributing to the underlying mechanisms that account for more severe periodontal destruction amongst diabetics. This may in turn contribute to impaired immune and healing responses (Grant-Theule, 1996; Fontana et al., 1999; Grossi, 2001).

Environmental stressors such as bacterial infection and stress by itself and smoking may effect on the gene set, modulating the immune response that affects pancreatic beta cells (Soskolne & Klinger, 2001). The beta cells are responsible for the synthesis of insulin. Both of these stressors in kind produce pro-inflammatory cytokines, affecting a hyper-response and AGE related micro-vascular changes among the end organs including periodontal tissues (Iacopino, 2001).

Adipocytokines: Diabetic researchers have been interested in the role of adipocytokines (adipocyte-derived active molecules), and leptin (important energy and body weight regulator) that affects adipocytes in obese subjects. The pro-inflammatory cytokine is believed to be derived from TNF-α from the above process and could perhaps have an additive effect together with monocyte produced TNF-α. This response may perhaps partially explain the bi-directional relationship among type 2 diabetes (Nishimura et al., 2003).

In summary, the possible mechanisms involved are based upon a combination of microbial insult on the periodontium, resulting in PMN dysfunction, insulin resistance, and AGE related cascade of inflammatory and immunological reactions resulting in varying degree of periodontal tissue damage. All these changes may explain the biologic plausibility that has led to the clinical manifestation of periodontal disease.

Figure 1 . Pathogenic mechanism of periodontal disease & diabetes



mechanism adapted from Tan, 2005; Soskolne & Klinger, 2001; Iacopino, 2001

2.3.3 Periodontal Treatment Response

While it is generally accepted that improved glycaemic control is associated with better periodontal health, there is no consistent agreement as to whether the reverse is true. Grossi et al., (1997) found that diabetics receiving non-surgical periodontal therapy supplemented with doxycycline showed a significant reduction in HbA1c by 10% from the pretreatment values ($p \leq 0.04$). Positive findings were also observed by as early as the 60s and 70s by Williams & Mahan (1960), Wolf, (1977) and in subsequent years by Miller et al., (1992). Some researchers cannot duplicate these findings (Barnett et al., 1984; Sastrowijoto et al., 1990a; Aldridge et al., 1995; Smith et al., 1996; Westfelt et al., 1996; Bridges et al., 1996; Christgau et al., 1998). The inconsistency, may be due in part to the use of antibiotics in some studies especially tetracycline derivatives such as doxycycline which works as inhibitors on the matrix metalloproteinases (MMPs). MMPs are destructive enzymes found in periodontal disease, and its inhibitors such as doxycycline may confound the effects of scaling, root planing and polishing (SRP) in controlling periodontal disease. For this reason, the issue of improved metabolic control through periodontal therapy would require further research at this point in time. However, Stewart et al., (2001) in a case control study of 36 Type 2 DM to control group intervention showed a significant reduction in glycaemic control without the use of antibiotics. Rodrigues et al., (2003) also found a significant improvement when Amoxycillin was used as an adjunct to scaling and root planing possibly due to its antimicrobial effects. In a recent study Llambes and co-workers (2005) followed up on the effect of doxycycline on periodontal parameters of diabetes-affected patients and found that an additional benefit was found with non-surgical intervention in the study compared to non-surgical

intervention without doxycycline. The study however did not mention the effect on HbA1c. A summary of the findings is shown in Table 3.1.

Table 3.1 Effect of Periodontal Therapy on periodontal parameters and Glycaemic control

Author	Design	Sample	Age	Parameter	Remarks
Williams & Mahan (1960)	Case study	9 DM ,no controls		FBG, insulin amount used	Improved 7/9
Miller et al., (1992)	8 weeks (doxycylcine & SRP)	9DM		HbA1c, HbA1c	Improved
Grossi et al.,(1996)	RCT 6 months (doxycycline)	113 DM(Pima)		PI, GI, PPD, AL, Pg, HbA1c	Significant
Taylor et al.,(1996)	Longitudinal (6 years)		>18 years	Severe Periodontitis (absence & presence) Glycaemic control	Significant
Smith et al.,(1996)	2 months	18 type 1 DM 18 non DM age & sex matched		Pg,Bf,Aa. PI, GI, PD, PAL HbA1c, IgG	NS
Westfelt et al.,(1996)	5 years SRP	20 DM & 20 non DM age & sexmatched	40-65	PI,BOP,PPD,PAL,HbA1c	NS
Collin et al., (1998)		25 type 2 DM 40 non DM	58-76 59-77	Plaque,BOP, calculus, Pockets≥ 6mm,LOA, ABL, Aa, Pg, Bf	Significant
Iwamoto et al.,(2001)	one months (minocycline)	13 type 1 DM BMI≥25	19-65	CPITN,bacterial samples HbA1c	Significant
Stewart et al.,(2001)	9 months	36 type 2 DM Tx match no Tx	67±10.8 62.4±8.4	Phase I therapy extractions, Hba1c	Significant

SRP=scaling,rootplaning&polishing;PI=periodontalindex;GI=gingival index;HbA1c=glycated hemoglobinA1c;API=approximalplaqueindex;PBI=papillarybleedingindex;BOP=bleeding on probing;PPD=probing pocket depth;PAL=probing attachment loss;PMN=;CRP=c-reactive protein;FBG=fullbloodglucose;LOA=loss of attactment;Pg= Porphyromonas gingivalis;Aa= Actinobacillus actinomycetemcomitans;Bf= Bacteroides forsythus;ABL=alveolarbone loss.;CAL=clinical attachmentl; NS= not significant

Table 3.1 .(continued) Effect of Periodontal Therapy on periodontal parameters and Glycaemic control

Author	Design	Sample	Age	Parameter	Remarks
Barnett et al.,(1984)	CS No SRP	45 type 1 DM Age cohort	10-18	PI,GI and HbA1c xrays	NS
Sastrowijoto et al., (1990a)	5 years	50 type 1, 5 type2DM 18 non DM	18-72 21-72	PI, BOP, PPD, PAL, HbA1c	NS
Christgau et al., (1998)	case matched(severity) 4 months	20 DM 20 non DM	30-66 30-67	API,PBI,BOP,PPD,PAL PMN, HbA1c, CRP C-peptide, cholesterol	NS
Rodrigues et al., (2003)	RCT(3 months) Amoxicillin (SRP)	15 type 2 DM 15 control		BOP,PD,PAL,suppuration FBG, HbA1c	Significant
Kiran et al., (2005)	Case(SRP)-control (3months)type 2	22 case 22 control	54.39±11.27	HbA1c,PI,GI,PPD,CAL,BOP	Significant
Llambes et al., (2005)	Case-Control(SRP) (2months) type 1	30case(doxycycline) 30control	35.3±9	PI,BOP,PPD,CAL	Significant

SRP=scaling,rootplaning&polishing;PI=periodontalindex;GI=gingival index;HbA1c=glycated hemoglobinA1c;API=approximalplaqueindex;PBI=papillarybleedingindex;BOP=bleeding on probing;PPD=probing pocket depth;PAL=probing attachment loss;PMN=Polymorphonuclear cells;CRP=c-reactive protein;FBG=fullbloodglucose;LOA=loss of attactment;Pg= Porphyromonas gingivalis;Aa= Actinobacillus actinomycetemcomitans;Bf= Bacteroides forsythus;ABL=alveolarbone loss.;CAL=clinical attachmentloss; NS= not significant

2.4 ROLE OF NON-SURGICAL THERAPY AND DIABETES

2.4.1 Scaling, root planing and polishing

Periodontal disease is treated traditionally with non-surgical treatment. The rationale of non-surgical treatment is to disrupt the microbial plaque and contributing factors which can cause gingival and periodontal disease (Greenstein, 1992; Perry & Schmid, 2002). The elimination of microbial plaque and calculus has been known to produce a shift from a Gram-negative anaerobic bacterial composition to a predominantly Gram- positive facultative microbial flora that is compatible with periodontal health (Listgarten et al., 1978; Magnusson et al., 1984).

Scaling and polishing (non-surgical treatment) is commonly rendered as a routine procedure in general practice in conjunction with dental checkups. It is usually recommended every 6 months for low risk individuals of all ages at a high cost for health institutions (Frame et al., 2000; DoH, 2000). Researchers and health administrators have questioned the role of routine scaling and polishing on normal adults. To address the issue, a Cochrane review was reported by Beirne and co-workers in 2005. From of a total of 496 papers, 8 papers (Lightner et al., 1971; Suomi et al., 1973; Listgarten et al., 1985; Listgarten et al., 1986; Nyman et al., 1975; Rosling et al., 1976; Glavind, 1977; Lambariti et al., 1998) were selected for the review based upon a set of inclusion criteria and stated hypotheses in the report. The benefits and harmful effects of routine scaling and polishing on periodontal health were compared between treatment versus no intervention; treatment carried out at different time intervals; treatment delivered by dentist versus dental

therapist/ dental hygienist; treatment with or without oral hygiene instruction. There was no consensus on the relative benefits of routine scaling and polishing on periodontal health. Nonetheless, the report showed that more frequent shorter intervals of 2 weeks in comparison to longer intervals showed more favourable results in periodontal health (Nyman et al., 1975; Rosling et al., 1976; Lightner et al., 1971). The authors finally concluded that there was insufficient evidence to reach a definite statement on the benefits of routine scaling and polishing and called for high quality clinical trials to address the problem. Furthermore, it could also be questioned whether the findings of the report is applicable for different population such as the high-risk category of patients with diabetes in the current investigation.

There is good evidence that improvements derived from non-surgical periodontal therapy among subjects with diabetes and subjects without diabetes are comparable. The number of studies reported ranged from 3 months to 5 years in duration. These studies supported the therapeutic benefits of non-surgical therapy in improving periodontal health among well-controlled diabetics and non-diabetic control subjects (Tervonen et al., 1991; Westfelt et al., 1996; Smith et al., 1996; Tervonen & Karjalainen 1997; Christgau et al., 1998). Gustke (1999), Hung and Douglas (2002), and Axelsson et al., (2004) also supported the improvement in treatment outcomes in their reviews. However, Tervonen and Karjalainen (1997) showed that scaling improvement in very poorly controlled diabetics did not respond as well as controlled diabetics.

2.4.2 Role of Oral Hygiene in non-surgical therapy

The importance of oral health behavior is ubiquitous at all levels of dental intervention: in patient-dentist interaction (positive and conducive), regular visits (professional care) and

oral hygiene adherence (maintenance). It has been well established that dental plaque is the primary etiological factor in gingivitis and periodontal disease (Socransky & Manganiello, 1971; Suomi & Doyle, 1972; Greenstein, 1992). Löe et al., (1965) in a classical experimental gingivitis study in man demonstrated that when oral hygiene procedures were suspended, gingivitis developed within 10-21 days, gingivitis resolved within a week when oral hygiene was reinstituted. These changes were supported by a corresponding shift in the micro flora (Theilade et al., 1966).

The mechanical disturbance of dental plaque (biofilm) to lower the putative microorganism load on the periodontium requires conventional measures to control periodontal disease including a combination of non-surgical periodontal therapy (e.g. scaling and root planing) and oral hygiene (self-care) (Lovdal et al., 1961; Listgarten et al., 1985; Wilson et al., 1993 & 1996). Oral hygiene is an obvious determinant associated with periodontal disease severity as suggested in the pilot study by Lim et al., (2002) for diabetics in Singapore. However, this would require the need for an in depth study.

Croucher (1994) described three possible explanations affecting oral hygiene performance, physical dexterity, social relationships and intra-individual variables. Although the study is psychosocially focused the mechanical aspects of oral hygiene should not be overlooked. For example, it has been reported that a patient's average brushing time is about 37seconds only (Beals et al., 1987) and the majority do not floss their teeth or do not floss at all (Lang et al., 1994; Bader, 1998). There are a few dexterity tests such as Toothbrushing ability Test (Felder et al., 1994) and Oral Hygiene Performance Test (Doherty et al., 1994). Use of plaque detecting dyes to evaluate oral hygiene efficiency are often included as part of oral hygiene regimen. However, the

visual acuity of the person concerned is often overlooked in most studies especially for the elderly or visually handicapped. One should bear in mind that visual impairment could indeed be a possible complication in diabetes. The social and intra-individual domains may be explained or predicted by psychosocial theory based models and need to be further explored.

2.5 FACTORS AFFECTING IMPLEMENTATION OF ORAL PLAQUE CONTROL AND ORAL HYGIENE MAINTENANCE

The behavioral part of oral hygiene maintenance programme is perhaps the most difficult and challenging aspect in view of the generally low compliance to oral health recommendation. Kiyak and Mulligan (1986) stated that, “Numerous programmes which have attempted to enhance oral hygiene have failed because of the lack of motivation”. Motivation is derived from within (internal source.e.g.self) rather than from an extraneous source (e.g. the provider). Therefore, it is incumbent upon oral health educators to understand the self- system and self-related domains such as self-efficacy, self-esteem, self-regulation, self-perception, etc. Dennet (2003) aptly stated, “ the existence of the illusion of self can be explained as an evolved feature of communicating agents, capable of responding to requests and queries about their decisions and action”.

2.5.1 Self-system, perception & value

The perceived value of a person is an important part of the belief system. In oral health, self-perception of the value for oral health is often regarded as a low-priority in association with low health expectations (Blinkhorn, 1993). The chronic and non-life threatening nature of oral disease has also not contributed much in perceived seriousness (Wilson, 1987). In relation to this nominal value of oral health among the general population, resultant problems such as dental neglect and dental indifference were found to be determinants of oral hygiene compliance (Jamieson & Thomson, 2002).

2.5.2 Oral hygiene compliance

Oral hygiene compliance and oral hygiene maintenance and oral hygiene adherence is often used interchangeably in periodontal literature. Furthermore, it is essential that an oral hygiene maintenance programme need to be planned to preserve a controlled environment that has been established by surgical and non-surgical methods.

Oral hygiene maintenance (*compliance*) implies a longer temporal expectation in terms of achieving effectiveness in prevention objectives and often requires a persistent effort by both subjects and health care providers to get the desired health outcome.

Unfortunately data pertaining to oral health compliance has not been very encouraging. Past studies show that total patient compliance (adherence) with dental instructions does not exceed 40% in private practice (Nevins, 1996). Wilson et al., (1987) also reported earlier that only 16% of his study group complied with recommended schedules, 49 % of the study group with erratic compliance and 34% did not report for any maintenance

therapy. Wilson in the same study also noted that the subjects with less recall visits for maintenance tend to adhere better to the maintenance program. Boyer (1983) in his telephone interview study found about one third of subjects to be highly compliant and similar proportion in the moderate and poor compliance categories. It must be noted that these compliance figures are derived from a non-diabetic population.

Oral Hygiene Compliance Criterion

There are difficulties in screening for compliance as researchers often use individual surrogate endpoints (e.g. plaque, BOP) to ascertain compliance and the lack of a comprehensive gold standard to measure oral hygiene compliance. Evidently, improvement in oral hygiene practices has been shown to be associated with a concomitant improvement of periodontal status in terms of reduction in bleeding and gain in clinical attachment (Lovdal et al., 1961; Rosling et al., 1976; Nyman et al., 1977; Sheiham et al., 1986; Hugoson et al., 1998).

Diabetes has also been shown to be a major risk factor for periodontal disease progression (Löe, 1993; Grossi et al., 1994) manifested in the form of increased gingival inflammation (Cohen et al., 1970; Gislen et al., 1980; Grossi et al., 1994; Campus et al., 2005), increased probing pocket depth (PPD) (Bacic et al., 1988; Emrich et al., 1991; Tervonen & Oliver 1993; Bridges et al., 1996) and calculus formation (Tervonen & Oliver 1993; Tervonen & Kajarlainen, 1997).

Compliance with oral hygiene is often used as a yardstick for determining the effectiveness of oral health promotion programmes. The outcome has been evaluated through various approaches such as verbal feedback or self-report of improved oral

hygiene practices, self-monitoring of oral hygiene and clinical observation of a reduction in plaque and gingival inflammation scores.

While verbal or written feedback has been partially useful in evaluating compliance, more objective measures have been advocated in the clinical setting. Plaque and Bleeding on probing (BOP) assessment are perhaps the most common clinical assessment criteria used to evaluate an individual compliance with oral hygiene self care. It is generally accepted that the use of an individual parameter such as plaque score alone to determine compliance with oral hygiene would not be adequate as an individual may not necessarily be consistent in achieving a good standard of plaque control at all times. A low plaque score could still be achievable if the individual cleans his teeth diligently just before the dental examination. The use of a combination of plaque and bleeding scores are therefore preferred as being more objective and reflective of sustained behavioural change (Abbas et al., 1986; Lim, 1991). Different investigators have used arbitrary levels of acceptable threshold values ranging from 10-25 % plaque score and 10-20% bleeding scores (O' Leary, 1972; Isidor et al., 1984; Lindhe et al., 1989; Kaldahl et al., 1990; de Abreu et al., 2002). The combined criterion however has not been objectively tested in relation to predictability with progression of periodontal disease.

Bleeding on Probing (BOP) by itself was reported to have a high negative predictive value (NPV) 98% with a low positive predictive value (PPV) 6%. While BOP may not be a sensitive predictor of disease progression, the absence of BOP was deemed a good indicator of periodontal stability as demonstrated by Lang et al., (1990).

Badersten et al., (1990) showed that diagnostic predictability of attachment loss (AL) peaked at 30% -75% plaque and concluded it has limited value as a predictor for AL. In the same study the mean percentage of BOP peaked at 30% and therefore limits its

predictive capacity. Claffey et al., (1990) also reported similar findings. On the other hand, Joss et al., (1994) found that two-thirds of sites with attachment loss were associated with BOP ≥ 30%, indicating a three-fold increase in risk as compared with one fifth of loser sites when BOP was ≤ 20%.

Renvert & Persson (2004) found that % plaque was only significantly associated with bone loss at the lower end range of between 10% to 20% bone loss, beyond which no significant association was shown. In the same study, % BOP failed to demonstrate any consistent association with alveolar bone loss at all levels. In summary, the findings highlight the limitations of Plaque or BOP when used alone as predictors for periodontal disease progression (Lindhe et al., 1989; Badersten et al., 1990; Kaldahl et al., 1990; MacGuire & Nunn, 1997). To date, the evidence for an optimal level of plaque combined with bleeding as a measure of compliance with oral hygiene has not been objectively evaluated in relation to other periodontal disease parameters.

To determine the optimum cut-off level of a diagnostic test or criteria, a classic trade off between sensitivity and specificity is often involved. For such purposes, Receiver Operator Characteristic (ROC) plots have been found to be a useful tool in clinical decision making in health sciences (Zweig & Campbell, 1993). A ROC curve involves a plot of pairs of sensitivity (true positive rate) and "1-Specificity" (false positive rate) for a given cut-off value of a diagnostic test or parameter. To compare the usefulness of the tests, the ROC curve with the larger area under the curve is considered the better or more accurate option. The advantage of ROC analysis is that positive and negative predictive values are independent of the prevalence of the problem (Obuchowski, 2003). In dentistry, ROC analysis have been found to be useful in caries diagnosis (Verdonschot et al., 1993; Hintze et al., 2003); endodontics (Syriopoulos et al., 1999; restorative decision making

(Kay and Knill-Jones, 1992); oral surgery (Loesche et al., 1997; Nair et al., 2000); and periodontal risk assessment (Mombelli et al., 2002; Persson et al., 2002; Renvert & Persson 2004; Yamamoto et al., 2005; Persson et al., 2005). To date, there is no observed report utilizing ROC analysis in determining compliance with oral hygiene in any population including a diabetic population. A combined oral hygiene compliance criterion is expected to offer an efficient way for screening as well as to validate in longitudinal studies.

2.5.3 Non-adherence as a risk factor

Researchers such as Levine & Wilson (1992), Bakdash (1994) have stated that non-adherence to oral hygiene is considered a risk factor for periodontal disease. Some of the common reasons given for periodontal non adherence in past studies are: poor understanding of the advice given, poor perception of oral health problems (Berndsen et al., 1993), lack of motivation (Alcouffe, 1988; Syrjala et al., 1999), poor dental health beliefs (Glavind, 1986), unfavourable dental health values (Camner et al., 1994), fear (Gatchel et al., 1983), indifference of attending dentist (Biro and Hewson, 1976) and low socio-economic status (Tedesco et al., 1992). These factors may also be considered as psychosocial determinants.

2.5.4 Psychosocial determinants

Psychological determinants do not act in isolation, and usually it may be associated with a social determinant. McCaul (1985) found that psychosocial variables were related to

dental hygiene behavior. Literature also shows that socio-economic status and education level significantly affected the periodontal status (Nikias et al., 1977; Paulander et al., 2003). There is also good evidence that oral health behavior of children and adolescents could be influenced by family background such as low socioeconomic status and educational level of parents (Sheiham, 1969; Aurelius and Lindström, 1980; Tan et al., 1981; Aström & Somdal, 2001; Petersen et al., 2004). Lang (1994) studied the relationship of demographic and socioeconomic variables on preventive behavior practices on periodontal health among 319 adults. The subjects were assessed for frequency of 3 preventive behaviors, plaque, gingivitis, calculus, and periodontal attachment levels. The study reported acceptable flossing behaviour in 20% of individuals with a corresponding lower plaque and calculus score. Three quarters of the subjects who had a dental checkup once a year also exhibited less plaque, gingivitis, and calculus. Although there were differences of acceptable flossing behavior among age groups, no marked difference in toothbrushing behavior was found for the various demographic and socio-economic groups. Furthermore, there are other factors that could influence oral health compliance such as people that may comply for cosmetic reasons, for health related reasons, or from peer pressure (Macgregor et al., 1997 a & b; Watt, 2002). All these evidence supports the concept that a behavioral approach with social determinants should be considered in health promotion programmes to improve compliance.

2.5.5 Other considerations

Other oral health behavior determinants: such as coping with a disease and optimism (Scheier & Carver, 1985) have all been discussed as important determinants of health behavior. There are two basic dimensions of coping, active (problem-focused) and passive (emotion-focused) coping. Research has shown that active coping acts as a mediator between optimism and health and optimism was also found to be associated with active coping (Billingsley et al., 1993; Ylostalo et al., 2003). Evidence of the positive effects of optimism affecting diabetics' oral health and the negative effect of depression has yet to be observed. Borkowska et al., (1998) shared that psychological mood affects patient adherence. Intermediate levels of anxiety may be optimal in terms of predicting patient adherence. If, the level of anxiety is too low in a subject, the subject may not be sufficiently concerned to carry out what they have been told. Conversely, if anxiety is too high, subjects will be too afraid to correctly interpret the advice provided (Friedman & Dimatteo, 1989). Schulkin (2002) suggests that behavioral expressions such as motivation is encoded in part by neuropeptide expressions and regulated by steroids. Ryan (2002) further contends that both the diabetic state and its medical management affect cognition, promoting depression, perhaps mood swings, and feelings of tiredness. It was found that diabetics have a higher incidence of clinical depression compared to non-diabetics and have found to affect glycaemic control (Lustman & Clouse, 2005). Although mood is adaptive in normal behavior and the reverse may also be true; mood is indeed fickle in nature.

The temporal nature of adherence itself lends difficulties to maintain it in the long run. Horne (1998) stated, " most people are non adherent at some point in time". It is perhaps

important to take note of the fact that, vulnerable groups at risk such as diabetics may require educational reinforcement regularly so as to avoid the effect of extinction procedure and conform to compliance.

Health maintenance, among diabetics is indeed a challenge as they are already challenged by their existing health problems. By virtue of their health problems, patients with diabetes have to face surmounting obstacles to cope with everyday living. To overcome some of the barriers to oral health maintenance among diabetics; preventive programmes should be perceived as part of individual's daily personal hygiene. This approach will enable people to claim ownership of holistic preventive programmes and not to be perceived as another health burden imposed on them by health care providers. Sheiham & Watt (2000) critiqued simple lifestyle approaches and advocated shared solutions approach where some chronic diseases share risk factors such as diabetes and periodontal disease.

At the same time, one must take note that it is important to review and analyze the theoretical framework of oral hygiene compliance behaviour and how to affect positive change.

2.6 ORAL HEALTH BEHAVIOUR MODELS & THE IMPLICATIONS ON ORAL HEALTH

2.6.1 Introduction

It has been well documented that effective oral hygiene is an essential element at all levels of periodontal therapy (Axelsson & Lindhe, 1974, 1978, 1981; Löe et al., 1965; Lang et al., 1973). One of the common problems that are encountered in periodontal therapy is a lack of patient motivation, a point raised by Greene as early as 1966 in the Ann Arbor Workshop for Periodontics. His statement made nearly four decades ago, still holds true today. Greene, "…. Probably the most important and difficult problem that remains to be solved before much progress can be made in the prevention of periodontal disease is how to motivate the individual to follow a prescribed effective oral health programme for the prevention of periodontal disease…".

An individual's compliance with oral hygiene could be influenced by cognitive, psychomotor, psychosocial, socio-demographic and environmental factors, which in turn can lead to change in oral health attitude and practices. The quest by the dental profession to explore the right balance to achieve optimal oral hygiene would require an understanding and contribution from the behavioural sciences. Various models of health behaviour has been introduced in the past employing different constructs and concepts attempting to explain the differences in health behaviour. Application of these models to predict adherence with oral health have been faced with mixed findings.

2.6.2 Concepts and Constructs of health behaviour

Most models of health are based on concepts and constructs. 'Concepts' by definition are the major components of a theory; they are analogous to building blocks or the primary elements of a theory. When the concepts have been developed and adopted for use in a particular theory/model, they are referred to as 'constructs'. The main difference between the two terminologies lies in the extent of the meaning. While concepts can be understood outside the context of the specific theory, constructs on the other hand is understood only within the context of the theory/model.

2.6.3 Theories / Models of health behaviour

A number of health behaviour models/theories have been developed to explain health behaviour and application in various health education activities. Health behaviours can vary from health enhancing behaviours (e.g. healthy eating, exercising) to health-protective behaviours (e.g. health screening and vaccination) to avoidance of health-harming behaviours (e.g.smoking cessation). It is likely that different theories/models will have different utility under different situations. An understanding of some of the health behaviours models will help to explain the various approaches to understand oral health behaviour and how to effect change in oral health promotion programmes.

The common models to be reviewed are (Table 4)

- Health Belief Model (Becker, 1974; Rosenstock, 1982)
- Theory of reasoned action & Theory of Planned Behaviour (Ajzen & Fishbein, 1975)
- Social Cognition Theory (Bandura, 1986)

- Self-Efficacy theory (Bandura, 1977)
- Transtheoretical Model of Change (Prochaska & DiClemente, 1983)
- New Century Model (Ingelhart & Tedesco, 1995)
- Locus of Control of Beliefs Theory (Rotter, 1966)
- PRECEDE-PROCEED model (Green & Kreuter, 1990)
- Knowledge, Attitude and Practice (KAP)

1. Health Belief Model (HBM)

The health belief model was originally developed to predict and explain health behaviour and is one of the most commonly utilized models. The five concepts of HBM include: perceived susceptibility to the disease, perceived severity of the disease, perceived benefits of the action, perceived barriers to action and cues to action. For example, a person is more likely to take action if he believes that he is susceptible to the disease, that the disease is serious, and that the advantages of taking the appropriate action to reduce the threat of the disease outweighs the inconvenience or difficulties and finally the belief that the individual has the ability to control the disease. HBM has provided an understanding of the individual preventive health seeking behaviour and could be applied in education. The HBM has been found to be useful in cancer screening, and AIDS protective behaviour. Several studies have been conducted for oral health behaviour with mixed findings. Kegeles, (1963) found in a sample of factory employees that those who believed that they were susceptible to dental disease as well as those who believed that dental problems could be serious, believed in the benefits of treatment made more preventive visits than those low in these beliefs. However, variables such as education and

income were found to be more strongly associated than that of belief variables. Smith, (1974) tested the applicability of HBM in school girls aged 12-17 years in England. It was found that although the girls had little knowledge on their susceptibility to periodontal disease and its consequences, they were practising effective oral hygiene and seeking regular dental check ups. The findings imply that socio-psychological factors and environmental influence played an important role. Similarly, Rayant & Sheiham (1980) found that although perceived vulnerability to periodontal disease acted as a cue to seek dental care, HBM could not predict the gingival status and oral hygiene of periodontal patients attending treatment. Kegeles and Lund (1984) in retrospect found that HBM could not predict nor explain health behaviour. Barker, (1994) also conducted a study of HBM in relation to compliance (surrogate endpoints plaque and bleeding) and found a significant relationship. Most of the HBM studies lack a standardized approach to measure health beliefs.

2. Theory of Reasoned action (TRA)

Theory of reasoned action was first used to study human behaviour in the inter relationship between attitudes and behaviour. The assumption of a rational individual is more likely to make use of information available at hand to make decisions of intent based on implications of the action. The constructs in the theory are; 1. Attitude 2. Behavioural beliefs (behavioural and normative) 3. Intention 4. Subjective norm.

The authors further strengthened the application of the theory with an added concept, volitional control. The revised version was called the Theory of Planned Behavior (TPB). The additional concept provided another determinant called perceived behavioural control.

A health related smoking cessation programme illustrates some of the concepts and constructs of TRA & TPB. When an individual is subjected to this programme; he/she starts to think that smoking is dangerous to his/her health (attitude towards the behaviour), and then he/she will consider that "my spouse & family will like me to stop smoking" (subjective norm). The subject with his/her sense of perceived behavioural control provides the will to ponder that he/she can stop smoking and will stop smoking (intention). Thus, the behaviour has been changed.

Tedesco et al., (1991) found that TRA provided an additional benefit to Self-efficacy theory to explain variance of brushing and flossing. Schwarz and Lo (1994) studied the relationship of knowledge and attitudes in Hong Kong using TRA attitude measurements (the higher the score, the more positive the attitude) and found that there were no correlation with knowledge and attitudes. Aström & Okullo (2004) tested TPB on 372 secondary school children in Nigeria and found that TPB constructs such as attitudes and perceived behavioural control predicted sugar consumption. Syrjälä et al., (2002) found firmer intentions of toothbrushing correlated to frequency of toothbrushing and subjective norm of toothbrushing with intention to brush. In the same study, a better attitude to oral health related with better diabetic adherence. The studies suggest that a modification of TRA with perceived behavioural control and self-efficacy has shown improvements to capture attitudinal change. The application relies on the assumption that people make rational decisions.

3. Social Cognitive Theory (Bandura 1982)

Social Cognitive Theory (SCT) is a derivative theory that had its origin in SLT (social learning theory). SCT maintains 3 constructs 1) Response consequences such as reward and punishment allows a person to form expectations of action and predict outcome 2) Vicarious learning allows humans to learn by observing others 3) Modeling also allows humans to model their behaviour based on people that they can identify with. Tedesco et al., (1992) conducted a study based on cognitive restructuring on 108 patients with mild to moderate gingivitis. The experimental group was exposed to slides on the etiology of periodontal disease and discussed on the process of periodontal disease, role of bacteria and self-efficacy for oral hygiene. The control group was also instructed together with the experimental group in oral self-care procedures. The results suggest that there is a delay in relapse in oral self-care behaviour by the experimental group compared to control group. McCaul et al., (1992) also applied SCT but did not observe any significant oral health behavioural change. As SCT is extensive and includes other constructs, researchers usually work with a few constructs such as self-efficacy. This construct is considered to be a critical determinant of self-regulatory mechanisms.

4. Self-Efficacy (Bandura 1977)

Bandura (1997) aptly stated, " people's level of motivation, affective states and actions are based more on what they believe than on what is objectively true". For example, when a person is in a weight control programme, self-efficacy is the confidence in the person's ability to judge oneself in his ability to reach his goal of losing weight. The

theory is highly utilized in behavioural improvement as well as in health related work (smoking cessation, compliance with diabetes). In dentistry, an early study by Beck and Lund (1981) showed that self-efficacy emerged as the best predictor of the intention to floss(r=0.69) and the actual behavior, frequency of flossing(r=0.44). Similarly, McCaul et al., (1985), studying a SLT model on oral hygiene behaviour showed a relationship with self-efficacy. Tedesco et al., (1991) also found that a stronger explanation emerged for flossing from his study of 39 subjects on toothbrushing when theories of self-efficacy and theory of reasoned action were combined together. Stewart et al., (1996) also found that self-efficacy was important for interventions in oral health behavioral change especially on flossing self –efficacy, which was achieved by professional psychological intervention.

Syrjälä et al., (1999), and Kneckt et al., (1999 a&b) also found that oral health behavior and diabetes adherence could be explained by various psychological characteristics; such as dental self-efficacy and oral hygiene, frequency of oral health habits with diabetes self-efficacy and diabetes adherence. In this study dental locus of control beliefs was found to be associated with plaque index and diabetes locus of control beliefs. Tedesco et al., (1991) study showed that dental self-efficacy could predict adherence in periodontal preventive programmes. However, Reisine & Litt (1993), and Wolfe et al., (1991) did not find a significant relationship with plaque and self-efficacy.

Graham and Weiner (1996) concluded that, self-efficacy was a reliable predictor of behavioral outcomes compared to other motivational constructs. In 2004, Syrjälä and co-workers found both dental and diabetes self-efficacy scores related to oral health habits. Compared with various explanatory theories of oral health behaviour such as, locus of control of health belief, self-esteem, and intent, self-efficacy was the best overall

determinant of various health behaviour practices. However, there were limitations to predict causality by the behavioural determinant (Syrjälä et al., 2004).

For practical application of the theory for motivation, Bandura (2001) outlined four methods of improving self-efficacy; self-mastery experiences, social modeling, social persuasion and efficacy belief enhancement.

5. Transtheoretical model or Stages of Change Theory (Prochaska and DiClemente, 1983)

This model is highly used in health promotional work and considers behaviour change as a process in continuum rather than an event in a person's readiness to change towards healthy behaviour. The conceptual processes are: precontemplation, contemplation, decision/determination, action and maintenance. This model is found to be in high utility for various health projects such as diet, smoking cessation, exercise, and HIV condom usage programmes. Tillis et al. (2003) used Transtheoretical model for the findings on exploring the stages of change in the population under investigation and found the construct on stages of change and decisional balance to be reliable and valid.

Practitioners use motivational interviewing to support self-efficacy of subjects and also use decisional balance sheets to monitor the progress of stages of change. In the study, regular interdental cleaning was used as an indicator for commitment to oral self-care. The effect of measuring self-efficacy in a transtheoretical model shows the contribution of health behaviour models working in synergy.

6. Locus of Control theory (Rotter, 1966)

This theory also originated from social learning theory similar to social cognitive theory. This is a theory of beliefs that influences the outcome based on "internal" and "external" control. For example, if a person believes that he is solely responsible for the outcome from his action, the subject is considered to have internal locus of control and the reverse is true for external locus of control. Wallston's Health Locus of Control (1978) was initially applied to ascertain people's belief on health being determined or not by their own behavior and it was used as a uni-dimensional construct. A multi-dimensional health locus of control scale was also developed to enhance the theory application in health sector with the use of more situation specific approach (e.g. cardiovascular health, diabetes, cancer, etc.). Dental health locus of control has been widely used, in examining the dental health locus of control on compliance behavior. One study found that periodontal inflammatory variables showed association with psychological constructs related to external factors (Borkowska et al., 1998). However, Scruggs et al., (1989) did not find any difference with children's health locus of control measures before and after an extensive dental health education programme for 25 children with juvenile diabetes. Kneckt et al., (1999b & 2000) also used situation specific LOC constructs and attribution theory in a study of diabetics and periodontal parameters. Kneckt's study highlighted the correlation of dental locus of control belief with frequency of dental visits, plaque index and in the attribution study, not bothering to clean interdentally correlated well with non diabetic adherence. Galgut et al., (1987), utilized the MHLC (Multidimensional health locus of control) in response to a plaque control programme, and found that subjects who were influenced by externals factors effecting susceptibility to disease and also who

believe that susceptibility to disease is controlled by their own action responds more positively to a plaque control programme than those who believe that susceptibility to disease is due to chance. It is with a note of interest that Wallston (1992) gave evidence from three large scale studies on MLHC did not advocate the use of MLHC. It was found that no more than 6% of MLHC scores explained the variance of self-reported health behavior and instead advocated use of "perceived competence"(a generalized indicator of self-efficacy) and "health hardiness" which included a component labeled 'perceived control of health'. The importance of self-efficacy is highlighted again as a psychogical toughening process.

7. New Century Model (Ingelhart & Tedesco, 1995)

The authors of this theory contend that traditional behavioural research using a single model approach and multi model approach to explain oral health behaviour are inadequate. In order to address these inadequacies, Ingelhart and Tedesco (1995) addressed the affected component together with the behavioural and cognitive components, and also recognized that oral hygiene is a habitual task. The theory contends that small or moderate increases are not enough to influence motivation, thus large increases through interaction, self-efficacy and diagnosing the affected component and reconciling it in a life-span approach. These constructs are quite broad and will be very useful to observe its application in oral health. One must take note that this model was designed to cover deficiencies by single or multiple theory models, at the same time it has recognized the importance of self-efficacy, affected component and the life span approach. Karikoski's (2001) study on a diabetic population explored the factors relating

to self-care; cognition on diabetes related periodontal disease (attitude to keep own teeth as long as possible), behavior on last dental visit, and the affected component on a Likert scale (oral health is not as important as general health). Results showed a comprehensive overview, on self-reported frequent dental visits and periodontal parameters such as calculus where the affected component showed a significant association with plaque and calculus. There are very few studies reported using this model at this point in time.

8. PRECEDE-PROCEED model

The PRECEDE-PROCEED model (Green & Kreuter, 1990) have been recommended in community intervention as it involves a series of diagnostical, management, monitoring, intervention and evaluation components for health promotion with emphasis on process evaluation. It is one of the most used multiple theory models in health promotional work.
In the diagnostic phase: Social diagnosis (phase I) is aimed to determine people's perception of their needs and quality of life using theory of community organization (Ross & Lappin, 1967) using methods such as focus group discussions, nominal group processes and ranking the needs with community participation.
In epidemiological diagnosis phase (phase II), the process is to identify the health problem in relation to the social problem, the risk factors, and ranking of the health problems and to set the programme goals and objectives.
Behavioral and environmental diagnosis phase (Phase III) provides a process to identify the most feasible and beneficial behavior as a target for intervention and its environmental effects from the intervention. The process includes rating the behavior and

environment for changeability based on HBM, Social Learning Theory and Community Organization Theory.

In Phase IV, educational and organizational diagnosis provides a process of selecting the predisposing, reinforcing and enabling factors to affect changes. Stages of change, HBM, SLT, organizational change and diffusion of innovation theories are used in this phase. Setting up of priorities, importance and changeability are also noted at this phase.

Administrative and policy diagnosis (Phase V) provides assessment of policies and resources that could facilitate the programme. At this stage, resources such as time, personnel and budget are taken into account, as well as barriers to implementation, negotiations, persuasion and advocacy for altering policies regulations that implement the programmes (Organizational and diffusion of innovation theory).

The implementation phase (Phase VI) is conducted according to the diagnostic and planning phases (Phases I, II, III, IV, V).

An evaluation phase (phase VII) follows the implementation phase. The cycle of evaluation and implementation follows on a periodic basis to improve the programme.

The model is designed to aid in planning, implementation, monitoring and evaluation of health promotional work on a community scale. A few studies utilizing the model in oral health promotional work and claim to have significant improvements in oral health status (Watson et al., 2001; Knazan, 1986). However, the model has not been tested on periodontal health promotion.

9. Knowledge, Attitude and Practice (KAP)

It will not be considered a complete review on cognitive theories and models if the traditional KAP approach is not mentioned in oral health education/promotion. Among the early health education efforts the KAP approach was highly adopted. However, changing approaches to health education have critiqued the traditional cognitive model that assumes the sequence of knowledge-→attitude→behavior change. This traditional approach may be applicable in high-risk individuals, where the knowledge, attitude, practice- gap is strongly evident. However, it must be noted that dental knowledge per se may not necessarily result in improved oral health status. It has been observed in longitudinal studies that the effect of a sustained change in oral hygiene does not exceed six months (Gjermo, 1967; Anerud, 1969; Kay & Locker, 1998; Watt & Marinho, 2005), nevertheless, it must be recognized that a cognitive component which provides correct information is a link for oral health promotion (Silversin & Kornacki, 1984) or it can be used as a tool for motivational purposes (Toassi & Petri, 2002).

In summary, Ramsay et al., (2000) observed that, earlier research on behavioral sciences emphasized on predicting adherence, using demographic factors, health beliefs, personality traits. Up to date these results were not conclusive (Cromer & Tarnowski, 1989), current research assesses how well an individual is following a specific regimen and on developing strategies to reverse poor adherence when it occurs (Ramsay et al., 1997). Multi theory models such as the New Century model and Unifying theory of control have all incorporated Self-efficacy theory as part of strategies to explain and reverse poor health behavior. The inclusion of self-efficacy theory may suggest that self-efficacy is an important explanatory theory of oral health behaviour.

The elements of the various theories and models are summarized in Table 4.

Table 4: Elements of various Theories and Models for Oral Health Promotion

Theory/model	Health focus	Self-aspect	Control	Social Aspects	Other aspects	Outcomes associated with oral health
Health Belief	Seriousness, susceptibility, benefit	Self-efficacy			Cue to action Barriers to action	Adherence belief
Theory of reasoned action	Attitude and consequence for change (intention vs.performance)	Self-efficacy aids TRA	Perceived behavioral control	Expectation of valued others	Subjective norm, Attitude	Intention to oral hygiene
Transtheoretical	Attitude and stages of change (readiness or attempt to change)	Self-efficacy		Precontemplation, Contemplation, Preparation, Action, Maintenance		Stage of change as commitment
Self-Efficacy	Based on belief system and derived from Social Cognitive Theory	Self-confidence belief judgement	Internal	Perceived social constraints	Affected component, Expectations, episodic nature of beliefs	Oral hygiene self-efficacy
Locus of control	Attribution	Self-agency, Perceived competence	Internal &. External		Personal control, self-determination	Internal control vs. external control
New Century	Patient-provider relationship for a life span approach, knowledge emphasis. Attitude, intentions, and expectations	Self-related beliefs	Control beliefs	Socioeconomic, social support, Stress	Affect: feelings, values, motivation Behaviour; past behaviour, psychomotor Skills,	Designed to be comprehensive Including affected component
PRECEDE-PROCEED	Intrapersonal[1], Interpersonal[2], Institutional, Community[3] and Public policy	Self-concept (Burns, 1979;Duvdevany, 2002)		Social planning and action	(Stages of Change, HBM, CIP) [1], SLT[2], (Community Organization, Organizational change, Diffusion of Innovation) [3]	Designed, for educational, advocative, organizational, policy development, economic support, environmental change with multi method programs

HBM: Health Belief Model, 1:CIP: Consumer Information Processing, 2:SLT: Social Learning Theory

2.7 STUDIES ON ORAL HEALTH ATTITUDES AND BEHAVIOURS

2.7.1 Oral health Attitudes

An earlier study conducted by the Dental Division of the Ministry of Health in 1992, with 3157 Singaporean adults aged 20 to 65 years showed that 66% required dental treatment; only 39% utilized the dental services at least once in two years. The low level of dental service utilization was reflected by a lack of perceived need and lack of time among the study cohort. Nevertheless, the study showed that 72% of the cohort brushed their teeth twice a day. Periodontal treatment needs assessment indicated a need for professional cleaning and oral hygiene instructions (Loh et al., 1995).

Soh (1992) reported that the majority of the population showed a general lack of appreciation on the use of floss and found regular dental checkups as non-essential for oral health prevention. At the same time, the number of people who reported that oral health prevention was important did not correspond to the proportion that visited the dentist for preventive care. The author also identified non-health directed reasons were given for brushing their teeth. There were differences seen among racial groups for preventive knowledge and behaviour, however, these were attributed to differences in education and exposure to product information (Soh, 1992). Lo and co-workers (2000) made a retrospective study of 1970, 1979, 1984, and 1994 dental health surveys and found that there was an improvement in periodontal health in general but only one third of the school population was free from periodontal disease. They recommended promoting better oral hygiene practices among the school children. There is very little information on the oral

health attitudes of adults in Singapore, although there is some evidence that severity of periodontal disease is highly related to oral hygiene and gender (Lim et al., 2002). It remains to be seen how the present cohort of diabetics will differ from the above data.

2.7.2 Oral health behaviour

A number of oral health promotion and behavioral studies among diabetics has shown a positive relationship between oral hygiene, oral health attitudes and periodontal status. People with diabetes are believed not to be dissimilar with the general population. There is also general evidence that indicates an association between oral hygiene compliance and initial good oral hygiene, gender, and healthy lifestyle (Schou et al., 1990; Kuusela et al., 1997; Borkowska et al., 1998). Researchers (Kneckt et al., 2000; Karikoski 2001; Syrjälä et al., 2002) in trying to find some insight to oral health behaviour among diabetics, generally agreed that there is a positive correlation of increased tooth brushing frequency with committed intention to brush, lower plaque levels, high self-esteem, frequent dental visits, adherence to dental instructions, educational level and the female gender. Visible plaque index was found to be inversely associated with dental locus of control, toothbrushing self-efficacy, frequent dental visits, and approximal cleaning self-efficacy (Kneckt et al., 1999a; Syrjälä et al., 1999). A KAP survey conducted by Thorstensson et al. (1989), found that a larger number of diabetics did not visit a dentist annually as compared with age and gender matched controls. More emergency care was required for diabetics who were also less willing than non-diabetics to spend time and money on oral

health care. Oral discomforts such as prickling and burning sensations, metallic and bad taste were rare in both groups. In diabetics, a feeling of dry mouth was more common. Spangler et al., (1994) elaborated the determinants of oral health behavior: family dysfunction with oral hygiene practices of Type 2 DM patients, and corroborated known relationships with white race, female gender and oral hygiene.

2.7. 3 Knowledge

Knowledge may not be a prerequisite to behaviour change but cognizance of facts can be helpful in changing behaviour. It was noted that 54%-85% of diabetics were not informed of oral complications (Moore et al., 2000; Taiwo, 2000). Almas et al., (2003) assessed the effects of oral hygiene instructions on periodontal disease among 60 Type 2 diabetics. At seven days, there was significant reduction in fasting blood glucose levels ($p<0.001$), and decreased gingival crevicular fluid ($p<0.001$). Overall CPITN score was reduced ($p <0.001$) but this was not significant in the group with advanced periodontitis. In contrast, Bali et al., (1999) did not find any significant association between patient education, professional oral hygiene and periodontal status among 83 type 1 diabetics. The effect of oral-hygiene instruction was short lived for the first six months and weaker during the rest of the duration of study of one year. The effect of oral hygiene instruction alone on periodontal status is still uncertain at this point in time. Taiwo (2000), reported on the oral health education needs of diabetics in an African based population; diabetics were as well informed as non diabetics on the frequency of tooth cleaning, less than 50% from both groups knew the cause of periodontal disease.

2.7.4 Oral health behaviour in relation to diabetes control and complications

Lack of interdental cleaning was found to be associated with non-adherence to diabetic treatment, (Kneckt et al., 2000). Diabetic patients with poorer oral hygiene had more advanced periodontal disease (Lim et al., 2002), higher gingivitis scores and higher calculus scores (Kawamura et al., 1998). Furthermore, it was found that oral health behavior is influenced by compliance with diet control, family support, regular maintenance care and glycaemic control of the individuals (Spangler and Konen, 1994; Tervonen and Karjalainen, 1997; Kawamura et al., 2001b) pointing towards a link between self-motivation in oral hygiene with metabolic control. Tervonen & Knuutilla (1986) recognized that good disease control could be attributed to patient co-operation and suggested that the patients with well-controlled diabetes might also be more co-operative regarding their oral health care habits and dental care.

Table 5 summarizes the findings related to oral health behaviour of selected studies among diabetics.

Table 5. Oral health promotion programmes on patients with diabetes

Authors	Design (n)	Clinical Parameters	Behaviour	Results showing significance
Syrjäla et al.,(1999)	**CS(149)** **Type 1**	**HbA1c,VPI**	**Self-Efficacy(SE)** ToothbrushingSE(6 items) ApproximalcleaningSE(6 items) Dental visit SE(6 items)	*toothbrushingSE-oralhealthbehaviour* *VPIinversely-toothbrushing SE* *VPIinversely-dentalvisitSE* *ApproximalcleaningSE-age*
Syrjäla et al.,(2002)	**CS(149)** **Type 1**	**HbA1c**	**Theory of Reasoned Action** Belief/outcome Subjective norm(SN) Intention	*firmintention-toothbrushingfrequency* *firmintention - low HbA1c* *attitude&SN -intention to brush* *dental attitude-good dental adherence* *dental attitude –fewer caries*
Syrjäla et al.,(2004)	**CS(149)** **Type 1**	**HbA1c,PD** **Caries**	**Dental(SE)** **Diabetes(SE)** **Self-esteem** **Dental Locus of Control** **Diabetes Locus of Control** **Intention to oral health behaviour** **Intention to diabetes self-care**	*oralhealthhabits-diabetes adherence* *dental&diabetesSE-oralhealthhabits* *dental&diabetesSE-diabetesadherence*
Taiwo (2000)	**CS(120 DM)** **50 control**	**FBG**	**Attitude,Knowledge,OHB**	*<50% DM knew cause of gum ds* *majority of DM do not know the link with periodontal disease*
Sandberg et al.,(2001)	**Case(102)** **Control(102)**		**Self-perceived** OralhealthStatus *Self-Care*	*85% of diabetics not informed of complications* *Drymouth:case(53%)-control(28.4%)*
Lim et al.,(2002)	**CS(155)** ALL DM	**CPI**	**Oral Hygiene**	*CPI4-oral hygiene(OR 2.7)* *CPI4-gender(OR 3.1)*

cs=Cross-sectional,DM=diabetes-mellitus,HbA1c=glycated-hemoglobin,VPI=visual-plaque-index,PD=probing-depth,FBG-fasting-bloodglucose,CPI=community-periodontal-index,SE=self-efficacy,SEs-self-esteem,OR=odds-ratio, SN=subjective norm

Table 5.(continued) Oral health promotion programmes on patients with diabetes

Authors	Design (n)	Clinical Parameters	Behaviour	Results showing significance
Kneckt et al.,(1999) (2000)(2001)	**CS(149) Type 1**	**HbA1c Oral Indexes**	**Locus control belief(LCB)**	*dentalLCB –diabeticLCB*
				dentalLCB –dentalvisitfrequency
			Dental LCB(8items)	*dentalLCB –plaque index*
				dentalLCB-decayed surfaces
				dentalLCB –root caries
			Attribution(Weiner)	*nonapproximalcleaning-diabetesnonadherence*
			Gingivitisattribution	*82%successavoidgingivitis-lowHbA1c*
			(17items)	
			Self-Esteem(SEs)(8items)	*highSEs-diabeticadherence-exercise*
				highSEs-toothbrushingfrequency
Karioski et al.,(2001)	**CS(120)** All DM	**CPITN**	**New Century Model** (29items)	*dentalvisitfequency-lowerplaquescore*
Karioski et al.,(2002)	**CS(336)** All DM		**New Century Model** (29items)	*type2>type1 for edentulousness(>40years)* h*ighereducatedfemales-toothbrushingfrequency*
Kawamura et al., (1998)(2001a)	**Case(102) Control(98)** Type 2	**HbA1c GI,PD, CI,DI.**	**GHB,PF,DC,RD HU-DBI(20 items) JRHQ(26 items)**	*GI of diabetics OR 2.39*
			GHB,PF,DC,RD	***LISREL-programme***
			HU-DBI(20 items)	*OHB-calculus*
				GHB-OHB;DC-plaque&HbA1c

cs=Cross-sectional,DM=diabetes-mellitus,HbA1c=glycated-hemoglobin,VPI=visual-plaque-index,PD=probing-depth,FBG-fasting-bloodglucose,CPI=community-periodontal-index,SE=self-efficacy,SEs-self-esteem,OR=odds-ratio
OHB-oral health behavior,GHB-general health behavior,PF-perceived fatigue,DC-diet control,RD-regular diet,GI-gingival index,DI-debris index,CI-calculus index,,HbA1c-glycated hemoglobulin ,BMI-basal metabolic index ,CPITN-community periodntal index for treatment needs,CPI-community periodontal index,HU-DBI-Hiroshima University dental behavior inventory,JRHQ-Japanese railways health questionnaire,LISREL-linear structural relations

2.8 MEASUREMENTS OF ORAL HEALTH BEHAVIOUR & ORAL HEALTH RELATED QUALITY OF LIFE

Clinical parameters are often used for evaluating the outcome of most oral health promotion programmes; however it is also important to have behavioral measurements. Stetson (2000) expressed reservations of relying solely on clinical and laboratory evidence as desired outcome to track patients' compliance.

Questions pertaining to knowledge, attitudes and practices of individuals have been commonly used to measure oral health behavior. Other instruments such as Hiroshima University Dental Behaviour Inventory (HU-DBI) have been utilized in several studies because of its simplicity and comparative value among existing studies.

2.8.1 Behavior Inventory

The Hiroshima University Behavioral Inventory (HU-DBI) was developed by Kawamura (1988). This inventory was used for behavioral identification for change and to be measured as an outcome measure of behavioral modification. It has been used in several cross sectional studies to measure oral health behavior as well as in some behaviour change studies. It comprises of 20 questions on oral health behavior. It was originally written in Japanese, translated and tested for validity in both English and Chinese versions in Hong Kong. The instrument showed good test-retest reliability Kappa value of 0.73 in a sample of 517 Japanese students. The English version also showed good test-retest reliability when carried out on a sample of 26 biologists.

Kawamura (1993) established that CPITN correlated well with oral health behaviour (HU-DBI). Most of the HU-DBI studies have concentrated on cultural difference from different countries; Japan, Korea, China, Australia, USA, Israel, Greece, Finland (Kawamura et al.,

1997, 1998, 2000, 2001b, 2002, 2005; Kim et al 2001;Porat et al., 2001; Kombayashi et al., 2005; Polychronopoulou & Kawamura, 2005). Two studies were related to diabetes, periodontal health and oral health behaviour and found that diet behaviour and oral health behaviour influenced severity of periodontal disease as well as diabetes (Kawamura et al., 1998, 2001a). HU-DBI was also utilized in some studies to explore the relationship of parents and schoolchildren and found it to be related to school children's gingival health/ caries status through the child's oral health behaviour (Okada et al., 2001, 2002).

2.8.2 Oral health quality of life

The term "health related QOL" has no strict definition, there is consensus that it is a multidimensional construct capturing people's perception about factors that are important in their every day lives. In every walk of life, it is conceivable that oral malconditions may affect the quality of life. The argument of traditional objective measures of outcomes of dental disease such as DMFT index, and CPITN index does not necessarily reflect people's perception and the need to address a multidimensional approach to oral health and possible outcomes was investigated by researchers (Allen, 2003). The interest promoted usage of generic quality of life indicators such as Sickness Impact Profile (Bergner et al., 1983) and utilized by Reisine & Miller (1985) found that the effects of tooth loss and edentulousness could not be detected with the generic instrument. Follow up research observed the development of oral health specific measures: General Oral Health Assessment Index (GOHAI: Atchison & Dolan, 1990) which measures impact of oral disorders; Dental Impact Profile (Strauss & Hunt, 1993) which measures salient dental events; Oral Health Impact Profile (OHIP) (Slade & Spencer, 1994); Dental

Impact on Daily Living (DIDL: Leao & Sheiham 1996), and Oral Impacts of Daily Living (OIDL: Adulyanon & Sheiham, 1997); Health related Quality of Life (HRQL: Sandberg and Wilblad, 2003)

Oral health impact profile OHIP-14 is one of the emerging oral health quality of measures used in oral health research. The historical development of this instrument was concurrent with emerging interest in oral health related quality of life. OHIP (Oral health impact profile) was developed by Slade & Spencer (1994) with the aim of providing a comprehensive measure of self reported dysfunction, discomfort and disability attributed to oral conditions based on Locker (1988) model of oral health. These impacts were intended to complement traditional oral epidemiologic indicators of clinical disease, thereby providing information about the burden of illness within populations and the effectiveness of health services in reducing the burden of illness. OHIP is concerned with impairment and three functional status dimensions (social, psychological and physical) that represent four of the Patrick and Bergners' (1990) seven quality of life dimensions. The development of the instrument OHIP-14 shorter version originated from the 49 questions (Slade 1997). OHIP-14 has been found to have good reliability (α=0.88), validity and precision. Robinson et al., (2003) found OHIP 14 a suitable instrument, amenable to analysis and appropriate for comparing groups in questionnaire-based research. Allen (2003) concurred with Robinson and highlighted the paucity of research in this area as a means of assessing outcome of clinical intervention. Most of the studies to date focused on oral health quality of life relating to dentures, implants and TMJ dysfunction; few addressed the effects of primary prevention and oral health promotion (Naito et al., 2006).

2.9 RESEARCH QUESTIONS, BASIS FOR ANALYSIS AND ANALYTICAL MODEL

2.9.1 Statement of Problems

It has been generally accepted that diabetes is a risk factor for periodontal disease. Intervention studies on periodontal care and oral heath promotion programmes for diabetics are lacking in Singapore. In view of the high prevalence of diabetes in the local population and the possible pre-disposition to periodontal breakdown, there is a profound need to promote oral health through oral self care as well as a need to better understand oral health behavior of individuals with diabetes in order to facilitate planning of appropriate oral health programmes.

Problems of past studies and lack of studies have shown that:

1. There has been lack of studies on periodontal status and oral hygiene behaviour for diabetics in Singapore.
2. The results of a Cochrane study (Beirne, 2005) on scaling, root planing (SRP) and polishing on normal adults has been inconclusive. The effect of SRP among a high-risk diabetic cohort was significantly lacking in the Cochrane study.
3. Most of the past studies were often limited to ≤ three months duration and were often based on a small sample size.
4. Traditionally, plaque and BOP has been used as an individual surrogate outcome for oral hygiene compliance. However, there has been a lack of a unified oral hygiene compliance criterion that has the properties to capture the plaque removal effect and inflammatory response to the removal of plaque.

5. There is a lack of a theoretical framework to explain oral hygiene behaviour among diabetics in Singapore. Studies from Scandinavia highlight the role of Self-efficacy on oral health behavior among diabetics and there is a lack of similar evidence in the Singaporean context.
6. A measurable dental behaviour inventory (HU-DBI) study is lacking in the Singaporean context to enable a better understanding of oral health behaviour.
7. Health behaviour and health related quality of life may influence oral health behaviour and there is lack of evidence in the Singaporean context.
8. There are a multitude of factors, which influences chronic diseases such as diabetes and perdiodontal disease. It is also true that these multifactors are dynamically interacting in these chronic diseases (Ahn, 2006 a&b). Multifactors influencing oral hygiene compliance among diabetics ranges from periodontal status, metabolic control, oral health quality of life, oral health behaviour and general health behaviour. There is a lack of relationship studies of these factors. Pathway analysis through Structural Equation Modeling provides an opportunity to test the overall model in contrast to multiple regression modeling without the need to take into account of non-normal & non-linear data, correlated independents, multicollinearities and regression dilution.

Research Questions arising from the problems identified in the research field are:

1. What is the periodontal status and oral health behaviour status among diabetics in Singapore?
2. What is the cutoff endpoint for oral hygiene compliance based on a combined criterion of Plaque and BOP?

3. What is the effectiveness of oral hygiene+scaling, oral hygiene alone and control therapies on the outcome of periodontal health and oral health behaviour among subjects with diabetes in a randomized controlled trial?
4. What is the relationship of metabolic control (HbA1c) on treatment responses and oral health quality of life?
5. What are the resultant oral health quality of life and oral health behaviour status among the diabetic cohort after intervention?
6. Does self-efficacy theory provide a theoretical explanation for oral health behaviour among diabetics in Singapore?
7. How will an 'a priori' theoretical oral hygiene compliance model explain factors that influence oral hygiene compliance among diabetics?

In summary, literature review has highlighted the global implication of the diabetic problem and related diseases such as periodontal disease imposing a health burden on the populations at large. The pathological disease pathway is closely related specifically in the area of TNF-alpha dysregulation through infection, stress, genetics and lipid metabolism. Hba1c, cholesterol and infection may cause modification of periodontal parameters that measure oral hygiene compliance (plaque and BOP). However, these measure have neither been unified nor objectively been determined to provide the optimal endpoint for oral hygiene compliance and may require development of a screening criterion. The treatment modalities for periodontal disease involve oral hygiene maintenance with or without scaling, root planing and polishing. The evidence of scaling, root planing and polishing (SRP) among normal adult is still inconclusive. However, SRP studies among diabetics (high-risk) indicate improvements in periodontal parameters and there is a need to investigate. In addition, the bi-directional relationship of HbA1c and periodontal

parameters are considered to be confounded through the influence of adjunct antibiotics may require further investigation.

Traditionally, plaque and BOP scores are used as individual surrogate endpoints for oral hygiene compliance. However, oral hygiene compliance is a behaviour problem and some researchers believe that behaviour should be measured directly. HU-DBI is one of the measurable oral health behaviour inventory tested for good validity and consistency. Researchers require a theoretical framework to better understand the behaviour in question. Literature review highlights the facts that most health behaviour models and theories exhibit a component of a self-efficacy construct (HBM, SCT, TRA, New Century, Locus of control and PROCEED-PRECEDE model), however the concepts may be too broad to highlight the effect of self-efficacy on health behaviour. Evidence shows that self-efficacy theory was able to explain oral health behaviour in comparison to other theories among diabetics in Scandinavian countries and there is a need to further investigate the findings in the Singaporean context.

The scientific community has highlighted the need for improvement in quality of life measures associated with clinical improvements. OHIP-14 is one of the oral health generic measures that have good reliability and validity that can be used for pre and post intervention assessments. It is conceivable that behaviour is related to quality of life through metabolic control and to oral health behaviour. Considering all the scientific evidence requirements, there is a need to conduct a randomized controlled trial among diabetics in Singapore with the following aims and objectives.

2.9.2 Aims and Objectives

1) To investigate the periodontal status and oral health behaviour status among diabetics in Singapore.

2) To determine an oral hygiene compliance criterion, which captures the essence of plaque cleanliness and inflammatory response to plaque cleanliness and to screen and compare the diabetic cohort for compliance in a randomized controlled trial.

3) To conduct a randomized controlled trial on the effects of oral hygiene maintenance (self-care) +scaling and polishing vs. oral hygiene maintenance alone vs. control (none) on the periodontal parameters and oral health behaviour among a diabetic cohort.

4) To analyze the effect of oral hygiene maintenance +SRP on glycaemic control in a randomized controlled trial.

5) To determine the effects of dental behaviour inventory and quality of life in the randomized controlled trial.

6) To determine whether self-efficacy theory will be able to explain oral health behaviour in the study cohort.

7) To conduct a Pathway analysis by Structural Equation Modeling of an ‘a priori’ oral hygiene compliance theoretical model in understanding the factors affecting oral hygiene compliance among diabetics in Singapore.

CHAPTER THREE MATERIALS AND METHODS

3.1 Background and Settings to Research

There are several Diabetic centers catering to the medical health needs of diabetic patients in Singapore. The target population of the proposed study was selected from the two Diabetic Centres at Alexandra Hospital and National University Hospital. Both centres cater to 800 diabetics a month (estimation). The proposed oral health promotion programme is a wide-ranging study, which investigates the effects of non-surgical periodontal therapy applied to the cohort of patients with diabetes. These effects will be studied in terms of clinical outcome, its behavioral components, oral health quality of life, and derive a model to explain oral hygiene compliance

3.2 Research Problem and Hypotheses

3.2.1 Hypotheses (in relation to aims and objectives 2, 3, 4 and 5)

The purpose of the study is to find the outcome of periodontal intervention by scaling in combination with oral hygiene (OH+ Sc) as compared with oral hygiene (OH self-care) alone and no intervention (control) in a nine-month clinical trial for a diabetic cohort. The following hypothesis forms the basis of the research.

The null hypothesis assumes that there is no significant difference in periodontal status, HbA1c and oral hygiene compliance behaviour among these groups after intervention.

Alternate hypothesis assumes that there is a significant difference in periodontal status, HbA1c and oral hygiene compliance behaviour among these groups after intervention.

3.3 Justification

The following list iterates the present research gap (lack of evidence) and summarizes the need and justification to conduct the current research work.

1. Health delivery research and services on oral health promotion does not exist in Singapore for diabetics at the current point in time. There is a need to develop guidelines based upon relevant data in the local context. (guideline information gap)
2. Lack of information on compliance (adherence) with oral hygiene and oral health attitudes of diabetics in Singapore. (behavioral information gap or KAP-gap)
3. Lack of comprehensive oral hygiene compliance criterion that can capture the essence of plaque cleanliness and tissue response to the effect of plaque cleanliness. (compliance criterion gap)
4. Need for a theory based study on the effects of oral hygiene maintenance to support the enquiry into Behavioral information-gap. (Theory based gap)
5. Need for a longitudinal study on the effects of periodontal intervention on the periodontal health of diabetics in Singapore. (long term study information gap)
6. Lack of consistency of information on the bi-directional nature of glycaemic control and periodontitis especially in the Singaporean context. (bi-directional effect study gap)
7. Randomized controlled trial is recognized as the gold standard of study designs. (RCT study gap)

8. The high prevalence of diabetes and the associated systemic complications can be best addressed in a preventive programme. (Oral health contribution to lighten the disease burden among diabetics gap)

3.4 Scope and Key Assumptions

The scope of study is behavioral (compliance) in nature with correlations to clinical and laboratory outcomes, based on a randomized clinical trial with 3 assessment levels at baseline, 3 months and 9 months.

Self-efficacy among diabetics may be a mediator or a moderator for motivation to act on oral hygiene maintenance.

3.5 The Sample Population

The sample population was recruited from two diabetic centres based in Alexandra Hospital and National University Hospital of Singapore.

Anticipating a within group reduction of 10% of BOP and plaque between pre and post intervention and using the McNemar's test, a sample size of 40 per group was estimated as sufficient to achieve a significant difference with a power of 80 % and a two-sided significance of 5 %. A between group reduction of 25% of BOP and plaque, a sample size of 40 per group was estimated as sufficient to achieve a significant difference with a power of 80 % and a two-sided significance of 5 % (ANOVA). Thereby, a minimum sample size of 50 per group was decided taking into consideration some possible attrition in the course of the study (a statistician was consulted for sample size estimation). The

final sample consisted of 59 subjects for the oral hygiene (OH) and scaling (Sc) group, 52 subjects for the oral hygiene group (OH) and 50 subjects for the control group at baseline.

3.6 Ethical Considerations

3.6.1 Plan for protection of human subjects:

Approval from the respective Institutional Review Board was obtained prior to implementation of the programme. Informed consent form includes the summary of the study, benefits and side effects expected from the study with signatures from participants and witness (Appendix A). Approval to use the questionnaires was approved from the relevant authorities.

3.7 Research Procedures and Methodology

3.7.1 **Study Design**:

The primary study is a hospital based randomized controlled trial (single blind) set at significance level 0.05. The baseline study serves as a cross sectional design.

3.7.2 Intervention strategies adopted are:

1. Periodontal Therapy: scaling, polishing and root planing.

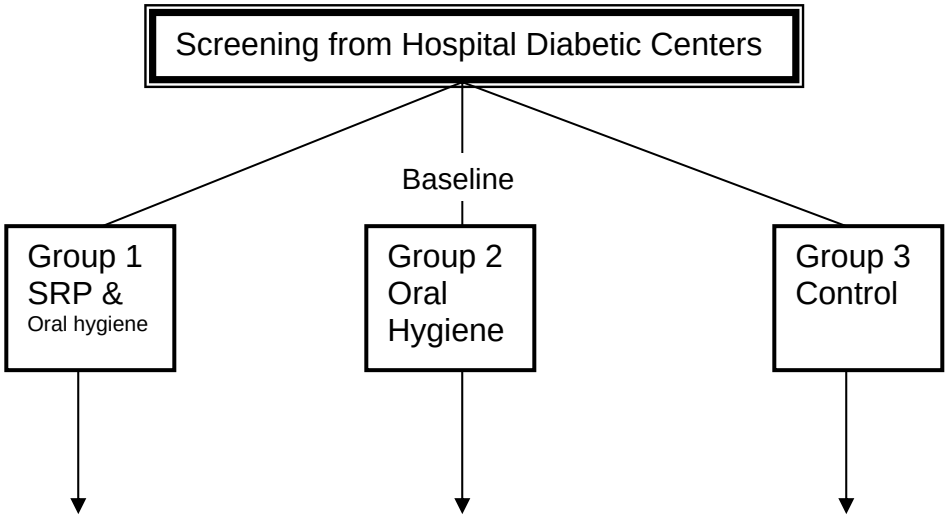
2. Oral health education: personal instruction supplemented by an oral health education booklet. (Researcher provides oral health education with Periodontal Health Booklet for Diabetics)

3. Evaluation: oral health assessments including periodontal health and oral hygiene.

3.7.3 Action plan of activities*:*

Subjects who were willing to participate in the study were interviewed and screened if they fulfilled the selection criteria according to the study protocol. Informed and written consent were obtained from all participants prior to commencement of the study. One hundred and sixty one subjects recruited into the clinical trial were examined at baseline, and randomly allocated into one of 3 groups. Follow up evaluations were carried out at 3 months and 9 months (Refer to flow chart Figure 2)

Figure 2. Flow Chart of Oral Health Promotion Programme Study



Baseline: Clinical examinations, Questionnaires for KAP, OHIP-14 & HU-DBI
Blood sample

3 months

3 months: Clinical examinations, Questionnaires KAP review,
Blood sample

9 months

9months: Clinical examinations, Questionnaires for HU-DBI, OHIP-14, Self-Efficacy
Blood sample

All groups were provided with scaling, root planing and polishing (SRP) at 9 months

3.7.4 Inclusion criteria:

- Confirmed diabetics (both type 1 &2) DM 21-65 years of age, both genders.
- Minimum of eight teeth remaining.

3.7.5 **Exclusion criteria**:

- Need for prophylactic antibiotics therapy (e.g. prophylaxis for bacterial endocarditis).
- Severe medical complications and blood disorders.

3.7.6 **Randomization**: (envelope method)

- Stratified, randomization sampling of patients from the 2 diabetic centers into the three modalities of treatment.
- Stratification based on glycaemic control and periodontal conditions. Examiners were blinded to the group allocation.

3.7.7 **Clinical parameters**:

Full mouth assessment was carried out around six sites of each tooth using a UNC probe with 1mm graduation markings for:

1. Presence of plaque.
2. Bleeding on probing (BOP).
3. Clinical attachment loss (CAL) as measured from the cemento-enamel junction to the bottom of the clinical pocket.
4. Probing pocket depth (PPD) to the nearest millimeter.
5. Presence of Supragingival calculus.
6. Presence of Sub-gingival Calculus.

Two examiners carried out all examinations; Kappa Statistics tested inter-rater and intra-rater reliability.

Full mouth assessments for:

1. **Plaque (absence or presence)**

Presence or absence of plaque was assessed using the UNC probe. The positive scores as percentage of the total number of sites examined were used as the plaque score. It is used as outcome for plaque cleanliness and oral hygiene compliance.

2. **BOP (Bleeding On Probing)**

The presence or absence of gingival bleeding was determined by gentle probing of the gingival crevice. The appearance of bleeding within ten seconds indicates a positive score that is expressed as the percentage of the total number of sites examined. It is used as outcome of host response expressed as gingivitis and oral hygiene compliance.

3. **CAL (Clinical Attachment Loss)**

Loss of attachment refers to the detachment of connective tissue fibers originally anchored in the root cementum and the proliferation of the pocket epithelium below the cemento-enamel junction, or in the case of recession of the gingival, the denudation of the root surface. Clinically, loss of attachment is measured as the distance from the cemento-enamel junction (CEJ) to the bottom of the clinical pocket.

4. **PPD (Probing Pocket Depth)**

Probing depth is measured to the nearest millimetre from the gingival margin to the base of the gingival sulcus. It is used as outcome of disease severity.

5. **Supra and subgingival calculus (presence and absence)**

Using the same standardized probe, the presence and absence of sub gingival calculus is determined by tactile sensation. The presence of supra-gingival calculus was determined

by direct vision. A positive score is expressed as the percentage of the total number of sites examined. It is used as outcome for effectiveness of calculus removal.

3.7.8 Clinical Intervention:

Post-graduate residents in periodontology provided scaling (30-60 minutes) for the OH+Sc group after randomization. A maximum of up to two visits was allowed during the initial phase of treatment if there was a need. To avoid bias, scaling was carried out by 2 clinicians different from the examiners. On ethical grounds, acute periodontal infection or degradation in probing depths of greater than 2 mm requiring therapy from the non-scaling groups were rendered treatment accordingly. Oral hygiene instructions (10-15 minutes) were provided for OH+Sc group and oral hygiene group only by the researchers using the periodontal health booklet and teaching aids. Reinforcement of oral hygiene instruction was conducted at each evaluation period (3 & 9 months) for the designated groups (OH+Sc and OH groups). Control did not receive any intervention at all time points.

3.7.9 Questionnaires:

Baseline Questionnaire on oral health knowledge, attitudes and practice was collected at baseline and followed up at three months by a review questionnaire. Health Questionnaires related to diabetic condition and control was also conducted at baseline. HU-DBI and OHIP-14 questionnaires were conducted at baseline and nine months. Self-efficacy Questionnaire was administered at 9 months only. (Figure 2) (Appendix B to G)

Baseline Questionnaires (Appendix B): There are 15 items on this questionnaire to capture the Knowledge, Attitude and Practice of oral health by the respondents at baseline. The baseline questionnaire also included diabetic conditions (13 items) to explore the baseline diabetic status and control of the diabetic condition by the respondents.

Three months review Questionnaire (Appendix C): This questionnaire was prepared to capture knowledge, attitude and practice changes that were affected by the intervention strategy. The questionnaire has 10 items and there were additional items to check on perceived control of diabetes, awareness and prevention of gum problems. Baseline and Review questionnaires served as a comparison for KAP.

Health Questionnaire (Appendix D): The questionnaire consists of 28 items and 26 items were on a Likert scale of four. The questionnaire is based on the Japanese Railways Health questionnaire that was utilized in a Japanese oral health behaviour study (Kawamura et al., 1998) to find out the association of oral health behaviour, periodontal conditions to health behaviour.

HU-DBI (Appendix E): The dental behaviour inventory consists of 20 items. The questionnaire was designed by Kawamura (1988) to provide a measurable standard of dental behaviour. The responses are based on a positive and negative response and scored "one" according to the acceptable response. The summation scores are used for comparison among groups and intervention effects. The questionnaire was applied at baseline and end of 9 months.

OHIP-14 (Appendix F): The short form OHIP-14 has 14 items with Likert scale responses (very often, quite often, occasional, seldom and never). OHIP-14 on a Likert scale ranges from (0) never, hardly ever (1), occasionally (2), fairly often (3), very often

(4). The affected score was calculated based on the sum scores (2+3+4). For comparative purposes, the affected responses can be derived from the responses, which exhibit, very often, quite often and occasional responses. The affected mean was also derived from the summation scores of these responses.

OHIP-14 Likert scores were recoded in the ascending scale for improvement in oral health, indicating the lesser the OHIP sum scores there is more impact on oral health quality of life. (e.g. '0' became '5', '1' became '4', '2' became '3', '3' became '2', and'4 'became'1'). Summation scores from likert responses were used for comparisons. Therefore the responses ranged from '1' (very much affected) to 70 (free from problems). The questionnaire was derived from the 7 dimensions (Functional limitation, Physical pain, Psychological discomfort, Physical disability, Psychological disability, Social disability, and Handicap). These dimensions can be compared from baseline in response to the intervention.

Self-Efficacyquestionnaire (Appendix G): The questionnaires were a modification from Syrjala et al., (1999) questionnaire. There are 47 items rated in 5 point Likert scale (very likely, likely, not likely, not at all likely and not applicable responses). It is further broken down into toothbrushing self-efficacy (12 items), interdental cleaning self-efficacy (12 items), dental visiting self-efficacy (8 items), oral health belief (6 items), diabetes control self-efficay (7 items). The summation scores are used for comparisons for each self-efficacy domain. This is further summarized in dental self-efficacy that includes toothbrushing, interdental cleaning and dental visit self-efficacy scores and oral health behaviour self-efficacy that consists of summation of all 47 items including diabetic control.

3.7.10 Laboratory parameters:

Fasting blood samples were collected at baseline, three months and nine months. The variable outcomes from these samples were HbA1c and total cholesterol counts.

HbA1c (Glycated Hemoglobin): Blood glucose binds to hemoglobin A and forms the HbA1c sub-type and usually represents the average level of the past 30-90 days of blood glucose levels. Non-diabetic subjects have a normal range of ≤ 6.0% HbA1c levels given into consideration the formation, decomposition and destruction of HbA1c. Usually high blood glucose levels among diabetics correspond well with HbA1c levels over a period of time and can be used as an indicator of the average blood glucose levels. For the purpose of stratifying HbA1c level, unacceptable level of HbA1c control is ≥ 8 % and levels < 8 % is dichotomized as acceptable HbA1c control.

Total cholesterol: The study opted to study the effect of total cholesterol only.

The levels of total cholesterol fall into the following categories:

- **desirable level:** cholesterol level in the blood less than 5.2 mmol/l.
- **borderline cholesterol level:** between 5.2 to 6.1 mmol/l.
- **high cholesterol level:** 6.2 mmol/l and above.

All blood samples were analyzed at NUH referral laboratory.

3.8 ANALYSIS OF DATA

3.8.1 Introduction

All data entry and statistical analyses were performed using SPSS 11.5 software. SAS 9.1 Pro Calis software was used for Structural Equation Modeling on the pathway analysis of the theoretical oral hygiene compliance model.

3.8.2 Statistical Plan

In accordance with the relevant aims and objectives the analyses will be performed in three phases. (Figure 3)

Phase I. Assessment of OHC and associated factors in the study before the intervention.

The following parameters were presented in treatment groups:

- **Demographics**: Frequency distribution of the study cohort was examined to find out the distribution of the randomized groups (OH+Sc, OH alone and Control) for variables such as age, gender, and ethnicity to show the demographic nature.
- **Diabetic Status**: A subgroup analysis by gender, ethnicity and age category on duration of diabetes was conducted. Control of diabetes, activities related to diabetes control, complications related to diabetes was also analyzed.
- **Clinical & Laboratory data**: Mean number of teeth, HbA1c, pocket depth, calculus, plaque and bleeding on probing analyses was conducted to test group differences at baseline. Denture status: Report on frequency of denture wearing, duration of denture wearing and satisfaction of wearing dentures.

- **Knowledge**: Frequency report on knowledge on cause of gum disease, risk perception. Pearson's Chi square test (adjusted Bonferroni) conducted for treatment group differences at baseline for knowledge and practice.
- **Practice**: Frequency report on toothbrushing practice, interdental cleaning, dental visits, smoking habits. Baseline difference between groups was analyzed by Pearson's Chi square test with Bonferrroni adjustments.
- **Attitudes**:

  OHIP-14: Frequency report on OHIP-14 with affected mean = 2 (occasionally) +3 (likely) +4 (very likely) was tabulated how each item responded at baseline. Another frequency table was stratified into 7 domains (functional limitation, Physical pain, psychological discomfort, physical disability, psychological disability, social disability, handicap) followed by summation mean scores and Cronbach alphas for each subscale. The summation mean scores were then tested with self-reported oral health symptoms by independent t test to find out the association of symptoms and OHIP-14.

  HU-DBI: Internal consistency was conducted for HU-DBI. Both HU-DBI at baseline and 9 months reported low Cronbach alphas. To enable a more reliable comparison, it was decided to delete items that exceeded the average Cronbach alpha in both baseline and 9 months. HU-DBI 13 items frequency distribution is reported.

  Oral Hygiene Compliance (OHC): Traditionally OHC is measured with plaque (cleanliness) and BOP (inflammatory response to cleanliness) scores as individual endpoint surrogate outcomes. Since, there was lack of a unified unit to provide an

OHC criterion. ROC analysis was used to determine the OHC criterion (plaque+BOP) based on the study group's clinical data (PPD, Calculus). The frequency distribution of OHC criterion is also provided at baseline stratified by gender, race, age, HbA1c levels and treatment groups. Furthermore, OHC compliance is further stratified in levels of compliance. (Note: OHC analysis follows General health behaviour in sequential order but mentioned here as analysis was conducted for group differences).

The following parameter was analyzed for the whole cohort

- **General Health Behaviour**: Frequency table was reported. Factor Analysis was also conducted to find out the major general behaviour domains derived from the data. The purpose of extracting theses domains enabled to better explain factors that affect oral health behaviour status through general health behaviour. These domains will be later used in the path analysis of factors explaining oral health behaviour for the study group.

Phase II. Assessment of intervention strategy in comparison to baseline with three and nine months data.

Planned comparisons: Comparative % differences from baselines were conducted at three and nine months (within groups and between groups) for continuous data.

II.1. Effects on knowledge, attitudes and practice:

- **Knowledge:** An evaluation of knowledge score responses on the cause of gum disease was first analyzed to evaluate critical item responses for the cause of gum disease (ineffective oral hygiene and plaque). A McNemar comparison between baseline and 3 months was conducted for total group responses and a Chi square

analysis was conducted to analyze the group differences for the knowledge score responses.

- **Practice:** An evaluation of an acceptable interdental cleaning habit frequency distribution for type of interdental device usage and number of devices used at baseline and 3 months are displayed to show the improvements or lack of it. A McNemar analysis was conducted for a within group comparison between baseline and three months. A Bonferroni corrected Chi square analysis was conducted to evaluate in between groups comparisons at 3 months.

Attitudes:

- **OHIP-14:** Frequency report on OHIP-14 with affected mean was tabulated on each item responses at nine months. Another frequency table was stratified into 7 domains subscales (functional limitation, Physical pain, psychological discomfort, physical disability, psychological disability, social disability, handicap) followed by summation mean scores and Cronbach alphas for each subscale. Summation scores of OHIP-14 were then analyzed with paired t test comparisons between baseline and nine months with adjusted Bonferroni within group comparisons. The seven dimension subscales summation mean were then analyzed for changes from baseline to nine months applying a Bonferroni adjusted paired t test for within group changes. Oneway ANOVA (Analysis of Variance) test was also conducted to analyze group differences at baseline and nine months. An ordinal regression analysis was also conducted to analyze the effect OHIP-14 level of change with other oral hygiene behaviour and associated factors.

- **HU-DBI:** HU-DBI reliability analyses are tabulated at baseline and 9 months. After item deletion of items that did not improve the reliability analysis provided 13 items for comparison. Basis of the comparison is based on the summation scores from the 13 items extracted by reliability analysis. A paired t test was conducted for within group comparison. Oneway ANOVA test was also performed to evaluate the between group differences. An ordinal regression analysis was also conducted analyze the effect HU-DBI level of change with other oral hygiene behaviour.

II.2 Effects on laboratory parameters

- **HbA1c:** ANOVA analysis at baseline did not show any group differences and a repeated measure analysis was conducted for between group analyses. Chi square tests with Bonferroni adjustments were also performed to analyze the group differences at 3 months and 9 months. A dichotomized unacceptable and acceptable HbA1c dependent variable was also analyzed using Bonferroni adjusted Chi square test for between group differences and a McNemar test for within group differences.
- **Cholesterol:** ANOVA analysis at baseline did not show any group differences and a repeated measure analysis was conducted for between group analyses.

II.3 Effect on periodontal parameters

- **Plaque:** One way ANOVA analysis showed a baseline difference for plaque scores between groups and an ANCOVA analysis was followed up to analyze the group differences at 3 month and 9 months (taking account for gender and age). A

paired t test comparison was also conducted with Bonferroni adjustments at 3 months and 9 months.

- **BOP:** One way ANOVA analysis showed a baseline difference for BOP scores between groups and an ANCOVA analysis was followed up to analyze the group differences at 3 month and 9 months (taking account for gender and age). A paired t test comparison was also conducted with Bonferroni adjustments at 3 months and 9 months.
- **Subgingival calculus:** One way ANOVA analysis showed a baseline difference for subgingival calculus scores between groups and an ANCOVA analysis was followed up to analyze the group differences at 3 month and 9 months (taking account for gender and age). A paired t test comparison was also conducted with Bonferroni adjustment at 3 months and 9 months.
- **Supragingival calculus:** ANOVA analysis at baseline and a repeated measure analysis were conducted for between group analyses. A paired t test comparison was also conducted with Bonferroni adjustment at 3 months and 9 months.
- **Probing pocket depth:** A one-way ANOVA analysis was conducted to ascertain the baseline differences. A paired comparison was also conducted with Bonferroni adjustments at 3 months and 9 months. As a baseline difference was observed, an ANCOVA (Analysis of Covariance) analysis was conducted taking into account for gender and age (between group comparisons).

II.4 Effect on Oral Hygiene Compliance criterion

- **Comparisons:** Frequency distribution of compliance rates are provided for comparison at baseline, 3 months and 9 months. McNemar analysis was

performed to show the baseline to 3 and 9 months within group differences. These were conducted and for total study group and each treatment group. Between groups comparisons were analyzed by logistic regression controlling for baseline OHC differences. Descriptives of OHC subcategories are provided and within group differences were analyzed by McNemar test.

- **Factors associated with Oral Hygiene Compliance (OHC) criterion:** Logistic regression was performed to determine the factors that are associated with OHC. A full saturation model was used with treatment group, self-efficacy levels and interdental cleaning. The full saturation model was justified by the exclusion of other variables such as gender, age and ethnicity at baseline assessment. To satisfy the completeness of assessment a multinomial regression analysis was performed to analyze the effect on the levels of OHC subcategories.

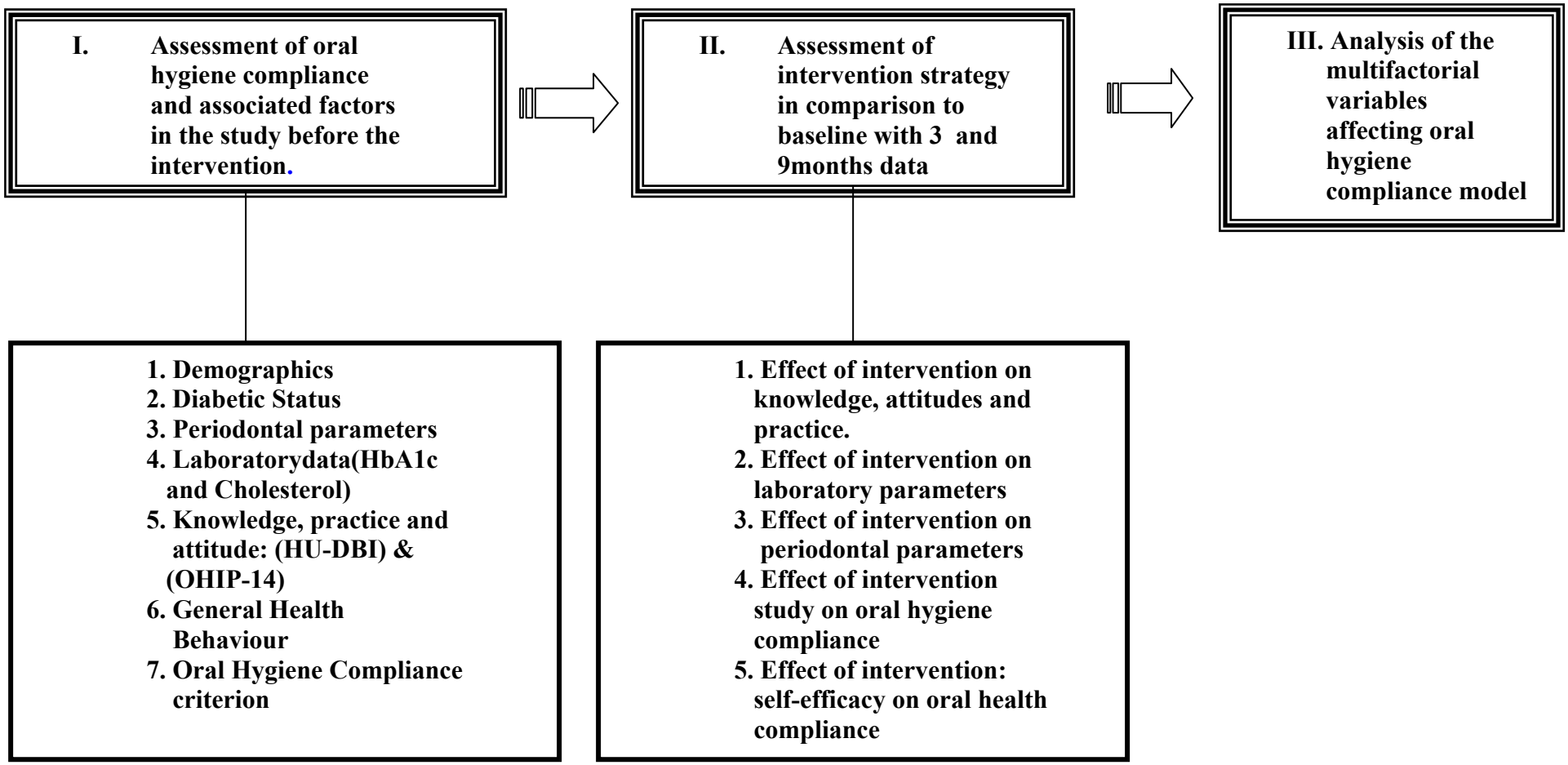
II.5 Effects of intervention: Self-efficacy on oral hygiene compliance

- **Comparisons:** Frequency distribution of self-efficacy responses is tabulated to compare positive= 4 (likely+ 5 (verylikely) and negative self-efficacy (summations of others). Descriptives of summations scores are also provided for comparisons. One-way ANOVA was performed to analyze group differences. An independent t test was conducted to test dental self-efficacy and health behaviour self-efficacy with acceptable dental visiting behaviour at baseline, acceptable interdental cleaning at baseline and three months, and 9 months unacceptable oral hygiene compliance at 9 months.

Phase III. Analysis of the multifactorial variables affecting oral hygiene compliance

Structural Equation Modeling was performed to analyze the pathway analysis of variables that are considered to affect the oral hygiene compliance model.

Fig. 3 Data Analysis Flow Chart



4.1 ASSESSMENT OF ORAL HYGIENE COMPLIANCE & FACTORS BEFORE INTERVENTION

4.1.1 Demographic Data

A total of 161 patients with diabetes (both Type I and II) were recruited into the study. There were 59 subjects (36.3%) in the 'scaling & oral hygiene group', 52 subjects (32.3%) in the ' oral hygiene group' and 50 subjects (31.1%) in the 'control group'. The age of the subjects ranged from 21 to 65 years old (mean 45.43 ±10.85). There were a higher proportion of male patients (56.9%) as compared to females (43.1%) in the study. The majority, 119 (73.9%) participants were of Chinese origin, 17 (10.6%) were Malays, 24(14.9%) were Indians and only one (0.6%) was from another racial group.

Table 6.0 Subjects by groups at baseline, 3 months and 9 months (drop out %)

	Baseline	3 months	9 months
OH+Sc	**59**	**55(6.8)**	**45(23.7)**
OH	**52**	**52(none)**	**45(13.5)**
Control	**50**	**48(4.0)**	**42(16.0)**
Total	**161**	**155(3.7)**	**132(18.1)**

Table 6.0 shows the number of subjects per experimental group at baseline, 3 months and 9 months with dropout rate of 3.75% at 3 months and 18.12% at 9 months.

Tables 6.0.1 to 6.0.6 show a subgroup breakdown for gender, ethnicity and age groups at baseline, 3 months and 9 months.

Table 6.0.1 Subjects by gender and ethnicity at baseline

	Total	Male	Female	Chinese	Malay	Indian	Others
OH+Sc	**59**	**37**	**22**	**49**	**5**	**5**	
OH	**52**	**27**	**25**	**40**	**7**	**5**	
Control	**50**	**27**	**23**	**30**	**6**	**13**	**1**
Total	**161**	**91**	**70**	**119**	**18**	**23**	**1**

Table 6.0.2 Subjects by gender and ethnicity groups at 3 months

	Total	Male	Female	Chinese	Malay	Indian	Others
OH+Sc	**55**	**34**	**21**	**47**	**3**	**5**	
OH	**52**	**27**	**25**	**40**	**7**	**5**	
Control	**48**	**26**	**22**	**29**	**6**	**12**	**1**
Total	**155**	**87**	**68**	**116**	**16**	**22**	**1**

Table 6.0.3 Subjects by gender and ethnicity groups at 9 months

	Total	Male	Female	Chinese	Malay	Indian	Others
OH+Sc	**45**	**28**	**17**	**39**	**2**	**4**	
OH	**45**	**26**	**19**	**35**	**7**	**3**	
Control	**42**	**21**	**21**	**26**	**5**	**10**	**1**
Total	**132**	**75**	**57**	**100**	**15**	**17**	**1**

Table 6.0.4 Subjects by age groups at baseline

	Total	21-45yrs	41-55yrs	56-65yrs
OH+Sc	**59**	**19**	**24**	**16**
OH	**52**	**18**	**26**	**8**
Control	**50**	**13**	**25**	**12**
Total	**161**	**50**	**75**	**36**

Table 6.0.5 Subjects by age groups at 3 months

	Total	21-45yrs	41-55yrs	56-65yrs
OH+Sc	**55**	**18**	**22**	**15**
OH	**52**	**18**	**26**	**8**
Control	**48**	**12**	**24**	**12**
Total	**155**	**48**	**72**	**35**

Table 6.0.6 Subjects by age groups at 9 months

	Total	21-45yrs	41-55yrs	56-65yrs
OH+Sc	**45**	**13**	**20**	**12**
OH	**45**	**16**	**22**	**7**
Control	**42**	**11**	**20**	**11**
Total	**132**	**40**	**62**	**30**

4.1.2 Diabetic Status

The cohort at baseline consisted of 60 (39.5%) subjects who were diagnosed with diabetes within the last 5 years. 36 (23.7%) individuals had diabetes for 6 to 10 years. 25 (16.4%) had diabetes for 11 to 15 years and 31(20.4%) had diabetes for more than 15 years. The HbA1c values that were recorded ranged from 5% to 14.6% (mean 7.81 % ±1.5). The majority of the cohort was diagnosed with diabetes for more than 5 years (60.5%) showing the chronic nature of the disease. No significant differences were found between males and females and amongst the different ethnic groups as shown in Tables 6.1 & 6.2.

Table 6.1 Duration of diabetes by gender n (%)

	≤ 5yrs	6-10yrs	11-15yrs	≥ 15yr	total
male	36 (41.8)	24 (27.9)	14 (16.3)	12 (14.0)	86
female	24 (36.4)	12 (18.2)	11 (16.7)	19 (28.7)	66
Total	60 (39.5)	36 (23.7)	25 (16.4)	31 (20.4)	152

Table 6.2 Duration of diabetes by ethnicity n (%)

	≤5yrs	6-10yrs	11-15yrs	≥15yrs	total
Chinese	46 (40.0)	26 (22.6)	23 (20.0)	20 (17.4)	115
Malay	9 (60.0)	1 (6.6)	1 (6.7)	4 (26.7)	15
Indian	5 (23.8)	8 (38.1)	1 (4.8)	7 (33.3)	21
Others	0	1 (100)			1
Total	60 (39.5)	36 (23.7)	25 (16.4)	31 (20.4)	152

The distributions of different duration of diabetes according to age group categories are shown in Table 6.3.

Table 6.3 Duration of diabetes by age category n (%)

	5yrs≤	6-10yrs	11-15yrs	15yrs≥	total
21-40 years	19 (38.8)	13 (26.5)	9 (18.4)	8 (16.3)	49
41-55 years	22 (32.4)	19 (27.9)	12 (17.6)	15 (22.1)	68
56-65 year	19 (54.3)	4 (11.4)	4 (11.4)	8 (22.9)	35
Total	60 (39.5)	36 (23.7)	25 (16.4)	31 (20.4)	152

Table 6.4 shows the frequency distribution of diabetic duration by treatment groups at baseline.

Table 6.4 Duration of diabetes by treatment group n (%)

	5yrs≤	6-10yrs	11-15yrs	15yrs≥	total
OH+Sc	23 (41.8)	13 (23.6)	10 (18.2)	9 (16.4)	55
OH	20 (40.8)	11 (22.4)	7 (14.3)	11 (22.4)	49
Control	17 (35.4)	12 (25)	8 (16.7)	11 (22.9)	48
Total	60 (39.5)	36 (23.7)	25 (16.4)	31 (20.4)	152

In the study cohort, diabetes was controlled by various measures: 97/154(63.0%) of the cohort was prescribed with oral medications, 42/154 (27.3 %) was given insulin and 96/154 (62.3%) was on diet-control, and 76/154 (49.4%) exercised. A combination of diet control and exercise or both were commonly practiced in addition to the prescribed medication.

Table 6.5 Activities related to diabetes control n (%)

Activities	1 Not at all	2 to a certain extent	3 most of the time	4 very much	total
Routine checkups	1 (0.6%)	5 (3.3%)	7 (4.5%)	141 (91.6%)	154
Family support	12 (7.8%)	49 (32.0%)	32 (20.9%)	60 (39.3%)	153
Daily routine	56 (36.6%)	33 (21.6%)	56 (36.6%)	8 (5.2%)	153
Disciplined	5 (3.2%)	18 (11.7%)	88 (57.2%)	43 (27.9%)	154
Diet control	3 (1.9%)	52 (33.6%)	80 (51.6%)	20 (12.9%)	155
Weight control	15 (9.7%)	54 (34.8%)	51 (32.9%)	35 (22.6%)	155
Control confidence	3 (2.0%)	31 (20.3%)	80 (52.3%)	39 (25.4%)	153

In Table 6.5 the majority (96.1%) of the study group was found to adhere to routine diabetes appointments, and 85.0% reported having a disciplined lifestyles to cope with the challenges of diabetes. 64.5% of the study cohort were likely to use diet control and 55.5% weight control to regulate their diabetes. A good majority, 77.8% reported that they had confidence in controlling their diabetes. However, only 41.8% of the

group reported that they could manage their daily routine well. Among the study group, 60.1% reported family support in helping them to manage their diabetes. Besides diabetes, no other medical complications were reported by 54.1% of the study group; 39.2% had one complication, 4.1% had two complications, 2% had three complications and 0.7% had four complications. The most common medical condition reported was high blood pressure 55/149 (36.9%), 3/148 (2%) had stroke, 7/149 (4.7%) had chronic heart disease, 20/149 (13.4%) had renal problems and 14/149(9.4%) had other health problems such as high cholesterol and angina. Ninety- two subjects (59.7%) reported that they had attended health educational talks prior to participation in this programme. Among these respondents, 36.4% found that educational programme was very useful and 54.5% found that it was useful.

4.1.3 Clinical & Laboratory data

Table 7.0 to 7.7 shows the distribution of the clinical and laboratory data at baseline. The number of teeth equally distributed among the treatment groups at baseline. (Table 7.0)

Table 7.0 Mean number of teeth at baseline by groups

No. of teeth	*Mean*	*SD*	*Min*	*Max*	*No.of subjects*
No. of teeth					
Total	**25.7**	**4.4**	**8**	**32**	**161**
OH+Sc	**25.6**	**4.8**	**8**	**32**	**59**
OH	**26.9**	**3.6**	**17**	**32**	**52**
Control	**24.8**	**4.5**	**13**	**32**	**50**

The level of HbA1c was equally distributed among treatment groups at baseline. (Table 7.1)

Table 7.1 Mean HbA1c levels at baseline

HbA1c (%)	*Mean*	*SD*	*Min*	*Max*	*No.of subjects*
HbA1c					
Total	**7.8**	**1.5**	**5**	**14.6**	**161**
OH+Sc	**8.1**	**1.6**	**5**	**13.2**	**59**
OH	**7.6**	**1.4**	**5.5**	**11.0**	**52**
Control	**7.7**	**1.5**	**5.4**	**14.6**	**50**

Table 7.2 shows the equal distribution of total cholesterol among the treatment groups at baseline.

Table 7.2 Mean Total cholesterol levels at baseline

Total cholesterol *(mmol/l)*	*Mean*	*SD*	*Min*	*Max*	*No.of subjects*
Total cholesterol					
Total	**5.1**	**1.0**	**3.4**	**8.5**	**141**
OH+Sc	**5.2**	**0.95**	**4.0**	**8.1**	**53**
OH	**5.2**	**1.2**	**3.4**	**8.5**	**48**
Control	**4.8**	**0.69**	**3.6**	**6.2**	**40**

Tabel 7.3 shows that OH+Sc group plaque levels differed significantly with OH group ($p<0.05$) at baseline.(one way ANOVA adjusted Bonferonni)

Table 7.3 Mean % plaque levels at baseline

Plaque	*Mean*	*SD*	*Min*	*Max*	*No.of subjects*
Plaque					
Total	**58.3**	**22.3**	**2.1**	**98.7**	**161**
OH+Sc	**62.6**	**20.4**	**11.1**	**96.0**	**59**
OH	**47.3**	**22.6**	**2.1**	**87.4**	**52**
Control	**60.7**	**22.1**	**14.3**	**98.7**	**50**

Tabel 7.4 shows that OH+Sc group BOP levels differed significantly with OH group ($p<0.05$) at baseline. (one way ANOVA adjusted Bonferonni)

Table 7.4 Mean % BOP levels at baseline

BOP	*Mean*	*SD*	*Min*	*Max*	*No.of subjects*
BOP					
Total	**53.9**	**23.2**	**4.3**	**100**	**161**
OH+Sc	**57.9**	**23.5**	**13.9**	**100**	**59**
OH	**47.3**	**22.6**	**4.3**	**92.7**	**52**
Control	**56.1**	**22.5**	**7.1**	**96.4**	**50**

Table 7.5 indicates that there were no treatment group differences at baseline for supragingival calculus.

Table 7.5 Mean % supragingival calculus levels at baseline

Supragingivalcalculus	*Mean*	*SD*	*Min*	*Max*	*No.of subjects*
Supragingivalcalculus					
Total	**15.8**	**17.4**	**0**	**79.9**	**161**
OH+Sc	**16.7**	**18.2**	**0**	**79.9**	**59**
OH	**13.9**	**15.6**	**0**	**68.4**	**52**
Control	**16.7**	**18.3**	**0**	**78.6**	**50**

Tabel 7.6 shows that OH+Sc group subgingival calculus levels differed significantly with OH group ($p<0.01$) and control ($p<0.01$) at baseline. (one way ANOVA adjusted Bonferroni).

Table 7.6 Mean % subgingival calculus levels at baseline

Subgingivalcalculus	*Mean*	*SD*	*Min*	*Max*	*No.of subjects*
Subgingivalcalculus					
Total	**52.8**	**24.8**	**3.2**	**100**	**161**
OH+Sc	**59.4**	**25.3**	**5.6**	**97.3**	**59**
OH	**43.9**	**22.4**	**3.2**	**82.7**	**52**
Control	**53.9**	**24.4**	**6.5**	**100**	**50**

Table 7.7 shows OH group difference for PPD with OH+Sc ($p<0.01$) and Control ($p<0.05$) at baseline (one way ANOVA, adjusted Bonferroni).

Table 7.7 Mean pocket probing depth(PPD) levels at baseline

PPD (mm)	*Mean*	*SD*	*Min*	*Max*	*No.of subjects*
PPD					
Total	**1.9**	**0.82**	**0.30**	**5.2**	**161**
OH+Sc	**2.1**	**0.83**	**0.30**	**3.8**	**59**
OH	**1.6**	**0.55**	**0.76**	**2.9**	**52**
Control	**2.0**	**0.97**	**0.80**	**5.2**	**50**

4.1.3.1 Denture status

There were 29 (19.2%) subjects wearing dentures among the 151 subjects who responded to the questionnaire. 47.2% had worn their denture for less than 5 years, 8.3% for 5 to 9 years, 33.3% for more than 10 years and 11.1% could not remember how long they had dentures. More than half of the subjects (64.7%) were satisfied with their dentures, 11.8% were not satisfied, while 23.5% were non-committal on the level of satisfaction.

4.1.4 KAP Questionnaire data at Baseline

4.1.4.1 Knowledge of cause of gum disease

Questionnaire data on knowledge, attitude and practice was analyzed for all groups. There were 15 items, which comprised of toothbrushing frequency, interdental cleaning, regular dental attendance which explains oral health compliance behaviour. It was found that knowledge on the cause of gum disease was lacking in the majority of this study cohort. Forty eight percent knew that ineffective oral hygiene was the cause of gum disease and 37.6% recognized that bacterial dental plaque was the basis of gum infection. However, only 22.8% was aware of the correlation of these two

factors. At baseline, the knowledge of the cause of gum disease did not differ between groups**.** Tables 8.1 & 8.2 display the frequency distribution of the variables at baseline. The comparable distribution of the knowledge scores among the three experimental groups provides a good basis for determining change in knowledge over time.

Table 8.1 Response by groups on cause of gum disease due to ineffective oral hygiene (baseline)

	OH+SRP (%)	OH (%)	CTRL (%)	Total
Ineffective oral hygiene as cause of gum disease	21(38.9)	27(56.3)	23(47.9)	71
Ineffective oral hygiene is not cause of gum Disease	33(61.1)	21(43.8)	25(52.1)	79
Total	54	48	48	150

(OH; oral hygiene, SRP; scaling, rootplaning, polishing.CTRL; control)

Table 8.2 Response by groups on cause of gum disease due to bacterial dental plaque (baseline)

	OH+SRP (%)	OH (%)	CTRL (%)	Total
Bacterial dental plaque as cause of gum disease	23(42.6)	15(31.3)	19(39.6)	57
Bacterial dental plaque is not cause of gum Disease	31(57.4)	33(68.2)	29(60.4)	93
Total	54	48	48	150

(OH; oral hygiene, SRP; scaling, rootplaning, polishing.CTRL; control)

Risk Perception

More than half of the study cohort (64.9%) was neither informed nor aware that diabetes was a risk factor for gum disease.

4.1.4.2 Oral health practices at baseline

Toothbrushing practice:

The majority of the study group of (99.4%) practices an acceptable level of toothbrushing. One hundred and eighteen (75.2%) reported brushing twice a day and 38 (24.2%) reported brushing once a day. These figures provide a quantitative measure for a self-reported behavior but it does not necessarily reflect the efficiency and effectiveness of oral hygiene for subjects who have diabetes.

Interdental cleaning practice:

Together with toothbrushing, interdental cleaning is an essential part of oral hygiene practice. In the current context, acceptable practice was defined as using some form of interdental cleaning aid at least once a day to 3 times a week. 56.3% of subjects reported using some form of interdental cleaning aids. Only 28/145 (19.3%) reported flossing regularly while a higher percentage 43/147 (36.1 %) used toothpicks; 25/142 (17.6 %) practiced interdental brushing. The numbers of interdental cleansing devices used are summarized in Table 9.

Table 9 Number of Interdental device used (n=142)

Number of devices	Frequency	Percentage of respondents
None	64	45.0%
One device	61	43.0%
Two devices	12	8.5%
Three devices	5	3.5%

There was no baseline differences detected between treatment groups when analyzed by Pearson's Chi square test (adjusted Bonferroni).

Dental Visits:

In reference to regular dental visits, 48.4%f of the patients reported that they visited the dentist regularly. Nearly seventeen percent (16.6%) visited a dentist twice a year and 31.8% visited a dentist once a year. For subjects who did not attend dental visits on a regular basis the reasons cited were: 30.3% did not perceive the need for services, 24.8% considered the treatment to be expensive, 22% did not have time, 12.4% were afraid to see a dentist, a small proportion (0.7%) did not know where to find a dentist and 6.2% cited various other reasons for not attending a dental visit regularly.

Table 10 shows the reasons given for dental attendance. The majority sought mainly pain related treatment (toothache, extraction, root canal treatment) and restorations (fillings, complex restoration, dentures). Only a quarter of the regular attendees sought preventive checkups and scaling. Gum infection was cited as one of the other reason for attendance.

Table 10 Reasons given for dental attendance

Reasons	**Frequency**	**Percentage**
Toothache	**32**	**20.6**
Fillings	**29**	**18.7**
Checkup	**45**	**29.0**
Cleaning	**47**	**30.3**
Extraction	**23**	**14.8**
Dentures	**13**	**8.4**
Complex restoration	**6**	**3.9**
Root canal treatment	**5**	**3.2**
Other	**5**	**3.2**

Smoking habit among diabetics

The majority of subjects (75.6%) did not smoke at all, 9.6% of diabetics were still smoking at baseline and 14.7% smoked at one point in time but had quit smoking. The

number of cigarettes smoked ranged from two to 50 cigarettes per day with a mean of 10.09 cigarettes per day ±12.65 (SD).

Satisfaction with teeth

Sixty percent (60.9%) of the study cohort was also satisfied with his or her own teeth.

4.1.4.3 Attitudes

Oral health Impact Profile

One hundered and thirty-eight diabetics completed OHIP-14 questionnaires at baseline, and the OHIP sum scores ranged from 0-12 out of a possible 14. Table 11 indicates the frequency distribution of OHIP-14 on a Likert scale ranging from never (0), hardly ever (1), occasionally (2), fairly often (3), very often (4). The affected score was calculated based on the sum scores (2+3+4). Cronbach alpha was observed at 0.86 indicating a good reliability score. There was homogeneity across all experimental groups. The affected mean in order of ranking showed OHIP-3, OHIP-4 and OHIP-5 in the highranking order. These items refer to pain in the mouth, eating discomfort, and self-consciousness due to oral health problems (Table 11). In general, the responses points towards a low perception of oral health impact among diabetic. OHIP-14 Likert scores were recoded in the ascending scale for improvement in oral health, indicating the higher the OHIP sum scores there was lesser impact on oral health quality of life. (e.g. ‘0’ became ‘5’, ‘1’ became ‘4’, ‘2’ became ‘3’, ‘3’ became ‘2’, and’4 ‘became’1’). There were no treatment group differences observed at baseline (one way ANOVA)

Table 11. Baseline Frequency distribution of OHIP-14. (n=138)
Never (0), Hardly ever (1),Occasionally (2),Fairly often (3), Very often (4). Affected (2+3+4). *denotes highranking order

Item	Description	Frequency distribution(%)					Affected
		0	1	2	3	4	Mean(S.D)
OHIP-1	Have you had trouble pronouncing any words because of problems with your teeth, mouth or dentures?	75.4	15.2	8.0	1.4	0.0	0..09(.29)
OHIP-2	Have you felt that your sense of taste has worsened because of problems with your teeth, mouth or dentures?	77.4	17.5	2.9	1.5	0.7	0.05(.22)
OHIP-3	Have you had painful aching in your mouth?	50.0	26.8	21.1	1.4	0.7	0.23(.42)*
OHIP-4	Have you found it uncomfortable to eat any food because of problems with your teeth, mouth or dentures?	54.7	16.8	20.4	4.4	3.6	0.28(.45)*
OHIP-5	Have you felt self-conscious because of problems with your teeth,mouth or denture?	57.7	11.7	20.4	7.3	2.9	0.31(.46)*
OHIP-6	Have felt tense because of problems with your teeth,mouth or denture?	64.9	20.9	9.0	5.2	0.0	0.14(.35)
OHIP-7	Has your diet been unsatisfactory because of problems with your teeth,mouth or denture?	65.7	23.4	9.5	0.7	0.7	0.10 (.31)
OHIP-8	Have you had to interrupt meals because of problems with your teeth,mouth or denture?	73.9	13.8	8.7	1.5	2.2	0.12(.33)
OHIP-9	Have you found it difficult to relax because of problems with your teeth,mouthor denture?	70.3	17.4	8.7	3.6	0.0	0.12(.33)
OHIP-10	Have you been a bit embarrassed because of problems with your teeth, mouth or denture?	63.0	23.2	10.9	2.2	0.7	0.14(.35)
OHIP-11	Have you been a bit irritable with other people because of problems with your teeth,mouth or denture?	76.8	14.5	6.5	1.4	0.7	0.09 (.28)
OHIP-12	Have you had difficulties doing your usual jobs because of the problems with your teeth,mouth or denture?	76.2	15.9	6.5	0.7	0.7	0.08(.27)
OHIP-13	Have you felt that life in general was less satisfying because of problems with your teeth,mouth or denture?	73.9	13.8	10.2	1.4	0.7	0.12(.33)
OHIP-14	Have you been totally unable to function because of problems with your teeth,mouth or denture?	87.0	8.0	3.6	0.7	0.7	0.05(.22)

The sum of the reversed scores was used consistently for the analysis.

The 7 conceptual dimensions are based on the following: Functional Limitation (Items 1, 7), Physical Pain (Items 3, 4), Psychological discomfort (items 5, 6), Physical disability (items 2 8), Psychological disability (items 9, 10), Social disability (items 11, 13) and Handicap (items 12, 14) (Locker, 1988). The corresponding questionnaires are itemized accordingly in Table 11.1. Table 11.2 shows the mean score for each subscale range and respective internal consistency.

Table 11.1 Frequency distribution of OHIP-14S items response

	Never	Seldom	Occasionally	Quite/Very often
Functional Limitation				
Difficult to pronounce	104(75.4)	21(15.2)	11(8.0)	2(1.4)
Difficult to chew	90(65.7)	32(23.4)	13(9.5)	2(1.4)
Physical Pain				
Sore spots	69(50.0)	37(26.8)	29(21.0)	3(2.2)
Uncomfortable to eat	75(54.7)	23(16.8)	28(20.4)	11(8.0)
Psychological discomfort				
Worried	79(57.7)	16(11.7)	28(20.4)	14(10.2)
Miserable	87(64.9)	28(20.9)	12(9.0)	7(5.2)
Physical disability				
Less tasty	106(77.4)	24(17.5)	4(2.9)	3(2.2)
Meals interrupted	102(73.9)	19(13.8)	12(8.7)	5(3.6)
Psychological disability				
Upset	97(70.3)	24(17.4)	12(8.7)	5(3.6)
Embarrassed	87(63.0)	32(23.2)	15(10.9)	4(2.9)
Social disability				
Trouble in getting along with others	106(76.8)	20(14.5)	9(6.5)	3(2.2)
Avoid going out	102(73.9)	19(13.8)	14(10.1)	3(2.2)
Handicap				
Unable to work	105(76.1)	22(15.9)	9(6.5)	2(1.4)
Unable to function	120(87.0)	11(8.0)	5(3.6)	2(1.4)

Table 11.2 Mean scores and internal consistency for OHIP-14S and individual subscales at baseline

	Mean scores(±SD)	Range	Cronbach's Alpha
Functional Limitation	9.2(1.1)	5-10	0.1719
Physical Pain	8.4(1.7)	2-10	0.5174
Psychological discomfort	8.6(1.8)	3-10	0.6640
Physical disability	9.3(1.3)	2-10	0.6176
Psychological disability	9.0(1.5)	3-10	0.7753
Social disability	9.2(1.3)	5-10	0.6939
Handicap	9.5(1.1)	5-10	0.6378
OHIP-14S	63.1(6.9)	39-70	0.8645

In table 11.3 a comparative paired t test is conducted to find out the association of self reported oral signs and symptoms observed over the past 3 months in relation to OHIP-14S. Periodontal disease signs and symptoms such as bleeding gums ($p<0.01$), red and swollen gums ($p<0.01$), loose teeth ($p<0.05$) and bad breath ($p<0.01$) were shown to have significant associations. Dental decay ($p<0.01$) and ulcers ($p<0.01$) also showed significant association.

Table 11.3 Self-reported symptoms over three months and oral health related quality of life. (Independent sample t test)

	N	OHIP-14S (mean ± SD)	t- test p- value
Dental Decay			
Yes	16	57.4(7.0)	p<0.01**
No	103	64.1(6.7)	
Toothache			
Yes	18	60.6(7.3)	NS
No	99	63.9(6.8)	
Bleeding gums			
Yes	26	60.2(8.6)	p<0.01**
No	91	64.3(6.2)	
Red & swollen gums			
Yes	20	58.9(6.1)	p<0.01**
No	100	64.7(7.0)	
Bad breath			
Yes	44	60.7(6.99)	p<0.01**
No	76	64.8(6.68)	
Loose teeth			
Yes	16	59.2(7.2)	p<0.05*
No	100	63.9(6.8)	
Ulcers			
Yes	20	57.2(7.8)	p<0.01**
No	97	64.6(6.2)	
Oral infection			
Yes	9	60.5(8.8)	NS
No	108	63.6(6.8)	
Dry mouth			
Yes	25	61.5(7.0)	NS
No	92	63.9(6.9)	

NS= not significant

HU-DBI

One hundred and thirty subjects completed the HU-DBI questionnaires. Reported Cronbach alpha was only 0.55 for the HU-DBI questionnaire. Since the questionnaire had a low internal consistency, a decision was made to delete the items that exceeded the average Cronbach alpha when item were deleted throughout baseline and nine

months. The resultant 13 items HU-DBI from this study was therefore used to analyze differences between baseline and 9months.

4.1.5 Health Behaviour

In Table 12.1 Only 46.1 % of subjects with diabetes reported that they were chewing adequately. Most of the subjects reported to be adherent to diet control as reflected by restricting fat intake (68.4%), and restriction of soft drinks/juices (78.4%). However, 53.7 % of diabetics ate very full meals and 70.9% ate regular meals (3 meals/ day). Conversely, only 32.3% restricted their diet to two meals a day. A higher frequency of eating out was also reported by 77.8% implying perhaps strict dietary control would be more difficult. Pattern of eating sweets since young was not reported to be very high (23.7%), it was compensated by the increased frequency of eating vegetable as reported by 90.4% of the study cohort.

In Table 12.2, 35.1% reported that they tired-out easily and only 14.5% needed a drink to replenish their energy. Twenty nine percent admitted that they would doze off un-intentionally in front of the TV.

The frequency on the number of hours of sleep showed that 18 (13.6%) diabetics slept more than 7 hours a day, 44 (33.3%) slept 7 hours, 45(34.1%) slept 6 hours and 25 (18.9%) slept less than 5 hours a day. However, the majority was satisfied with the number of hours slept (81.4%).

Seventy eight percent (78.2%) claimed to be engaged in some activities for improving their health (Table 12.3). Among the cohort, 82.1% exercised (53.7% on a daily basis), 79.9% controlled their weight. The majority, 89.2% claimed that they would be committed to do something for health. In addition, confidence of controlling diabetes

was high as reported by 73.3% and the majority of 74.6% was willing to follow instructions given by the nurses and doctors.

In examining the coping lifestyle of the study group, 47.7% reported that they have experienced stress. It was also true among the group that 83.5% were satisfied with their present job. The majority of the group were teetotalers who rarely drank alcohol and the very few that drank alcohol represented only 3.1% of the group.

Factor analysis

Kawamura's study (1998) utilized the health behaviour questionnaire to explore explanatory variables correlating to oral health behaviour. The present study also expresses the intent to compare data as well as observe the general health behaviour in relation to oral health behaviour. Table12.5 shows the Factor analysis of the health related questionnaire. A principal component analysis, varimax rotation expressed 4 factors with eigenvalues more than one. These factors were characterized as: general health behavior (GHB), diet control (DC), Energy & Control (EC), Confidence & Control (CC). 40.5% cumulative percentage of the data explained these domains. GHB factor constitutes items 2, 6, 11, 12, 13, 14, 15 & 26; DC factor constitutes items 1,3,4,5,8,24 &25. EC factor constitutes items 7, 9, 19, 22 & 23. CC factor constitutes items 16, 20 & 21.

Table 12.1 Frequency distribution of health questionnaire (Likert scale 1 to 4, incremental with numerical scale), n (%)

Description	n(%) 1(lowest)	n(%) 2(low)	n(%) 3(high)	n(%) 4(highest)	total
Chewing food adequately	5(3.4)	30(20.7)	50(34.5)	60(41.4)	145
Eating fatty food	24(15.8)	81(53.3)	40(26.3)	7(4.6)	152
Drinking soft drinks/juices	57(37.7)	63(41.8)	24(15.9)	7(4.6)	151
Eating full meals	26(17.2)	47(31.1)	61(40.4)	17(11.30)	151
Eating regular meals (3meals/day)	7(4.6)	37(24.5)	78(51.7)	29(19.2)	151
Eating out frequency per week	16(10.5)	35(23)	77(50.7)	24(15.8)	152
Eating 2meals /day/per week	90(59.6)	12(79)	24(15.9)	25(16.6)	151
Childhood consumption of sweets	52(34.2)	67(44.1)	23(15.1)	10(6.6)	152
Vegetable consumption (regular)	1(0.7)	12(7.9)	63(41.4)	76(50)	152

Table 12.2 Frequency distribution of energy related questionnaires (Likert scale 1 to 4, incremental with numerical scale), n (%)

Description	1(lowest)	2(low)	3(high)	4(highest)	total
Feeling tired easily	23(15.6)	74(50)	35(23.6)	16(10.8)	148
Need a drink to re-energize	68(45.9)	60(40.6)	19(12.8)	1(0.7)	148
Doze off un-intentionally infront of TV	40(27)	64(43.3)	36(24.3)	8(5.4)	148
Sleeping well	21(8)	31(20.6)	79(52.7)	28(18.7)	159

Table 12.3 Frequency distribution of healthy life style questionnaire (Likert scale 1 to 4, incremental with numerical scale), n (%)

Description	1(lowest)	2(low)	3(high)	4(highest)	total (n)
Exercise for diabetic control	14(9.3)	5(9.9)	74(49)	48(31.8)	141
Exercise daily	12(7.9)	56(37.1)	49(32.5)	34(22.5)	151
Doing something to benefit health	11(7.3)	26(17.3)	64(42.7)	49(32.7)	150
Weight control	6(4)	26(17.2)	51(33.8)	68(45)	151
Commitment to health	3(2)	14(9.5)	84(57.2)	46(31.3)	147
Confidence to control diabetes	1(0.7)	38(25.9)	92(62.6)	16(10.9)	147
Follow medical instructions	3(2.1)	35(24)	38(26)	70(47.9)	146

Table 12.4 Frequency distribution stress related questionnaires (Likert scale 1 to 4, incremental with numerical scale), n (%)

Description	1(lowest)	2(low)	3(high)	4(highest)	total (n)
Job satisfaction	7(5.1)	17(12.5)	78(57.4)	34(25)	136
Experience of stress	18(12.2)	62(42.2)	53(36.1)	14(9.5)	147
Watching TV	4(2.7)	53(35.3)	64(42.7)	29(19.3)	150
Getting drunk	122(83.6)	19(13)	5(3.4)	0(0)	146

Table 12.5 Varimax rotated factor structure of health related questionnaire

Item	Description	eigenvalues	loadings
D1.	General health behavior (GHB)	4.022	
2.	Do not like to eat fatty foods		0.458
6.	Often take vegetables		0.415
11.	Exercise often		0.756
12.	Doing good for health		0.789
13.	Weight control		0.679
14.	Exercise daily		0.777
15.	Committment		0.489
26.	Follow medical advice		0.478
D2.	Diet Control (DC)	2.384	
1.	Do chew properly		0.456
3.	Do not eat until full		0.418
4.	Do not often drinks soft drinks or juice		0.703
5.	Do not like to eat sweets		0.628
8.	Do not often eat out		0.407
24.	Do not drink for energy		0.552
25.	Do not drink alcohol		0.431
D3.	Energy & control (EC)	2.118	
7.	Take regular meals at regular time		-0.489
9.	Often eat 2 meals per day		0.422
19.	Sleep well		0.559
22.	Do not experience stress		0.597
23.	Do not get tired easily		0.617
D4.	Confidence & Control (CC)	2.003	
16.	Watch TV		0.610
20.	Confident to control health		0.610
21.	Satisfaction with current job		0.688

4.1.6 Assessment of Oral Hygiene Compliance

Receiver Operator Characteristic Curve Analysis

To evaluate the compliance with oral hygiene, a combination of plaque and bleeding scores were used for the purpose of determining an objective criterion.

A Receiver Operator Characteristics (ROC) analysis for oral hygiene compliance was conducted and the results in terms of area under the curve, sensitivity (SN), specificity (SP), positive predictive value (PPV), and negative predictive value (NPV).

A composite model that includes mean pocket depth, mean % supragingival and subgingival calculus, provided good diagnostic properties. The justification for using these parameters are that these variables are plaque retention factors and may also be reflective of periodontal disease severity. It must be noted that oral hygiene compliance is considered a surrogate endpoint for change in behaviour in relation to gingival host response.

Using the range of combined plaque and BOP scores (30-25,30-20,30-15,25-25,25-20,25-15,20-25,20-20,20-15), the highest ROC curve area was obtained for 25-15 (≥ 25% plaque and ≥ 15 % BOP) with a value of 0.868 (95% CI 0.740 to 0.996) and the next highest ROC score was found for 20-15 (0.843, 95% CI 0.689 to 0.996). The respective Sensitivity (SN), Specificity (SN), Positive Predictive Value (PPV) and Negative Predictive Value (NPV) for 25-15 level was 98.6, 75.0, 97.3 and 85.7 as compared with Sensitivity 99.3, Specificity of 69.2, PPV97.3, and NPV90.0 for 20-15. The ROC curves for selected combination of scores are displayed in Table13.1. It shows the ROC values for the different range of plaque and BOP cutoff levels. Table 13.2 shows the respective Sensitivity, Specificity, PPV, and NPV values.

Based upon the cut-off criterion at 25% plaque and 15% BOP (25-15), 145 were categorised as non-compliant (90.1%, 95% CI 85.5% to 94.7%) and only 16 (9.9%, 95% CI 5.3% to 14.5 %) were considered compliant with oral hygiene at baseline.

In summary, the cutoff level 25-15 showed the highest ROC estimate with a correspondingly high Sensitivity, Specificity, PPV and NPV. The cutoff level 20-15 which showed the second highest ROC estimate also demonstrated good diagnostic and predictive capacity. The OHC criterion will be used for screening and comparing the effects of oral hygiene compliance in this study.

Table 13.1 ROC: Area under the curve assessment from different oral hygiene cut-off levels (probability of 0.5)

Cutoff	A_z (Area under the curve)	95% Confidence Interval		
30-25	0.714	0.590	to	0.839
30-20	0.738	0.611	to	0.865
30-15	0.743	0.610	to	0.875
25-25	0.758	0.625	to	0.892
25-20*	**0.830**	**0.695**	**to**	**0.964**
25-15***	0.868	0.740	to	0.996
20-25	0.723	0.575	to	0.871
20-20	0.797	0.641	to	0.952
20-15**	0.843	0.689	to	0.996
15-15	0.717	0.523	to	0.912

(cutoff levels as combination of %plaque-%BOP.e.g. 30-25 stands for ≥ 30%plaque-≥ 25%BOP) ***highest,**second highest,*third highest

Table 13.2 Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value from different oral hygiene compliance cut-off levels

Cutoff	Sensitivity	Specificity	PPV	NPV
30-25	94.7	48.1	90.7	65.0
30-20	95.6	52.0	91.5	68.4
30-15	96.4	52.2	92.3	70.6
25-25	97.1	54.5	93.1	75.0
25-20*	**99.3**	**66.7**	**95.9**	**92.3**
25-15***	98.6	75.0	97.3	85.7
20-25	97.2	69.2	93.2	69.2
20-20	99.3	90.0	96.0	60.0
20-15**	99.3	69.2	97.3	90.0
15-15	98.0	62.5	96.1	45.5

(cutoff levels as combination of %plaque-%BOP.e.g. 30-25 stands for ≥ 30%plaque-≥ 25%BOP) ***highest,**second highest,*third highest

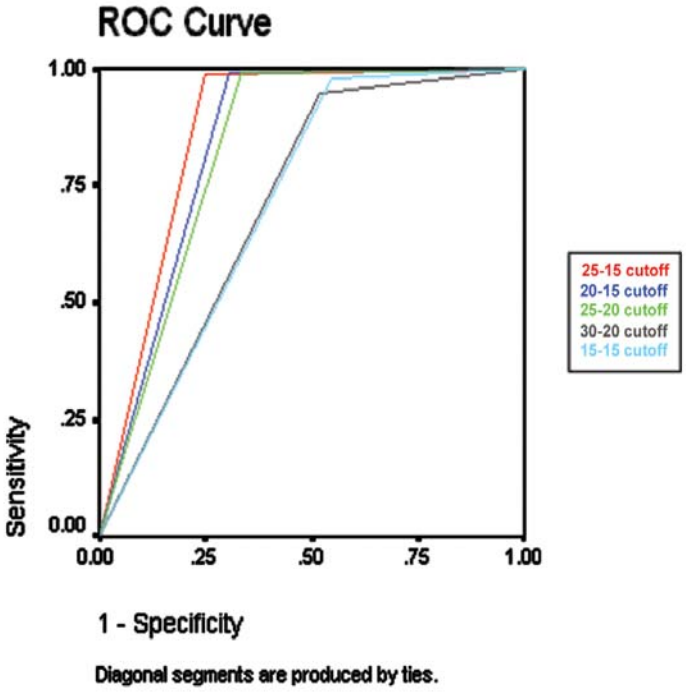


Figure 4.ROC curve analysis of oral hygiene compliance

4.2 ASSESSMENT OF INTERVENTION STRATEGY IN COMPARISON TO BASELINE WITH 3 AND 9 MONTHS DATA

4.2.1 Effect of intervention on knowledge

Knowledge of cause of gum infection:

The two items used to determine the cause of gum infections were essential knowledge on plaque (bacterial biofilm) and ineffective oral hygiene. Comparing the baseline and three months responses, there was an improvement from baseline after oral health promotion (OHP) was introduced as shown in Table 14.1. However, the difference did not show a statistical significance amongst treatments (Table 14.2 & 14.3). There was an increase in proportion of responses that indicated traumatic brushing as a cause of gum disease. Certain items such as heatiness, lack of vitamin C as cause of gum disease remained unchanged perhaps embodies an element of folklore and myth.

Table 14.1 Comparison response to cause of gum disease: baseline and 3 months (McNemar)

Cause of gum disease		baseline	3 months	p
Sugar & sweets	yes	50(33.3%)	54(37.5%)	0.123
	no	100(66.7%)	90(62.5%)	
Ineffective oral hygiene	yes	71(47.3%)	84(58.3%)	0.055
	no	79(52.3%)	60(41.7%)	
Excessive Toothbrush pressure	yes	12(8%)	31(21.5%)	0.001*
	no	174(92%)	113(78.5%)	
Plaque (bacteria)	yes	57(38%)	73(49.3%)	0.061
	no	93(62%)	71(50.7%)	
Lack of Vitamin C	yes	11(7.3%)	12(8.3%)	0.424
	no	139(92.7%)	132(91.7%)	
Heatiness	yes	13(8.7%)	15(10.4%)	0.648
	no	137(91.3%)	129(89.6%)	

Table 14.2 Response by groups for cause of gum disease due to ineffective oral hygiene (3months)

	OH+SRP n (%)	OH n (%)	CTRL n (%)	Total
Ineffective oral hygiene as cause of gum disease	28 (54.9)	34 (68)	22 (51.2)	84
Ineffective oral hygiene is not cause of gum Disease	23 (45.1)	16 (32)	21 (48.8)	60
Total	51	50	43	144

(OH; oral hygiene, SRP; scaling, rootplaning, polishing.CTRL; control)

Table 14.3 Response by groups for cause of gum disease due to bacterial dental plaque (3months)

	OH+SRP n (%)	OH n (%)	CTRL n (%)	Total
Bacterial dental plaque as cause of gum disease	25 (42.4)	26 (52)	22 (51.2)	73
Bacterial dental plaque is not cause of gum Disease	26 (44.1)	24 (48)	21 (48.8)	71
Total	51	50	43	144

Non significant differences for all groups ;(OH; oral hygiene, SRP; scaling, rootplaning, polishing.CTRL; control)

4.2.2 Effect of intervention on oral health practice

Acceptable interdental cleaning:

In evaluating the change in interdental cleaning habits of the subjects, a comparison between baseline and 3 months is tabulated in Table 15.1. In addition Table 15.

2. shows an increase in the number of devices used were noted at 3 months ($p<0.01$). Notably, flossing frequency was high among the OH+Sc group as compared to Control group ($p<0.01$) (Pearsons' Chi square test with Bonferroni adjustment) with an Odds

Ratio of 4.6. The number of devices used also increased as well a decrease in people not using any interdental devices in Table 15.2. To provide a measure of subjects who are considered to be flossing and using interdental brush at least 3 times a week were considered to be practising acceptable interdental cleaning.

Acceptable interdental cleaning (flossing + interdental brush) also showed an impressive improvement for the whole group ($p<0.01$) (McNemar test). Within group analysis showed that OH+Sc group improved significantly ($p<0.01$). Oral hygiene group showed an improved trend although the change did not reach statistical significance. A between group comparison showed that OH+Sc group improved significantly as compared with control group ($p<0.05$) with Odds Ratio of 3.5.

It was noted that a third of study group reported the usage of oral mouth rinses at baseline and 3 months.

Table 15.1 Comparison of acceptable interdental cleaning between baseline and 3months

Type of interdental device	**baseline(n)**	**3 months(n)**
Dental Floss	**19.3% (145)**	**31.9% (141)**
Toothpick	**36.1%(147)**	**33.6%(140)**
Interdental brush	**17.6%(142)**	**30.2%(139)**

Table 15.2 Comparison of number of interdental device usage at baseline and 3 months

Number of devices used	baseline (%)	3 months (%)	Remark
0	**45.1%**	**32.4%**	**improved**
1	**43.0%**	**45.3%**	**improved**
2	**8.5%**	**17.3%**	**improved**
3	**3.5%**	**5.0%**	**improved**

Table 15.3 Acceptable interdental (floss+interbrush) usage between baseline and 3 months (McNemar) (acceptable: not acceptable)

	Baseline	3months	p
Acceptable interdental usage (all)	**44:98**	**70:69**	**0.000***
OH+Sc	**18:32**	**31:18**	**0.007***
OH	**17:30**	**25:23**	**0.065**
Control	**9:36**	**14:28**	**0.180**

McNemar test:* p<0.01

Table 15.4 Between groups comparison at 3 months for acceptable interdental usage.

	OH+Sc	OH	Control	p
Acceptable:not acceptable				
	31:18		**14:28**	**0.012***
		25:23	**14:28**	**0.219**
	31:18	**25:23**		**0.795**

Pearson's Chi Square test. *p<0.01(bonferroni adjusted)

4.2.3 Effect of intervention on attitudes

OHIP-14

OHIP-14 at nine months showed a more variable response compared to the baseline responses. The affected mean rates (Table 16.1) increased in general especially the same 1st order ranking OHIP3, OHIP4 and OHIP 5.These same items were also consistent in the highranking order at baseline. Internal consistency with a Cronbach alpha of 0.87 was observed at this evaluation period.

OHIP-14 Likert scores were recoded in the ascending scale for improvement in oral health, indicating the higher the OHIP sum scores there is lesser impact on oral health

quality of life. (e.g. ‘0’ became ‘5’, ‘1’ became ‘4’, ‘2’ became ‘3’, ‘3’ became ‘2’, and’4 ‘became’1’). The results in Table 16.2 shows a significant difference ($p<0.05$) compared from baseline and nine months OHIP sum score in a negative direction. Treatment subgroup comparisons did not show any significant differences as well as between treatment and all groups.

The seven conceptual dimensions are based on the following: Functional Limitation, Physical Pain, Psychological discomfort, Physical disability,
Psychological disability, Social disability and Handicap (Locker, 1988). The corresponding questionnaires are itemized accordingly in Table 16.3.

Further analysis of the mean change based on the 7 conceptual dimensions is shown in Table 16.3. Functional limitation subscale is based on OHIP-14 items 1 and 7; Physical pain on OHIP-14 items 3 and 4; Psychological discomfort on OHIP-14 items 5 and 6; Physical disability on OHIP-14 items 2 and 8; Psychological disability on OHIP-15 items 9 and 10; Social disability on OHIP-14 items 11 and 13; Handicap on OHIP-14 items 12 and 14. Table 16.4 shows the mean score for each subscale range and respective internal consistency. Table 16.5 shows the OHIP-14S subscale differences between baseline and 9 months. The analysis was conducted with paired t test with Bonferroni adjustments. The results showed that physical pain response was the main change noted among all subscales with a significance difference detected from baseline to 9 months ($p<0.05$). Subgroup analysis was conducted on the 7 subscales with treatment groups as shown in Tables.16.6 to 16.13. Table 16.7 shows that OH+Sc group showed physical pain subscale within group difference at 9 months ($p<0.05$). The subscale difference did not show differences between groups. In Table 16.11 control group showed a significant within group difference at 9 months ($p<0.05$) for psychological disability subscale. There was one notable baseline difference

between OH group and control group ($p<0.05$) (one way ANOVA) at baseline for this subscale. The difference was not noted at 9 months.

Table 16.1 Frequency distribution of OHIP-14 at 9 months . (n=124)

Never (0), Hardly ever (1), Occasionally (2),Fairly often (3),Very often (4). Affected (2+3+4). *denotes high ranking order

Item	Description	Frequency distribution(%)					Affected
		0	1	2	3	4	Mean(S.D)
OHIP-1	Have you had trouble pronouncing any words because of problems with your teeth, mouth or dentures?	62.9	19.4	12.1	3.2	2.4	0.18 (.38)
OHIP-2	Have you felt that your sense of taste has worsened because of problems with your teeth, mouth or dentures?	71.0	18.5	7.3	1.6	1.6	0..11 (.31)
OHIP-3	Have you had painful aching in your mouth?	38.7	32.3	25.0	1.6	2.4	0.29 (.46)*
OHIP-4	Have you found it uncomfortable to eat any food because of problems with your teeth, mouth or denture?	43.6	26.6	17.7	8.9	3.2	0.30 (.46)*
OHIP-5	Have you felt self-conscious because of problems with your teeth,mouth or denture?	47.6	22.6	14.5	11.3	4.0	0.30 (.46)*
OHIP-6	Have felt tense because of problems with your teeth,mouth or denture?	54.8	27.4	12.2	4.0	1.6	0.18 (.38)
OHIP-7	Has your diet been unsatisfactory because of problems with your teeth,mouth or denture?	66.9	25.8	5.6	1.6	0.0	0.07 (.26)
OHIP-8	Have you had to interrupt meals because of problems with your teeth,mouth or denture?	61.3	27.4	7.3	2.4	1.6	0.11 (.32)
OHIP-9	Have you found it difficult to relax because of problems with your teeth,mouthor denture?	67.7	24.3	4.8	3.2	0.0	0.08 (.27)
OHIP-10	Have you been a bit embarrassed because of problems with your teeth, mouth or denture?	56.5	24.2	14.5	2.4	2.4	0.19 (.40)
OHIP-11	Have you been a bit irritable with other people because of problems with your teeth,mouth or denture?	66.9	23.4	8.1	0.0	1.6	0.10 (.30)
OHIP-12	Have you had difficulties doing your usual jobs because of the problems with your teeth,mouth or denture?	74.2	21.8	4.0	0.0	0.0	0.04 (.20)
OHIP-13	Have you felt that life in general was less satisfying because of problems with your teeth,mouth or denture?	69.4	17.7	8.9	4.0	0.0	0.13 (.34)
OHIP-14	Have you been totally unable to function because of problems with your teeth,mouth or denture?	81.5	12.9	4.8	0.8	0.0	0.06 (.23)

Table 16.2 Comparison of OHIP-14 sum score between baseline and 9 months Paired t test (within group)n=102

OHIP-14 sum score	Baseline(SD)	9months(SD)	p
Mean	**63.5 (6.9)**	**61.6 (7.5)**	**0.026***
OH+Sc	63.2(6.7)	60.50(8.30)	0.129
OH	62.10(7.7)	62.30(7.00)	1.000
Control	63.34(6.2)	62.20(7.4)	0.468

*p<0.05(bonferroni adjusted)

Table 16.3 Frequency distribution of OHIP-14S items response at 9months

	Never n (%)	Seldom n (%)	Occasionally n (%)	Quite/Very often n (%)
Functional Limitation				
Difficult to pronounce	78 (62.9)	24 (19.4)	15 (12.1)	7 (1.4)
Difficult to chew	83 (66.9)	32 (15.8)	7 (5.6)	4 (1.6)
Physical Pain				
Sore spots	48 (38.7)	40 (32.3)	31 (25.0)	5 (4.0)
Uncomfortable to eat	54 (43.6)	33 (26.6)	22 (17.7)	15 (12.1)
Psychological discomfort				
Worried	59 (47.6)	28 (22.6)	18 (14.5)	19 (15.3)
Miserable	68 (54.8)	34 (27.4)	15 (12.2)	7 (5.6)
Physical disability				
Less tasty	88 (71.0)	23 (18.5)	9 (7.3)	4 (3.2)
Meals interrupted	76 (61.3)	34 (27.4)	9 (7.3)	5 (4.0)
Psychological disability				
Upset	84 (67.7)	30 (24.3)	6 (4.8)	4 (3.2)
Embarrassed	70 (56.5)	30 (24.2)	18 (14.5)	6 (4.8)
Social disability				
Trouble in getting along with others	83 (66.9)	29 (23.4)	10 (8.1)	2 (1.6)
Avoid going out	86 (69.4)	22 (17.7)	11 (8.9)	5 (4.0)
Handicap				
Unable to work	92 (74.2)	27 (21.8)	5 (4.0)	0 (0)
Unable to function	101 (81.5)	16 (12.9)	6 (4.8)	1 (0.8)

Table 16.4 Mean scores and internal consistency for OHIP-14S and individual subscales at 9 months

	Mean scores (±SD)	Range	Cronbach's Alpha
Functional Limitation	8.9 (1.4)	3-10	0.5265
Physical Pain	8.0 (1.7)	2-10	0.5491
Psychological discomfort	8.3 (1.9)	3-10	0.6766
Physical disability	9.0 (1.5)	2-10	0.7211
Psychological disability	8.9 (1.5)	2-10	0.6109
Social disability	9.1 (1.4)	5-10	0.6828
Handicap	9.5 (1.1)	5-10	0.6052
OHIP-14S	61.6 (7.5)	35-70	0.8726

Table 16.5 Mean scores OHIP-14S differences between baseline and 9months

Mean scores (±SD)	9months	Baseline	p value (paired t test)
Functional Limitation	8.9 (1.4)	9.2 (1.1)	0.056
Physical Pain	8.0 (1.7)	8.4 (1.7)	0.048*
Psychological discomfort	8.3 (1.9)	8.6 (1.8)	0.104
Physical disability	9.0 (1.5)	9.3 (1.3)	0.129
Psychological disability	8.9 (1.5)	9.0 (1.5)	0.125
Social disability	9.1 (1.4)	9.2 (1.3)	0.066
Handicap	9.5 (1.1)	9.5 (1.1)	0.211
OHIP-14S	61.6 (7.5)	63.5 (6.9)	0.026*

$p<0.05$(bonferroni adjusted)

Table 16.6 Functional Limitation subscale within group comparison

OHIP-14 sum score	Baseline (SD)	9months (SD)	p
OH+Sc	8.95(0.93)	8.70 (1.5)	0.831
OH	9.24(1.2)	8.95 (1.4)	0.567
Control	9.30(.98)	9.10 (1.4)	1.000

*$p<0.05$(bonferroni adjusted)

Table 16.7 Physical pain subscale within group comparison

OHIP-14 sum score	Baseline (SD)	9months (SD)	p
OH+Sc	8.6 (1.4)	7.8 (1.9)	0.039*
OH	8.0 (1.8)	7.8 (1.6)	1.000
Control	8.4 (1.8)	8.2 (1.8)	1.000

*p<0.05(bonferroni adjusted)

Table 16.8 Psychological discomfort subscale within group comparison

OHIP-14 sum score	Baseline (SD)	9months (SD)	p
OH+Sc	8.4 (1.8)	7.9 (2.0)	0.251
OH	8.7 (1.6)	8.5 (1.9)	0.465
Control	8.7 (1.8)	8.3 (1.9)	0.382

*p<0.05(bonferroni adjusted)

Table 16.9 Physical disability subscale within group comparison

OHIP-14 sum score	Baseline(SD)	9months(SD)	p
OH+Sc	9.3 (0.9)	8.9 (1.5)	0.200
OH	9.1 (1.5)	9.1 (1.4)	1.000
Control	9.4 (1.1)	9.1 (1.4)	0.750

*p<0.05(bonferroni adjusted)

Table 16.10 Psychological disability subscale within group comparison

OHIP-14 sum score	Baseline (SD)	9months (SD)	p
OH+Sc	9.1 (1.3)	8.6 (1.6)	0.164
OH	8.6 (1.8)	9.1 (1.5)	0.191
Control	9.5 (0.90)	8.7 (1.4)	0.039*

*p<0.05(bonferroni adjusted)

Table 16.11 Social disability subscale within group comparison

OHIP-14 sum score	Baseline (SD)	9month (SD)	p
OH+Sc	9.3 (1.2)	8.7 (1.5)	0.091
OH	9.2 (1.5)	9.2 (1.3)	1.000
Control	9.4 (1.1)	9.1 (1.4)	0.750

*p<0.05(bonferroni adjusted)

Table 16.12 Handicap subscale within group comparison

OHIP-14 sum score	Baseline (SD)	9months (SD)	p
OH+Sc	9.6 (0.82)	9.3(0.09)	0.228
OH	9.2 (1.4)	9.3 (1.2)	1.000
Control	9.7 (0.58)	9.6 (0.68)	1.000

*p<0.05(bonferroni adjusted)

OHIP-14 trend in relation to oral hygiene behaviour

OHIP-14 questionnaire difference responses were categorized in the same manner for HU-DBI differences. Category 1 -worsened response (negative); Category 2 -no difference response (0); Category 3- improved response (positive). In Table 16.5 it was

found that subjects with unacceptable oral hygiene compliance associated with negative direction of positive oral health impact ($p<0.01$), with Odds Ratio 0 .07 (95% CI 0 .01 to 0 .33). In other words, acceptable oral hygiene compliance was not found to be associated with a positive impact on oral health quality of life. In addition, health behaviour self-efficacy lowest scale also showed a negative association with positive oral health impact ($p<0.01$) with Odds Ratio 0.04 (95% CI 0.003 to 0.45). The translated finding indicate that respondents with lower oral health behaviour self-efficacy score was found not to be associated with better oral health impacted profile. No significant differences were found between genders or across the age categories.

Table 16.13 Summary table for OHIP- 14 difference (Ordinal regression)

	Parameter estimates			
	Est.(S.E)	**p-value**	**OR**	**95% CI**
Threshold				
OHIP Cat 1	**-0.793 (0.92)**	**0.389**	**0.45**	**0.07-2.75**
OHIP Cat 2	**-0.081 (0.91)**	**0.929**	**0.09**	**0.15-5.53**
compared to OHIP Cat 3				
Location				
Oral hygiene compliance (9 months)				
Acceptable	**-2.73 (0.82)**	**0.001****	**0.07**	**0.013- 0.33**
compared to unacceptable oral hygiene compliance(25-15)				
Gender				
Male	**-0.298 (0.61)**	**0.622**	**0.74**	**0.227-2.43**
compared to female				
Age category				
21-40 years	**1.63 (0.98)**	**0.094**	**5.1**	**1.32-34.54**
41-55 years	**0.425 (0.79)**	**0.583**	**1.53**	**0.32-7.25**
compared to 56-65 years				
Health Behaviour Self-efficacy				
HB SE(1)lowest	**-3.256 (1.3)**	**0.009***	**0.04**	**0.003- 0.45**
HB SE(2)2nd lowest	**-0.336 (0.8)**	**0.684**	**0.72**	**0.14 – 3.6**
HB SE(3)3rd lowest	**-0.818 (0.8)**	**0.322**	**0.44**	**0.087-2.23**
compared to SEHB(4) highest self-efficacy (health behaviour)				
Groups				
OH+Sc	**0.634 (0.84)**	**0.452**	**1.9**	**0.36-9.85**
OH	**-0.236 (0.74)**	**0.749**	**0.79**	**0.19-3.35**
compared to control group				
Interdental cleaning (3 months)				
InterD(unacceptable)	**1.143 (0.76)**	**0.134**	**3.14**	**0.71-13.99**
compared to acceptable interdental cleaning(3months)				

Logit link function.*(p<0.05),(p<0.01). OHIP Cat1=worsenedresponse; OHIPCat2=no difference; OHIPCat3 =improved response**

HU-DBI

In Table 17.1 and 17.2 HU-DBI (Kawamura) from baseline to nine months exhibited low Cronbach alphas at 0.4975 for nine months and0 .5530 for baseline. Considering these low values, it was assumed that there was a wide variance of responses from this study cohort.

Items that did not alter the mean Cronbach alpha were identified as items 1, 5, 9, 11, 16, 17, 20 in both analyses at baseline and nine months. These items were eliminated in the analysis. The 13 items provided a stronger Cronbach alpha of 0.5851(9months) and 0.6407(baseline).

The HU-DBI sum score is scored positive for variable scores noted in Table 17.3 and 17.4.These variable scores are them summed up to provide the sum score for each HU-DBI 13 items at baseline and nine months.

Table 17. 1 Reliability analysis of HU-DBI at Baseline

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
HUDBI 1	**6.46**	**7.599**	**0.003**	**0.570***
HUDBI 2	**6.92**	**7.241**	**0.166**	**0.542**
HUDBI 3	**6.68**	**6.655**	**0.348**	**0.507**
HUDBI 4	**6.76**	**7.020**	**0.210**	**0.534**
HUDBI 5	**7.09**	**7.650**	**0.073**	**0.552**
HUDBI 6	**6.78**	**6.666**	**0.362**	**0.506**
HUDBI 7	**6.78**	**6.635**	**0.375**	**0.503**
HUDBI 8	**6.93**	**6.825**	**0.369**	**0.509**
HUDBI 9	**6.45**	**7.754**	**-0.062**	**0.580***
HUDBI 10	**6.86**	**7.174**	**0.173**	**0.541**
HUDBI 11	**7.03**	**7.627**	**0.038**	**0.557***
HUDBI 12	**6.92**	**7.256**	**0.159**	**0.543**
HUDBI 13	**6.33**	**7.107**	**0.270**	**0.527**
HUDBI 14	**6.50**	**6.950**	**0.249**	**0.527**
HUDBI 15	**6.67**	**7.045**	**0.191**	**0.538**
HUDBI 16	**7.10**	**7.703**	**0.041**	**0.554***
HUDBI 17	**6.92**	**7.157**	**0.208**	**0.535**
HUDBI 18	**6.85**	**6.885**	**0.293**	**0.520**
HUDBI 19	**6.98**	**7.442**	**0.108**	**0.550**
HUDBI 20	**6.89**	**7.818**	**-0.084**	**0.581***

Reliability Coefficients

N of Cases = 130 N of Items = 20

Alpha = 0 .553

* items noted for not improving Alpha

Table 17.2 Reliability analysis of 9 months HU-DBI

Item-total Statistics

	Scale Mean If Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
HUDBI 1	**6.90**	**6.530**	**0.230**	**0.470**
HUDBI 2	**7.40**	**6.754**	**0.112**	**0.493**
HUDBI 3	**7.19**	**6.175**	**0.317**	**0.450**
HUDBI 4	**7.22**	**6.385**	**0.230**	**0.468**
HUDBI 5	**7.58**	**7.219**	**-0.055**	**0.511***
HUDBI 6	**7.29**	**6.491**	**0.197**	**0.476**
HUDBI 7	**7.33**	**6.186**	**0.339**	**0.445**
HUDBI 8	**7.39**	**6.469**	**0.236**	**0.468**
HUDBI 9	**6.98**	**7.380**	**-0.151**	**0.543***
HUDBI 10	**7.45**	**6.639**	**0.189**	**0.478**
HUDBI 11	**7.49**	**6.836**	**0.117**	**0.491**
HUDBI 12	**7.04**	**6.449**	**0.214**	**0.472**
HUDBI 13	**6.83**	**6.618**	**0.237**	**0.471**
HUDBI 14	**7.07**	**6.455**	**0.207**	**0.473**
HUDBI 15	**7.17**	**6.637**	**0.127**	**0.491**
HUDBI 16	**7.59**	**6.882**	**0.138**	**0.484**
HUDBI 17	**7.48**	**7.013**	**0.025**	**0.506***
HUDBI 18	**7.36**	**6.586**	**0.174**	**0.481**
HUDBI 19	**7.54**	**6.747**	**0.200**	**0.479**
HUDBI 20	**7.38**	**7.228**	**-0.090**	**0.531***

Reliability Coefficients

N of Cases = 114 N of Items = 20

Alpha = 0.4975

* items noted for not improving Alpha

Comparing the respective HU-DBI items provided an opportunity to evaluate oral health attitudes and practice among the study cohort from baseline to nine months.

There were trends in improvement of attitude and practice but on the whole there was no significant difference (Table 17.3 and Table 17.4).

There was a marked increase in the number of respondents who indicated that they checked their teeth after brushing, implying perhaps a heightened oral health awareness. At 9 months HU-DBI 13 items sum score was 7.3805 (SD 1.8) as compared with the baseline value 6.8939 (SD1.6). For HU-DBI sum scores there was differences between control and intervention groups OH+Sc and OH at baseline ($p<0.05$) one way ANOVA (Table 17.5). However there were no group differences at 9 months.

Table 17.3 Frequency distribution of HU-DBI 13 item sum scores at baseline

Item	question	yes (%)	No (%)	variable (+) (%)
2.	Gums tend to bleed when brushing	(24.6%)	(75.4%)	(75.4%)
3.	I worry about the colour of my teeth	(48.9%)	(51.1%)	(48.9%)
4.	I have noticed some white sticky deposits on my teeth	(38.0%)	(62.0%)	(38.0%)
6.	I think that I cannot help having false teeth when I am old	(37.7%)	(62.3%)	(62.3%)
7.	I am bothered by the colour of my gums	(37.7%)	(62.3%)	(37.7%)
8.	I think my teeth are getting worse despite my daily brushing	(22.1%)	(77.9%)	(77.9%)
10.	I have never been taught professionally to brush teeth	(28,5%)	(71.5%)	(71.5%)
12.	I often check my teeth in the mirror after brushing	(24.6%)	(75.4%)	(24.6%)
13.	I worry about having bad breath	(81.9%)	(18.1%)	(81.9%)
14.	It is impossible to prevent gum disease with brushing alone	(65.2%)	(34.8%)	(65.2%)
15.	I put off going to the dentist until I have toothache	(49.6%)	(50.6%)	(50.6%)
18.	I don't feel I've brushed well unless I brush with strong strokes	(31.4%)	(68.6%)	(68.6%)
19.	I feel I sometimes take too much time to brush my teeth	(16.7%)	(83.3%)	(16.7%)

scoring :(no)item2+ (yes) item3 + (yes) item4 + (no) item6 + (yes)item 7 + (no) item8 + (no) item10 + (yes) item12 + (yes) item13 + (yes) item14 + (no)Item15 + (no)Item18 + (yes)Item19+ = HU-DBI-13 items sum score.

Table 17.4 Frequency distribution of HU-DBI 13 item sum scores at 9 months

Item	question	yes (%)	No (%)	variable score (+)(%)
2.	Gums tend to bleed when brushing	(27.0%)	(73.0%)	(73.0%)
3.	I worry about the colour of my teeth	(47.8%)	(52.2%)	(47.8%)
4.	I have noticed some white sticky deposits on my teeth	(44.3%)	(55.7%)	(44.3%)
6.	I think that I cannot help having false teeth when I am old	(37.4%)	(62.6%)	(62.6%)
7.	I am bothered by the colour of my gums	(34.8%)	(65.2%)	(34.8%)
8.	I think my teeth are getting worse despite my daily brushing	(27.8%)	(72.2%)	(72.2%)
10.	I have never been taught professionally to brush teeth	(21.7%)	(78.3%)	(78.3%)
12.	I often check my teeth in the mirror after brushing	(62.6%)	(37.4%)	(62.6%)
13.	I worry about having bad breath	(83.5%)	(16.5%)	(83.5%)
14.	It is impossible to prevent gum disease with brushing alone	(60.0%)	(40.0%)	(60.0%)
15.	I put off going to the dentist until I have toothache	(49.6%)	(50.4%)	(50.4%)
18.	I don't feel I've brushed well unless I brush with strong strokes	(30.4%)	(69.6%)	(69.6%)
19.	I feel I sometimes take too much time to brush my teeth	(13.9%)	(86.1%)	(13.9%)

scoring :(no)item2+ (yes) item3 + (yes) item4 + (no) item6 + (yes)item 7 + (no) item8 + (no) item10 + (yes) item12 + (yes) item13 + (yes) item14 + (no)Item15 + (no)Item18 + (yes)Item19+ = HU-DBI-13 items sum score.

Table 17.5 HU-DBI 13 items difference between groups at baseline

HU-DBI	mean (SE) difference	95%CI	p
Baseline			
OH + Sc vs. OH	**-0.1 (0.3)**	**-0.8 to 0.7**	**1.0**
OH+ Sc vs. Control	**1.1 (0.3)**	**0.3 to 1.9**	**0.003***
OH vs Control	**1.2 (0.3)**	**0.4 to 1.9**	**0.002***

One way ANOVA Bonferroni **p<0.01, *<p0.05

HU-DBI trend in relation to oral hygiene behaviour

An ordinal regression analysis was conducted to analyze the scale like effects with direction from baseline and nine months evaluation on HU-DBI-13 and OHIP-14 questionnaire responses. The differences were categorized as 1 -Worsened responses (negative difference); 2 - no difference in responses (0 difference); 3 - improved responses (positive difference). The analysis is not meant to measure the magnitude of the difference but to indicate the trend for the path analysis.

HU-DBI 13-item response difference ordinal scale was used as a dependent variable for the ordinal regression analysis using the Logit link method. Table 17.6 shows that the male gender was more likely to display an improved HU-DBI score than the female gender ($p<0.01$) with Odds ratio 5.9 (95% CI 1.9-18.9). Main effect variables included in the model were unacceptable oral hygiene compliance at nine months, treatment groups, age category and health behavior self-efficacy scale and acceptable interdental cleaning at three months interval. All of these variables did not show any significance in the analysis.

Table 17.6 Summary table for HU-DBI 13 items difference (Ordinal regression)

	Parameter estimates			
	Est.(S.E)	**p-value**	**OR**	**95% CI**
Threshold				
HU-DBI Cat 1	**-0.949 (0.94)**	**0.311**	**0.39**	**0.06-2.4**
HU-DBI Cat 2	**0.189 (0.93)**	**0.839**	**1.2**	**0.20-7.5**
compared to HU-DBI Cat 3				
Location				
Groups				
OH+Sc	**-1.18(0.89)**	**0.187**	**0.31**	**0.05-1.75**
OH	**-0.936(0.76)**	**0.217**	**0.39**	**0.09-1.77**
compared to control group				
Oral hygiene compliance at 9 months				
acceptable	**-0.255(0.69)**	**0.711**	**0.77**	**0.20-2.98**
compared to unacceptable OHC3				
Gender				
Male	**1.77(0.58)**	**0.002***	**5.9**	**1.9-18.98**
compared to female				
Age category				
21-40 years	**0.151(0.88)**	**0.863**	**1.16**	**0.20-6.5**
41-55 years	**0.158(0.74)**	**0.830**	**1.17**	**0.30-4.97**
compared to 56-65 years				
Health Behaviour Self-efficacy				
HB SE(1)lowest	**0.344(1.1)**	**0.739**	**1.4**	**0.19-3.95**
HB SE(2)2nd lowest	**1.18(0.79)**	**0.138**	**3.25**	**0.69-15.12**
HB SE(3)3rd lowest	**0.538(0.76)**	**0.477**	**1.7**	**0.13-2.57**
compared to SEHB(4) highest self-efficacy(health behaviour)				
Interdental cleaning 3 months				
Unacceptable	**-0.765(0.68)**	**0.260**	**0.47**	**0.12-1.76**
compared to acceptable interdental cleaning(3months)				

Logit link function. HU-DBI Cat 1= worsened response; HU-DBI Cat2= no difference; HU-DBI Cat3= improved response

4.2.4 Effect of intervention on Laboratory Data

HbA1c

Tables 18.1& 18.2 compare the HbA1c data at all three time points. There was no marked change in mean value over time. The proportion of subjects showing acceptable and unacceptable HbA1c also did not change markedly over time.

Table18.1 Comparison of mean HbA1c at baseline, 3 months and 9 months

mean±SD(n)	Baseline	3 months	9 months
Total	**7.81%±1.5(161)**	**7.75%±1.4(152)**	**7.76%±1.4(129)**
OH+Sc	8.1%±1.6(59)	8.2%±1.6(54)	7.9%±1.5(48)
OH	7.6%±1.4(52)	7.6%±1.3(50)	7.6%±1.4(42)
Control	7.7%±1.5(50)	7.4%±1.2(48)	7.8%±1.4(39)

There were no group differences at baseline and when analyzed with repeated measures adjusted Bonferroni at 3 months and 9 months when age and gender were taken into account.

Table 18.2 Comparison of distribution of acceptable and acceptable (HbA1c) at baseline, 3 months and 9 months

HbA1c mean	Baseline (%)	3months (%)	9month s(%)
< 8%(acceptable)	**97(60.2)**	**96(63.2)**	**38(60.5)**
≥ 8%(unacceptable)	**64(39.8)**	**56(36.8)**	**51(39.5)**
Total	**161**	**152**	**89**
Acceptable/ total number			
OH +Sc	**31/59**	**26/54**	**25/48**
OH	**36/52**	**36/50**	**30/42**
Control	**30/50**	**34/48**	**23/39**

There were also no within group difference by McNemar's analysis for acceptable HBA1c at all levels of assessment. However, there was a significant difference between OH + Sc vs. OH ($p<0.05$) in favor of OH group at 3 months analyzed by Pearson's Chi Square test with Bonferroni correction (Table 18.2) but non significant

at 9months. There was no effect of OH+Sc on HBA1c at all time assessment.

Similarly, an analysis of OHC criterion with the dichotomized HBA1c using Pearson's Chi square test did not show any association at baseline, 3 months and 9 months.

Total cholesterol

Table 18.3 Comparison of mean Cholesterol at baseline, 3months and 9 months

mean±SD (n)	Baseline	3months	9months
Total	**5.1±1.0(141)**	**4.97±.84(130)**	**4.9±.94(129)**
OH+Sc	5.2±0.95(53)	5.0±0.79(45)	5.0±0.95(48)
OH	5.2±1.2(48)	5.1±0.97(42)	4.9±0.89(42)
Control	4.8±0.69(40)	4.9±0.73(43)	4.8±1.1(39)

Cholesterol measures in mmol/l

There were no group differences at baseline. A repeated measure analysis did not show any within group differences (adjusted Bonferroni) at 3 months and 9 months when age and gender were taken into account. (Table 18.3)

4.2.5 Effects of intervention on periodontal parameters

Plaque

Table 18.4 Plaque difference between groups at baseline

%Plaque	**mean(SE) difference**	**95%CI**	**p**
Baseline			
OH + Sc vs. OH	**11.6(4.2)**	**1.5 to 21.7**	**0.018***
OH+ Sc vs. Control	**1.9(4.2)**	**-8.3 to 12.1**	**1.0**
OH vs. Control	**-9.7(4.3)**	**-20.2 to 0.85**	**0.083**

One way ANOVA (Bonferroni) **p<0.01, *<p0.05

Baseline data showed a significant difference between OH+Sc and OH alone ($p<0.05$) (Table 18.4). Since there was a significant difference at baseline among groups, an

ANCOVA analysis was conducted controlling for age and gender. Control showed a significant difference for plaque in comparison with both groups at 3 months ($p<0.01$) and at 9 months ($p<0.05$). There were no group differences between OH alone and OH+Sc at both 3 and 9 months. (Table 18.5)

Table 18.5 Plaque % mean difference between groups from baseline at 3 months and 9 months

Plaque	mean(SE) difference	95% CI	p
3months			
OH+Sc vs. OH	**-0.9(4.1)**	**-10.9 to 9.1**	**1.0**
OH+Sc vs. Control	**-17.3(4.3)**	**-27.5 to-7.0**	**0.000*** **
OH vs. Control	**-16.3(4.3)**	**-26.8 to-5.9**	**0.001*** **
9months			
OH+Sc vs. OH	**-1.7(4.3)**	**-12.1 to 8.8**	**1.0**
OH+Sc vs. Control	**-14.7(4.4)**	**-25.4 to-4.0**	**0.003** **
OH vs. Control	**-13.1(4.5)**	**-23.9 to-2.2**	**0.012***

ANCOVA adjusted fror gender and age. Bonferroni adjusted ***p<0.001, **p<0.01, *<p0.05

Within group changes for plaque reduced significantly in the OH+Sc and OH group at both 3 and 9 months. Control group showed a within group reduction at 9 months compared to baseline. (Table 18.6)

Table 18.6 Within group comparison of Plaque at 3 months and 9 months from baseline. Paired t test (bonferroni adjusted)

Plaque mean(SD)	0/12 n=161	3/12 n=155	9/12 n=132
OH + Sc	62.6 (20.4)	37.6 (21.1)**	33.9 (18.7)**
OH	51.0 (23.4)	39.2 (20.7)**	36.1 (21.7)**
Control	60.7 (22.1)	54.9 (22.4)	48.4 (21.6)**
Total	58.3 (22.4)	43.5 (22.6)**	39.3 (21.4)**

paired t test ** p<0.01; *<p0.05, (bonferroni adjusted)

BOP

Baseline data showed a signficant difference between OH+Sc and OH alone ($p<0.05$)

Table 18.7

Table 18.7 BOP difference between groups at baseline

BOP	mean (SE) difference	95% CI	p
Baseline			
OH + Sc vs. OH	10.7 (4.4)	0.2 to 21.2	0.045*
OH+ Sc vs. Control	1.9 (4.4)	-8.8 to 12.5	1.0
OH vs Control	-8.8 (4.6)	-19.8 to 2.1	0.159

One way ANOVA(Bonferroni) **p<0.01, *<p0.05

Since there was a significant difference at baseline among groups, an ANCOVA analysis was conducted controlling for age and gender. At 3 months, Control showed a significant difference of BOP in comparison with OH alone group ($p<0.01$) and OH+Sc group ($p<0.001$). At 9 months, only OH+Sc showed a significant difference

with control (p<0.01). There were no group differences between OH alone and OH+Sc at both 3 and 9 months and no difference between OH alone and control. (Table 18.8)

Table 18.8 BOP % mean difference between groups from baseline at 3 months and 9 months

BOP	mean (SE) difference	95% CI	p
3months			
OH+Sc vs. OH	**-1.1 (4.3)**	**-11.6 to 9.3**	**1.0**
OH+Sc vs. Control	**-16.8 (4.4)**	**-27.6 to-6.1**	**0.001****
OH vs. Control	**-15.7 (4.5)**	**-26.6 to-4.8**	**0.002***
9months			
OH+Sc vs. OH	**-5.0 (4.3)**	**-15.5 to 5.5**	**0.757**
OH+Sc vs. Control	**-15.0 (4.4)**	**-25.7 to-4.3**	**0.003***
OH vs. Control	**-10.0 (4.5)**	**-20.9 to 0 .8**	**0.078**

ANCOVA adjusted fror gender and age. Bonferroni adjustedp<0.001, *<p0.01**

Within group changes for BOP reduced significantly in the OH+Sc at both 3 and 9 months (p<0.05). OH alone group showed an improvement only at 3 months (p<0.05). Notably, there was within group reduction for control group at 9 months when it was compared to baseline. (Table 18.9)

Table 18.9 Within group comparison of BOP at 3 months and 9 months from baseline.Paired t test (bonferroni adjusted)

BOP Mean(SD)	0/12 n=161	3/12 n=155	9/12 n=132
OH + Sc	**57.9 (23.5)**	**37.8 (20.7)****	**35.4 (17.1)****
OH	**47.3 (22.6)**	**39.8 (22.8)****	**40.8 (21.4)**
Control	**56.1 (22.5)**	**53.9 (24.4)**	**49.9 (23.4)****
Total	**53.9 (23.2)**	**43.5 (23.5)****	**41.9 (21.4)****

paired t test ** p<0.01; *p<0.05, bonferroni adjusted

Subgingival Calculus

Baseline data showed a significant difference between OH+Sc and both groups (OH alone and control) Table 18.10.

Table 18.10 Subgingival calculus difference between groups at baseline

Subgingival Calculus	mean (SE) difference	95% CI	p
Baseline			
OH + Sc vs. OH	**-18.4 (.5.5)**	**-31.8 to -5.0**	**0.003***
OH+ Sc vs. Control	**-21.6(5.5)**	**-31.9 to -8.3**	**0.000****
OH vs Control	**-3.2(5.7)**	**-16.9 to 10.6**	**1.0**

One way ANOVA (Bonferroni) **p<0.001, *<p0.01

Since there was a significant difference at baseline among groups, an ANCOVA analysis was conducted controlling for age and gender. The results showed that, at 3 months the OH+Sc group demonstrated a significant reduction of subgingival calculus in comparison with both groups, OH alone group ($p<0.01$) and control ($p<0.001$). Similar findings were also observed at 9 months. There were no group differences between OH alone and control at both 3 and 9 months. (Table 18.11)

Table 18.11 Subgingival calculus % mean difference between groups from baseline at 3 months and 9 months

Subginigival Calculus	mean (SE) difference	95% CI	p
3months			
OH+Sc vs. OH	**-16.8 (5.0)**	**-28.8 to -4.8**	**0.003***
OH+Sc vs. Control	**-26.3 (5.1)**	**-38.7 to -13.9**	**0.000****
OH vs. Control	**-9.5(5.1)**	**-21.9 to 2.8**	**0.192**
9months			
OH+Sc vs. OH	**-17.2 (5.5)**	**-30.7 to -3.8**	**0.007***
OH+Sc vs. Control	**-20.3(5.7)**	**-33.8 to -6.7**	**0.001****
OH vs. Control	**-3.0(5.8)**	**-17.0 to 11.0**	**1.0**

ANCOVA adjusted fror gender and age. Bonferroni adjustedp<0.001, *<p0.01**

Subgingival calculus within group differences was reduced significantly in the OH+Sc group at both 3 and 9 months. OH group did not show any within group reduction. Notably, there was a within group reduction for control group at 9 months when it was compared to baseline. (Table 18.12)

Table 18.12 Within group comparison of % Subgingival calculus at 3 months and 9 months from baseline.Paired t test (bonferroni adjusted)

Mean(SD)	0/12 (n=161)	3/12 (n=155)	9/12 (n=132)
OH + Sc	**59.4(25.3)**	**26.2(24.2)****	**22.31(20.1)****
OH	**43.92(22.4)**	**43.19(23.6)**	**40.74(25.2)**
Control	**53.90(24.4)**	**51.78(27.3)**	**43.9(27.9)***
Total	**52.7(24.8)**	**40.2(27.1)****	**36.2(26.1)****

paired t test ** p<0.01,*p<0.05, bonferroni adjusted

Supragingival Calculus

There were no group differences at baseline and when analyzed with repeated measures adjusted Bonferroni at 3 months and 9 months when age and gender were taken into account.

Supragingival calculus within group differences was reduced significantly in the OH+Sc group at both 3 and 9 months. OH alone and control group did not show any reduction (Table 18.13).

Table 18.13 Within group comparison of % Supragingival calculus at 3 months & 9 months from baseline.Paired t test (bonferroni adjusted)

Mean(SD)	0/12 n=161	3/12 n=155	9/12 n=132
OH + Sc	16.7 (18.2)	7.6 (10.3)**	9.5 (16.4)**
OH	13.9 (15.6)	13.7 (15.6)	13.4 (15.5)
Control	16.7 (18.3)	16.6 (17.9)	17.1 (20.3)
Total	15.8 (17.4)	12.4 (15.2)**	13.1 (17.6)**

paired t test **p<0.01,*p<0.05, bonferroni adjusted

Probing pocket depth

Table 18.14 PPD difference between groups at baseline

PPD	mean (SE) difference	95% CI	p
Baseline			
OH + Sc vs. OH	0.50 (0.15)	0.13 to 0.87	0.005**
OH+ Sc vs. Control	0.05 (0.16)	-0.33 to 0.43	1.0
OH vs. Control	-0.40 (0.16)	0-.83to -0.05	0.020*

One way ANOVA (Bonferroni) **p<0.01, *<p0.05

As there was a significant difference between oral hygiene group compared to OH+Sc and control group at baseline (Table 18.14), an ANCOVA analysis was conducted taking into account for age and gender for comparing group differences. The results did not show any group differences (Table 18.15).

Table 18.15 PPD % mean difference between groups from baseline at 3 months and 9 months

PPD	mean (SE) difference	95% CI	p
3months			
OH+Sc vs. Control	**0.17 (0.08)**	**-0.02 to 0.35**	**0.088**
OH vs. Control	**0.01 (0.08)**	**-0.05 to 0.33**	**0.204**
OH+Sc vs. OH	**-0.02 (0.08)**	**-0.21 to 0.17**	**1.0**
9months			
OH+Sc vs. Control	**-0.35 (0.15)**	**-0.71 to 0.02**	**0.066**
OH vs. Control	**-0.33 (0.15)**	**-0.69 to 0.04**	**0.096**
OH+Sc vs. OH	**-0.02 (0.15)**	**-0.39 to 0.34**	**1.0**

ANCOVA adjusted fror gender and age. Bonferroni adjustedp<0.01, *<p0.05**

Table 18.16 Within group comparison of PPD at 3 months and 9 months from baseline. Paired t test (bonferroni adjusted)

Mean(SD)	0/12 (n=161)	3/12 (n=155)	9/12 (n=132)
OH + Sc	**2.1(0.83)**	**1.6(0.61)***	**1.55(0.51)****
OH	**1.56(0.59)**	**1.59(0.54)**	**1.58(0.51)**
Control	**2.0(0.97)**	**2.03(0.94)**	**1.90(0.97)**
Total	**1.89(0.82)**	**1.74(0.73)***	**1.69(0.7)****

paired t test **p<0.01,*p<0.05, bonferroni adjusted

In Table 18.16 a highly significant within group improvement of probing pocket depth was observed for the oral hygiene + scaling group at both 3 months and 9 months evaluation ($p<0.01$). In contrast, these changes were insignificant in both oral hygiene group and control group.

4. 2. 6 Effects on Oral Hygiene Compliance

Oral hygiene compliance criterion

Within group comparison

Oral hygiene compliance criterion of ≥ 25% plaque + ≥ 15% BOP was monitored at all assessment levels at baseline, 3months and 9 months.

Table 19.1 shows the frequency distribution of the assessment of the study across the time period. There was a decrease of non-compliant subjects from 90% at baseline to 72% at 3 and 9 months.

Table 19.1 OHC criterion 25-15 at baseline, 3months and 9 months

	25-15	
	Compliant	**Non-compliant**
Baseline (n=161)	**16 (9.9% 95%, CI 5.3-14.5)**	**145 (90.1% 95%, CI 83.5-94.7)**
3 months (n=155)	**42 (27.1% 95%, CI 20.1-34.1)**	**113 (72.9% 95%, CI 65.9-79.9)**
9 months (n=132)	**37 (28% 95%, CI 20.3-35.7)**	**95 (72% 95%, CI 64.3- 79.7)**

McNemar analysis showed a significant improvement OHC set at 25-15. ($p<0.001$) at 3 months and 9 months as shown in Table 19.2.

Table 19.2 Oral Hygiene Compliance (25-15) comparison between baseline and 3months, 9months (whole study group)

	Oral Hygiene Compliance (25-15)			McNemar
	Acceptable	Unacceptable	Total	Exact Significance (2sided)
Baseline	**16**	**145**	**161**	**0.000***
3 months	**42**	**113**	**155**	
Baseline	**16**	**145**	**161**	**0.000***
9 months	**37**	**95**	**132**	

a=Binomial distribution used, *($p<0.001$)

A sub-group comparison of the oral hygiene non compliance (OHC) responses were carried out for gender, race and age at baseline, three months and nine months.

Gender: Males generally showed better oral hygiene compliance at 3months ($p<0.01$) and also at 9 months ($p<0.01$). In contrast, females did not show marked improvement at 3 months but a significant improvement was found at nine months (Table 19.3).

Ethnic based assessment showed that the Chinese showed a consistent improvement at 3 months and 9 months ($p<0.01$). . However, the Malay and Indian groups did not show significant improvement. This difference may be attributed to the smaller sample size from these two ethnic groups (Table 19.4).

Age: An assessment of oral hygiene compliance by age was carried out by dividing age categories into three sub groups 21-40 years, 41-55 years and 56-65 years. At 3 months, all three age cohorts showed improved oral hygiene compliance. At 9 months, there was a sustained compliance for those in the 21-40 years and 41-55 age categories but the oldest age group deteriorated (Table 19.5).

Table 19.3 Comparison of Oral Hygiene Compliance (25-15) at baseline and 3months, 9 months (within gender groups)

	Oral Hygiene Compliance(25-15)			McNemar
	Acceptable (%)	Unacceptable (%)	Total	Exact Significance (2sided)
Gender(male)				
Baseline	**9(9.9)**	**82(90.1)**	**91**	**0.000****
3 months	**30(34.5)**	**57(65.5)**	**87**	
Baseline	**9(9.9)**	**82(90.1)**	**91**	**0.003****
9 months	**22(29.3)**	**53(70.7)**	**75**	
Gender(female)				
Baseline	**6(9.7)**	**63(91.3)**	**69**	**0.109**
3 months	**11(16.4)**	**56(83.6)**	**67**	
Baseline	**6(9.7)**	**63(91.3)**	**69**	**0.006***
9 months	**15(26.8)**	**41(73.2)**	**56**	

*(p<0.05)**(p<0.01); **a=Binomial distribution used**

Table 19.4 Comparison of Oral Hygiene Compliance (25-15) at baseline and 3 months, 9 months (within Ethnic groups)

Oral Hygiene Compliance (25-15)			McNemar	
	Acceptable (%)	Unacceptable (%)	Total	Exact Significance (2sided)
Race (Chinese)				
Baseline	**12(10.1)**	**107(89.9)**	**119**	**0.000****
3 months	**31(26.7)**	**85(73.3)**	**116**	
Baseline	**12(10.1)**	**107(89.9)**	**119**	**0.001***
9 months	**29(29.0)**	**71(71.0)**	**100**	
Race (Malay)				
Baseline	**2(11.8)**	**15(88.2)**	**17**	**0.625**
3 months	**4(25.0)**	**12(75.0)**	**16**	
Baseline	**2(11.8)**	**15(88.2)**	**17**	**0.500**
9 months	**4(28.6)**	**10(71.4)**	**14**	
Race (Indian)				
Baseline	**2(8.3)**	**22(91.7)**	**24**	**0.070**
3 months	**7(31.8)**	**15(68.2)**	**22**	
Baseline	**2(8.3)**	**22(91.7)**	**24**	**0.375**
9 months	**5(23.5)**	**13(76.5)**	**17**	

*(p<0.05)**(p<0.01); **a=Binomial distribution used**

Table 19.5 Comparison of Oral Hygiene Compliance (25-15) at baseline and 3 months, 9 months (within age groups)

Oral Hygiene Compliance(25-15)			McNemar
	Acceptable (%)	Unacceptable (%)	Total	Exact Significance (2sided)
Age (21-40years)				
Baseline	**4(8.0)**	**46(92.0)**	**50**	**0.039***
3 months	**10(20.8)**	**38(79.2)**	**48**	
Baseline	**4(8.0)**	**46(92.0)**	**50**	**0.004****
9 months	**12(30.0)**	**28(70.0)**	**40**	
Age (41-55years)				
Baseline	**7(9.8)**	**68(90.2)**	**75**	**0.004****
3 months	**20(27.8)**	**52(72.2)**	**72**	
Baseline	**7(9.8)**	**68(90.2)**	**75**	**0.012***
9 months	**18(29.0)**	**44(71.0)**	**62**	
Age (56-65years)				
Baseline	**5(13.9)**	**31(86.1)**	**36**	**0.016***
3 months	**12(34.3)**	**23(65.7)**	**35**	
Baseline	**5(13.9)**	**31(86.1)**	**36**	**0.625**
9 months	**7(23.3)**	**23(76.7)**	**30**	

*($p<0.05$)**($p<0.01$); a=Binomial distribution used

Experimental groups comparison

Table 19.6 shows that OH + Sc was the only group which exhibited a consistent improvement in oral hygiene compliance at 3 months ($p<0.01$) and 9 months ($p<0.01$).

Table 19. 6 Oral Hygiene Compliance (25-15) comparisons between baseline and 3 months, 9 months (within each group)

	Oral Hygiene Compliance(25-15)			McNemar
	Acceptable	Unacceptable	Total	Exact Significance (2sided)
OH+Sc group				
Baseline	**1**	**58**	**59**	**0.000***
3 months	**20**	**35**	**55**	
Baseline	**1**	**58**	**59**	**0.003***
9 months	**19**	**26**	**45**	
OH group				
Baseline	**10**	**42**	**52**	**0.109**
3 months	**16**	**36**	**52**	
Baseline	**10**	**42**	**52**	**0.180**
9 months	**15**	**30**	**45**	
Control group				
Baseline	**5**	**45**	**50**	**0.687**
3 months	**6**	**42**	**48**	
Baseline	**5**	**45**	**50**	**1.000**
9 months	**3**	**39**	**42**	

a=Binomial distribution used ,*(p<0.01)

There were no differences for within group change from 3 months to 9 months.

Figures 6, 7 & 8 illustrate the oral hygiene compliance (25-15) scatterplot for oral hygiene+ scaling, oral hygiene alone and control groups.

Figure 5 oral hygiene compliance

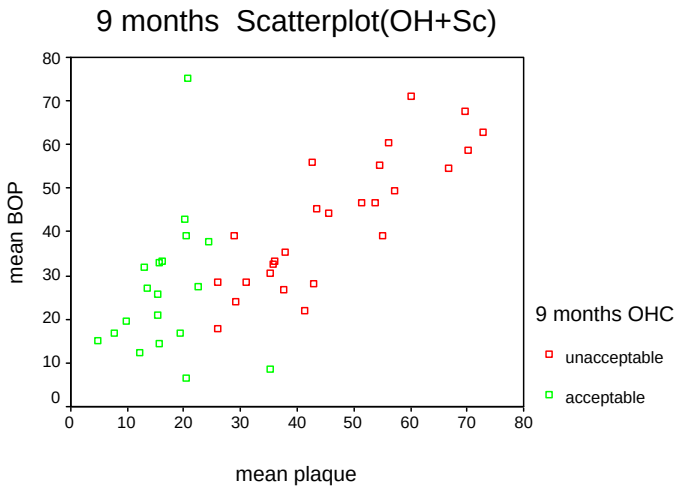


Figure 6 Oral hygiene compliance

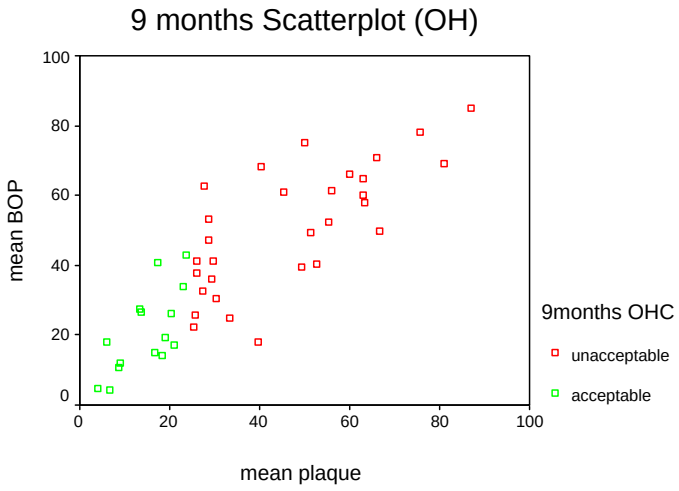
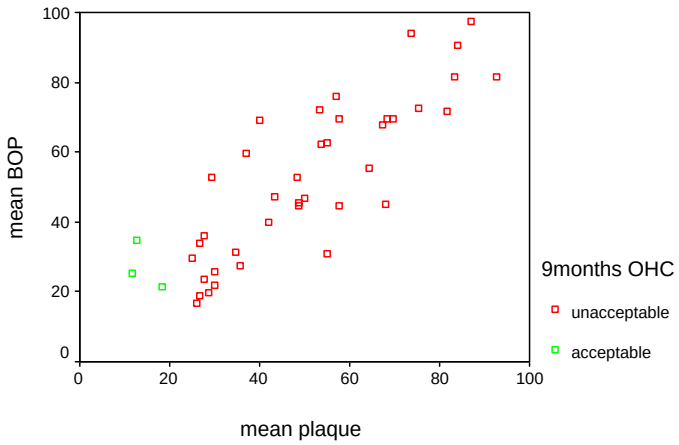


Figure 7 Oral Hygiene Compliance



Between group comparisons

At baseline a significant difference in OHC was noted between OH+Sc vs. OH ($p<0.05$) groups only (Table 19.7). In consideration for the baseline difference, a logistic regression was conducted for 3 and 9 months controlling for unacceptable OHC at baseline (Table 19.8). The results showed that at three months, there was a significant difference in oral hygiene compliance between Oral hygiene+Scaling group and control ($p<0.01$). The control group was 5.9 times more likely to have unacceptable OHC compared to OH+Sc group. No significant difference was found for the OH group when compared to control at 3 months. At nine months, unacceptable OHC remained high in control group as compared with oral hygiene + scaling group ($p<0.001$) with Odd Ratio of 12.8 (95% CI 3.164- 51.78). A comparison of OH group with control showed a significant difference in OHC at 9 months ($p<0.01$). It was also found that control group was 2. 6 times more likely to be non-compliant than OH group at 9 months. (Table 19.8)

There were no differences observed between the different age groups and races, except for a gender difference at 3 months ($p<0.05$). (Table 19.9)

Table 19.7 Baseline group differences for OHC noncompliance using logistic regression

	B (S.E)	p-value	Odds Ratio	95% CI
Group		**0.035**		
OH	**-2.62(1.1)**	**0.014***	**0.073**	**0.009-0.588**
Control	**-1.86(1.1)**	**0.094**	**0.256**	**0.018-1.376**
Compared to OH+Sc group				
Group				
OH+Sc	**1.86(1.1)**	**0.094**	**6.426**	**0.727-56.81**
OH	**-0.76(0.59)**	**0.195**	**0.467**	**0.147-1.47**
Compared to control group				

*(p<0.05)

Table 19.8 Comparison of Oral Hygiene Compliance (25-15) at baseline and 3 months, 9 months by treatment modality

OHC noncompliance (9 months) using logistic regression controlling baseline OHC

	B (S.E)	p-value	Odds Ratio	95% CI
Group		**0.087**		
OH+Sc	**-2.55(0.71)**	**0.000*** **	**0.078**	**0.019-0.316**
OH	**-1.66(0.72)**	**0.020***	**0.190**	**0.047-0.772**
Compared to control group				
Group				
OH	**0.89(0.49)**	**0.071**	**2.432**	**0.926-6.391**
Control	**2.55(0.71)**	**0.000*** **	**12.80**	**3.164-51.78**
Compared to OH+Sc group				
Baseline				
OHC acceptable	**-2.17(0.69)**	**.002****	**0.114**	**0.030-0.437**
Compared to unacceptable group				

OHC noncompliance (3 months) using logistic regression controlling baseline OHC

	B (S.E)	p-value	Odds Ratio	95% CI
Group		**0.087**		
OH+Sc	**-1.79(0.58)**	**0.002****	**0.168**	**0.054-0.517**
OH	**-0.97(0.59)**	**0.101**	**0.379**	**0.119-1.208**
Compared to control group				
Group				
OH	**0.82(0.47)**	**0.081**	**2.261**	**0.905-5.653**
Control	**1.79(0.58)**	**0.002****	**5.965**	**1.933-18.40**
Compared to OH+Sc group				
Baseline				
OHC acceptable	**-2.69(0.67)**	**.000*** **	**0.068**	**0.018-0.253**
Compared to unacceptable group				

*** (p<0.05)**(p<0.01)***(p<0.001)**

Table 19.9 Unacceptable OHC (3months) by Gender

				Asymp.Sig(2-sided)
	Male n(%)	**Female n(%)**	**Total**	**p**
Acceptable	**30(34.5)**	**11(16.4)**	**41**	**0.012***
Unacceptable	**57(65.5)**	**56(83.6)**	**113**	
Total	**87(100)**	**67(100)**	**154**	

Pearson Chi -square

Oral Health Compliance Subcategories

The OHC criterion requires a cutoff level for determining a level for ROC analysis and comparative analysis requirement. It is also based on strict inclusion criteria of fulfilling ≥ 25% plaque and ≥ 15% BOP. However, there are categorical situations where one of plaque and BOP requirements may not be fulfilled. These categories are subcategories of oral hygiene compliance and frequencies in Table 19.10.

- A: < 25% plaque + < 15% BOP
- B: ≥ 25% plaque + <15% BOP
- C: < 25% plaque + ≥ 15% BOP
- D: ≥ 25% plaque+ ≥ 15% BOP

Table 19.10 Comparison of OHC categories (baseline, 3months, and 9months)

	A	B	C	D
	n(%)	n(%)	n(%)	n(%)
Baseline	**8(5.0)**	**2(1.2)**	**6(3.7)**	**145(90.1)**
3 months	**8(5.2)**	**5(3.2)**	**29(18.7)***	**113(72.9)***
9 months	**9(6.7)**	**1(1.5)**	**27(20.7)***	**96(71.6)***

McNemar :*(p<0.01) comparisons in reference to Baseline. A: < 25% plaque + < 15% BOP; B: ≥ 25% plaque + <15% BOP; C: < 25% plaque + ≥ 15% BOP; D: ≥ 25% plaque+ ≥ 15% BOP

Table 19.11 Comparison of OHC categories (baseline, 3months, 9months)Groups

	A	B	C	D
	n(%)	n(%)	n(%)	n(%)
OH+Sc				
Baseline(n=59)	**1(1.7)**	**0(0)**	**0(0)**	**58(98.3)**
3 months(n=55)	**2(3.6)**	**1(1.8)**	**17(30.9)***	**35(63.6)***
9 months(n=46)	**3(6.5)**	**1(2.2)**	**15(32.6)***	**27(58.7)***
OH				
Baseline(n=52)	**6(11.5)**	**0(0)**	**4(7.7)**	**42(80.8)**
3 months(n=55)	**5(9.6)**	**2(3.8)**	**9(17.3)**	**36(69.2)**
9 months(n=45)	**6(13.3)**	**0(0)**	**9(20.0)**	**30(66.7)**
Control				
Baseline(n=50)	**1(2.0)**	**2(4.0)**	**2(4.0)**	**45(90.0)**
3 months(n=48)	**1(2.1)**	**2(4.2)**	**3(6.3)**	**42(87.5)**
9 months(n=46)	**0(0)**	**1(2.3)**	**3(7.0)**	**39(90.7)**

McNemar :*(p<0.01) comparisons in reference to Baseline. A: < 25% plaque + < 15% BOP; B: ≥ 25% plaque + <15% BOP; C: < 25% plaque + ≥ 15% BOP; D: ≥ 25% plaque+ ≥ 15% BOP

No observed differences were found between groups for age, gender and race. Significant improvement in OHC was found in the OH+ Sc group and the greatest improvements were observed in the category C (<25% plaque, >15 % BOP). For the OH group, a similar trend was found but to a lesser degree. For the control group, no marked improvement was found. (Table 19.11)

Logistic Regression Analysis

The main research question of the study is focused on non oral hygiene compliance criterion based on a combination of events when the cutoff levels equals or exceed plaque 25% and BOP 15%. This outcome criterion at 9 months was used as a dependent variable to determine factors associated with oral hygiene compliance utilizing logistic regression analysis. The results in Table 19.12 showed that OH+Sc group had a significant association in the negative direction ($p<0.05$) for unacceptable oral hygiene compliance compared to control group with Odds Ratio of 0.125 (95% CI .020-.725.) It means that occurrence of unacceptable oral hygiene compliance is unlikely to belong in a group where oral hygiene education and scaling procedures were done. For health behaviour self-efficacy those showing the lowest self-efficacy scorers were more likely to be non compliant ($p<0.05$) with Odds Ratio of 8.4 (95% CI 1.19-59.35). In translating the finding, it means that those who had responded with lowest self-efficacy (health behaviour) were likely to have unacceptable oral hygiene compliance in comparison to those who have the highest self-efficacy in oral health behaviour.

The above findings were also observed when acceptable interdental cleaning (flossing+interdental brush) usage was controlled as a variable in the logistic

regression model the difference however did not reach statistical significance. Other demographic variables were not included in the model, as outcome assessments at baseline did not show any significant differences.

Table 19.12 Summary table for OHC noncompliance (9 months) using logistic regression

	B(S.E)	p-value	Odds Ratio	95% CI
Group		**0.087**		
OH+Sc	**-2.08(0.95)**	**0.028***	**0.125**	**0.020-0.795**
OH	**-1.35(0.91)**	**0.135**	**0.259**	**0.044-1.524**
Compared to control group				
Health Behaviour Self-efficacy		**0.170**		
HB SE(1)$_{lowest}$	**2.13(0.99)**	**0.033***	**8.4**	**1.19-59.35**
HB SE(2)$_{2^{nd}\ lowest}$	**1.09(0.82)**	**0.182**	**2.98**	**0.600-14.79**
HB SE(3)$_{3^{rd}\ lowest}$	**1.13(0.80)**	**0.159**	**3.09**	**0.643-14.95**
Compared to SEHB(4) highest self-efficacy (health behaviour HB)				
Interdental Cleaning 3months				
Unacceptable	**-0.844**	**.214**	**.430**	**0.114-1.627**
Compared to acceptable interdental cleaning				

***(p<0.05)**

Multinomial regression analysis

It is noted that the unacceptable oral hygiene compliance (OHC) criterion is set when two conditions are fulfilled, when plaque level is ≥ 25% and BOP level is ≥ 15%. This allows for single indicators of plaque and BOP to be categorized as compliant, without conforming to both conditions. For example, when a subject is evaluated as <25% plaque, the subject is categorized as compliant to oral hygiene measures and BOP of < 15% also fits this criteria. These situations are categorized irrespective of the levels of the associated plaque and BOP levels. (e.g. the compliance categories can either be <25%plaque <15% BOP(<<), ≥ 25%plaque <15% BOP (≥<), <25%plaque

≥ 15% BOP (< ≥) event). In due consideration for the categories, an analysis of OHC subcategories at 9 months were analyzed with multinomial regression.

In Table 19.13, the results showed a significant trend between OHC group (<25% plaque + <15% BOP) strictly compliant and (≥ 25% plaque + ≥ 15% BOP) strictly noncompliant group. The strictly compliant was more likely to be found in oral hygiene + scaling group rather than in the strictly non-compliant control group ($p<0.01$). The findings were significant when acceptable interdental cleaning variable was taken into account and controlled in the model. However, the data should be used with caution as the very large confidence intervals indicate a singularity effect due to the very low number of sub-categorical compliance.

Table 19.13 Summary table for OH noncompliance categories (9 months) multinomial regression.

	B(S.E)	p-value	Exp(B)	95% CI
<25%plaque+<15%BOP(ref=25% ≥ plaque+15% ≥ BOP)				
Intercept		**0.000**		
unacceptable interdental cleaning compared to acceptable interdental cleaning	**-0.078(1.4)**	**0.954**	**0.925**	**0.063-13.6**
Self-efficacy(lowest) health behaviour compared to highest Self-efficacy(HB)	**0.095(1.5)**	**0.937**	**1.099**	**0.105- 11.5**
OH+Sc	**19.4(1.2)**	**0.000***	**2.8E+08**	**2.8E+08-2.6E+10**
OH compared to control	**19.0(0)**	**NS**	**-**	**-**

Compared to ≥ 25%plaque+ ≥ 15%BOP group. *(p<0.05) NS=not significant

OHC category 1(≥ 25%Plaque+<15%BOP) and 2(<25%plaque+ ≥ 15%BOP) were not significant

4.2.7 Self-efficacy

To find out a possible explanation of oral health behavior among diabetics, a self-efficacy questionnaire was administered to the subjects at 9 months by the end of the study period. One hundred and thirty five subjects responded to the Self-efficacy questionnaire and the results showed a good reliability score of Cronbach Alpha 0.94. However, the number of subjects who responded on items for dental visits relating to oral health belief and diabetes were less, due to a small number of subjects who did not complete the questionnaire. Tables 20.1 displayed the frequency distribution in a five point Likert scale ranging from; not applicable (1), not at all likely (2), not likely (3), likely (4), very likely (5).

In the analysis, the scores were dichotomized into positive and negative self-efficacy (SE) by collapsing scores 1, 2, 3 as negative rating and scores 4+5 as the positive rating score for the following items: toothbrushing SE, interdental cleaning SE, dental visit SE, oral health belief SE and diabetes SE.

Toothbrushing self-efficacy

Table 20.1 shows a high tooth brushing self-efficacy score. A higher percentage of, lesser self-efficacies (< 50% of positive rate) were noted when the patients were tired in the evenings (Q1), unwell (Q5), weak (Q 7) and when depressed (Q8).

Interdental cleaning self-efficacy

For interdental cleaning as shown in Table 20.2 more than 50% gave a negative rating on most items listed in the questionnaire. However, nearly 60% indicated the need to relearn new ways cleaning teeth, this item did show a positive impact on self-efficacy indicating perhaps the novelty of a technique might have motivated the individuals.

Dental Visit self-efficacy

Dental visit self-efficacy is shown in Table 20.3. The negative responses were higher indicating that participants are less inclined to take the initiative to visit the dentist for preventive reasons.

Oral health belief self-efficacy

On the whole, most individuals recognize the importance of self-care in maintaining oral health (Table 20.4), although a fair proportion believed tooth loss is still an inevitable process of ageing.

Diabetes control self-efficacy

The responses on self-efficacy in diabetes control were generally positive indicating a commitment towards the control of diabetes at the individual level. It is noteworthy that, the cohort showed willingness in wanting to control diabetes (Table 20.5). Nevertheless, as depicted by response Q43, individuals felt they did have to depend on the medical care team and family support to help them avoid medical complications.

Table 20.1 Frequency distribution of Self-efficacy (tooth brushing) (n=135)

Response; not applicable(1),not at all likely(2),not likely(3),likely(4),very likely(5).(-)N(1+2+3), (+)P(4+5). Notation(*) denotes lesser self-efficacy(i.e. <50%)

How likely do you think that you can brush your teeth effectively in the following situation?

item	Description	Frequency distribution(%)						
		1	2	3	N(-)	4	5	P(+)
1.	When you are tired in the evening?	5.9	8.9	35.9	50.7	35.6	13.7	49.3*
2.	When you do not have an appointment to see the dentist in the near future?	8.9	6.6	21.5	37.0	46.7	16.3	63.0
3.	When you are on a holiday?	2.2	3.7	23.0	28.9	50.4	20.7	71.1
4.	When you have a lot of work to do?	3.7	6.0	30.6	40.3	44.8	14.9	59.7
5.	When you have a headache or feel ill?	3.0	9.6	43.0	55.6	31.1	13.3	44.4*
6.	When you have a problem with diabetic control?	7.4	5.2	22.2	34.8	43.0	22.2	65.2
7.	When you are feeling weak?	5.9	8.2	39.3	53.4	37.0	9.6	46.6*
8.	When you are feeling depressed?	7.4	8.8	34.8	51.0	37.0	12.0	49.0*
9.	When there is no family support?	12.6	8.1	23.4	44.1	38.5	17.4	55.9
10.	When you are under stress?	5.3	8.8	28.1	42.2	43.7	14.1	57.8
11.	When you have problems with your eye sight?	8.9	6.7	27.4	43.0	43.0	14.0	57.0
12.	When you have to relearn new ways to clean teeth effectively?	6.0	4.4	17.9	28.3	54.5	17.2	71.7

Table 20.2 Frequency distribution of Self-efficacy (interdental cleaning) (n=135)

Response; not applicable(1),not at all likely(2),not likely(3),likely(4),very likely(5). (-)N(1+2+3), (+)P(4+5). Notation(*) denotes lesser self-efficacy(i.e.<50%)

Likelihood of respondent cleaning in-between the teeth effectively in the following situation:

item	Description	Frequency distribution(%)						
		1	2	3	N	4	5	Y
13.	When you are tired in the evening?	8.9	8.1	51.1	68.1	25.2	6.7	31.9 *
14.	When you do not have an appointment to see the dentist in the near future?	10.4	6.7	31.1	48.2	37.8	14.0	51.8
15.	When you are on a holiday?	5.9	5.9	44.5	56.3	30.4	13.3	43.7 *
16.	When you have a lot of work to do?	6.7	6.7	51.1	64.5	27.4	8.1	35.5 *
17.	When you have a headache or feel ill?	5.1	10.4	57.8	73.3	20.0	6.7	26.7 *
18.	When you have a problem with diabetic control?	8.1	4.4	36.3	48.8	37.0	14.2	51.2
19.	When you are feeling weak?	12.1	6.0	54.9	73.0	19.5	7.5	27.0 *
20.	When you are feeling depressed?	11.1	8.1	46.7	65.9	26.7	7.4	34.1 *
21.	When there is no family support?	12.3	9.6	39.3	61.4	26.7	11.9	38.6 *
22.	When you are under stress?	8.9	8.9	46.7	64.5	27.4	8.1	35.5 *
23.	When you have problems with your eye sight?	12.5	5.2	41.5	59.2	30.4	10.4	40.8 *
24.	When you have to relearn new ways to clean teeth effectively?	6.7	3.0	31.1	40.8	46.6	12.6	59.2

Table 20.3 Frequency distribution of Self-efficacy (dental visit) (n=127)

Response; not applicable(1),not at all likely(2),not likely(3),likely(4),very likely(5).(-) N(1+2+3),(+)P(4+5). Notation(*) denotes lesser self-efficacy(i.e.<50%)

Certainty of respondent making regular dental visits as recommended in the following situation:

item	Description	Frequency distribution(%)						
		1	2	3	N(-)	4	5	P(+)
25.	When the dentist did not call you to visit?	5.4	10.9	45.0	61.3	27.1	11.6	38.7 *
26.	When you do not have any dental problems?	3.1	13.2	43.4	59.7	28.7	11.6	40.3 *
27.	When you have financial problems?	10.1	17.1	44.2	71.3	24.8	3.9	28.7 *
28.	When you are busy?	2.3	10.1	51.9	64.3	29.5	6.2	35.7 *
29.	When you cannot get appointment with own dentist?	5.5	13.3	51.6	70.4	26.5	3.1	29.6 *
30.	When you had an earlier unpleasant experience?	7.8	11.6	44.2	63.5	29.5	7.0	36.5 *
31.	When you are frightened of painful dental procedures?	11.6	10.1	40.3	62.0	34.1	3.9	38.0 *
32.	When you do not know where to go for dental appointments?	12.5	14.8	38.3	65.6	30.5	3.9	34.4 *

Table 20.4 Frequency distribution of Self-efficacy (oral health belief) (n=127)

Response; not applicable(1),not at all likely(2),not likely(3),likely(4),very likely(5).(-)N(1+2+3), (+)P(4+5). Notation(*) denotes lesser self-efficacy(i.e.<50%)

Respondent's beliefs in regards to the following statements:

item	Description	Frequency distribution(%)						
		1	2	3	N(-)	3	4	P(+)
33.	I believe that the dentist is the only person who can prevent oral diseases.	0.9	10.9	35.9	47.7	36.9	15.4	52.3
34.	I believe that I can prevent gum disease by effectively brushing my teeth.	1.6	0.8	2.4	4.8	60.8	34.4	95.2
35.	I believe that I can prevent gum disease by effectively cleaning between the teeth.	2.3	2.3	5.5	10.4	56.3	33.6	89.9
36.	I believe that , if both of my parents or one of them have bad teeth, brushing and flossing will not help my teeth.	11.6	5.4	12.4	29.4	32.6	38.0	70.6
37.	I believe that by brushing/ cleaning in between my teeth I am less susceptible tooth decay and gum disease.	1.6	0.0	7.8	9.4	52.3	38.3	90.6
38.	I believe that tooth loss is part of growing old.	0.8	7.2	44.3	52.3	33.6	14.1	47.7 *
39.	The health of my teeth and gums are a matter of good luck.	8.7	4.8	7.1	20.6	36.5	42.9	79.4

Frequencies are shown in reverse order of response for Q 33, Q36, Q38 and Q39.

Table 20.5 Frequency distribution of Self-efficacy (diabetes control) (n=100)

Response; not applicablel(1),not at all likely(2),not likely(3),likely(4),very likely(5). (-)N(1+2+3), (+)P(4+5). Notation(*) denotes lesser self-efficacy(i.e. <50%)

Beliefs in regards to the following statements by respondents:

item	Description	Frequency distribution(%)						
		1	2	3	N(-)	4	5	P(+)
40.	I am confident diabetes control is my own responsibility	0.8	5.5	10.7	17.0	35.0	48.0	83.0
41.	My diabetes remains under control best if I meet other diabetics.	4.5	6.2	28.6	39.3	47.4	13.5	60.7
42.	If my diabetes is going out of control, it will do so no matter what I do.	5.3	11.3	21.1	37.7	43.7	18.6	62.3
43.	If I am able to avoid complications, it will be because others(doctors, nurses,family friends) have been taking good care of me.	3.0	22.6	34.6	61.2	30.1	9.7	39.8*
44.	Avoiding complications is largely a matter of good fortune.	2.3	9.7	12.8	24.8	43.6	31.6	75.2
45.	I will probably develop complications no matter what I do.	4.2	0.8	15.0	20.0	54.4	25.6	80.0
46.	I have so many worries in my life that my diabetes will not stay under control	1.5	3.6	21.1	26.2	51.2	22.6	73.8
47.	If my diabetes goes out of control it is usually by accident.	4.0	1.0	9.8	14.8	60.4	24.8	85.2

Frequencies are shown in reverse order of response for items except Q40.

The summation scores are provided in Tables 20.6 & 20.7.

Table 20.6 Summation scores for Self-efficacy

Description (Summation scores)	Mean (SD)	Min	Max	Subjects	Alpha
Toothbrushing Self-efficacy	**42.4(9.6)**	**12**	**60**	**133**	**0.9319**
Interdental-cleaning Self-efficacy	**38.9(10.3)**	**12**	**60**	**133**	**0.9527**
Dental-visit Self-efficacy	**25.1(5.6)**	**8**	**40**	**127**	**0.8527**
Oral health belief Self-efficacy	**27.5(3.7)**	**12**	**35**	**127**	**0.6633**
Diabetes control Self-efficacy	**30.5(5.0)**	**8**	**38**	**100**	**0.6398**

SD=standard deviation

In order to provide a measurable variable for self-efficacy the summation of scores were defined. Dental self-efficacy summation scores represent the dental hygiene domains of toothbrushing, interdental cleaning and dental visit as depicted below. Although it would be pertinent to separate health self-efficacy and dental self-efficacy, it is evident from Syrjala et al., (1999) and Kneckt et al., (1999) studies that dental and health self-efficacy are associated. Therefore, the combination of dental self-efficacy score, oral health belief scores and diabetes control self-efficacy score represent the health behaviour self-efficacy score in this study.

Dental self-efficacy = (toothbrushing SE+ Interdental cleaning SE + Dental Visit SE)

Health Behaviour Self-efficacy = (tootbrushing SE+ Interdental cleaning SE+ Dental Visit SE+ oral health belief SE+ diabetes SE)

Table 20.7 Summation scores for Dental Self-efficacy and Self-efficacy (health behaviour)

Description (Summation scores)	Mean (SD)	Min	Max	Subjects	Alpha
Dental Self-efficacy	**106.7(20.2)**	**34**	**147**	**124**	**0.9496**
Health behaviour Self-efficacy	**164.5(25.1)**	**93**	**207**	**89**	**0.9436**

SD=standard deviation

Analysis by one-way ANOVA did not show any significant difference between OH+Sc, OH and control groups (Table 20.8).

Table 20.8 Summation scores for Dental Self-efficacy and Self-efficacy by groups

Description (Summation scores)	Mean(SD)	Min	Max	Subjects
Dental Self-efficacy				
OH+Sc	**105.4(20.2)**	**56**	**147**	**42**
OH	**109.8(19.1)**	**34**	**146**	**43**
Control	**104.4(21.7)**	**37**	**147**	**38**
Health behaviour Self-efficacy				
OH+Sc	**162.6(28.1)**	**93**	**205**	**28**
OH	**166.9(20.3)**	**93**	**207**	**33**
Control	**163.1(28.1)**	**93**	**206**	**27**

SD=standard deviation. Between groups NS(one way ANOVA)

An independent t test was performed in Table 20.9 to find out the relationship of self-efficacy sum scores and self-reported oral health practices. The results showed that at baseline, dental self-efficacy (SE) showed a significant association with acceptable dental visits ($p<0.05$) and acceptable interdental cleaning ($p<0.05$). After oral health

intervention at 3 months, the association improved in association with acceptable interdental cleaning and dental SE ($p<0.01$). The association was also observed for health behaviour SE (HB-SE) and interdental cleaning ($p<0.01$). At nine months, both SE sums scores showed a significant association with oral hygiene compliance criterion ($p<0.05$).

Table 20.9 Self-reported practices and Self-Efficacy sum scores t test

(independent t test)	N	Dental-SE mean (± SD)	p	N	HB-SE mean (± SD)	p
Acceptable Dental Visit at baseline						
Yes	64	110.4(18.7)	p<0.05	40	168.8(22.6)	NS
No	57	102.4(21.5)		47	160.5(27.04)	
Acceptable interdental cleaning at baseline						
Yes	38	111.53(19.4)	p<0.05	27	168.2(23.9)	NS
No	73	103.73(17.9)		50	161.2(22.9)	
Acceptable interdental cleaning at 3 months						
Yes	60	112.02(18.1)	p<0.01	45	172.1(22.1)	p<0.01**
No	51	101.35(19.6)		36	157.4(24.9)	
9 months Oral Hygiene Compliance(unacceptable)						
Yes	84	104.6(19.9)	p<0.05	60	161.8(25.4)	p<0.05*
No	28	113.7(13.7)		19	175.6(16.7)	

In order to test oral hygiene compliance and health behaviour self –efficacy the summation mean scores were then categorized into quartiles for the purpose of utilizing Self –efficacy as an independent variable in the regression analysis.

Table 20.10 shows the frequency distribution by quartile Likert like scale for Self-efficacy categories.

Table 20.10 Frequency of Self-efficacy categories in quartiles (Likert scale) from low (1) to high (4)

Self-efficacy	n	1(%) Lowest	2(%) low	3(%) high	4(%) highest
Toothbrush	133	36(27.4)	29(21.8)	39(29.3)	29(21.8)
Interdental Cleaning	133	25(18.8)	40(30.1)	36(27.1)	32(24.1)
Dental Visit	127	32(25.2)	34(26.8)	26(20.5)	35(27.6)
Oral health Belief	126	30(23.8)	25(19.8)	33(26.2)	38(30.2)
Diabetes control	100	20(21)	24(24)	35(35)	20(20)
Dental	124	32(25.8)	32(25.8)	30(24.2)	30(24.2)
Health behaviour	89	22(24.7)	22(24.7)	23(25.8)	22(24.7)

4.3 ANALYSIS OF MULTIFACTORIAL VARIABLES AFFECTIING ORAL HYGIENE COMPLIANCE BY STRUCTURAL EQUATION MODELING

Structural equation modeling is often used in behavioural sciences to provide a wider understanding of the behaviour in question. The analysis of factors that contribute to oral hygiene compliance in the previous analyses has given some insight to some of the possible factors involved. However, the determinations of these factors are limited to assumptions that have to be taken into account such as nonlinearities, modeling interactions, correlated independents, and multicollinearity. A pathway analysis of these factors through structural equation modeling (SEM) is considered to be advantageous as it takes into account the above limitations that are inherent in multiple regression models. In addition, SEM allows testing over all models in contrast to testing coefficients individually and also in reducing measurement error. SEM also has the ability to handle difficult data with non-normal and incomplete data sets. Path analysis is considered as a method to test theoretical relationships in contrast to causal relationships (Wright, 1960). Observed variables are analyzed for its' direct or indirect effect in the model. Oral hygiene compliance is multifaceted and traditionally studies have relied on determination methods that have to take into account such as nonlinearities, model interactions, correlated independents and multicollinearity (Der, 2002). To overcome these limitations, researchers have commonly utilized structural equation modeling in behavioural science, social science and educational research to provide a wider understanding of the behaviour in question. Cross sectional research in oral health behaviour has been documented by Okada et al., (2001), Kawamura et al (2001a), Aleksejuniene et al., (2002 a & b), Shinohara et al., (2005) and health services usage by Dobalian et al., (2003). Newton & Bower (2005) also advocated the use of SEM in research work to determine social aspects of oral health. The advantages of

SEM allows the use of pathway analysis in testing over all models in contrast to testing coefficients individually and also in reducing measurement error and it also has the ability to handle difficult data with non normal, non-continuous and incomplete data sets (Singh-Manoux et al, 2002).

The study proposes to conduct a pathway analysis for the factors associated with oral hygiene compliance. The present data collected was designed to test the hypothesis of the effects of intervention among three therapeutic regimes in relation to oral hygiene compliance bearing in mind that there was a sample size of 161 at baseline with a reduced sample size at 3 months and 9 months. The study recognized that a sample size less than 200 cases may be associated with unstable parameter estimates and significance lacks power (Loehlin, 1992). Since the aim is to confirm the path analysis in accordance with the direction of the path coefficient, the critical ratio and significance of path coefficient is the main criteria that will be used to assess validation of factors associated with oral hygiene compliance. Critical ratio (CR) >1.96 for a regression weight is considered as significant at the 0.05 level. Ideally, a model is accepted or rejected based on a Goodness of fit tests. The accepted Goodness of Fit Index GFI (Joreskog-Sorbom) cutoff is (>0.90) and Root Mean Square Error of Approximation (RMSEA) cut-off is (≤0.05), Model chi-square (discrepancy) is also used to test the model fit. It should not exhibit significance if the model fit test is good. Maximum Likelihood estimation method was used as the standard method.

4.3.1 The Model

To test the oral hygiene compliance model the following model was adopted to conduct a pathway analysis by structural equation modeling.

It is hypothesized that,

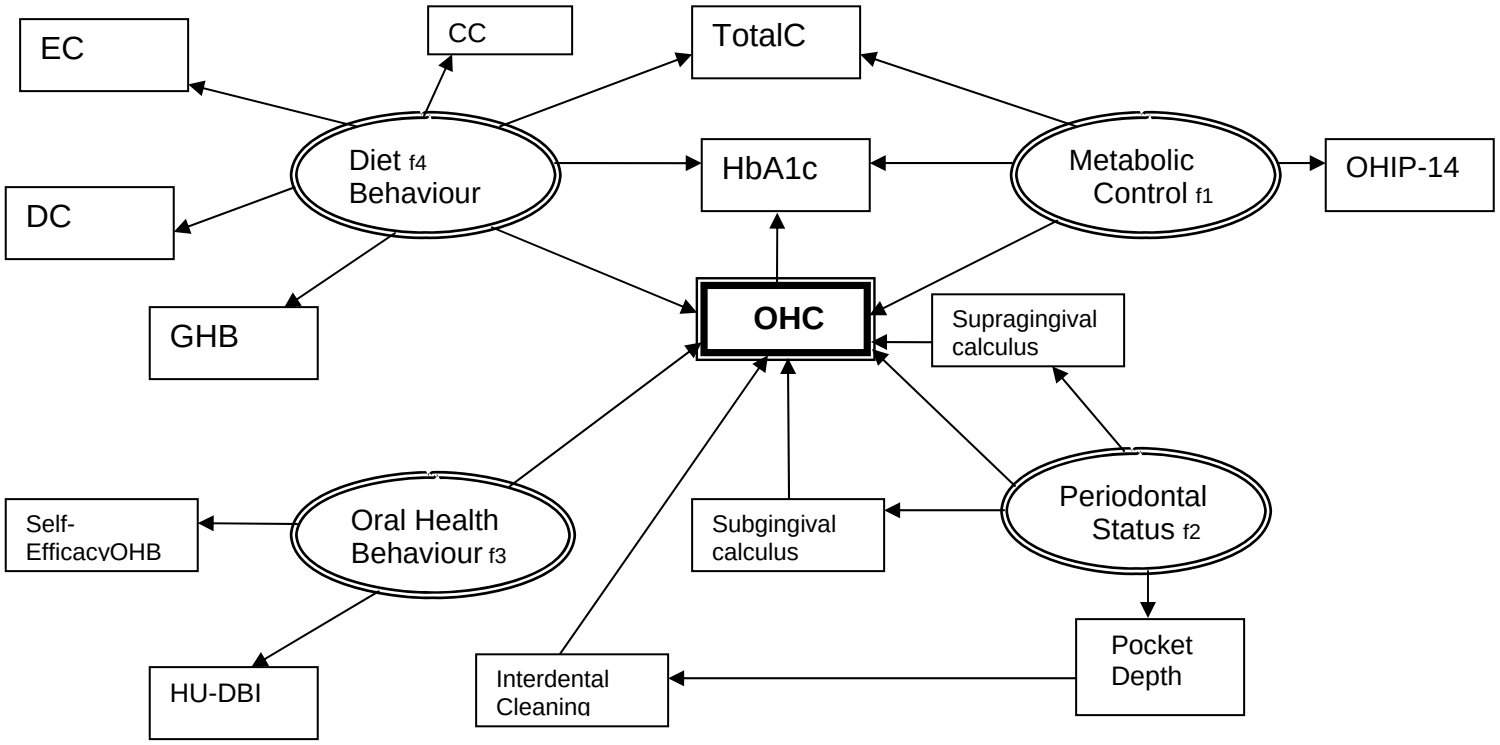
- Oral hygiene compliance criterion is believed to be causally linked to periodontal health (latent variable) with Calculus and probing pocket depth (measurable variables). It must be noted that OHC criterion itself is a derivation from BOP and Plaque and is subject to causality to periodontal health status. Presence or absence of calculus and interdental cleaning may also moderate the OHC status.
- Metabolic control as a latent variable is also believed to be causally linked to HbA1c, total cholesterol. OHIP-14S that measures impact of oral health quality of life is also believed to be associated with outcome assessments. Adding this measurable variable provides an added quality of life construct to the metabolic control latent variable.
- Oral health behaviour (OHB) as a latent variable is also believed to be causally linked to HU-DBI as a measurable behaviour data. Self-efficacy is also believed to be an explanatory theory for oral hygiene behaviour.
- The latent variable for diet behaviour is also believed to be linked with variables extracted from general health questionnaires such as GHB (general health behaviour), DC (Diet Control), EC (Energy control) and CC (Confidence control). Diet behavior is believed to moderate metabolic control through HbA1c and total cholesterol status.

The linkages of measurable and latent variables are intended to provide the basis of analysis for confirming these factors that influence oral hygiene compliance.

The analysis was conducted based on the "*a priori"* hypothesis model as mentioned above. The models were tested on different combinations of measurable variables at baseline, 3months and 9 months evaluations. In order to test the predictability of baseline factors on 9 months oral hygiene compliance, baseline measures were also tested for OHC at 9 months. As interventions may have affected the outcome through measurable variables differences, these differences were also tested.

To compensate for missing data, mean imputed models and last carry forward models were also conducted. A flow chart of the proposed model is summarized and depicted in figure 8.

Figure 8 Oral Hygiene Compliance Theoretical Model



OHC= oral hygiene compliance, OHB=oral health behaviour, GHB=general health behaviour, DC= Diet control, EC= Energy control, CC= Confidence control, TotalC=totalcholestrol

f1= metabolic control; f2= periodontal status; f3= oral health behaviour; f4=diet behaviour

4.3.2 STRUCTURAL EQUATION MODELING (PATHWAY ANALYSIS)

A systematic evaluation of models was tested for:

1. Original model (O): unacceptable oral hygiene compliance (9 months) is tested against baseline data for measurable variables at baseline such as subgingival calculus, supragingival calculus, HBA1c, total cholesterol and acceptable interdental cleaning at baseline. Self-efficacy for health behaviour (hbSE), general health behaviour (GHB), energy & control (EC), confidence & control (CC), OHIP-14 categories exhibiting impact or OHIPless (Ohpl), OHIP-14 categories exhibiting no impact or OHIPhigh (Ohph), HU-DBI 13items categories exhibiting lesser improvements in behaviour or HUless (HUl) and HU-DBI 13items categories exhibiting higher or improvements in behaviour or HUhigh (HUh) were the consistent final outcome variables that were used in all models.

To compensate for limited data, mean imputed data (Mn) and last carry forward (lcf) data was also used to analyze the models as well as raw data (Raw). Table 21 shows each model for Original in Raw, Mean imputed and last carry forward models denoted as ORaw, OMn and Olcf respectively.

2. Dichotomized HbA1c model (D). To find the effect of unacceptable HbA1c (≥ 8%) levels vs. acceptable HbA1c (< 8%) was used to test the models. These models are prefixed with 'D" in the model description. For example DORaw means HbA1c dichomtomized original raw data model.

3. Baseline model (B). This model is tested on all baseline measurable variables; especially oral hygiene compliance at baseline is tested against baseline data for measurable variables at baseline such as subgingival calculus, supragingival calculus, HbA1c, total cholesterol and acceptable interdental cleaning at baseline. Table 21 shows each model for Baseline models in Raw, mean imputed and last carry forward

models denoted as BRaw, BMn and Blcf respectively. Consistent final outcome variables remain the same. A dichotomized baseline model will read as DBRaw.

4. Three months model (3). Three months' data is denoted with the prefix "3". Similarly to baseline model 3 months Raw, mean imputed and last carry forward models denoted as 3Raw, 3Mn and 3lcf respectively. Consistent final outcome variables remain the same. A dichotomized baseline model will read as 3DRaw.

5. Three months difference model (3df). This model uses data as a difference from baseline to 3 months instead of 3 months measurable data. Three months difference data is denoted with prefix "3df" and the model follows the same pattern
Raw, Mean imputed and last carry forward models denoted as 3dfRaw, 3dfMn and 3dflcf respectively. Consistent final outcome variables remain the same.

6. Nine months model (9). Nine months data is denoted with the prefix "9". Similarly 9 months Raw, mean imputed and last carry forward models are denoted as 9Raw, 9Mn and 9lcf respectively. Consistent final outcome variables remain the same. A dichotomized baseline model will read as 9DRaw.

7. Nine months difference model (9df). This model uses data as a difference from baseline to 9 months instead of 9 months measurable data. Nine months difference data is denoted with prefix "9df" and the model follows the same pattern
Raw, mean imputed and last carry forward models denoted as 9dfRaw, 9dfMn and 9dflcf respectively. Consistent final outcome variables remain the same.

4.3.3 SEM Results

Table 21 shows the outcome of the above models tested in term of Goodness of Fit (GFI), Chi-square (discrepancy) and RMSEA. Goodness of fitness tests could not confirm model fit. The best fit was observed on 9 months difference with last carry forward data where GFI showed .8818 and RMSEA at .0797; however they did not reach levels of significance for a good model fit. With a good sample size this model may improve. Chi-square (discrepancy) values did not correspond with GFI and RMSEA.

Since the focus of the analysis was to observe the significance of path coefficients of various latent variables, the critical ratio (CR) for a regression weight is assigned to each variable in Table 21. Only the values of variables that exhibit CR of >1.96 depicts the path significance at the 0.05 level are marked in the columns.

In Table 21. the presence of subgingival calculus is consistently and strongly associated with unacceptable oral hygiene compliance from all models and data seems to be considerably stable. CR ranging from 2.1 to 7.4 was obtained.

The presence of supragingival calculus was not significant, except when the presence was negatively associated with unacceptable oral hygiene compliance in the negative direction at only post intervention assessments. It must be taken into account that intervention effects may have contributed to this finding as well as covariance effects from calculus removal. The data is not considered stable to conclude the findings.

HbA1c was found to be significantly associated with unacceptable oral hygiene compliance utilizing baseline data with a CR range of 2.2 to 2.6. In addition, there was a detection of CR 2.9 at 9 months when HbA1c dichotomized raw data was used. The results may suggest that the higher the HbA1c the more likely that the subject will have unacceptable oral hygiene compliance at baseline.

The association of unacceptable oral hygiene compliance and latent variable metabolic control (f1) was found but data showed both pathway direction and considered to lack stability and no definite conclusion could be reached with this data set.

The association of unacceptable oral hygiene compliance with latent variable periodontal status (f2) was more consistent at post intervention assessments with a CR range of 2.6 – 14.1. The direction also indicates a positive correlation.

There was a negative association between acceptable interdental cleaning and unacceptable oral hygiene compliance in a negative direction when it was analyzed by 3 months difference model with a CR of -2.17. As this was the only finding in all models the finding cannot be conclusive and the data considered not stable.

Acceptable interdental cleaning and periodontal status showed a negative association with a CR range of -2.5 to -4.9.However, there were some observations with positive significance at 3month difference and 9 months difference indicating that the relation will have to be interpreted with caution from this data set.

The three measurable variables that provided the latent variable f1 (metabolic control showed some significant association separately. The association of f1 latent variable with total cholesterol CR range 2.3 and oral health impact lesser improvement CR range 2.8-2.9 was found to be in the positive direction. HbA1c was found to be associated only at 3 months and 9 months difference level CR range 3.0-6.3. The results show that the three variables are indicative that they do play a part in metabolic control with an added dimension of oral health quality of life.

OHIP-14 was divided into improved quality (high) and lesser quality (lesser) and the association with latent variable f1 was considerably consistent indicating that lesser quality was predominant where positive association were observed in the lesser quality and negative association were observed on improved quality (higher) simultaneously

(i.e. the direction changes in consistency with the direction). There were some negative direction findings for 9 months difference model. The data may not be considered stable for latent variable f1 (metabolic control).

HU-DBI was also divided into improved behaviour (high) and unimproved behaviour (lesser). The association with f1 was consistent with lesser improvements in oral health behaviour and showing consistency in direction similar to OHIP-14 path direction. These observations were only seen in 3 and 9 months difference data that is in accordance with the observed data change from baseline. However, this data must be concluded with caution.

It is noteworthy that Self-efficacy, general health behaviour, energy & control, confidence and control variables did not show significant trend with oral hygiene compliance although it was analyzed in the model. This may be due to the fact that the there was not enough power to interpret the associations with the present model.

Conclusion

The pathway analysis confirmed that factors such as the presence of subgingival calculus and unacceptable HbA1c at baseline contributed to unacceptable oral hygiene compliance. The practice of acceptable interdental cleaning was also associated with acceptable oral hygiene compliance when it was analyzed at the 3 months difference model indicating the importance of acceptable interdental cleaning.

Table 21 Structural Equation Modeling of Oral Hygine Compliance (critical ratios provided for measurable and latent variables)

	GFI	χ^2	χ^2 df	pr> χ^2	rmsea	ohc& sub	ohc & sup	ohc & hba	ohc& f1	ohc& f2	ohc& interd	inter d& f2	tchol & f1	Hb& f4	Ohpl& f1	Ohph& f1	Hul& f3	Huh& f3	HbA& f1
ORaw	0.7049	162.2	87	0.0001	0.1508	2.1			-3.3						9.1	-8.0			
OMn	0.7996	349.3	87	0.0001	0.1344	4.0		2.4											
Olcf	0.7992	349.6	87	0.0001	0.1344	4.1		2.4											
DORw	0.7049	154.6	87	0.0001	0.1429	2.1			-3.4						9.4	-8.2			
DOMn	0.8021	343.7	87	0.0001	0.1329	4.1			3.9										
DOlcf	0.8017	343.8	87	0.0001	0.1329	4.1		2.3	4.1						-1.99				
BRaw	0.6627	193.3	88	0.0001	0.1798	4.3		2.5							2.1				
BMn	0.8092	320.1	88	0.0001	0.1275	7.4		2.6	-4.7				2.3		2.8				
Blcf	0.8096	320.2	88	0.0001	0.1257	7.4		2.6	-4.7				2.3		2.9				
DBRw	0.6578	201.6	88	0.0001	0.1868	3.9		2.2							4.5	-3.4			
DBMn	0.8095	320.4	88	0.0001	0.1258	7.3		2.5			6.0	-4.9			2.2	-2.2			
DBlcf	0.8085	322.7	88	0.0001	0.1264	7.3		2.4		2.6	4.9	-3.1							
3Raw	0.6664	197.2	120	0.0001	0.1739	6.9	-4.2								3.0	-3.0			
3Mn	0.8322	276.5	120	0.0001	0.1133	6.8				4.6					2.8				
3lcf	0.8204	292.7	120	0.0001	0.1180	7.0			-3.6	8.9					2.2				
3DRw	0.6707	194.2	120	0.0001	0.1716	7.4	-3.7								2.3	-2.3			
3DMn	0.8291	293.0	120	0.0001	0.1181	6.6				8.4									
3Dlcf	0.8231	304.8	120	0.0001	0.1215	6.7			2.6	5.1									
3dfRw	0.7035	148.3	88	.0001	0.1361										6.8	-6.6			
3dfMn	0.8606	234.9	88	0.0001	0.1000				2.2		-2.17	3.6					1.96	-2.0	5.1
3dflcf	0.8662	226.4	88	0.0001	0.0970	-2.2			2.2	4.1									6.3
9Raw	0.6429	190.5	88	0.0001	0.1879	2.5	-2.4					-2.5			2.8	-2.7			
9Mn	0.8329	282.3	88	0.0001	0.1150	5.9	-2.3												
9lcf	0.8354	268.8	88	0.0001	0.1109	5.5	-2.3			14.1									
9DRw	0.6568	176.0	88	0.0001	0.1741	3.6	-3.2	2.9			1.98	-2.5			3.9	-3.7			
9DMn	0.8296	27442	88	0.0001	0.1126	6.3	-2.5								-3.0	2.6			
9Dlcf	0.8309	263.5	88	0.0001	0.1093	6.0	-2.4								-3.5	2.7			
9dfRw	0.7289	117.8	90	0.0261	0.1015		3.0								19.4				
9dfMn	0.8739	185.7	90	0.0001	0.0798	3.9						2.4			-2.9	-4.3	2.7	-3.0	
9dflcf	0.8818	185.4	90	0.0001	0.0797		2.1												3.0

ORaw=originraw, OMn=originmean, Olcf=originlastcarryforward, DORw=dichotmizedoriginraw, DOMn= dichotmizedoriginrmean, DOlcf= dichotmizedoriginlastcarryforward, Braw=BaselineRaw, BMn=BaselineMean, Blcf=Baselinelastcarryforward, DBRw= dichotmizedbaselineraw ,DBMn= dichotmizedbaselinemean, DBlcf= dichotmizedbaselinelastcarryforward, 3Raw=3monthsRaw, 3Mn=3months mean, 3lcf=3monthslastcarryforward, 3DRw= 3monthsdichotmizedraw, 3DMn= 3monthsdichotmizedmean, 3Dlcf= 3monthsdichotmizedastcarryforward, 3dfRw=3monthsdifferenceraw, 3dfMn=3monthsdifferencemean, 3dflcf=3monthsdifferencelastcarryforward, 9Raw=9monthsraw, 9Mn=9monthsmean, 9lcf=9monthslastcarryforward, 9dfRw=9monthsdifferenceraw, 9dfMn=9monthsdifferncemean, 9dflcf=9monthsdifferencelastcarryforward. Ohc=unacceptableoralhygienecompliance, sub=subgingivalcalculus, sup=supragingivalcalculus, hba=HbA1c, interD=acceptableinterdentalcleaning, chol=totalcholesterol,Ohpl=ohiplesser,Ohph=OHIPhigher,Hul=HUDBIlesser, Huh=HUDBIhigher ; f1= metabolic control; f2= periodontal status; f3= oral health behaviour; f4=diet behaviour

Diabetes has been recognised as one of the key risk factors associated with destructive periodontal disease. The purpose of the present study is to evaluate the effectiveness of an oral health promotion programme in improving periodontal health and to explore factors associated with oral hygiene compliance in a cohort of patients with diabetes in Singapore.

5.1 ASSESSMENT OF ORAL HYGIENE COMPLIANCE AND ASSOCIATED FACTORS

5.1.2 Knowledge on the cause of periodontal disease

Baseline

The knowledge scores were based on two essential knowledge items: 'ineffective oral hygiene' and plaque (bacteria) as the cause for gum infection. At baseline, less than 50% knew the cause of gum disease that was consistent with other studies (Thorstensson et al., 1989; Moore et al., 2000; Taiwo, 2000). Studies have shown that increase in knowledge is not necessarily a prerequisite for behavioural change (Stetson, 2000; Kay & Locker, 1998). However, knowledge was found to be essential as a motivational tool in oral hygiene compliance programmes (Toassi & Petry, 2002). It was found that two thirds of the study group did not believe that they were at risk of periodontal disease, this was further compounded by the fact that, they were neither informed nor were they aware that they were at risk to periodontal disease. The findings were consistent with Moore's study (2000). The fact that the study cohort had a low level of knowledge and perceived risk regarding susceptibility to periodontal disease highlighted the need for oral health promotion among the group to increase oral health awareness.

Post-Intervention

Following oral health education intervention, at three months, OH+Sc group and OH group showed a marginal gain in knowledge for the cause on gum infection indicating that there was some cognitive gain. No differences were found between the different treatment groups. Notably, 10 % of subjects still harbored folklore beliefs such as 'heatiness' as the cause of gum disease at both baseline and three months. In addition the cause of gum disease attributed to 'sugar and sweets ' was a source of confusion among the study group by three months. Responses on 'Vitamin C' as the cause for gum infection remained unchanged at baseline and 3 months. The finding suggests that it is difficult to change people's traditional beliefs on certain health related matters (Soh, 1992; Roberts Thomson & Spencer, 1999)

5.1.3 Attitudes

To evaluate the oral health attitudes, behaviour and perceived oral health quality, the oral health impact profile (OHIP-14) and Hiroshima University Dental Inventory (HU-DBI) were used at baseline and at the end of the programme at 9 months.

OHIP-14

The oral health impact profile (OHIP-14) was used at baseline to provide a measurement on self-perceived oral health quality of life and change if any following clinical interventions.

Baseline

The frequency distribution shows that the highest affected means were identified for items 4, 5 and 3 at both baseline and 9 months. These items are related to physical pain and psychological discomfort. At baseline, the assessment of OHIP-14S showed a significant association with self-reported periodontal signs and symptoms over the past 3 months. The findings were consistent with a study reported in Hong Kong by Ng and Leung (2006). It must be noted that the Hong Kong study was a cross sectional study conducted on a larger (>700) study cohort and it did not compare the change in OHIP-14S after intervention.

Post-Intervention

There were no significant between group differences at 9 months. The results may imply that there was no marked impact in oral health quality of life despite the intervention. Currently, there are no other studies reported that could be used to compare the utility of OHIP-14 in a diabetic population. It should also be noted that OHIP-14 scores are not highly responsive to change and it would require a scale difference of 5 units to detect change with a large sample size as indicated by Locker et al., (2004). However, these findings reported by Locker were not periodontal related findings. It is estimated that 250-300 subjects would be required per group to make a meaningful detection of quality of life change (Machin and Fayers, 1998). The present study falls far short of the required sample size.

A comparison of OHIP-14S within group changes indicated that there was overall difference at the end of the programme. However, this was in the negative direction and there were no within group differences among the study groups. A subscale analysis indicates that Physical Pain was the domain that contributed to the difference.

When this difference was stratified it was found that this was observed in the OH+Sc group. The results may suggest that the experience of pain during and after instrumentation may have influenced the negative responses as shown by Pihlstrom et al., (1999) and van Steenberge et al., (2004). It is uncertain whether, OHIP-14 responses recorded later at 15 months would have negated these effects on the OH+Sc group as time and type of illness or condition can mitigate quality of life responses. The presence of the tooth sensitivity after scaling from OH+Sc may have contributed to this anomaly.

Even with the limitation on sample size, OHIP-14 managed to pick up the physical pain subscale affecting the OH+Sc within group changes and can be deemed to be sensitive to changes. The change may be due to post-operative tooth sensitivity following root instrumentation rather than pain due to progession in disease as there were no results indicating periodontal disease progression. There are other instruments that can offer an alternative for OHIP-14; the Oral health quality of life instrument OHQol-UK 16 items may be a potential instrument as it was shown to correlate well to periodontal conditions (Needleman et al., 2004). However, the study was conducted on a cross- sectional study design and was not evaluated on a longitudinal basis as in the current experimental design. This instrument could also be tested for sensitivity to periodontal health related quality of life change in the future. There are distinct contextual differences between OHQol-UK and OHIP-14. Physical pain is not mentioned explicitly in OHQol-UK 16 items. OHQol-UK 16 items are based on oral symptoms, physical aspects, psychological aspects and social aspects. In assessing the effect response, the scale allows for a neutral response and provides a positive and negative response in contrast to a one-way response for OHIP-14 items. An alternative is the generic HRQL (Health related quality of life) instrument. Sandberg and

Wikblad (2003) used oral health variables such as dissatisfaction of teeth and mouth, feeling of dry mouth and other socioeconomic variables to analyze HRQL.The instrument has yet to be tested on periodontal health related quality of life.

The 2005 Cochrane report (Beirne et al., 2005) on the effects of scaling and polishing carried out on normal adults critiqued the lack of studies addressing quality of life issues and the adverse effects of scaling and polishing such as tooth sensitivity (Brothwell et al., 1998). Although tooth sensitivity is bothersome it may not necessarily reflect the periodontal health quality of life related to the final periodontal health improvements. Peridontal health quality of life specific domains such as feeling of cleanliness and mouth refreshening appeal (related to mouth odour) are some of the areas that can be supplemented in conjunction with current oral health quality of life instruments. Naito et al., (2006), observed a similar and unique situation and noted that very few studies reported quality of life for malocclusion and orthodontics since orthodontic conditions are generally asymptomatic and related outcomes are esthetic in nature.

An ordinal regression of OHIP-14 suggests that improvements in oral health quality of life may not reflect on improvements in oral hygiene compliance as treatment groups did not report better OHIP-14 and it may not be related to treatment rendered. In consideration of these findings it is recommended that post operative OHIP-14 assessments to be conducted at 15 months after treatment with a larger sample size for future studies. The association of oral health behaviour self-efficacy and improvements in oral health quality of life should be viewed with caution for the similar reasons mentioned above.

HU-DBI

Hiroshima University Dental Behaviour (HU-DBI) inventory was primarily designed to measure the dental behaviour of a study cohort and to provide a measurable variable for analysis with other related factors.

Baseline

At baseline, amongst the respondents only a small proportion checked in the mirror after brushing their teeth (24%) and even less professed spending enough time on brushing teeth (16.7%). In contrast, 87% of Greeks and 50% of Japanese students checked their teeth with the mirror after tooth brushing. 32% of Greek students and 50% of Japanese students felt they spent enough time on toothbrushing (Polychronopoulou & Kawamura, 2005). The low response among the diabetics in this study may reflect a lower priority given to oral cleanliness that needs to be addressed in oral health programmes. Nevertheless, there was an improvement in self-check behaviour following the implementation of the programme at 3 months, indicating increased awareness.

Post-Intervention

HU-DBI 13 items: A low internal consistency was observed for the Total Kawamura 20 items, Cronbach Alpha 0.55 (baseline), 0.49 (9months) as compared to an internal consistency of Cronbach Alpha 0.80 in the study by Kawamura et al., (1998) in their study. The elimination process of some of these items resulted in 13 items HU-DBI compared to Kawamura's 12 items. The elimination allowed a strengthening of Cronbach alpha values for both baseline (0.62) and 9 months (0.59). The disparity could be due to a different target population being assessed with different sets of oral health problems. The sum score from 13 items HU-DBI forms the basis for comparison on behaviour for this study group at baseline and 9 months.

In Kawamura HU-DBI 12 items studies, it was shown that highly educated young age group in Japan and Israel HU-DBI mean scores ranged from 5.33 to 5.97 (Kawamura et al.1997, 2000; Levin and Shenkman 2004). The present study used HU-DBI 13 item score, the results showed a score of 6.9 (±1.6) at baseline and 7.4 (±1.8) at 9 months. The components of HU-DBI 12 item differs from the current 13 items, the former results included a highly educated cohort and may not be applicable in the local context where it represents a cohort of adult patients of diabetes presenting with a wider range of background education and socio-economic status.

Kawamura et al., (1998) however reported in their study that dental health behaviour among diabetics and non-diabetics were similar using HU-DBI criteria. In this study, healthy controls were not included; therefore it will be difficult to conduct a similar comparison. However, the study allows comparison between groups and within groups at different timelines. Previous comparative studies utilizing HU-DBI as an outcome measure showed improvements through oral health education among dental hygiene students and nurses. The results showed HU-DBI score improvements from year 1 to year 2 among dental and nursing students but the scale of improvements were seen among the dental hygiene students compared to nursing students in a survey (Kawamura et al., 2000). In the present study, there was a significant difference observed from baseline to 9 months showing improvements in dental behaviour. However, the difference was observed for only within oral hygiene group, no significant difference was found between the three groups. The responses HU-DBI responses were based on a positive and negative dichotomous scale response. Currently, there is limited data utilizing HU-DBI in a diabetic population for comparative purposes.

An ordinal regression on HU-DBI 13 items showed that males were more likely to be reporting a higher behaviour inventory score than the females. The treatment group did not affect any association at this level of analysis. No differences were found between the treatment groups. Although, data showed limitation in the study, the analysis provides a basis for comparison with other studies based on its' strengths and weakness.

5.1.4 Oral health practices

Good oral health behaviour is usually determined by toothbrushing frequency, interdental cleaning frequency and regular dental visits and these variables are often used as indicators of compliant oral health behaviour (Beals et al., 1987; Wilson, 1996). The results of the study indicated that the participants have reasonable toothbrushing habits; at least 75% reported brushing at least twice a day. However, the majority of the participants did not practise acceptable interdental cleaning.

Acceptable interdental cleaning

Baseline

Research indicates that interdental regions are most likely to be affected by periodontal disease (Hugoson & Koch, 1979). Interdental cleaning have been found to be associated with improved periodontal health (Lang et al., 1977; Hugoson & Koch, 1979; Waerhaug, 1981). Lack of interdental cleaning may therefore pose as a 'risk behaviour' to periodontal disease particularly so in patients with diabetes who are already more susceptible to periodontal disease. Interdental cleaning using toothpicks was practised by about one third of the cohort, flossing and the use of interdental brush

was used less commonly. However, the use of traditional toothpicks is often observed among individuals for the sole purpose of removing food particles between the teeth. Toothpicking for removing plaque are not commonly recommended by the dental profession in Singapore. It would perhaps be feasible to modify toothpicking habits as a means to improve oral hygiene. Soh (1992) reported 35% of the population practised flossing as compared to 19.3 % who floss and 17.6% who use the interdental brush in the current study. The low level of interdental cleaning among a non high-risk cohort may not be crucial for periodontal health, but the absence of interdental cleaning may be critical amongst a high-risk group of diabetics (Karikoski et al., 2003).

Post Intervention

Oral hygiene+scaling group was found to be 3.5 times more likely to practise acceptable interdental cleaning more than the control group at 3 months reflecting that the programme did help to improve the dental awareness of the participants. The same improvements of oral hygiene + scaling group was found compared to oral hygiene group although this difference was not statistically significant. The better compliance could be due to the interaction with the operator during therapy, the removal of the plaque retention factors during scaling also facilitates the use of interdental device. Karikoski et al., (2003) report suggested that interdental cleaning was an important factor for controlling periodontal disease among diabetic patients and the effect of promoting interdental cleaning should therefore be beneficial for oral hygiene maintenance.

Dental Visits

It is generally accepted that regular dental visits is necessary for maintenance of oral health. Regular dental visits serve as a timely evaluation of dental diseases as well as to allow prompt treatment and feedback on oral health related matters. Regular maintenance care has been found to prevent relapse and deterioration of periodontal disease (Axelsson & Lindhe, 1981; Soderholm et al., 1982). In addition, the effectiveness of oral hygiene instruction depends on reinforcement carried out during the review appointments (Schou, 1998).

The majority of the study group was found not to be compliant in attending regular dental visits. The findings in this study are consistent with Thorstensson et al., (1989) based on patients with diabetes. The present study participants gave reasons for not attending regular dental visits due to social-economic reasons and low priority placed on oral health. Reasons given for attending were notably in pain oriented problems and restorations as compared with regular checkups and cleaning. It must be noted that in Singapore, the general population dental services utilization was low at 32 % (visit dentist once a year) as reported by Loh et al., (1995) and may be related to the social demographic factors. It will be incumbent upon future research to look into the poor dental services utilization in Singapore and how to improve dental visit behaviour for preventive reasons.

Health Behaviour

In studying the general health behaviour questionnaire responses, the fact that less than 50% of the study group was chewing adequately may indicate that there is area for

improvement in this respect. In summary, the study group was generally compliant with health related issues indicating positive attitude.

A Factor Analysis of the item responses from the health behaviour questionnaires produced 4 behaviour constructs. These construct were identified as 1) General health behaviour (GHB) 2) Diet & control (DC) 3) Energy & Control (EC) 4) Confidence & Control (CC).

These constructs are in contrast to Kawamura's (2001a) study where 4 domains were identified from the same set of questionnaire with a Japanese study cohort: GHB, Diet Control, Restricted Diet and PF (perceived fatigue) the differences could be due to different background factors.

Oral hygiene compliance criterion

Researchers have established the association of poor oral hygiene with gingivitis and periodontitis for some time (Loe et al., 1965; Axelsson & Lindhe, 1981; Haffajee et al., 1985). Improvement in oral hygiene practices has been shown to be associated with a concomitant improvement of periodontal status in terms of reduction in bleeding and gain in clinical attachment. Historically, individual indicators (plaque and BOP) for oral hygiene compliance have been used for determining compliance as surrogate endpoints. However, these individual indicators have not shown to be ideal indicators to precisely indicate oral hygiene compliance. It is obvious that the use of plaque score alone does not necessarily reflect the consistency in self performed oral hygiene. Furthermore, in a plaque re-growth study, it has been demonstrated that plaque could be detected as early as 3 hours after cleaning, even more so in the presence of sucrose supplemented diet (Lim et al., 1986). On the other hand, a low plaque score could still

be achievable if the individual cleans his teeth diligently just before the dental examination. Other studies looking into different levels of plaque or gingivitis scores as separate parameters have also failed to demonstrate these to be good predictors for periodontal disease progression (Lindhe et al., 1989.; Badersten et al., 1981, 1990; Claffey et al., 1990: Hujoel et al., 1997; MacGuire & Nunn, 1997, Renvert & Persson, 2004).

In view of the fact that not all patients are equally susceptible to periodontal disease despite the presence of plaque, some authors have advocated the use of BOP to plaque ratio (van der Velden et al., 1985; Abbas et al., 1986; Sastrowijoto et al., 1990b). By combining the two variables: the host response (as measured by BOP) in relation to plaque levels (plaque score) was measured; it could serve as a means to identify the level of susceptibility to gingival inflammation. However, this has not been shown to be a good indicator nor predictor for periodontal disease progression due to the inherent limitations in calculating the ratio. For example, if a bleeding /plaque ratio of 0.5 is used to depict low susceptibility, it merely reflects that the bleeding score is half that of the plaque score. An individual with a 50% BOP and 100% plaque would give the same ratio as an individual with 10% BOP and 20% plaque; while in reality the interpretation of the risk is obviously higher in the former case. Galgut (1988) pointed out that the relationship between BOP and plaque can be improved upon before being used as a predictor for likelihood of good gingival health.

Receiver Operating Characteristic (ROC) curve has been commonly used to evaluate the usefulness of diagnostic tests. ROC values of 0.8 and above are considered good estimates as demonstrated in the current study. Besides a high ROC estimate, the respective sensitivity, specificity, positive predictive value, and negative predictive value should also be high. The current study is one of the first attempts to explore the

utility of ROC in defining an appropriate optimal level of plaque and bleeding scores as a measure of compliance with oral hygiene. The use of a gold standard is a prerequisite in assessing the ROC curve; however, in the absence of such a gold standard, common periodontal parameters like probing depths and calculus were used as a composite score for different combination of plaque and BOP levels. The justification of including mean pocket depth and calculus is based on evidence that these variables may modify the presence and absence of BOP and plaque. The architecture of the pocket may become more complex for plaque removal as the pocket depth increases and the plaque retentive potential of calculus appear to be valid determinants of periodontal disease. In the ROC analysis, ≥ 25% mean plaque and ≥ 15 % mean BOP achieved the highest ROC area under the curve at .868 with a high Sensitivity (98.6%), Specificity (75%), PPV (97.3%) and NPV (85.7%) values. This level was therefore taken as the cut-off point to determine oral hygiene compliance for the study. Based upon the criterion of oral hygiene compliance with ≥ plaque 25 %, and ≥ BOP 15%; at baseline the proportion that was considered non compliant was 91.1%, at 3 months it decreased to 72.9% ($p<0.01$) and to 72% ($p<0.01$) at 9 months. OHC significant comparative group difference between OH+Sc vs. control groups was similar to plaque differences after intervention at 3 and 9 months. However, OH vs. control significant differences was only noted at 9 months in contrast to BOP significant group difference at 3 months only. It must be noted that the reduction in OHC criterion is not optimal as very few subjects had very low plaque and BOP scores. The validity of the OHC 25-15 criterion at this point in time, however, still needs to be ascertained.

As the present model is based upon an estimation of the baseline characteristics in the cohort of patients with diabetes under consideration, the findings may not necessarily

be applicable to other patient groups or explain the external criterion. To objectively test for an optimal cut-off level for different categories of periodontal patients, separate ROC analysis may be required. Since patients with diabetes have been shown to have more severe periodontal breakdown and have higher susceptibility to gingival inflammation (Soskolne & Klinger 2001; Salvi et al., 2005), it is possible that a less stringent criteria may be required for patients with low risk to periodontal disease. Conversely, an even more stringent cut-off level may be needed for patients in the very high-risk category. The present oral hygiene compliance criterion has shown that the study cohort is relatively homogenous based on age categories and ethnic groups; therefore it provides sound baseline data to compare the effects of intervention in a longitudinal study. Even with the limitations, this study confirms that some of the commonly recommended targets of plaque control with oral hygiene programmes appear applicable and justified in the current context.

5.2 ASSESSMENT OF INTERVENTION STRATEGY ON CLINICAL AND LABORATORY OUTCOMES

Clinical parameters

In general, most periodontal parameters such as presence and absence of Plaque, Bleeding on probing (BOP), Subgingival calculus improved at both 3 months and 9 months for those who received scaling and oral hygiene instructions (OH+Sc).

Plaque-There was a significant improvement in plaque scores for all groups at 9 months. The within group improvements of oral hygiene + scaling group demonstrated the best improvement in the range of 38-42% and 18-19 % for oral hygiene alone at 3 and 9 months. The effect of plaque improvements in both groups showed a significant comparative difference with control at 3 and 9 months. The findings concurred with

that of Stewart et al., (1991), Cercek et al., (1983), Glavind et al., (1983), Lim et al., (1991) and Watt & Marinho, (2005) who reported improvement in the range of 45-90% for non-diabetics. Similar studies carried out in patients with diabetes also showed improvement in plaque scores from 12 % - 80 % (Westfelt et al., 1996; Karjalainen & Knuuttila 1996; Almas et al., 2003; Llambes et al., 2005; Kiran et al., 2005). Even the control group that did not receive any form of therapy showed a significant group reduction in plaque score at 9 months, this may be explained by the Hawthorne effect; the mere participation in the programme would have motivated the subjects to clean their teeth better. Similar explanation was given by Lim, (1991) among a group of healthy company employees in Hong Kong in her study.

Bleeding on Probing - There was a significant within group reduction of bleeding scores at the follow-up evaluations for the Oral hygiene+ scaling group at 3 months and 9 months by 28-32%. The OH group showed significant improvement in BOP at 3 months only, however, this was not sustained at 9 months. The findings concurred with other studies conducted in patients with diabetes that showed a range of 30%- 56% reductions in BOP (Miller et al., 1992; Westfelt et al., 1996; Llambes et al., 2005; Kiran et al., 2005). Improvements of 27% - 43 % were reported in studies in non-diabetic populations (Cercek et al., 1983; Gaare et al., 1990; Lim 1991). On the contrary, Bali et al., (1999) found that BOP did not improve after professional hygiene and intensive patient education implying that factors other than oral hygiene may be affecting BOP for diabetics. It must be noted that both OH+Sc and OH alone group showed significant differences in BOP as compared with control group at 3 month. The effect was sustained with OH+Sc group at 9 months suggesting the superiority of the treatment modality in the longer term for more favourable gingival response.

Probing Pocket Depth (PPD). The OH+Sc group showed within group improvements in mean pocket depth reduction at 3 and 9 months. The finding was consistent with previous research on non-surgical periodontal therapy on diabetics (Grossi et al., 1996; Smith, 1996; Kiran et al., 2005; Rodrigues et al., 2003). However, the comparative difference between OH+Sc group and the other groups (OH and Control) was not evident during the review appointments when age and gender were controlled. The study highlighted the difficulties in reducing probing depths in a cohort of subjects who have shallow pockets at baseline (Gaare et al., 1990). Oral hygiene alone has limited effects in reducing probing depths as demonstrated by Cercek et al., (1983) especially so in the presence of deep pockets.

Subgingival calculus was significantly reduced within OH+SC group at 3 and 9 months (56-62%). The reductions are clearly related to the physical removal of calculus in the scaling procedures performed on the OH+Sc group. The omnipresence of calculus in a significant proportion of subjects indicated that scaling is indeed beneficial in achieving an improvement in treatment outcome. Research has shown that a reduction in subgingival calculus by 30.7 % was observed among patients with good diabetes control (Tervonen & Kajarlainen, 1997).

The Cochrane report failed to reach a consensus on the beneficial effects of routine scaling and polishing on periodontal health in healthy adults (Beirne et al., 2005). The review was carried out due to the concern regarding the beneficial and harmful effects of scaling and polishing on healthy adults. In principle there is no evidence to indicate that effects of scaling and polishing should be different between diabetics and healthy adults. Nonetheless, there were notable differences between the report and the present study: Among the studies included in the report, Glavind (1977) study on scaling and polishing vs. non scaling and polishing studies reported on some questionable

improvements in plaque and gingivitis at 3, 7 and 11 months. This is in contrast to the current study where there were improvements in plaque, BOP at 3 and 9 months. However, it must be noted that the present study provides oral hygiene instruction in conjunction with scaling and polishing. The importance of oral hygiene maintenance phase is supported in the present study.

Listgarten et al., (1985 & 1986) studies for scaling and polishing at fixed intervals vs. scaling and polishing intervention when clinical signs and symptoms are indicated also reported questionable improvements in plaque, gingivitis and pocket depth at 6, 12, 18, 24, 30, 36, 48 months. The present study was not designed to compare this effect although scaling and polishing was repeated when needed. The Cochrane report also made observation on studies that compared scaling and polishing at fixed intervals vs. different fixed intervals. Questionable results were reported on the benefits of plaque and gingivitis reduction when comparing scaling and polishing was carried out at different time intervals such as; 3 vs. 12 months, 4 vs. 12 months, 6 vs. 12 months (Lightner et al., 1971; Soumi et al., 1973). However, the report also found that scaling and polishing carried out at two weekly intervals showed significant improvements for plaque, gingivitis and pocket depth as compared with 6 and 12 months (Nyman, 1975; Rosling et al., 1976). In the current study, scaling and polishing was carried out after assessments at baseline and 3 months with a favourable gingival response at 3 and 9 months.

In the Cochrane report, a study conducted by Soumi (1973) also showed questionable improvements of pocket depth when comparing scaling and polishing with oral hygiene instruction vs. scaling and polishing without oral hygiene instruction at 4, 6 and 12 months. It must be noted that the study cohort was recruited from a US Coast guard Academy of young adults. The current study also reported similar findings on

pocket depth improvements. In both studies, duration of the study and baseline periodontal parameters may have influenced the outcomes.

The Cochrane report stated that the studies included in the review lacked reporting in size of the treatment effect, adverse effects of scaling such as tooth sensitivity (Cuervo & Clarke, 2003; Brothwell et al., 1998), and quality of life assessment (Needleman, 2004). The present study has fulfilled these areas of interest. It is also conceivable that the economic cost of shorter interval scaling and polishing may pose an economical burden for normal adults but the alternative method of repeated scaling and polishing on a need basis only may be more cost effective for managing high risk diabetic periodontal health. The treatment aspects of scaling and polishing in the Cochrane report were conducted by dental hygienists on healthy adults in comparison to treatment carried out by post-graduate residents in Periodontology on diabetics in this study.

Laboratory parameters

HbA1c: There was no marked change in HbA1c over time in all groups. This is in agreement with findings by Seppala & Ainamo (1994), Christgau et al., (1998), Smith et al., (1996) and in a review by Janket et al., (2005). A possible explanation is that adjunctive antibiotics were not used in this study. Most of the studies that showed improvement in HbA1c through non-surgical therapy attributed the change to administration of adjunctive antibiotics (Grossi et al., 1996; Taylor, 2000 review; Iwamoto et al., 2001; Rodrigues et al., 2003). Even when the HbA1c levels were dichotomized into acceptable and unacceptable level of HbA1c there was no indication that OH+Sc group had any beneficial effect on HbA1c. The results may imply that

scaling and polishing per se did not influence improvements in glycaemic control. The findings may partially be explained by the presence of a significant proportion of unacceptable oral hygiene compliance individuals with diabetes in the current study even after following therapy.

Total cholesterol: In most diabetes control programmes, weight control and cholesterol control to reduce cardiovascular risk programmes are incorporated as part of the armamentarium in the overall treatment strategy. Lipids metabolism through the role of adipocytokines-TNF-α dysregulation is believed to play a role in periodontal disease (Iacopino, 2001). Cutler et al., (1999), in their study found that there was a significant association of poorly controlled diabetics with higher levels of serum triglyceride and poor periodontal health. In the present study, improvement in total cholesterol was not consistent throughout the different time points.

5.3 FACTORS ASSOCIATED WITH ORAL HYGIENE COMPLIANCE

It has been generally accepted that compliance with oral hygiene is a complex phenomenon that involves social, psychological, cultural and interpersonal factors. Ahn (2006 a &b) indicated that complex chronic diseases such as diabetes and by virtue of similar chronicity and complexity, periodontal disease involves dynamically interacting multiple factors. Ahn (2006) advovcates a systems approach in the analysis of complex chronic multifactorial diseases. In the current investigation, statistical analyses were carried out in a series of steps to explore factors that may be related with oral hygiene compliance. This includes frequency distribution of findings, factor analysis, regression analyses and a pathway analysis by Structural Equation Modeling (SEM). The advantages of SEM analysis provide an opportunity to test over all models

with multiple dependent variables rather than individual dependent variables. Furthermore, unlike regression analysis, variables need not be left out from the analysis as predictors can be arranged in temporal order and usage of latent variables reduces regression dilution (Der, 2002: Singh-Manoux et al., 2002).

The salient findings resulting from the analyses will be highlighted.

5.3.1 Treatment modalities

Non-surgical treatment modality carried out in the form of oral hygiene + scaling group was highly associated with improved oral hygiene compliance consistent with previous studies of non-surgical therapy among diabetics (Tervonen et al., 1991; Westfelt 1996; Tervonen & Karjailainen 1997; Christgau 1998). Control of gingivitis and chronic periodontitis with oral hygiene and scaling (Tagge et al., 1975; Lovdal et al., 1961; MacGregor et al., 1986; Pihlstrom et al., 1983; Kaldhal et al., 1996) have also been well documented and findings from the current study supports the beneficial effects of oral hygiene and scaling effects on oral health. The 2005 Cochrane Collaboration report could not reach any definite conclusion on the benefits of routine scaling and polishing on normal adults. This could be due to the strict inclusion criteria employed in the report. The study however, indicates a beneficial effect of shorter two weekly intervals compared to longer intervals of intervention. In the present study, the clinical outcomes were derived from patients with diabetes who are considered to be at higher risk for developing periodontal disease more than healthy adults. However, it must be noted that the observation was derived from the regression analysis, and an attempt to analyze the data set by 3 experimental groups independently by SEM analysis was limited by the sample size in each group.

5.3.2 Subgingival Calculus:

The SEM results showed that the presence of subgingival calculus was consistently associated with unacceptable oral hygiene compliance. This highlights that the removal of subgingival calculus is essential to maintain a gingival environment that is conducive to acceptable oral hygiene practices consistent with studies by Waerhaug (1952, 1956) and Lovdal et al., (1958) on the effects of subgingival calculus removal on gingival tissue. Thus, the finding confirms that non-surgical therapy and oral hygiene maintenance (behavioural) are essential elements in the control of periodontal disease among diabetics. In the SEM analyses, subgroup analyses for treatment groups were not possible due to limitations in power. However, the pathway analysis confirms that the presence of subgingival calculus is indeed a factor that contributes to unacceptable oral hygiene compliance.

The presence of subgingival calculus and the contribution to periodontal status could be due to the plaque products such as endotoxins incorporated on the root surfaces leading to inflammatory responses and periodontal breakdown (Jones & O'Leary, 1978; Nakib et al., 1982). The findings are similar to population-based findings, where a larger proportion of periodontal sites have subgingival calculus than supragingival calculus, an area overlooked by some practitioners (Lim et al., 2003).

Although the contribution of supragingival calculus to OHC was difficult to ascertain in the SEM analysis, the importance of removal of the supragingival calculus should not be overlooked, as it is believed to be a reservoir for subgingival plaque recolonization (Lang et al., 2002). The presence of subgingival calculus is considered to contribute to providing a convenient haven for plaque establishment in the subgingival environment.

5.3.3 Self-efficacy

While oral hygiene maintenance is recognized as the corner stone of periodontal therapy, most studies were shown to be of inadequate design and methodology and lack a theoretical framework or model to explain oral health behaviour research (Schou, 1998). Self-efficacy theory expressed as dental SE (Self-Efficacy) showed a significant association with post intervention oral hygiene compliance and it is consistent with similar findings by Kneckt et al., (1999) and Syrjala et al., (1999 & 2004). It must be noted that in the present study, OHC ($\geq$ 25% plaque + $\geq$ 15% BOP) criterion was used as a surrogate endpoint for change in oral health behaviour in contrast to the use of visible plaque index end point (VPI) in Syrjala's study. The OHC criterion provides a more comprehensive explanation of plaque cleanliness and host response in comparison with BOP or plaque as individual indicators (Htoon et al, 2006).

Studies supported the concept that subjects with good dental SE may act as a good predictor for oral health behaviour (McCaul et al 1985; Stewart et al., 1996). In this study, oral health behaviour such as acceptable dental visits and acceptable interdental cleaning practices at baseline and 3 months were associated with higher dental SE at 9 months. This implies that subjects with good oral health practice tend to have a higher dental SE. However, as the study was designed to assess SE after intervention, a comparative overview cannot be provided at baseline. Such information would have been useful to provide better information on whether self-efficacy was indeed enhanced after intervention.

Tedesco et al., (1991) study showed that dental self-efficacy ability to predict adherence in periodontal preventive programmes and supported by Philippot et al., (2005). Phillipot and co-workers utilized self-regulation theory (Leventhal et al.,

1992) that includes a self-efficacy construct to explain oral hygiene compliance and Plaque Index. However, researchers Wolfe et al., (1991) Reisine & Litt (1993) did not find this relationship. The negative findings from these researchers may be due to SE affecting the psychology of human functions. Subjects who have a higher SE than their actual ability usually fail to perform to expectations and may not prepare themselves for the required task; at the same time those with a very low SE also may not have enough confidence to perform the task (Bandura, 1986). Optimal SE is a little above actual ability in performance related tasks as in sports. It should be noted that healthy individuals are not subjected to health challenges such as those who have diabetes have to face and persevere. The perseverance factor may influence higher SE among subjects who have enrolled themselves in health improvement programmes. Although, self-efficacy enhancements indicated by Bandura (2001) were not applied in this study, the participation in the oral health promotion programme may have lent itself some self-efficacy enhancement among the study cohort. There were no differences noted among the treatment groups as the effect was felt across the groups. The change if any could be explained by the Hawthorne effect in the current study. Similar, observations have also been reported in other oral hygiene compliance studies (Jeffcoat, 1993; McCracken et al., 2000; Feil et al., 2002; Hutchinson, 2003).

In analyzing other factors relating to SE, it was found that Self-efficacy (dental) as a dependent variable was shown to have an association with HbA1c (Syrjala et al., 1999), whereas, the association was not observed in the present study. This may be due to the fact that self-efficacy enhancement was not part of the study design.

The frequency distribution of the self-efficacy questionnaire responses provided a good insight on toothbrushing, interdental cleaning, and dental visits. Taxing situations such as tiredness in the evening, being ill (headache), feeling weak and feeling

depressed affected the self-efficacy of the diabetics in performing oral hygiene. It was noted that there were more responses from the subjects that they were taxed in performing interdental cleaning than performing toothbrushing.

Ko et al., (1995) showed that 21 % of a cohort of 100 (65year+) clinically depressed patients in Singapore suffered from diabetes. Evidence also suggests that clinically depressed subjects tend to have poor oral hygiene due to lack of self-care (Antilla et al., 2001; Little, 2004; Friedlander, 2003). Due consideration should therefore be given to emotional states in the study of oral hygiene compliance. Stress has also been implicated in oral health behaviour (Deinzer et al., 2005), and there is evidence that stress affects self-efficacy (Badr, 2005). Although, there are no reports of stress and dental self-efficacy, a probable influence of stress on dental self-efficacy may warrant further investigation. Syrjala et al., (1999) & Kneckt et al., (1999) found that dental self-efficacy and diabetes self-efficacy correlated well. In this study, dental self-efficacy was considered high among the cohort and showed a significant association with oral hygiene compliance at 9 months. The significance of this study highlighted Self-efficacy as a potential explanatory theory behind the improvement in oral hygiene compliance behaviour at 9 months after intervention. However, in the path analysis of the OHC model, self-efficacy was not found to be a significant factor. This may be due to the fact that the physical presence or absence of subgingival calculus may be a more powerful indicator of oral hygiene compliance than a behavioural component.

5.3.4 HbA1c: SEM analysis showed that HbA1c at baseline was a significant explanatory variable associated with oral hygiene compliance. It seems logical that

those with better glycaemic control may have better oral health behaviour practices and have a better gingival response. On the other hand, it remains uncertain whether the level of glycaemic control at baseline could have influenced the gingival tissue inflammatory response. This may suggest that having a controlled HbA1c level at baseline may contribute to more acceptable OHC behaviour. It is noted that Tan, (2006) with the same data from the current study found that poor glycaemic control was associated with poor plaque and BOP scores at baseline. Following periodontal therapy, the gingival response was comparable with acceptable and unacceptable glycaemic control in both treatment groups. In contrast, Tervonen and Karjalainen (1997) reported that scaling therapy for poorly controlled diabetics did not respond as well as to controlled diabetics; thereby, the evidence remains unclear.

5.3.5 Behaviour related variables: The effect of behavioural related variables in the SEM model, such as OHIP-14, HU-DBI-13, OHC, total cholesterol showed some association with the hypothesized latent variables. In comparison, Self-efficacy, General Health Behaviour (GHB), Energy Control (EC), Diet Control (DC) and Confidence Control (CC) variables did not show any association. Nevertheless, the role of these related variables may influence the outcome of oral hygiene compliance in larger studies.

5.4 LIMITATIONS OF THE STUDY

Sample size

Although the sample size estimates were adequate to evaluate the comparative effectiveness of the three (oral hygiene +scaling; oral hygiene alone and control) treatment modalities, sample size was not adequate for a goodness of fit for SEM analyses. Nonetheless, the pathway analysis was able to confirm the most probable factors influencing oral hygiene compliance among the study group given the limitation. The limitations the study may be due to lack of power as the present SEM model is attributable to 161 subjects compared to a sample size of 200 required to provide adequate power for goodness of fit (Loehlin, 1992). Similarly, sample size was not adequate for oral health quality of life (OHIP-14) for making a conclusion on pre and post intervention difference.

Appropriateness of questionnaire instruments

Although some information was derived from HU-DBI & OHIP-14, the instruments and questionnaire design used to assess oral health attitudes and oral health quality of life may not necessarily be suitable for the cohort under consideration. It is generally good to have questionnaire related variables that have an internal consistency Cronbach alpha 0.8 or more to provide a goodness of fit index. HU-DBI was the weakest questionnaire variable that may be due to cultural differences. Health related quality of life studies could be mitigated by time and type of illness. The present study showed that there was an increment in physical pain subscale in the form of tooth sensitivity encountered among the OH+Sc group after intervention. Tooth sensitivity resulting from root planing procedures (Brothwell et al., 1998; Pihlstrom et al., 1999;

van Steenberge et al., 2004) is a common side-effect of scaling and polishing and may offer a possible explanation of the increase in physical pain subscale among this group. Although tooth sensitivity is bothersome initially, the progressive healing process may alleviate the effect of tooth sensitivity after a period of time. It is likely that, if OHIP was administered at 15 months there may be a difference in the responses. In addition to the timing of assessment there are still areas of concern among generic oral health quality of life instruments and may find that there is also a possibility of improving upon oral health quality of life instruments. Measures like Oral Health Impact Profile are more generic and not specific enough for quality of life changes related to periodontal disease.

There may be areas that may lack the specific domain of quality of life in generic oral health quality of life instruments. Naito et al., (2006) critiqued that there were very few quality of life studies in areas of malocclusion and orthodontics as these conditions are asymptomatic and improvements are more biased towards esthetics. Similarly, quality of life issues related to periodontal disease may not be adequately reflected since periodontal disease is often asymptomatic in the early stages. Perhaps attention could be directed towards preservation of teeth, perceived oral cleanliness and oral freshness (free from mouth odour). The inclusion of these domains can be added to existing generic oral health quality of life instruments.

Differences in therapeutic intervention

The SEM analyses were limited in due respect to the treatment outcomes arising from the different modality of periodontal therapy.

Duration of the study

Improvement in periodontal health following periodontal intervention may be influenced by the duration of 9 months study and it may not be adequate to detect sustained change. A longer term evaluation period of > 9 months is therefore necessary for the programme.

Interpretation of oral health behaviour model

There are very few oral health behaviour models analyzed by SEM analysis in patients with diabetes. Kawamura et al., (2001a) conducted a similar study but with some differences. In the present study, an oral health quality of life measure was added to the latent variable metabolic control. Self-efficacy, HU-DBI –13 was used for oral health behaviour. In addition, the present study used binary data for OHIP-14, HU-DBI-13, acceptable interdental cleaning and unacceptable OHC. SEM is a suitable way to analyze data and can maintain a temporal order of independent variables as analyzed in this study (Der, 2001). The data set for this study is based on a longitudinal data as compared to the cross sectional data used by Kawamura. The comparison with Kawamura's study will therefore be rather limited.

In **summary**, given the limitations of the SEM pathway analysis of the present study, the analysis has confirmed that the removal of subgingival calculus is a pre-requisite for oral hygiene compliance and that the level of Hba1c at baseline may predict the state of oral hygiene compliance. Although, the association was weak, a person performing acceptable interdental cleaning was more likely to demonstrate more favourable periodontal responses at 9 months, thereby supporting oral hygiene and scaling therapy as the most appropriate therapy in providing periodontal health for diabetics.

Based upon the findings of the study, the following conclusions are made:

Periodontal status and oral hygiene behaviour at baseline

The high prevalence of plaque and BOP suggested that there was a need for oral hygiene measures at baseline. In addition, the high prevalence of calculus also suggested that there was also a need for scaling, root planing and polishing at baseline among the diabetic cohort.

The study cohort was considered to be health compliant but there were still areas on periodontal health knowledge, attitudes and practices at baseline that required intervention.

Oral hygiene compliance criterion

The Oral hygiene compliance (OHC) criterion using ROC analysis is one of the first attempts used to provide a combination of plaque and bleeding scores as a more objective measure of non-compliance with oral hygiene. OHC 25-15 (plaque score ≥ 25%+ BOP ≥ 15%) showed good Sensitivity, Specificity, PPV and NPV. However, this would have to be validated in a larger population group with a similar intervention strategy.

Effectiveness of intervention therapy:

Scaling and oral hygiene maintenance as a modality of therapy is more effective than oral hygiene maintenance therapy alone and control group in achieving oral hygiene compliance in terms of plaque and BOP scores. The effect of intervention by OH alone showed comparable effectiveness in reduction of plaque and BOP but not as strong as OH+Sc group. The effect of intervention on PPD, HbA1c and cholesterol was insignificant. There were some improvements in knowledge scores but not statistically

significant. Nevertheless, there were improvements observed in acceptable interdental cleaning among the oral health educated groups at 3 months.

Glycaemic control

Both continuous data and dichotomized HbA1c levels (acceptable and unacceptable) showed inconclusive results of the effects of scaling and polishing on control of HBA1c levels. The effect of acceptable an unacceptable HbA1c levels on gingival response through therapy was also inconclusive. The results may have reflected the presence of a large proportion of unacceptable oral hygiene compliance subjects in the present study after intervention. There will be a need for further investigations with a larger study and with a shorter interval of scaling and polishing interventions.

Theoretical framework for explaining oral health behaviour

The finding that dental self-efficacy showed an association with oral health behaviour (acceptable dental visiting at baseline, acceptable interdental cleaning at 3 months and oral hygiene compliance at 9 months) may suggest that self-efficacy explains oral health behaviour among diabetics in Singapore. Thereby, self-efficacy enhancement programmes may be considered beneficial to oral health promotion programmes among diabetics. Further investigation will be warranted in this research area.

Effect of intervention on oral health quality of life and oral health behaviour

Oral health behaviour as measured with HU-DBI showed some improvements but it was not statistically significant when groups were compared. The findings of low internal consistency may further investigation into the cultural differences on a larger population study.

OHIP-14 showed good internal consistencies at both measurements. However, due to lack of adequate power and time of post intervention measurement, there were no group differences noted to conclude the oral health quality of life assessment in the

present study. Alternatively, a larger population study with a longer time interval more than 9 months may prove useful to compare oral health quality of life.

Analysis of an 'a priori' oral hygiene compliance theoretical model

Among the clinical parameters, the presence of subgingival calculus was the most significant factor associated with unacceptable oral hygiene compliance, thereby substantiating the removal of subgingival calculus as a therapeutic regime.

There was also a positive association observed between glycaemic control as measured by HbA1c at baseline and oral hygiene compliance. A longer-term evaluation and a larger sample size are necessary to evaluate the impact of periodontal health on oral health attitudes and oral health quality of life.

In summary, the study shows that untreated diabetics require oral health promotional effort to increase awareness on periodontal health and also look into the possibility to provide oral hygiene instructions plus scaling, root planing and polishing to maintain/ improve periodontal health on a need basis. Furthermore, individuals who have good glycaemic control at baseline and higher self-efficacy score may contribute to good oral hygiene compliance behaviour.

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APPENDICES

Appendix A

PATIENT INFORMATION SHEET & CONSENT FORM

PROJECT TITLE :

Prospective Study of Periodontal disease Risk markers and treatment outcome of a Periodontal Programme for Adult Diabetics in Singapore

INFORMATION REGARDING THE PROJECT

Background

Gum disease(Periodontal disease) is one of the most common oral diseases in the adult population. It has been estimated that diabetics are at least 2 times more likely to suffer from more severe gum disease than non-diabetics. It has been shown that with proper oral health care, early diagnosis and treatment, gum disease can be controlled to a large extent. Simple periodontal treatment like effective oral hygiene and scaling (cleaning the hard deposits from around the teeth) have been shown to improve gingival health in population based studies. However, there have been only a limited number of such studies being carried out in diabetics and none as yet in Singapore. Various factors may explain the different response to treatment which includes the individual's immune and healing response, oral hygiene and metabolic control of the diabetes by the individual. One of the questions that is yet to be confirmed is whether improved gum health could lead to improved metabolic control of diabetes and vice versa.

Purpose of Study

The purpose of this research is to :

i) To investigate the short term and longer term effects of simple gum treatment like scaling and oral hygiene on gum health
ii) To find out the influence of behavioural factors on treatment outcome
iii) To find out possible reasons which account for the healing response to treatment. This would include diabetic control and various risk markers for gum disease.

Selection of subjects

Participation is voluntary. A total sample of about 150 is required. The following selection criteria should be fulfilled

i) Adult diabetics males or females aged 21-65
ii) Does not have heart condition or other medical conditions that would require antibiotic cover before dental treatment
iii) Is not pregnant
iv) Does not have any Bleeding disorders
v) Willing to attend at least 5 appointments over a 21 month period.
vi) Have at least 16 teeth present

Study Procedure

The total duration of the study is 21 months
You will be required to attend a total of at least 5 visits: first visit, 3 months, 9 months, 15 months and 21 months later. The purpose of the visits at the various time points is to find out the short term and long term effects of the programme and to monitor you gum status over this period. You will be allocated into one of the three groups:

Group A Oral examination, Scaling & Oral Hygiene education
Group B Oral examination + Oral hygiene education
Group C Oral examination only.

As you will be randomly allocated to one of the three groups, you would not be given any choice to which group you should belong to.

However, after 9 months, those in Group B and C will receive scaling and oral hygiene education. This would mean irrespective of the group you were allocated to in the first place, all those who participate in the programme would eventually receive the same treatment after 9 months.

During all the visits you will be required to undergo an oral health assessment of your oral health condition.

In addition at the point of entry, 3 months 9 months and 21 months the following procedures would be carried out

i) Answer a Questionnaire relating to perceptions of your oral health and oral health habits
ii) Blood sample will be drawn to check your glycaemic control(HbA 1c), blood cholesterol and C reactive protein(a test related to inflammation/infection) A total volume of about 16ml of blood will be drawn at each visit. HbA1c and total cholesterol are routine blood tests that are carried out during the review of your diabetes
iii) Collection of saliva for analysis of markers which indicates risk to gum disease. This include flow rate of saliva, enzymes and cytokines(these are markers of gum inflammation/infection) Saliva will be collected over a time period of 5 minutes

The blood and saliva samples will be used solely for the investigations listed in this study, they will not be used for other purpose without your permission and will be discarded after the listed investigations have been carried out. .

At the end of the assessment, you will be given proper advice on your dental health condition

Possible Risks and Discomforts

Treatment includes oral health assessment, oral hygiene education and scaling for different groups at various time points as stated in the protocol.

Oral examination : You should have minimal discomfort apart from the fact you would have to open your mouth for 10-20 minutes during the dental health examination.

Scaling : Scaling will be carried out by qualified dentists. Mild discomfort and some bleeding may occur during the procedure as expected during routine gum treatment; these problems should be effectively controlled. Local anesthetic may be given if required. Some patients may experience mild sensitivity of the teeth immediately after scaling.

For the taking of blood, these are routine tests that are done during review of diabetes in the clinics. The possible side effects would be the same as what may be expected from the drawing of blood. Occasional discomfort includes pain, bruising, these effects if any are usually minimal.

For the collection of saliva, it will be your normal resting saliva, you will not be required to chew on any special substances.

Possible benefits

The benefits you are likely to get are :

i) A detailed examination of your gum condition and your general oral health
ii) You will be given appropriate simple treatment for management of your gum condition which includes oral hygiene, cleaning the areas around your gums by removing the hard deposits (scaling) from your teeth
iii) Free blood tests, some of the tests are already standard tests that are carried out during your routine review with your doctor
iv) Improvement in your oral health through recognition of gum disease, more effective self and professional care

On the other hand, through the study, we will also be able to better understand the reasons which help to explain why individuals respond differently to treatment. The results would also help us to develop more effective treatment strategy to improve the oral health quality and gum health of diabetics in Singapore

Confidentiality

The records we have collected from you will be kept confidential and will not be disclosed to outside bodies. However, certain information like your blood glucose control, cholesterol may be made known to you and your physician who is taking care of your diabetes. Your oral health condition may be made know to the person who is giving you advice on your dental health so that appropriate advice could be given to tailor to your needs. Any published results of the project will be pooled data, there **will not** be identification or reference to you as an individual.

Treatment and Compensation for Injury

If you follow the directions of the doctor in charge of this study and you are physically injured due to the trial procedure properly given under the plan of this study, the NUH will pay the medical expenses for the treatment of that injury.
Payment for the management of the normally expected consequences of your treatment will not be provided by the NUH. No compensation will be given for minor discomfort that may be encountered during the investigations and the procedures. Such discomfort if any is likely to be related to slight bruising when taking blood and during scaling. Some patients may experience mild sensitivity during the oral examination and scaling. Efforts will be made to minimise such discomfort during treatment.

Contact for Question or Problems

If you have any questions regarding the project you may contact :

i) Assoc Prof Lim Lum Peng, Faculty of Dentistry, National University of Singapore, 5 Lower Kent Ridge Road, Singapore 119074. (tel : 67794940)

ii) Dr Fidelia Tay, Dental Department, Alexandra Hospital (Tel :64752220)

For an independent opinion, you may contact a member of the NUH Review Board (attn : Ms Emily Cheong tel 67725927)

Withdrawal from Study

As participation is voluntary, you have the right to withdraw from the programme at any time with no penalty or loss of benefits to the treatment you currently receive from NUH.

On the other hand, if for some reasons in the course of the project you could not comply with the requisition in the study protocol, your participation in the project could be terminated with no penalty or loss of benefits to the treatment you currently receive from NUH. You would however only lose the benefits as a participant in this project.

Reimbursement/Cost involved in study

Please note that only the dental examination, scaling and oral hygiene , the specified blood tests and saliva tests are given to you free of charge. Fillings, dentures and extraction and other dental treatment are not provided for in the project. There will not be re-imbursement for any additional cost and treatment you may undertake in this hospital.

CONSENT FORM

This study has been explained to me on _____ (date)

by_____(Name) in _____(Language used)

I understand the procedures involved and that no other tests will be carried out without my permission. The Investigator was able to clarify any questions I have regarding the project.

I also understand that apart from the oral examination, oral health education and scaling at the appropriate time point depending on the group I am being allocated to, **NO** other dental treatment will be provided for in this project

Name of Subject _____

Signature of subject & Date _____

Name of Investigator _____

Signature of Investigator & Date _____

Name of Witness _____

Signature of Witness & Date _____

APPENDIX B

BASELINE QUESTIONNAIRE

Questionnaire : Prospective Study of Periodontal Disease Risk Markers and Treatment Outcome of a Periodontal Programme for adult diabetics in Singapore

(Confidential)

Name of Subject _____

Code Number _____

Date of Questionnaire _____

Baseline

Oral health Related Practices and Attitudes (Baseline Questionnaire)

1 How often do you visit the dentist?
- i) At lest Once every 6 months
- ii) Once a year
- iii) At least once every 2 years
- iv) Only when there is pain
- v) Seldom
- vi) Never

2 What is the main reason for **NOT** visiting the dentist at least once a year?(May choose more than 1 option)
- i) Treatment is too expensive
- ii) Afraid of dental treatment
- iii) Do not see the need for dental treatment
- iv) No time for dental treatment
- v) Do not know where to go for dental treatment
- vi) Others(please specify) _____

3 What was the main reason for visiting the dentist the last time?(May choose more than 1 option)
- i) Toothache
- ii) Fillings
- iii) Dental check-up
- iv) Cleaning
- v) Extraction
- vi) Dentures
- vii) Complex restorations(crowns, bridges, implants)
- viii) Root canal treatment
- ix) Others(please state) _____

4 How often do you brush your teeth daily?
- i) At least 2 times daily
- ii) Once daily
- iii) Occasional

5 Are you satisfied with the way your natural teeth look?
- i) No
- ii) Yes
- iii) Not applicable (no natural teeth)

6 Do you currently smoke ?
- i) No, never
- ii) No, has quit smoking
- iii) Yes

7 If you smoke, on average how many cigarettes do you smoke a day?
_____ Sticks

8 What do you think causes gum disease?

i) Sugar and sweet food
ii) Ineffective oral hygiene
iii) Excessive pressure from brushing
iv) Dental plaque/bacteria
v) Lack of Vitamin C
vi) 'Heaty'
vii) Do not know
viii) Others(Please state)_____

9 How do you know if you have gum disease?

i) Bleeding gums
ii) Loose teeth
iii) Bad breath
iv) Receding gums
v) Pain
vi) Swollen gums
vii) Others(please state)_____

10 How often do you use the following devices to clean your teeth

	At least once a day	**At least 3 times a week**	**At least 1 time a week**	**Seldom /never**
Dental floss				
Toothpicks				
Special brush for cleaning between teeth				
Mouthrinse				
Special toothpaste				
Others(please state)				

11 For the past 3 months , do you think you have the following oral problems?

Condition	**Yes**	**No**	**Don't know**
Dental decay			
Tooth ache			
Bleeding gums			
Red & swollen gums			
Ulcers			
Oral infections			

Dry mouth			
Bad breath			
Loose teeth			
Others(Please state)			

12 Do you think you are more prone to gum disease?

i) No
ii) Yes
iii) Do not know

13 Do you wear dentures?

i) No
ii) Yes

14 If you wear dentures, how old are your present dentures?

i) < 5year old
ii) 5-9 year old
iii) >10 year old
iv) Do not know/cannot remember

15 If you have dentures, how satisfied are you with your present set of dentures?

i) Not satisfied
ii) Neither satisfied nor unsatisfied
iii) Satisfied

DIABETIC CONDITION (IF YOU HAVE DIABETES , PLEASE ANSWER Q1-12)

1. How long have you been diagnosed with diabetes?

(a) 5 years or less (b) 6-10 years (c) 11-15 years (d) More than 15 years

2. Do you get regular checkups for your diabetic condition?

(a) Yes, regularly (b) Most of the time (c) Sometimes (d) No

3. Does your family help you in controlling your diabetes?

(a) Very often (b) Quite often (c) To a certain extent (d) Not at all

4. Does diabetes affect your daily routine?

(a) Yes, very much so (b) To some extent (c) A little (d) Not at all

5. Are you confident in controlling your diabetes?

(a) Very confident (b) Confident (c) Not quite confident (d) Not at all

6. Do you think you tend to lead a more disciplined lifestyle as a diabetic?

(a) Very much (b) to some extent (c) not quite (d) not at all

7. Do you keep strict control of your diet?

(a) Very often (b) Often (c) Sometimes (d) Not at all

8. Do you watch your weight by weighing yourself regularly?

(a) Very often (b) Quite often (c) sometimes (d) Seldom or never

9. Your main method of controlling diabetes is by (you may have more than 1 option)

(a) Diet control (b) exercise (c) oral medication d) Insulin e) Others(please state)

10. Do you have other medical conditions besides diabetes?

(a) High Blood pressure (b) stroke (c) Coronary heart disease (d)Kidney problem

(e) Others _____

11. Have you attended any talks on diabetes?

(a) No (b) Yes

If yes, when was the last time?

12. Were the talks on diabetes useful?

(a) Very useful (b) Useful (c) A little useful d) Not useful

13 If you do **not have diabetes**, Do you have family members with diabetes?

a) Yes b) No

APPENDIX C

REVIEW QUESTIONNAIRE(3 MONTHS)

Questionnaire: Prospective Study of Periodontal Disease Risk Markers and Treatment Outcome of a Periodontal Programme for adult diabetics in Singapore

(Confidential)

Name of Subject _____

Code Number _____

Date of Questionnaire _____

Occupation _____

Visit : 3 months

Version 2 19/09/2003

Version 2 19/09/2003

Review Visit Questionnaire

1 For the past 3 months, do you think you have controlled your diabetes well?

i) Yes, very well
ii) Yes, satisfactory
iii) NO

2 Do you think you have given more attention to cleaning your teeth for the past 3 months?

i) Yes
ii) No

3 What causes gum disease?

i) Sugar and sweet food
ii) Ineffective oral hygiene
iii) Excessive pressure from brushing
iv) Dental plaque/bacteria
v) Lack of Vitamin C
vi) 'Heaty'
vii) Do not know
viii) Others(Please state)_____

4 How do you know if you have gum disease?

i) Bleeding gums
ii) Loose teeth
iii) Bad breath
iv) Receding gums
v) Pain
vi) Swollen gums

Others (please state) _____

5 Do you currently have the following oral problems?

Condition	**Yes**	**No**	**Don't know**
Dental decay			
Tooth ache			
Bleeding gums			
Red & swollen gums			
Ulcers			
Oral infections			
Dry mouth			
Bad breath			
Others(Please state)			

6 How often do you use the following devices to clean your teeth?

	At least once a day	**At least 3 times a week**	**At least 1 time a week**	**Seldom /never**
Dental floss				
Toothpicks				
Special brush for cleaning between teeth				
Mouth rinse				
Special toothpaste				
Others(please state)				

7 How do you think gum disease could be controlled?

i) Good oral hygiene
ii) Professional cleaning
iii) Use of medication
iv) Avoid eating 'heaty' food
v) Others(Please state)

8 Do you think you gum condition has improved over the past three months?

i) Yes
ii) No

9 How confident are you in controlling gum disease?

i) Confident
ii) Not quite confident
iii) Not at all confident

10 Are you satisfied with the treatment you received from the programme?

i) Yes
ii) No

Why? _____

APPENDIX D

HEALTH QUESTIONNAIRE

Diet/Mastication

1. Are you able to chew your food properly?
   (a) not adequate (b) not adequate (c)partially (d)not at all

2. Do you like to eat fatty food?
   (a) Very much (b) Fair (c) not much (d) Not at all

3. Do you usually eat a very full meal?
   (a) Very much (b) fair (c) to a certain extent (d) restrict intake

4. Do you often take soft drinks and fruit juice?
   (a) Very often (b) fairly (c) Not often (d) Seldom or never

5. Do you like to eat sweet food and dessert?
   (a) Very often (b) adequate (c) Not often (d) Seldom or never

6. Do you often take vegetables?
   (a) Very often (b) Often (c) Sometimes d) Seldom or never

7. Do you take your meals at regular times?
   (a) All the time (b) Most of the time (c) Sometimes (d) Not at all

8. How often do you go out for meals every week
   (a) More than 3 times (b) 2 times (c) once (d) Seldom

9. Within a week, how often do you take two meals only?
   (a) Seldom (b) Once (c) Twice (d) More than 3 times

10 When you were young, do you often take sweet meals?
   (a) Very often (b) Often (c) Not often (d) Seldom or never

11. Do you exercise often?
   (a) Very often (b) sometimes (c) inclined not to (d) Seldom or never

12. Do you do anything to benefit your health?

(a) Yes (b) As far as possible (c) Not often (d) Seldom or never

13. Do you watch your weight by avoiding being overweight?
(a) Yes, (b) To Some extent (c) Not quite (d) No

14. Do you exercise daily?
(a)Yes, very much (b) In between (c) Not quite (d) Not at all

15. If you have decided to do something, would you be committed to this decision?
(a) Yes, very much so (b) To some extent (c) Not quite (d) Not at all

16. During your leisure time, do you often watch TV?
(a) Very often (b) Often (c) Not quite (d)

17. Do you often sleep or doze off without intention?
(a) Very Often (b) Often (c) Not often (d) Seldom

18. How many hours do you sleep daily?
(a)More than 7 hours (b) about 7 hours (c) 6 hours (d) 5 hours or less

19. Do you sleep well generally?
(a)Very well (b) satisfactory (c) Sometimes (d) not well

20. Are you confident about controlling your own health?
(a)Very confident (b) Confident (c) Not quite (d) Not at all

21Are you satisfied with your current job?
(a) Very much so (b) satisfied (c) not very satisfied (d) not at all

22. Do you often experience stress
(a)Very often (b) Often (c) Sometimes (d) Not at all

23. Do you feel you get tired easily?
(a) Very often (b) Often (c) Sometimes (d) Seldom or never

24. Do you often take drinks to regain energy?
(a)Very often (b) Often (c) Not often (d) Seldom or never

25. Do you often get drunk?
(a) Very often (b) Sometimes (c) Not often (d) Seldom or never

26. Do you often follow the instructions of the doctor or nurse?

(a) Very often (b) Sometimes (c) To a certain extent (d) Not often

27. Current Weight:…….kg

Height:……cm

28. Do you have

(a)Hypertension (b)stroke (c) chronic heart disease (d)Diabetes

End of Questionnaire

Thank you

APPENDIX E (HU-DBI)

No.	Item description	Yes	No
1.	I don't worry much about visiting the dentist.		
2.	My gums tend to bleed when I brush my teeth.		
3.	I worry about the colour of my teeth.		
4.	I have noticed some white sticky deposits on my teeth.		
5.	I use a child sized toothbrush.		
6.	I think that I cannot help having false teeth when I am old.		
7.	I am bothered by the colour of my gums.		
8.	I think my teeth are getting worse despite my daily brushing.		
9.	I brush each of my teeth carefully.		
10.	I have never been taught professionally how to brush.		
11.	I think I can clean my teeth well without using toothpaste.		
12.	I often check my teeth in the mirror after brushing.		
13.	I worry about having bad breath.		
14.	It is impossible to prevent gum disease with brushing alone.		
15.	I put off going to the dentist until I have toothache.		
16.	I have used a dye to see how clean my teeth are.		
17.	I use a toothbrush which has hard bristles.		
18.	I don't feel I've brushed well unless I brush with strong strokes.		
19.	I feel I sometimes take too much time to brush my teeth.		
20.	I have had my dentist tell me that I brush very well.		

APPENDIX F (OHIP-14)

	Very often	Quite often	Occasional	Seldom	never
1. Have you had trouble pronouncing any words because of problems with your teeth or dentures?					
2. Have you felt that your sense of taste has worsened because of problems with your teeth or dentures?					
3. Have you had painful aching in your mouth?					
4. Have you found it uncomfortable to eat any foods because of problems with your teeth or dentures?					
5. Have you been self-conscious because of problems with your teeth or dentures?					
6. Have you felt tense because of problems with your teeth or dentures?					
7. Has your diet been unsatisfactory because of problems with your teeth or dentures?					
8. Have you had to interrupt meals because of problems with your teeth or dentures?					
9. Have you found it difficult to relax because of problems with your teeth or dentures?					
10. Have you been a bit embarrassed because of problems with your teeth or dentures?					
11. Have you been a bit irritable because of problems with your teeth or dentures?					
12. Have you had difficulty doing your usual jobs because of problems with your teeth or dentures?					
13. Have you felt that life in general was less satisfactory because of problems with your teeth or dentures?					
14. Have you totally unable to function because of problems with your teeth or dentures?					

APPENDIX G (SELF-EFFICACY)

I.*Toothbrushing*

How likely do you think that you can brush your teeth effectively in following situations?

	Very much likely	likely	Not likeley	Not at all likely	NA
1.When you are tired in the evening					
2.When you do not have an appointment to see the dentist in the near future					
3.When you are on a holiday					
4.When you have a lot of work					
5.When you have a headache or feel ill					
6.When you have a problem with diabetic control					
7.When your are feeling weak					
8.When your are feeling depressed					
9.When there is no family support					
10.When you are under stress					
11.When you have problems with you eye sight					
12.When I have to relearn new ways to clean my teeth effectively					

II. Cleaning between the teeth
How likely do you you think you will use the following gadgets in cleaning between the teeth in the following situations?

	Very much likely	likely	Not likeley	Not at all likely	NA
1.When you are tired in the evening					
2.When you do not have an appointment to see the dentist in the near future					
3.When you are on a holiday					
4.When you have a lot of work					
5.When you have a headache or feel ill					
6.When you have a problem with diabetic control					
7.When your are feeling weak					
8.When your are feeling depressed					
9.When there is no family support					
10.When you are under stress					
11.When you have problems with you eye sight					
12.When I have to relearn new ways to clean my teeth effectively					

III.*Dental Visit*

How certain are you, in making regular dental visits as recommended in situations:

	Very likely	likely	Not likely	Not at all likely	NA
1.When a dentist did not call you to visit					
2.When you do not have any dental problems					
3.When you have financial problems					
4.When you are busy					
5.When you cannot get appointment with your own dentist					
6.When you had an earlier unpleasant experience					
7.When you are frightened of painful dental procedures					
8.When you do not know where to go for dental visits					

IV. Oral Health Belief
Please indicate your beliefs in regards to the following statements:

	Strongly agree	agree	disagree	Strongly disagree	NA
1.I believe that the dentist is the only person who can prevent oral diseases					
2.I believe that I can prevent gum disease by effectively toothbrushing my teetth					
3. I believe that I can prevent gum disease by effectively cleaning between the teeth					
4.I believe that if both of my parents or one of them have bad teeth, brushing and flossing will not help my teeth					
5.I believe that by brushing/ cleaning in between my teeth I am less susceptible to tooth decay and gum disease					
6.I believe that tooth loss is part of growing old					
7.The health of my teeth and gums are a matter of good luck					

V. Diabetes

Please indicate your beliefs in regards to the following statements:

	Strongly agree	agree	disagree	Strongly disagree	NA
1. I am confident diabetes control is my own responsibilty					
2.My diabetes remains under control best if I meet other diabetics regularly					
3.If my diabetes is going out of control, it will do so no matter what I do					
4.If I am able to avoid complications, it will be because others (doctors, nurses, family, friends) have been taking good care of me					
5.Avoiding complications is largely a matter of good fortune					
6.I will probably develop complications no matter what I do					
7.I have so many worries in my life that my diabetes will not stay under control					
8.If my diabetes goes out of control it is usually by accident					

V.*Others(please highlight response)*

1.Did you read the Periodontal Health booklet on your own time?

Yes (a) once (b) a few times (c) often (d) very often

No (a) did not have time (b) have no interest (c) forgot (d) NA

2. If, yes, was it useful for improving your oral hygiene?

Yes (a) very much (b) a little bit (c) not at all (d) NA

3. Do you think that oral hygiene is part of your personal hygiene?

Yes (a) very much (b) a little bit (c) not at all (d) NA

No. Please state why?…….