ESTIMATING ORAL HEALTH NEEDS AND WORKFORCE REQUIREMENTS USING SOCIODENTAL AND SKILL MIX APPROACHES

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I, Norintan Abdul Murat, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

Background: Traditional measures for planning in dentistry estimate dental workforce requirements based solely on normative approach. In contrast, the sociodental approach combines normative and subjective needs assessments and also incorporates behavioural propensity. The sociodental model has been recommended as a more rational approach to assessing dental needs. Much lower and more realistic levels of dental treatment needs have been reported using the sociodental approach compared to normative measures. This study compares the two approaches and applied the sociodental approach to different skill mix scenarios.

Objectives: 1) To estimate and compare dental treatment needs and dental workforce requirements for a sample of Malaysian adults using the traditional normative and the sociodental approaches. 2) To estimate workforce requirements using different skill mix scenarios.

Methods: This cross-sectional study was carried out on a selected sample of 732 adults aged 30-54 years who were employees of a public university in Kuala Lumpur, Malaysia. The participants' sociodental need was assessed at three different levels; i) Normative Need, where their treatment needs were assessed based on professional judgements; this is equivalent to the traditional normative need estimates, ii) Impact-Related Need, where those who had normative need were assessed on their level of oral impacts using the Oral Impacts on Daily Performances (OIDP) index, and iii) Propensity-Related Need, where those who had both normative need and oral impacts associated with their treatment needs were assessed on their level of behavioural propensity to determine the type dental interventions most appropriate for them. The estimates of sociodental approach based on the integration of Normative, Impact-related and Propensity-related needs were compared to normative approach. Then, the requirements for dental workforce per 100,000 adults were assessed and compared between the different methods of assessing needs. Next, five different skill mix scenarios were developed where different ranges of dental tasks were delegated from dentists to professionals complementary to dentistry (PCDs).

Results: The sociodental approach which comprises the assessments of Normative, Impact-Related and Propensity-Related needs resulted in significantly lower estimates than the conventional approach which uses normative assessment alone. The percentage differences in needs estimates between the sociodental and normative approaches were 91% for periodontal treatment and 89%-91% for prosthodontic treatment. Consequently, there were also differences in the number of dentists needed to treat 100,000 people. For restorative treatment, the number of dentists needed were 12.54 (normative approach) and 12.12 (sociodental approach), for periodontal treatment the respective figures were 14.43 (normative approach) and 2.32 (sociodental approach) and for prosthodontic treatment the need for dentists was 10.26 (normative approach) and 0.98 (sociodental approach). There was considerable potential for delegation of care to the PCDs, whereby the required number of dentists decreased and the required number of PCDs increased for varying levels of delegation.

Conclusions: The sociodental approach to assessing dental treatment needs resulted in much lower estimates of oral health and workforce requirements than the normative needs approach. The numbers of dentists needed to deal with the dental needs of Malaysian adults can be markedly reduced by using PCDs.

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CHAPTER 1
INTRODUCTION

Chapter 1

Introduction

Health workforce planning is a complex and systematic process which aims to determine the appropriate number and composition of health teams required to improve the level of health in the population (Hornby et al. 1980). Careful planning in the production and deployment of health workforce is important to ensure that their uses are optimized. A number of health workforce models have been developed to assist planners in estimating human resources requirements. The method chosen by health planners reflect their political, economic and social values of a health system (Hall and Mejia 1978; Dreesch et al. 2005).

Health workforce models such as the Health Needs model (Hall and Mejia 1978; Roberfroid et al. 2009), Service Target model (Hall and Mejia 1978; Adams and Woods 1990) and the WHO/FDI JW6 model (WHO 1989; Bronkhorst et al. 1991) estimate workforce requirements based on the assumption made on the quantity of health services that the population requires. A common limitation of these models is that they judge the service requirements based solely on normative needs which is heavily influenced by the disease based theoretical approach drawn from biomedicine. This biomedical model implies that any deviation from the normal structure of the body anatomy should serve as the basis for needing medical intervention (Reisine 1981; Patrick and Bergner 1990; Coulter et al. 1994). People's subjective feelings and perceptions of health are often ignored despite being contributing factors for health services utilization (Locker 1992; Locker and Slade 1994; Lo et al. 2001). The discrepancy between needs assessed using normative and subjective assessment has been extensively documented (Tervonen and Knuuttila 1988; Adulyanon 1996;

Srisilapanan and Sheiham 2001; de Oliveira and Sheiham 2003; Vered and Sgan-Cohen 2003; Gherunpong et al. 2006a; Ryu 2006; Colussi et al. 2009). Hence it is vital to assess both subjective perceptions and presence or absence of disease so that resources are better allocated to those with actual needs (Fitzpatrick et al. 1992; Locker 1995).

Another limitation of the normative needs assessment is that it does not consider factors that predispose people towards dental disease which is important in determining the success of treatment (Sheiham et al. 1982). The assessment of people's behaviour and compliance with prescribed preventive and clinical dental regimens is important to ensure that maximum benefit is gained from the intervention and wastage of resources is prevented. The estimation of health workforce that focuses on normative needs and disregards both the subjective and behavioural propensity measurements would provide an overestimation of their requirement (Bronkhorst et al. 1991; de Oliveira and Sheiham 2003; Ryu 2006; Sheiham and Tsakos 2007).

The Manpower to Population Ratio model (Hall and Mejia 1978; Prescott 1991; Dreesch et al. 2005) estimates workforce requirements based solely on the population size. Despite having numerous shortcomings, it is the method used by most health planners (Hall and Mejia 1978; Sheiham 1981; O'Brien-Pallas et al. 2001). The desirable ratio is not universally defined and could vary according to the prevalence of diseases, the availability of resources and health goals (WHO 1980b). In Malaysia, the target is to have one dental professional per 4000 people by the year 2020. As the existing publicly funded dental schools were not able to produce the required number of dentists to reach the target, seven new dental schools have been established since 1998 (Malaysian Dental Council 2006). The three existing dental faculties also increased their student intake. The decision to increase the number of dentists to achieve the arbitrary set ratio could eventually lead to surplus of health professionals (Hall and Mejia 1978). The same hasty decision to increase the number of dentists was made by western countries decades ago. It resulted in a surplus of dentists in some countries and consequent closure of some dental schools (Special Committee on the Future of Dentistry 1984; Moore 1986; Chaudhry and Scully 1988). A recent review on the Malaysian dental workforce conducted in 2008 demonstrated that by using the Health Needs method, there will be a possibility of oversupply of dentists in 2020 (Ministry of Health Malaysia 2009). However no actions have been taken to modify the targeted dentist to population ratio.

When the numerical estimates of workforce needs are being projected, the different type of oral health workers and skills needed to perform the services must also be identified simultaneously (Hornby et al. 1980). However, most workforce models failed to recognize the potential delegation of tasks between health professions in their projection of workforce requirements (Birch et al. 2003; Dreesch et al. 2005). The optimum mix and utilization of different types of personnel within an oral health team are essential for any country if it is to achieve the most efficient oral health care for the population (King 2000). In medicine, skill mix is being maximized and nurses and other health auxiliaries are providing clinical tasks which were previously undertaken only by doctors (Laurant et al. 2005; Medical Education England 2012). The development of skill mix in dentistry is slow compared to medicine and this is possibly due to the overprotection of dental organizations towards their profession (Nash et al. 2012) and dentists' lack of knowledge on the roles and responsibilities of dental auxiliaries (Jones et al. 2007; Ross et al. 2007; Edmunds and Tane 2011a). This is despite the overwhelming evidence that has consistently shown the capability of dental auxiliaries in carrying out various dental tasks after undergoing comprehensive additional training

(Lotzkar et al. 1971; Wilson et al. 1985; Anderson 2002; Tuominen 2003a; Bolin 2008; Wetterhall et al. 2010). Several studies have demonstrated the potential for delegation of dental care from dentists to dental auxiliaries (Wang 1994; American Dental Association 2007; Evans et al. 2007; Gallagher et al. 2010). The delegation of simple and routine work would free up dentist time for more complex dental work, practice management and advocacy. The provision of oral health care by those with the most appropriate qualification and skills would ensure a more efficient delivery of health care.

This study intended to bridge the gap identified in most workforce models indicated above. The next chapter reviews the literature on the conceptual models of workforce planning used in predicting and projecting the number of health personnel needed, the importance of health needs assessment in health care planning and of using different skill mixes to meet oral health needs.

CHAPTER 2
LITERATURE REVIEW

Chapter 2

Literature Review

2.1 Introduction

This chapter has three main sections. The first is a review of the conceptual models of workforce planning that have been used in estimating the number of health personnel needed. The second discusses the importance of health needs assessment in health care planning and appraises the sociodental approach of assessing needs. The possibility of using different skill mixes to meet oral health needs is examined next by looking at the evidence on the effectiveness and efficiency of utilizing dental auxiliaries in carrying out dental procedures.

2.2 Health Workforce Planning

Health workforce planning is important as the right mix of quantity and type of personnel will facilitate provision of care by the most appropriate personnel and hopefully improve the population's oral health at regional, provincial and national levels. Policies for workforce planning must aim at increasing economic and geographic accessibility and regulating workforce production and utilization (Deliege 1987). In the early 1960's, the aim of workforce planning was to achieve and sustain "the right number of people, in the right place, with the right skills, at the right time". More recently, driven by financial limitations and demands for efficient use of resources, the additional importance of finding workers "with the right attitudes, doing the right work, at the right cost, with the right productivity" was emphasized (Hornby 2007).

When planning or forecasting needs for health workforce, factors such as the changes of population demographics, social development, economic and budgets allocated to health needs to be taken into account (Deliege 1987). In addition, modifying factors that could affect the worker's behaviour and practice such as the feminization of health sectors, aging workforce or increased use of auxiliary staff must also be considered (Cole and Cohen 1971; Bourgeois et al. 1993). In the past, health workforce planning had limited success because there were limited support for long term strategic planning and use of unsuitable or complex planning methods for the country situation. As a result, some countries ended up with too many or too few health workers and poor geographic distribution of the workforce (Hall 1998). This stresses the importance of having good workforce planning as the outcome would assist policy makers to formulate policy and decisions based on objective considerations, rather than subjective judgment as was commonly done.

A practical approach to workforce planning involves the following steps: i) the establishment of measurable goals for oral health services based on situation analysis, taking into consideration of available workforce, facilities and funds; ii) the calculation and distribution of the workforce needed to achieve the goals; iii) the assessment of the health services goals that can be achieved with the current available workforce and the training programme that are in operation or needs to be developed; iv) the modification of goals if there is no combination of workforce that can satisfy the initial goals; v) recalculating the workforce needed for the new goals; vi) the establishment of the quantitative and qualitative goals for workforce production (WHO 1980b; McQuide et al. 2008). These steps need to be repeated until the number and types of workforce required to deliver the oral health goals is achieved. The target should not be about producing the highest proportion of health professionals, the aim should instead set on having the quantum suitable with the population needs, demands and the country's health budget (Hall and Mejia 1978).

Numerous workforce models have been developed to assist oral health planners in deciding the appropriate number and the proper mix of human resource skills. The method chosen to estimate workforce requirement reflects the political and economic choices and social values of a health system (Dreesch et al. 2005). Most of the models intend to define the supply versus 'requirements' gap (DeFriese and Barker 1983). The supply of health care is the stock of health workforce available at present or in the future to deliver health care (Goodman and Weyant 1990; Dreesch et al. 2005). The requirements may be i) professionally determined need for care i.e. normative need (Spencer 1980b; Striffler 1983) or ii) effective demand for health care measured by the current levels of services utilization and behaviour patterns of consumers (Goodman and Weyant 1990; Orlans et al. 2002; University of Missouri-Kansas City 2006). The next section presents an overview of the workforce planning models that can be applied when assessing workforce requirements.

2.3 Models of Health Workforce Planning

2.3.1 Health Needs Model

The Health Needs Model uses the current disease levels of the population to calculate the workforce requirements (Hall and Mejia 1978; Born 1981; Dreesch et al. 2005; Roberfroid et al. 2009). Professional judgment or normative need is used to estimate the most appropriate services and technologies needed for a specific type of health needs. The number, type, frequency and quality of services to be provided to the section of the population that suffers from diseases are quantified and these are converted into the amount of time required by health professionals to perform the services (Hall and Mejia

1978). The current quantity of health providers needed is calculated using estimates of health professional's annual working hours and the population's health status or treatment need (Hall and Mejia 1978; Born 1981). A forecast of future health workforce requirements can also be made based on the trends in the population's health needs and the demographic distribution of health professionals (Roberfroid et al. 2009). The health needs approach is explained using the following formula (Hornby et al. 1980; Bawden and DeFriese 1981):

$$M_{pt} = \frac{P * C * V * T}{W}$$

Where:

M_{pt} = workforce required in year t;

P = the population that needs a given type of care for a specific health problem in year t (current or projected)

C = the average number of 'conditions' per person per year

V = the average number of a given kind of service per condition per year, based on need

T = average time required per service

W = average workload of the individual practitioner – total amount of service time provided by the average practitioner per year for a given service.

The North Carolina Dental Manpower Study used the health needs model to produce estimates of dental workforce requirements for the State and six sub-regional areas. It relied upon epidemiological data on dental diseases, dentist productivity and estimates of treatment needs. The outcome measures for this workforce review was the percentage increase in productive capacity that is required to meet the needs for dental care (DeFriese and Konrad 1981; Schonfeld 1981). This method was also used in a recent dental workforce review in Malaysia which aimed to determine the need for dentists for the year 2020. The projections showed that there will be far more supply of dentists compared to the actual requirements needed (Ministry of Health Malaysia 2009).

The health needs method can be perceived as rational by both health professionals and members of the public because it is consistent with social and professional ethics which warranted that health services be provided to all those in need regardless of their social and economic circumstances. The health needs method was considered suitable for use in a country with a sound planning capacity, an active government policy toward health, a dominant public sector, and a relatively high public awareness of health issues (Hall and Mejia 1978). However, it could be argued that countries with a good policy in health planning would probably incorporate some sort of prioritization system in their need assessments process knowing that it is impossible to meet all professionally defined needs. Nevertheless, the health needs method has also been used in a country where private practice is the dominant sector, such as New York, Iowa and North Carolina in the United States (DeFriese and Barker 1982; Cons et al. 1983; Orlans et al. 2002).

The model assumes that the health needs of the population should and can be met and professional judgements are the best means to identify the needs of the population. It fails to appreciate the importance of people's subjective needs. There is a danger of using this 'expert knows best' or 'top down' approach that puts the professionals in a position of power. Health professionals can influence the volume and type of need. There is a possibility that the experts will put their own narrow professional interests above those of the population (Robinson and Elkan 1996; Mooney 2003). Studies have shown that even when the supply of health professionals is increased to align with the needs of the population, the need for health care continued to increase as health professionals created demand for health services by increasing the number of patients requesting care or by increasing the amount of care provided per patient. This practice is known as supplier induced demand (Grytten 1992). These phenomena indicate that estimating health workforce requirements based on normative needs alone will not provide good workforce predictions but instead would possibly lead to an oversupply of health workers.

This model also implies that cost-effective methods and resources are available in accordance with needs (Hall & Mejia 1978; O'Brien Pallas 2001; Dreesch et al. 2005). However, due to constraints in human resources and health budget in most countries, it is impossible to satisfy all health needs (Yee and Sheiham 2002; Petersen et al. 2005). Furthermore, the model ignores the reality of economic demand in that not everybody can afford to purchase the services provided (Born 1981; Goodman and Weyant 1990).

This model requires the translation of needs into the treatment required and the hours needed to treat. It is difficult to arrive at a specific treatment plan and consequently predict the future workforce requirement as there are wide variations in the methods and types of treatment for a given dental condition (Schonfeld 1981; Sheiham 1981; Nuttall 1983; Nuttall and Elderton 1983) and the type of provider to be involved (Bawden and DeFriese 1981; Shugars and Bader 1992). In addition, needs assessed in epidemiological surveys have been found to under- or overestimate needs assessed in ideal clinical settings (Long et al. 1979; Eddie and Elderton 1983; Goodman and Weyant 1990) and the needs assessed might not translate to effective demand (Naegele et al. 2010). Determining the health needs of the population requires a high level of skills and knowledge by the health care workers. Health care professionals involved in the clinical examination and survey must be calibrated to ensure the standardization and accuracy of their opinion/finding and this process could be time consuming and costly.

The strengths of the approach are that it is logical and easy to understand as the basis underlying it is that some people have needs for medical or dental care, and to satisfy those needs, a sufficient number of health workers must be available. Addressing the health needs using a mix of health workers is possible under this method (Markham and Birch 1997; O'Brien-Pallas et al. 2001). It has been claimed that this technique is particularly useful in a health programme where the health problems and the health services needed are clearly demarcated in a well-defined target population (Hall and Mejia 1978; Goodman and Weyant 1990).

2.3.2 Health Demands Model / Utilization Technique

In this method, workforce requirements are projected based on current and estimated future utilization rates. Indices of demand are constructed using utilization rates by age, sex, occupation and race; and future demand is derived from the expected changes in the size of these population groups and the proportionate change in services that this might imply in the future (Hornby et al. 1980; Sheiham 1981; Roberfroid et al. 2009). Demand and utilization are two terms that have been used interchangeably. Demand is defined by the seeking behaviour for health care by patients, resulting directly from the perceived or subjective need for treatment (Spencer 1980b; Davis 1982) while the term utilization refers to the amount of dental care consumed or purchased as a result of compromised decisions between the patients and providers (Grytten 1992). The workforce requirement is projected based on the data of dental utilizations obtained from health providers, the average dental visits made by the patients and the expected population growth (Hornby et al. 1980; Born 1981). Proxies for demand/utilization data have been used such as practitioner's productivity or professional opinion surveys

(DeFriese and Barker 1982) or other influences of demand such as data on dental insurance or socioeconomic status (Odrich 1985).

This method has been used for projection of dental workforce needs in England, Scotland and Victoria, Australia (Victorian Department of Human Services 2002; Department of Health 2004; NHS Scotland 2004). In estimating the dental workforce requirement for England, the time needed to carry out the demanded treatment was also included as an additional variable for dental utilization data (Department of Health 2004). This 'treatment hours' approach takes into account the effect of changes in oral health on the type of treatment required and hence the length of time required for the treatment. The findings for the workforce modeling using demand-based approach were similar in all the three countries. It showed that demand will outstrip capacity to supply in the future.

The demand-based method is based on several assumptions. Demands or the productivity of the health care providers observed in the past or in the base year are assumed to remain constant over time despite any possible changes of the populations' demographic profile and evolution of tasks for health workers (Hall and Mejia 1978; McQuide et al. 2008; Roberfroid et al. 2009). The supply of dentists is assumed to rise according to market demands and increases in patient visits will require proportionate increases in dental workforce requirements. It is also presumed that there is less or no variability among dentists in terms of their patient volume and auxiliary utilization (Born 1981).

The strength of this model is that it enables health care planners to assess interactions between demand and supply, the dynamics of health services utilization and inequality of access to service (Hornby et al. 1980). Assumptions made on the constancy in demand correlates over time will avoid the risk of setting excessively expensive or unrealistic objectives. This method is a little more sensitive than the gross ratio method that will be reviewed later as it captures more of the reality of the dental marketplace (Born 1981) and is more likely to predict workforce requirements that will be utilized compared with the need-based model (Odrich 1985).

However the model relies heavily on utilization rates to estimate future workforce need and assumes that increases in demand should create increased supply. It fails to understand that there are some populations who are in need of health care but could not demand it. Demand for dental services is often lowest among those with the highest needs (Goodman and Weyant 1990) and highest among those frequent attenders with needs for routine care only (Bronklehurst and Tickle 2011). Failure of health care planners to account for differences in demands would lead to further inequality and prolong the status quo (Orlans et al. 2002; Godson and Williams 2008; McQuide et al. 2008; Milsom et al. 2009). The projections made are based on current users or 'effective demand' data and neglects the current non-users of dental services (Cole and Cohen 1971). The failure to assess total demand, both met and unmet, can limit the value of workforce planning (Reinke and Hall 1977). Moreover, the type and quality of dental visits, for example for emergency or preventive reasons, is not considered (Orlans et al. 2002). Another problem of the demand-based model is that data on utilization rates of sufficient detail are seldomly collected (Odrich 1985) and expensive to obtain (Orlans et al. 2002). When available, they might not portray the true characteristics of the population under study (Born 1981) or the interpretation of the detailed data could be challenging (O'Brien-Pallas et al. 2001). This method also fails to address factors that could seriously affect utilization such as the financial aspects of both providers and clients (University of Missouri-Kansas City 2006).

2.3.3 Service Targets Method

The Service Target Method involves the setting of targets by health authorities for the production and delivery of specified health services at various levels of care, considering the current level of technology, the demand of the population for certain services and the various services already performed by health workers. Compared to the need and demand-based method, this method uses other criteria to develop targets, which would consequently create demand or provision of health workforce. These other criteria include factors such as the public demand for services, political views, costs, efficiency for service delivery, likely effects, segment of the population benefitted, access and administrative feasibility (Hall and Mejia 1978; Hornby et al. 1980; Dreesch et al. 2005). When the number of services has been identified, the workforce required to render the services is calculated.

This method was used by Adams and Woods (1990) when estimating physicians' requirements for Canada. They assessed the current levels and future targets of service adjusted by experts' opinion on the norms provision of care. However they only addressed the physicians' requirement without looking at the possibility of substitution among health workers. Dreesch et al (2005) addressed this limitation by combining both the service target approach and functional job analysis to estimate the human resources needed to achieve the Millennium Development Goals (MDGs). The potential for sharing skills among various objectives/health programmes and combining and substituting various skills were identified in that study.

The strengths of this approach lie in its method which breaks down the activity and components of health services. This in turn facilitates the matching of each part of the health system with the most appropriate method for estimating demand, which makes it relatively easy to put into practice and allows for assessment of interaction between variables (Wibulpolprasert 1997). The method places importance on productivity and its improvement, simplifies cost estimates and has an active approach towards improving the health services (Hall and Mejia 1978). The target setting method allows integration of function and resources across various health programs and prevents overlapping of activities (Dreesch et al. 2005).

However this method requires comprehensive workflow studies and expert opinions which are subject to bias or errors in judgment. The ability of the health sector to expand, the capacity of health workers to deliver the targets established and the probability that the public will use the service is difficult to ascertain only through assessments made by health authorities (Hall and Mejia 1978). It is also difficult to define the tasks and skills required to deliver the programme and to match it with available resources (Dreesch et al. 2005). Sheiham (1981) commented that although the dental profession appears to follow a target setting approach by having a specific target or solutions on each oral health goals, if the importance of preventive action is not recognized, they would in reality still be using the supply-demand model.

2.3.4 The Manpower to Population Ratio method

The Manpower to Population Ratio is the simplest workforce method to apply and to understand compared to other approaches as it is a count of health care personnel for a given population. The desirable ratios are established on the basis of current situations, international comparisons, recommended standards, ratios observed in a favored area of the country and extrapolation of past trends (Hornby et al. 1980; Dreesch et al. 2005). However, the ratio used is arbitrary and not universally defined and usually depends on disease levels, workforce adequacy and oral health goals (WHO 1980b). For example, at one point it was suggested that the acceptable ratio is one dentist to every 2000 people (Rosenbaum et al. 1975), then a decade later the recommended ratio changed to one dentist to every 5000 people (Holler and Machans 1989). WHO (1980b) outlined a working basis for oral health services planning based on the following workforce ratio:

i. Ratio of 1:20,000 and lower requires planner to focus more on the assessment of existing and projected resources over the next 10 years
ii. Ratio of between 1:20,000 to 1:50,000 encourages a more ambitious health care planning
iii. Ratio of 1:5000 and higher requires a plan for a more comprehensive coverage of the population's oral health needs.

This method is based on several assumptions, most of which are not justified and cannot be easily defended. The model assumes that there will be a constant need and demand of health professionals (Hall and Mejia 1978; Sheiham 1981; Markham and Birch 1997; O'Brien-Pallas et al. 2001; Roberfroid et al. 2009) regardless of changes in the populations' demographic profiles, changes of health pattern, political and economic situations and research advances. It also assumes that health professionals' productivity would remain the same and that there will be no evolution of tasks for both the professionals and other supporting health workers and no advances in technology would be further created (Yett et al. 1972; DeFriese and Konrad 1981; Odrich 1985; Goodman and Weyant 1990; Dreesch et al. 2005). The supplies of health workforce and health facilities are assumed to be independent of wages and demands for health services are independent of prices and ability to pay (Yett et al. 1972). The straight forward calculations of the number of health workforce to the number of population, without disaggregating them into different geographical areas, would presumably indicate that there is reasonable geographical distribution of health workforce in both areas. The manpower to population ratio estimated for Zimbabwe was one to almost 80,000 people with the majority of dentists located mainly in urban areas (Khan and Sithole 1991). It was predicted that increasing the ratio by producing more dentists would not improve the geographical equity of the personnel distribution and hence introduction of dental auxiliaries was recommended at rural areas as a solution to the shortages of dental workforce.

Another shortcoming of the ratio method is that it fails to consider the interaction between demand and supply and the variables that tend to increase or depress demand (Hall and Mejia 1978; Goodman and Weyant 1990). Factors such as changes in funding mechanisms, technological advances, socioeconomic development and disease shifts that could affect demand are not considered (DeFriese and Barker 1982; Odrich 1985; Goodman and Weyant 1990). Further, because the ratio addresses demand and need only indirectly at best, it is difficult to differentiate the severity of oral disease or the different type of treatment needed in the population (Connor et al. 1994) or the levels of untreated diseases (Orlans et al. 2002). This method does not give indication of whether the existing health workforce are able to meet patient needs (Cavanaugh 1983) and it does not consider the different categories of needs based on the type and severity which could be performed by different categories of health specialty (Odrich 1985; Goodman and Weyant 1990). The ratio mentioned as the satisfactory number of manpower to population is also arbitrary, but some politicians will express the demand to achieve that subjective figure and this could eventually lead to surplus of health professionals or even inequalities of health services. Despite the aforementioned limitations, this method is popular and is frequently used as it is cheap, quick, easy to apply and to understand/interpret, and requires little information (Hall and Mejia 1978;

Born 1981; DeFriese and Konrad 1981). It is claimed to be more appropriate for used in a situation where dental diseases are more widespread (Meskin and Martens 1970).

Some modifications of the manpower-population approach have been proposed. Thailand modified this method by including other measurements such as the specific characteristics of the Thai health care system and the future economic scenarios (Sirikanokvilai 1998). Beazoglou et al. (2002b) estimated the number of dentist needed in the United States by adding measures of total dental output and gross billings of dental practice in the ratio method. Others have included adjustments for factors such as the age of the health professionals, the impact of water fluoridation and the increased productivity due to average auxiliary utilization (Born 1981).

2.3.5 The Econometric Model

The Econometric Model is sometimes described as a simple equation of supply and demands which requires few variables, but other times it is defined as a complex equation that could involve numerous variables (Born 1981). Data required for projection would depend on the scope and complexity of that particular model. This model uses the interaction between supply and demand, but emphasizes the price of health care (to the patient) and income (to the providers) as the primary factors. The model divides the health sector into a demand sector, which is concerned with the decisions of the general population to seek care; and a supply sector which is concerned with the decisions of providers to supply care (Feldstein and Roehrig 1980). The interaction between these two will determine how much care is provided, to whom, and at what prices. The actual demand will depend upon the prices people are willing to pay for the services which includes the price of dental care, annual per capita income of the population, availability of health insurance and waiting time, both in securing an appointment and in being kept waiting in the health care agency (Feldstein and Roehrig 1980; O'Brien-Pallas et al. 2001). Health care providers' willingness to offer services (supply) will depend upon the price received, the value providers place on their own time, wages paid to other supporting health personnel and the state of existing technology. Given all the factors involved in determining supply and demand, it is the price that ultimately adjusts so that quantity supplied equals quantity demanded (Feldstein and Roehrig 1980).

The econometric model looks at many major economic variables that would influence demand and supply and uses possible scenarios to gauge possible consequences. For example, Hogan et al. (1996) described a workforce model for physiatrists that was based on several scenarios which included managed care growth, competition from other providers, and other factors such as education, current supply, age of current providers, technology and the epidemiology of certain diseases to gain understanding of how these variables could manipulate the market. Yett et al. (1972) discussed a macroeconometric model developed at the Human Resources Research Center of the University of Southern California which evaluated the effects of a national policy on the supply and demand interaction using several policy initiatives.

This method was used in dental workforce projection in Wisconsin, United States (Beazoglou et al. 2002a). Economic factors such as dentist location, average income, dental insurance and other practice costs were included in the modeling. The findings suggested a misdistribution of dentists in which concentration was highest in the largest counties (Beazoglou et al. 2002a).

This model assumes that the supply of workforce determines the demand, rather than vice versa (DeFriese and Barker 1982) and that there is a constant interdependency between supply and demand (Born 1981). Certain variables are presumed to be the critical components in the health financial system and the relationship of those variables to the production of services is assumed to behave in accordance with general economic theory (Born 1981).

It was claimed that the strengths of this model lie in its objective (Born 1981) and logic (Wibulpolprasert 1997) approach as demand for health care is usually related to the ability of people to purchase health care and the monetary benefit that the providers think they will receive if they provide the care. However, this could be true from an economic point of view, but might not conform to public health perspectives. The model is also said to provide frameworks that are useful for assessment of the relationship among stock, wages, demand and budgets (O'Brien-Pallas et al. 2001). Nevertheless, the econometric approach is limited in terms of its conceptual adequacy. It does not sufficiently consider population health needs, budget pressures, political/socio/economic factors, the influence of the changing health system and the impact of outcomes (O'Brien-Pallas et al. 2001). The data required for the analysis of workforce requirement is either nonexistent or inadequate and there is a possibility that the health economic system may not behave in a traditional manner as presumed by the economists (Born 1981). Furthermore these models can be extremely complex and costly- both in computer time and manpower hours (Odrich 1985).

2.3.6 The WHO/FDI JWG6 model (needs-based, demand weighted method)

In 1988, a Joint Working Group of the WHO and the FDI developed a spreadsheet computer programme (WHO/FDI JWG6) for prediction of dental workforce requirements. The proposed model takes into account various types of data: basic data for calculating oral care needs, modifying factors which influence decision-making and decisions on options and strategies available for plan implementation (Figure 2.1) (WHO / FDI 1989; Bourgeois et al. 1993; Morgan et al. 1994). The final outcome of the computer programme is expressed as an operator-to-population ratio specific for that population.

This computer programme provides two sets of calculated results:

- The quantity of services required to deal with the needs of current and projected population and the full time equivalent (FTE) personnel needed to provide them.
- The quantity of services which could actually be provided given the level of demand.

The computer programme also requires that dental needs are divided into seven distinct groups for each age cohort (0-14 years, 15-29 years, 30-64 years, 65-79 years). These are special group care (handicapped or geriatric), surgical group care (impaction and trauma), orthodontic care, restorative care, periodontal care, preventive care and prosthetic care (WHO / FDI 1989; Morgan et al. 1994).

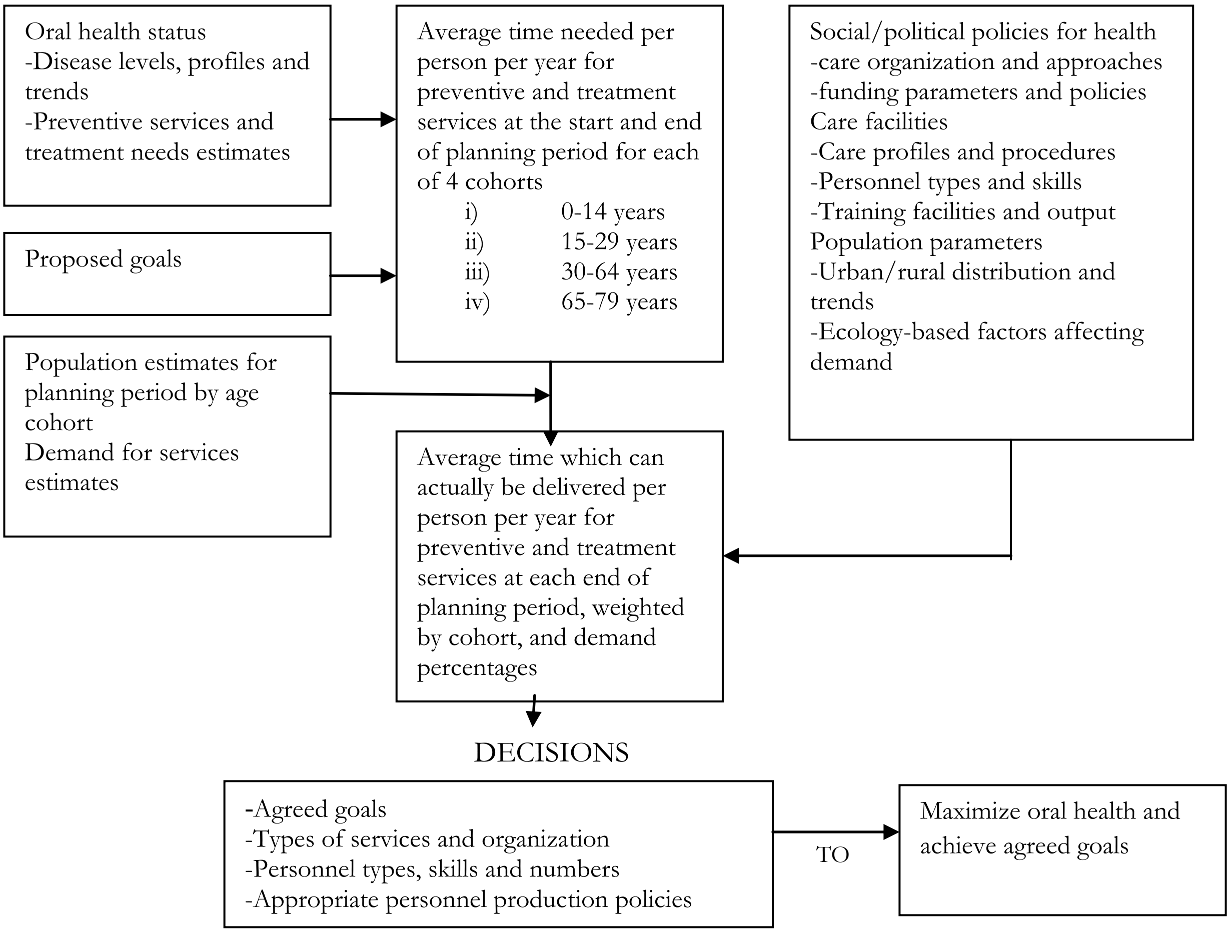

Figure 2.1: Planning flow chart for WHO/FDI JWG6 programme (WHO 1989)

The WHO/FDI model has been used to estimate dental workforce requirements in France (Bourgeois et al. 1993). The model's prediction of the dentist to population ratio was similar to the current situation in France. However, that does not mean that the ratio was appropriate for that population. When using this model for projecting workforce needs for dentists in Lebanon, the model suggested that the projected supply of dentist will exceed the required number of dentists (Doughan et al. 2005).

The strength of this model is that it assesses both treatment needs and demand for health services. An individual might have a need for health care but might not demand any interventions and vice versa. Assessing both need and demand would give a better estimate of the use of health resources (Vetter 2002). This model also emphasizes the use of different treatment times for different cohorts. The time needed to manage people in the older age group could be higher than those in the younger cohort due to the complexity of their oral conditions and co-morbidity with other medical conditions and this would translate to a higher need for health workers. Forecast requirements that are made based on data by age cohort or by type of care may generate a better estimate of health workforce.

However, this model has been severely criticized because it 'neglects cohort and period effects in its estimates of oral care needs, neglects aspects of demand, and provides overly simplistic answers to complex questions in workforce forecasting' (Bronkhorst et al. 1991). Morgan et al. (1994) argued that the age cohort put forward by the WHO makes comparison of data among countries difficult. Although it was stated in the handbook that the age cohorts could be changed, there was no explanation regarding the consequences of doing so (Morgan et al. 1994). Moreover, the 'unit' of oral health stated in the programme is not clearly defined and the various oral health care workers and the services that they provide could not be distinguished (Gibson 2004). The computer programme for the method also fails to consider socioeconomic factors that could modify the behaviour and the practice of dentists. These factors could be changes in oral health pattern, politico-economic incentives and constraints, dental workforce mix, population changes, research advances and dentists' capacity to supply services (Morgan et al. 1994).

2.3.7 System Dynamic Model

System Dynamic Model is a computer simulation programme that illustrates processes of accumulation and feedback and is used to find effective policies using various scenarios that can be tested in a systematic way that answers both 'what if' and 'why'. It was developed in the mid-1950s by computer pioneer, Jay W. Forrester. A key emphasis within the model is placed on the presence of feedback loops, characterized as loop of causes and effects. The details of causal factors that are responsible for a particular problem or affect the performance of a system needs to be laid out first. Then these causal factors are represented in diagrams that make the relationships among them explicit. It was suggested that the enumeration and diagramming steps should be carried out with active participation of decision makers (Hirsch 1977; Homer and Hirsch 2006).

The System Dynamic model has been applied in dentistry (Hirsch and Killingsworth 1975; Levin et al. 1976; Steering Committee on Future Health Scenarios 1994). It was used in the Netherlands to simulate a model of supply and demand of the dental health care system. The model consisted of five sub-models concerning the population, the dental attendance behaviour, the pathology model which assessed the dynamic of caries and periodontal disease, the supply model which gave figures for the work potential of dentists and dental hygienists, and the treatment model (Bronkhorst 1995). Five different oral health scenarios were developed on the basis of the developments and expectations regarding dental health care and were tested on the simulation model (Steering Committee on Future Health Scenarios 1994). The result showed that the model was able to replicate fairly well the behaviour of the Dutch dental health care system as observed for the period 1970-1984 (Bronkhorst et al. 1990).

System dynamics shows potential of modeling multiple interacting diseases and risks and the relations between delivery system and diseased population (Homer and Hirsch 2006). It is useful in a data poor environment as model can be developed using important variables regardless the quality of the data. Consequently it will assist decision-makers to identify data that should be collected in the future (Hirsch 1977). The major strength of this model is that it requires the involvement of decision-makers in the process. This would create a better understanding of the health scenarios being modeled and the greater commitment on the decision-maker's part to use the results subsequently. However decision-makers could be reluctant to take part in the disciplined and slow process of computer modeling. It will also not excites those who do not trust findings based on intuition (Hirsch 1977). Besides that, the requirement of multiple data might lead to overly complex models that are difficult to work with or to understand.

2.3.8 Overall appraisal of the health workforce planning models

The previous section reviewed different types of workforce planning models which can be utilized by decision-makers in deciding the quantity and quality of health workers appropriate at the level of diseases and services available and affordable within the specified health budget. It is important to weigh the strengths and limitations of each model before choosing the right approach as different type of model chosen will generate different outcomes. For example when using the Manpower to Ratio methods, Khan and Sithole (1991) found that Zimbabwe needed to have an additional 624 dentists but the number of dentists needed decreased to only 96 when need-based method was used. Similarly, Malaysian Ministry of Health (2009) found that the difference between the number of dentists needed in Malaysia for the year 2020 was more than 3000 when comparing between Service Target method and Health Need method. Therefore decision-makers need to have guiding principles in selecting the appropriate methods to prevent over- or undersupply of health workforce in the future.

Most of those methods discussed earlier, especially the Manpower to Population Ratio approach, are profession-specific and have largely failed to recognize the potential of substitution between health professions (Birch et al. 2003; Dreesch et al. 2005). Nevertheless it is the most commonly used method to estimate dental workforce. Projections of needs often focus only the dentist/doctors and the effect of working in a team and the potential of substituting or supplementing amongst health workers is ignored.

There have been changes in the pattern of dental diseases and in the ways needs for treatment is defined which called for the reassessment of the role of future dental workers. Dental caries is declining (Burt 1985; Renson 1989a; Ministry of Health Malaysia 2004; White et al. 2011) and this has been accompanied by changes in the nature of lesion presented in the population. Carious lesions are now smaller and more frequently found on easily accessible sites such as pit and fissures compared to approximal sites (Batchelor and Sheiham 2004; Sheiham 2005). More adults are retaining their teeth for much longer and could require more complicated dental procedures such as crowns and bridges. The recent Adult Dental Health Survey showed that in England, there was no measurable increase in the average number of restored teeth between adults aged 25 to 34 in 1998 with those aged between 35 and 44 in 2009. This indicates that the accumulation of restorations is slow in those age groups, and if this scenario is sustained as the younger groups get older, there will probably be far lower levels of restoration across a lifespan (Steele et al. 2011). The findings from the same survey also demonstrated that the prevalence of coronal caries in England has decreased by 40% between 1998 and 2009, with the largest reduction being among the 25 to 34 age group. For periodontal condition, the prevalence of shallow pocketing has decreased by 18% but for deep pocketing, the prevalence has increased by 50% for the same decade (White et al. 2011). Changes in the oral disease patterns have resulted in polarization of needs towards self-care and minimal simple intervention on the one hand and high technology care on the other. The increasing level of need for self-care and minimal simple intervention suggests that a multidisciplinary approach may be needed with dentists providing more complex services and dental auxiliaries providing the simpler and routine tasks (Barmes and Tala 1987; WHO 1990; Department of Health 2000b).

In addition to the aforementioned trends, the patterns of dental disease should also be considered in workforce planning. The progression of dental caries is slow (Pitts 1983; Sheiham 2005a) and decreasing with the more widescale use of fluorides. The mean time for a lesion to progress through enamel takes more than six years (Berkey et al. 1988; Lervik et al. 1990; Pitts and Kidd 1992; Mejare et al. 1999; Lith et al. 2002) and another three to four years from the inner to the outer half of dentine (Lith et al. 2002). For periodontal disease, the theory of progression has changed from the previous concept that support the 'linear' progression of disease (Loe et al. 1978) to a 'random' (burst theory) model (Socransky et al. 1984). Most sites with gingival inflammation did not progress to periodontal disease but remained stable for years (Burt 1988). It was also found that in countries where periodontal disease levels are usually high, the type of care needed is usually oral hygiene instructions (FDI / WHO 1985; Renson 1989b). This slow or non-progression of dental caries and periodontal disease has an impact on the recommended frequency of visits and the appropriate workers needed to monitor the progress of disease (Sheiham 1991). Policy makers should adopt a more integrated approach and consider the possibility and the effects of delegation of tasks between health professions (Renson 1989b; Dreesch et al. 2005). The likely scope of the future roles of health professionals must be introduced and matched against current health needs which also need to be constantly monitored. Planning must also move towards identifying evidence-based health care for patients who will benefit from the treatment (Sheiham and Tsakos 2007). The potential of initiating skill mix approach in dentistry will be discussed in detail at the latter part of this chapter.

The principal limitation shared by most workforce models is how they justify the provision of health care based on prior assessment of needs. Most models, for examples the Health Needs, the WHO/FDI JWG6 and the Service Target model often uses professional judgments to assess the dental needs of the population. The limitation of this normative based judgment has been documented (Hall and Mejia 1978; DeFriese and Barker 1983; Connor et al. 1994; Orlans et al. 2002; Sheiham and Tsakos 2007) and the tendency of this approach to give unrealistic high estimates of workforce needs has been established (Bronkhorst et al. 1991; de Oliveira and Sheiham 2003; Srisilapanan et al. 2003; Department of Health 2004; Ryu 2006). Clinical decisions based on normative needs often lead to overtreatment and increasing complexity of treatment (Elderton 1996; Leles and Freire 2004). The lack of objectivity in normatively assessed needs leads to variations of diagnosis and treatment planning given for a similar kind of oral health condition (Spencer 1980b; Elderton 1990; Bader and Shugars 1995; Sheiham and Spencer 1997; Bader and Shugars 1998; Sheiham and Tsakos 2007). This is because treatment decisions made by health providers depend on their knowledge, philosophies, values and personal attitudes which could differ among each other (Bader and Shugars 1992; Kay et al. 1992; Espelid et al. 1994a; Lazarchik et al. 1995). Furthermore normative needs often overlook elements that would increase the likelihood of a successful long term outcome of the intervention. This includes the behaviour and compliance of the patients and the updated scientific evidence of the effectiveness and efficiency of the intervention that is being recommended (Leles and Freire 2004; Sheiham and Tsakos 2007).

Needs determined by health professionals disregards social aspects and the broader definition of health and needs (Locker 1988; Sheiham and Tsakos 2007). Little or no value is given to the subjective perceptions of patients in relation to psychological and social impacts of arising from the health condition (Locker 1988; Leles and Freire 2004). There are conflicts between the type, amount and degree of treatment dentists believe patients should receive and what patients perceive they need and these discrepancy between the normative and perceived need have been extensively documented (Smith and Sheiham 1980; Davis 1982; Gilbert et al. 1994; Locker and Jokovic 1996; Nevalainen et al. 1997; Cochrane et al. 1999; Ahmed et al. 2001; Srisilapanan et al. 2003; Leles and Freire 2004; Colussi et al. 2009; Naegele et al. 2010). The reasons for this inconsistency are because the professional assessment is based on clinical signs which could appear before any symptoms are experienced; while people consider the functional and social problem arising from the oral diseases which might affect their daily life experiences such as speaking, smiling or eating (Otchere et al. 1990; Kay 1993; Gilbert et al. 1994). Some aspects such as malocclusion, loss or fractures of teeth might lead the professionals to diagnose the need for intervention but patients might not express the need for one if they are free of pain, feel functionally adequate and please with their aesthetics. In addition to this, patients usually tend to have a more positive view regarding their health compared to the professional assessments made to them even in the poorest of their health (Reisine and Bailit 1980; Smith and Sheiham 1980;

Cushing et al. 1986; Davenport et al. 2000; da Silva and Castellanos Fernandes 2001; Rich and Goldstein 2002).

However, perceived needs may be limited by the perceptions of an individual. Individuals may think that they do not have needs simply because they do not know what is available in terms of treatment or services (Naidoo and Wills 2000). Hence it is important to consider both normative and perceived needs in order to evaluate better the needs for health care. People with high perceived needs might be most likely to seek health care in order to achieve better health and they will subsequently benefit from the care received (Atchison and Dubin 2003; Azodo et al. 2010).

Because of the aforementioned limitations of normative needs, it has been suggested that the assessment of needs should also comprise patient driven information, which include the subjective measures of general health and functional state and whether the conditions that they are in is of sufficient importance and magnitude to seek professional advice (Andersen 1995; Gift and Atchison 1995). The inclusion of subjective measures should provide an improved assessment of needs as it relate to human experiences and involve the interaction between various factors in people's life, namely biological (Davis 1987; Locker 1989), psychological (Engel 1980; Maizel et al. 1991) and socioenvironmental factors (Davis 1987; Locker 1989; Mechanic 1995). Assessment of perceived need for treatment has the potential to predict the use of health services and provide a more accurate projection of health resources (Evashwick et al. 1982; Tuominen and Paunio 1986; Freeman 1999; Scheutz and Heidmann 2001). The documentation of the multidimensional aspects of patient perceived needs, desires and expectations, which is often ignored in most health services and workforce planning, is important in establishing the extent of the health needs in the population.

Bradshaw (1972) commented that the concept of need 'has always been too imprecise, too complex, and too contentious to be a useful target for policy' and Locker (1997) stated that the concept of health is 'elusive and abstract'. To properly assess health needs, it is necessary to understand the main philosophy and concept underlying both health and needs. Because of the pivotal role of assessment of need, the concept of need will be reviewed in some detail.

Table 2.1: The strengths and limitations of health workforce planning model

Type of model	**Strengths**	**Limitations**
Health Needs Model	1.logical and easy to understand 2.consistent with professional ethics 3. has the potential of addressing the health needs of the population using a mix of human resources for health. 4.useful in a health programme where the health problems and the health services needed are clearly demarcated	1.requires a high level of skills and knowledge of the health care workers 2.Ignores the question of efficiency in allocation of resources among other sectors eg school teachers, primary health workers 3.ignore the perceived needs of the population and other impacts of healthy population 4.ignores the reality of economic demand 5.difficulty of converting the dental health status measurement into treatment needs 6. does not take into account evidence-based dentistry and use of outdated approaches by health professionals 7.Is likely to project unattainable service and staff targets
Health Demands Model / Utilization technique	1. provides a comprehensive view of the dynamics of health services utilization 2. avoid the risk of setting excessively expensive or unrealistic objectives 3. captures more of the reality of the dental marketplace	1. relies heavily on utilization rates and assumes that increases in demand should create increased supply 2 fails to understand that there are some populations who are in need but could not demand for it. 3. it violates severe fundamental assumptions of a perfectly competitive market 4. does not take into account financial or economy factors 5.Produces a status quo projection, since future population segments are assumed to have a similar utilization rates as base year segments
Service Targets Method	1.breaks down the activity and components of health services which facilitates estimation of demand 2.easy to put into practice 3.allows assessment of interaction between variables 4.places the importance of productivity 5.simplifies cost estimates 6. active approach towards improving the health services	1.it allows the planner discretion in departing from extrapolations of past experience 2.errors of judgment could be made on productivity rate and capacity to deliver

The Manpower to Population Ratio	1. cheap, quick, easy to apply and to understand/interpret, and requires little information 2. allows comparison be made between different continents.	1. does not consider how demand and supply forces interact 2. assumes that the demand of each people is the same 3. fails to recognize and address the different levels of disease in different age cohorts 4. ignores the various categories of oral health auxiliaries 5 implies that wages, prices and other costs need not be considered in the calculation.
The Econometric Model	1. scientific and objective approach 2. solid theoretical base, cost-conscious and can be subjected to testing and analysis 3. could gain review from health economists	1. data required are either nonexistent or inadequate 2. health economic system may not behave in a traditional manner as presumed by the economists 3. ignores the role of other supporting health workers 4. does not sufficiently consider population health needs, budget pressures, political/ socio/ economic factors, the influence of the changing health system and the impact of outcomes
The WHO/FDI JWG6 model	1. enables the user to forecast requirements, by age cohort and by type of care, while at the same time including socio-economic variables 2. flexible and adaptable	1. neglects cohort and period effects 2. neglects aspects of demand and provide overly simplistic answers to complex questions 3. ignores the role of other supporting health workers 4. ignores socio-economic factors that could modify the behaviour and the practice of dentists
The System Dynamic Model	1. Requires involvement of policy maker which will results use of product for policymaking 2. useful in data-poor environments 3. The outcome is applicable at strategic level, concerning policies and new programme	1. Decision maker might not want to be involved in the disciplined and slow process 2.Decision makers might be unfamiliar with the technical aspects 3. Too much data are needed and might lead to overly complex models that are difficult to work with. 4. unpredictability based on incomplete data and the unpredictability based on non-linear feedback loop

2.4 The concept and definition of needs

Needs can be viewed from different perspectives; a sociological, an epidemiological and an economic point of view. A sociological standpoint is exemplified by Bradshaw (1972) who classified needs in terms of i) normative need (professionally defined needs), ii) felt need (individual perception of want), iii) expressed need (vocalized needs or demand for service) and iv) comparative need (comparison of needs among different people on the health care that they received). This taxonomy demonstrates that there are no absolute measures of needs (Thayer 1973). Bradshaw's definition has been a useful framework for policy making as it categorizes the different factors that might influence needs.

Needs measured using an epidemiological approach is defined in terms of the morbidity and mortality status or in other words the amount of ill health or disease in the population. It focused on normative or professionally defined needs (Billings and Cowley 1995) which may be expressed in terms of items of health care, or need equivalents such as time, cost or workforce requirements (Spencer 1980b). This approach is similar with the humanitarian approach of health care which implies that action must be taken when disease is detected (Acheson 1978). There is no resource allocation rule within this approach; assessment of needs is made with the assumption that resources will be available to satisfy them.

The economists' approach to health care defines needs within the context of cost-effectiveness and supply and demand (Billings and Cowley 1995). Health economics is a branch of economics concerned with issues related to scarcity in the allocation of health and health care. Fuchs (1998) has pointed out that in health care, people are often romantic and/or monotechnic. Health care professionals are romantic in the sense that they believe that needs should be fulfilled irrespective of their cost. They are monotechnic because they prefer to operate in an environment with the most sophisticated equipment, although realising the fact that only a small part of the society would benefit from the technology (Fuchs 1998). Health needs should only be identified when there is an effective intervention available to improve the health of those in needs (Matthew 1971). Black (1994) stressed that although meeting health needs is a moral or ethical question, it is not possible to meet all needs as there are limits to the resources available. Mooney (1994) concluded that if health care resources are to be allocated on the basis of 'need' or on the capacity of an 'ability to benefit', therefore health needs assessment must inevitably result in some form of rationing. This 'needology' concept is considered as a 'realistic' approach as needs will only be fulfilled after the costs and benefits has been accounted for (Acheson 1978; Mooney 1992). The difference between 'realistic' and 'humanitarian' approaches is that the starting point of the former is identifying resources that are available to meet the needs, while for the latter it starts with identification of need (Acheson 1978).

Health needs assessment is an important component in health care planning. It provides a platform to systemically assess unmet health and health care needs and to collect data required in improving health of the population (Sheiham and Tsakos 2007). Health gains can therefore be achieved by reallocating resources as a result of identifying:

- non-recipients of beneficial health care interventions (that is unmet need)
- recipients of ineffective health care (and releasing resources for unmet need)
- recipients of inappropriate health care (for whom the outcomes could be improved) (Stevens and Gillam 1998)

The estimation of need for health care has been a challenging task because of the difficulty of defining health. To accurately define health needs requires the existence of a well-defined standards of what constitutes good health status and a knowledge of technology that can improve ill health (Spencer 1980). However the concept of health is multidimensional and complex and the abundance of terms that have been used to describe it such as wellness, well-being, illness or psychosocial impact, has made defining what health is even more complicated (Locker 1997).

2.4.1 Measurements of health status

Perceptions of health vary according to a person's sociodemographic status (Coulter 1987), level of education, age, gender (Cox et al. 1987) and culture (Bowling 1994). Health professionals view health as the freedom of disease and abnormalities while lay people perceive health in a variety of ways such as simply the absence of disease, being able to maintain normal role functioning, being fit, being able to cope with crises and stress, having healthy habits and vitality, being socially active and possessing a state of good mental and physical equilibrium (Bowling 2009). The different insights given on health by lay people prove that health cannot be defined in terms of anatomical, physiological or mental attributes only, but must also consider the ability of the individual to function in a manner acceptable to themselves or to the group of which they belong (Dubos 1959). This was reinforced by Lerner (1973) who stated that health "involves a social human being functioning in a social environment with social roles he must fulfil".

In the last four decades, the definitions of health have moved away from a total disease model to one which incorporates health and well-being. The first formal recognition of the multidimensional nature of health was formulated by the WHO (1948) which defined health as ‘a complete state of physical, mental and social well-being and not merely the absence of disease’. Here health is defined not only in terms of the absence of disease but also embraces the social and functional aspects of health (Lerner and Levine 1994; Allen 2003). However this definition was criticized as being inflexible and unrealistic as it is highly unlikely that anyone would be in ‘complete’ state of health for a reasonable period of time. It was also commented that the definition corresponds more to happiness than to health (Saracci 1997). In response to this criticisms, WHO (1980) then developed The International Classification of Impairments, Disabilities and Handicaps (ICIDH) model to link the biological concept to behavioural and social factors. This model has been criticized because of the linear progression approach which implied a fixed sequence and because it ignores the role of the environment that could exacerbate or reduce the nature of disablement (Simeonsson et al. 2000). In 2001, The International Classification of Functioning, Disability and Health (ICF) was developed with the intention to improve the ICIDH (WHO 2001). The ICF model has moved away from being a ‘consequences of disease’ classification as illustrated by ICIDH to become a ‘components of health’ classification.

With the wider definition of health, there has been a move towards developing a more holistic approach of health measurement instruments. Although the traditional clinical measure is still important, they were not able to capture the wide-ranging characterisation of health. Hence, they need to be complemented with subjective data that captures people’s experiences and concerns (Fitzpatrick et al. 1998). Consequently, the measurement of health has moved i) from concern with disease to concern with health, ii) from therapy to prevention and health promotion, iii) from an emphasis on health services to physical and social environments. Overall there was a shift from a reductionist way of thinking to a more holistic perspective on health and disease

(Locker 1997). Intervention of medical care now aim to not only make people free of disease but also to make they feel better in life (Guyatt and Cook 1994).

Among the pioneer holistic measurements constructed were the Index of Well-Being and the instruments used in the RAND Health Insurance Study (Coulter et al. 1994). These indicators that aim to measure the multidimensional concept underlying health are called health-related quality of life measures (HRQOL). They are multidisciplinary and encompass measurements from sociologist, psychologist, economists, operational researchers and biostatisticians' perspectives (Locker 1988; Sheiham and Spencer 1997).

2.4.2 Measurement of oral health status

Although it was recognized that there is a broader concept of oral health, the construction of the sociodental instruments lagged behind those of sociomedical measures. This was despite the findings that there was numerous individual and community consequences arising from oral disease such as work loss (Sheiham and Croog 1981; Reisine 1984), work disability and social contacts (Locker and Grushka 1987). At that time, there was a lack of coherent theoretical or conceptual framework as a guide in formulating sociodental measures and this serves as another reason for the slower development of sociodental measures (Locker 1988).

The traditional oral health status and outcomes instruments focused on using clinical indicators such as the DMFT and the Periodontal Index to record the morbidity of oral health condition. Tooth loss is the ultimate consequences of oral diseases and is considered as a mortality indicator in oral health. As disease rates decline and the focus moves to prevention of disease and retention of function, a different conceptualization of oral health became imminent. The need to develop measures of socio-dental indicators was first advocated by Cohen and Jago (1976) who believed that the existing clinical index failed to document the full impact of oral health disorders. It was thought that the inclusion of social impact would encompass a broader implication of oral conditions which would then be useful for resolutions of policy decisions.

Locker (1988) defined sociodental indicators as the 'measures of the extent to which dental and oral disorders disrupt normal social role functioning and bring about major changes in behaviour such as an inability to work or attend school, or undertake parental or household duties'. The measurements range from survival through impairment, to function and perceptions. With the passage of time, the terms subjective oral health, measures of oral health status or the social impacts of oral disease have been used interchangeably to refer to sociodental indicator. Following similar trends in general health field, the term oral health-related quality of life has been gradually used by researchers which defines oral health as 'multidimensional concept that incorporates survival, illness and impairment, social, psychological, physical function and disability, oral health perceptions, opportunity as well as interactions between the aforementioned domain' (Gift and Atchison 1995).

The use of an oral health-related quality of life approach would support the development of a health oriented model of care and improve better allocation of resources (Sheiham et al. 1982; Fitzpatrick et al. 1992; Locker 1995). It upholds the advancement of evidence-based dentistry by promoting preventive behaviour in assuring higher effectiveness and better treatment outcome (Sheiham et al. 1982). In addition, the use of the broader measures would assist i) clinicians, in selecting treatments and monitoring patient outcomes, ii) researchers, in identifying determinants of health and demand (Gift and Atchison 1995) and iii) policy makers, in establishing health programmes priorities and securing public funds (Slade and Spencer 1994; Gift and Atchison 1995).

Various measures have been developed in the assessment of subjective impact of oral conditions on quality of life. Allen (2003) reviewed the different approaches used to develop these measures. The first approach was formulated through a construction of scales that provide an index of the impact of oral disorders. The impact is measured by the calculation of the overall score which would indicate the extent of the functional and psychosocial consequences. This approach was employed by the developer of Geriatric Oral Health Assessment index (GOHAI) (Atchison and Dolan 1990), Social Impacts of Dental Disease (SIDD) (Cushing et al. 1986) and Subjective Oral Health Status Indicators (SOHSI) (Locker and Miller 1994). The second approach measures patients' salience of events as demonstrated by the Dental Impact Profile index (DIP) (Strauss and Hunt 1993). The respondents are asked whether their teeth and dentures have a positive, negative or no effect on the 25 DIP items. Impact scores are calculated by adding the proportion of positive and negative responses. The third approach measures functional disorders and their social consequences in a hierarchy of outcomes based on the ICIDH (WHO 1980a) and Locker's theoretical framework for measuring oral health (Locker 1988). Impacts are measured by computing the scores of the frequency and severity of oral health problems on functional and psychosocial well-being. This approach was used in Oral Health Impact Profile index (OHIP) (Slade and Spencer 1994), Dental Impacts on Daily Living (DIDL) (Leao and Sheiham 1996) and Oral Impacts on Daily Performance (OIDP) (Adulyanon and Sheiham 1997).

Among the aforementioned OHRQOL measures, the OIDP is the only measure developed with the intention to be incorporated with the health need assessment system

(Srisilapanan and Sheiham 2001; Srisilapanan et al. 2003; Gherunpong et al. 2006c; Sheiham and Tsakos 2007; Ryu et al. 2008). It has a distinct characteristic that allows the OIDP to better evaluate the needs of the population and to facilitate dental service planning (Locker and Allen 2007; Sheiham and Tsakos 2007). That is mainly because the OIDP includes a Condition Specific element whereby the subject is asked what they consider is the cause of the impact they have reported. So the need for treatment can be linked to the clinical condition related to the impact. The next section will describe the sociodental system of oral health needs assessment which uses the OIDP index in assessing subjective needs and has the capacity to be used for estimating workforce requirements in dentistry.

2.5 The sociodental approach to assessing dental treatment needs.

The inadequacy of using normative needs in oral health planning has been extensively discussed by Sheiham and Tsakos (2007). They criticized the traditional approach for lacking in objectivity and reliability, for ignoring the concept of quality of life and for disregarding scientific evidence. The need to incorporate the functional and social dimensions of dental diseases into the assessment of dental health needs was first expressed by Sheiham et al. (1982) who pointed out that service-related approach to needs assessment has numerous shortcomings. They recommended that a more appropriate measure of oral health needs would incorporate the impact of ill-health on daily life, the degree of dysfunction it causes and the perceptions and attitudes of patients which would provide a better division of resources in providing care. This idea was supported by Kay (1993) who felt that the measurements of oral health needs which take into account physical, psychological and social aspects will uphold the status of oral health professionals as one that cares for the society beyond the mere palliative aspect.

Maizels et al (1993) combined oral health status and oral health behaviour in assessing oral health needs and proposed different strategies to different treatment need group based on their propensities level. Adulyanon (1996) moved the idea of using sociodental measures to assess needs forward by formulating a comprehensive needs assessment model that includes contemporary concepts of health and which emphasized health gain in assessing needs. The gradual inclusion of oral impact assessments and behavioural propensity into the normative needs assessment provides a systematic approach to identifying priority groups who will benefit from dental interventions. This rational evidence-based patient oriented approach to treatment provision based on the degree of need should serve as an acceptable basis for establishing ethical priorities in health services.

This sociodental approach is conceptually appropriate as it correspond to broader concepts of health and needs. This approach 'conforms to the modern, theoretical, multifactorial approach for the assessment of oral health care needs' (Sheiham and Tsakos 2007). It has four essential components which have been recognized as important in assessing health needs:

1. Clinical assessment of normative need

Despite having numerous shortcomings, normative needs is still useful for identifying diseases and impairments. The need for any treatment on an individual can only be estimated after the examination of health professionals by using clinical indices. The data gained can be gathered to produce the prevalence and patterns of diseases in the population. During a diagnostic examination, the dentists are not only looking for existing disease but they are also able to detect any possible signs of future diseases.

Hence the type of treatment and prevention measures could be recommended during this assessment.

2. Subjective perceptions of needs

This is measured through an oral health related quality of life indicator. Among many of the oral health related quality of life instruments developed, only the Oral Impacts on Daily Performance (OIDP) index constructed by Adulyanon and Sheiham (1997) is specifically designed for used in treatment needs assessment. It is based on the WHO's International Classification of Impairments, Disabilities and Handicaps which was adopted and modified for dentistry by Locker (1988). The theoretical model of oral health related quality of life appraisal divides oral health consequences into three levels. The first level refers to oral impairments. The second level, 'intermediate impacts', includes the possible earliest negative impacts caused by oral health status which could include pain, discomfort or functional limitation. The third level, which the OIDP index concentrates on, represents impacts on the ability to perform daily activities which composes of physical, psychological and social performance (Sheiham and Tsakos 2007). By focusing on only the third level of health consequences, the OIDP measures only the ultimate impact; that is the behaviour impacts of oral disorders and the extent to which the ability to perform physical, psychological and social performances is compromised (Locker and Allen 2007). This avoids the double scoring of the same impacts on different levels and resolves the problematic assessment of subjective feelings by measuring the behavioural translation (Tsakos 1998). This has made the index concise and yet comprehensive as it covers the main dental consequences.

Assessing only the impact one has from the mouth will not give much information about the type of treatment needed to deal with the condition. A distinctive feature of the OIDP is that the impacts reported can be attributed to a specific dental condition that is called Condition Specific OIDP (CS-OIDP) (Adulyanon and Sheiham 1997b; Sheiham and Tsakos 2007). CS-OIDP links the oral impact with the specific oral conditions or diseases as perceived by the patients. For example, a patient that has a normative need for periodontal treatment who reports that having a bad breath has an effect on doing his daily activities which they say is related to their gums can be considered as having an impact related need for a scaling and polishing. Thus this feature enables assessment of the specific treatment need required by the individual, and thereby assists planners in estimating the type of dental workforce required to carry out the treatment needs.

3. Propensity for oral health behaviours

A patient's commitment to good oral health is fundamental for a successful outcome in dental treatment. Hence, a measurement of propensity when combined with the professional and lay perceptions should provide a more complete assessment of treatment needs and thereby improve treatment planning (Sheiham et al. 1982). Most common oral diseases such as dental caries and periodontal disease, are caused by poor oral behavioural which is preventable. To ensure that maximum benefit is gained within available resources, it is vital that treatment is given to those who are more likely to benefit from the treatment (Sheiham and Tsakos 2007).

There are five oral health-related behaviours which could influence oral health status and treatment outcomes:

- The use of fluoride toothpaste

  Fluoride in its various forms has been shown to significantly decrease caries risk (Twetman et al. 2003; Petersson et al. 2004; Twetman 2009). It acts by preventing the start of lesions, decrease the speed of the progression or completely retard the development of lesions (Carvalho et al. 1992; Biesbrock et al. 1998; Koo and Cury 1998; Lo et al. 1998). The use of fluoride has also been shown to be very cost-effective (Davies et al. 2003; Yee et al. 2004; Splieth and Flessa 2008). It was concluded in a systematic review on the effectiveness of fluoride toothpastes among children that 'the benefits of fluoride toothpastes are firmly established. Taken together, the trials are of relatively high quality, provide clear evidence that fluoride toothpaste are efficacious in preventing caries' (Marinho et al. 2003). Similarly, another systematic review conducted on adults showed that exposure to self-applied fluoride reduces caries by about 25% (Griffin et al. 2007).

- The frequency of tooth brushing

Tooth brushing is a practical way to remove plaque and to transport fluoride to tooth surface. Hence, it supports the improvement of gingival health which will subsequently prevent periodontal diseases (Holmgren and Davies 1989; Gaare et al. 1990; Lim and Davies 1990) and ensure the success of any periodontal intervention (Sheiham 1997). Good tooth brushing with fluoride toothpaste behaviour will significantly reduce risk of caries (Dummer et al. 1990; Schou and Uitenbroek 1995; Stecksen-Blicks and Holm 1995). Brushing twice or more a day with fluoride toothpaste results greater caries reductions than brushing once a day or less. Twice a day brushers had a consistently lower caries increment than less frequent brushers (Chesters et al. 1992; O'Mullane et al. 1997; Chestnutt et al. 1998; Ashley et al. 1999; Gibson and Williams 1999). As it takes about 48 hours for plaque to produce signs of gingival inflammation (Loe et al. 1965; Theilade et al. 1966; Loe 1967; Brecx et al. 1980), it has been suggested that brushing once a day or once every two day is adequate (Sgan-Cohen 2005; Claydon 2008). However brushing twice daily is recommended as it will increase the efficacy of tooth brushing and the delivery of fluoride to the tooth surfaces (Claydon 2008).

- Sugar intake

The evidence linking dietary sugars as an aetiological factor in dental caries has been well established (Sreebny 1982; Marthaler 1990; Rugg-Gunn 1993; Szpunar et al. 1995; Ruxton et al. 1999; Sheiham 2001; Moynihan 2005). A systematic review on the relationship between sugar and caries risk recommended the restriction of sugar consumption to prevent caries (Burt and Pai 2001). The intake of sugar more than four times a day leads to an increase risk of dental caries (Sheiham 1983; Holbrook et al. 1995; Rodrigues and Sheiham 2000; Sheiham 2001; WHO 2003). In terms of amount, it was recommended that sugar levels should not exceed 60g/person/day (Sheiham 2001). However there was a strong correlation between both the amount and frequency of sugars consumption (Cleaton-Jones et al. 1984; Ismail et al. 1984; Rugg-Gunn et al. 1984; Rodrigues et al. 1999). So in terms of caries development, both frequency and amount are potentially important (WHO 2003).

- Pattern of dental attendance

People who regularly attend dental clinic have better oral health (Richards and Ameen 2002), a higher number of functioning teeth (Sheiham et al. 1985) and experience less pain and have less untreated disease (Todd and Lader 1991; Murray 1996). Regular attenders also tend to perceive oral health as having a positive impact on quality of life (McGrath and Bedi 2001). However it was also found that regular attenders have higher dental caries incidence and fewer sound untreated teeth (Todd and Lader 1991). For treatment that requires periodical check-up visits such as prosthodontics or orthodontic treatment, the assessment of patient's compliance or cooperation is an important part in treatment planning (McDonald and Avery 2000). Poor cooperation, non-compliance or discontinuation of treatment will lead to poor treatment outcome (Shaw et al. 1991).

- Smoking behaviour

A systematic review done to establish the relationship between smoking and periodontal disease showed an overwhelming positive consistency between the two variables (Bergstrom 2006). Smoking will affect the treatment outcome for scaling, root planning (Preber and Bergstrom 1986; Bergstrom 2006) and dental implant (Hinode et al. 2006; Klokkevold and Han 2007; Strietzel et al. 2007). There is evidence to support significant benefits of tobacco use cessation with regard to various oral health outcomes. The odds ratio for having severe periodontitis is reduced after quitting smoking (Haber and Kent 1992; Bolin et al. 1993; Tomar and Asma 2000). Former smokers have a better periodontal condition or less relative risk than comparable smokers (Bergstrom 2004; Ojima et al. 2006; Okamoto et al. 2006; Shimazaki et al. 2006; Thomson et al. 2007; Warnakulasuriya et al. 2010).

4. The effectiveness of treatment

The long term success of treatment and the positive health outcomes gained by patients should be one of the main criteria to be considered when recommending interventions to the patients. This can be acquired if evidence-based dental care approach (EBD) is practiced. EBD is defined as 'the integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences' (ADA 2008). The move toward EBD practice has been recommended as it could identify and reduce the use of any treatment shown to be unnecessary or ineffective and release resources for more appropriate and effective uses (Sheiham 2005b). The Oral Health Group of the Cochrane Collaboration helps dentist to make well-informed decision regarding oral health care by producing and publishing systematic reviews on the prevention, treatment and rehabilitation of dental disorders.

2.5.1 Integration of components into the sociodental system for assessing dental treatment needs

The sociodental system for needs assessment involves a gradual integration process of the aforementioned essential components (normative needs, subjective perceptions, propensity behaviour and evidence-based treatment). The needs assessment pathway which involves three levels is shown in Figure 2.3 (Adulyanon 1996; Srisilapanan et al. 2003; Gherunpong et al. 2006c; Sheiham and Tsakos 2007).

The first level is the assessment of needs by the professionals based on the best available evidence of the natural history of oral diseases. People with life threatening conditions, such as oral cancer or precancerous lesion, or with chronic progressive conditions such as dentinal caries, will be only evaluated at this level and need not go through subjective assessment. This is because these oral disorders seldom give any symptoms that impact a person quality of life at the early stage of the lesions. Delaying the treatment might deteriorate the conditions. Hence, those with these oral conditions should receive treatment regardless of whether they have any oral impact arising from it. However the type of treatment they receive will depend on their propensity for dental treatments based on their oral health behaviours. On the other hand, individuals with non-life threatening and non-progressive oral conditions will be further assessed at the second level. In summary there are two models involved in the sociodental system:

- A model of dental treatment needs for life-threatening and chronic progressive oral conditions (DNLP) which include the assessment of normative needs and behavioural propensity
- A basic model for dental treatment needs referring to all other conditions (BMDN) which include the assessment of normative need, subjective measures and behavioural propensity.

The second level of need assessment involves the integration of the normative need with the reported oral impacts assessed through the OIDP index, which results in 'Impact-related need' (IRN). This level will determine whether the individuals will require the intervention based on their reported disability and handicaps resulting from oral problems. Those whose oral problems do not provoke any impacts on their daily life might not receive the priority in getting dental treatment. A decision on their dental needs should be made by evaluating the level of impacts, the type of treatment available as well as ethical considerations.

The third level takes into the consideration the individuals behavioural propensities for dental treatment and integrates this with the previous IRN, resulting in 'Propensity-related need' (PRN). The oral health behaviour considered depends on the type of treatment that is provided. For example, for restorative treatment, tooth brushing, usage of fluoride and sugar intake should be assessed. Those with high propensities will receive the initially planned dental treatment, those without are considered as having a need to change their behaviour through dental health education / oral health promotion in order to maximise their oral health gain for future dental treatment.

Evidence-based dentistry applies through all the three levels of assessment. The type of treatment offered to the patients must be proper with the local settings, available resources and general needs of the community (Sheiham and Tsakos 2007).

The difference between the oral health needs measured using the normative method and the sociodental approach range between 40 to 90% when used in children, adolescents, adults and older people (Adulyanon 1996; Srisilapanan and Sheiham 2001; de Oliveira and Sheiham 2003; Srisilapanan et al. 2003; Gherunpong et al. 2006a; Ryu 2006a; Astrom and Kida 2007; Mtaya et al. 2008; Ryu et al. 2008; Korwanich 2011).

Gherunpong et al. (2006a) assessed the sociodental needs of 1126 Thai primary schoolchildren for traumatic dental injuries, enamel defects, discoloration or dental anomalies, gingival inflammation, malocclusion and missing teeth and compared the findings with normatively assessed needs. They found that the prevalence of the aforementioned oral conditions was high at 98.8%. However, when using the sociodental approach, the treatment need reduced to 39.5%; that is a 60% reduction from normative to sociodental approach.

The assessment of subjective measures in orthodontic treatment is important as the main aim of the intervention should be to improve aesthetic and oral function (Shaw et al. 1991). Gherunpong (2006b) combined both professional and subjective measurements in assessing orthodontic treatment need among 11-12 years old children and found that the differences between the two assessment approximates 70%. When only children with high or medium high propensity were considered for treatment, the need for treatment decreased by 80% from normative to sociodental assessment. A similar reduction of need for orthodontic treatment was observed amongst 13 year old primary school children in Tanzania (Mtaya et al. 2008). In that study, of 865 children diagnosed as having malocclusion through professional judgement, only 192 fulfilled the criteria of impact-related and propensity-related treatment need.

A number of new dimensions were integrated into the sociodental system when assessing the dental treatment needs of elderly people in Chiang Mai, Thailand. Srisilapanan et al. (2001, 2003) incorporated measurements of general health and financial status into the system as these influence service utilization and accessibility amongst older people. One of the factors they considered important when assessing the elderly general health was nutritional status. Older people who had symptoms of malnutrition as a result from their dentition state or from ill-fitting dentures were considered as having the need for prosthetic treatment. In that study, the need for full dentures decreased by 40% when sociodental needs with the integration of general health and financial status was used instead of normative assessment (Srisilapanan et al. 2003). The need for partial dentures amongst elderly people with good or poor general health was lower by 85% and 82% respectively when using the sociodental approach (Srisilapanan and Sheiham 2001a). Astrom et al (2007) assessed the sociodental need for partial dentures among Tanzanian adults aged 50 years and above. They incorporated general health assessment into the system. Their findings showed that the need for partial dentures among healthy adults who had missing teeth was lower by 78% when using the sociodental instead of the normative approach.

Although the sociodental approach has been shown to give a more rational estimate of dental treatment need compared to normative approach, it has a number of shortcomings. For the BMDN model, because the oral conditions covered by it are considered to be non-progressive, a positive need for treatment depends on the presence of normative need, a sociodental impact and the positive behavioural propensity. No account is taken of the perceived needs expressed by the individual because it is assumed that if a person does not have a sociodental impact they would not seek treatment. Although people may not report the presence of oral impact, they might feel the need for treatment. There are differences between self-reports of dental problems and perceived need for dental care (Gilbert et al. 1994; Jokovic and Locker 1997; Heft et al. 2003). The sociodental account also did not consider the various factors that would affect the demand and utilization of services. Variables such as income, education, age, cultural and racial demography could influence individual's propensity to use health care services regardless of the presence of impact (Odrich 1985; Andersen 2008). The stringent criterion for allocating treatment to those without oral impact could therefore result in underestimating the people's wants. It could be worthwhile to consider subjective perceived need for condition specific treatments even when there is no impact related to that condition.

Amongst studies that have compared the treatment needs assessed using normative or sociodental approach, only Ryu (2006) proceeded in using the outcomes to estimate the requirements for dental workforce. She converted the estimated time needed to treat restorative, prosthetic and periodontal in adult population in Korea into the number of dentists needed to treat. The findings showed that the number of dentists required to treat adult patients decreased by 9.1% for restorative treatment, by 78% for prosthodontic treatment and by 88% for periodontal treatment when the sociodental need assessment was used instead of normative approach. However, this study did not take into account the potential of using dental auxiliaries when calculating the dental workforce requirements. It has been established that the use of dental auxiliaries as a substitute for dentists in the management of 'routine' dental procedures could increase productivity and cost-effectiveness in dental offices (Galloway et al. 2002; Abelsen and Olsen 2008). The next section discusses the potential for using skill mix approaches in improving the delivery of oral health care.

2.6 Incorporating skill mix approach in the workforce model

2.6.1 Approaches to skill mix

As indicated earlier, most of the workforce models such as the Manpower to Population Ratio and Health Needs model do not take into account the potential of substitution for physician / dentist input. Calculation and projection of health workforce often showed that there is not sufficient number of physicians, hence training of physicians which is expensive and takes a long time is often the option taken by the policy makers to ensure that future health needs will be met (Moore 1986; Chaudhry and Scully 1988). The success of a health care service is usually judged by its effectiveness and efficiency of delivery of care; however this is difficult to be achieved through the use of physicians alone. Using a skill mix approach by having dentists and more PCDs providing tasks that correspond to their skill level will increase accessibility and affordability if the responsibilities of providing care to low income and underserved populations were given to the PCDs. This would consequently improve delivery of services (Harris and Haycox 2001; Nash 2004). Skill mix would also reorient health services goals because the PCDs should shift oral health care towards prevention, in line with the orientation of their professional training (Harris and Haycox 2001).

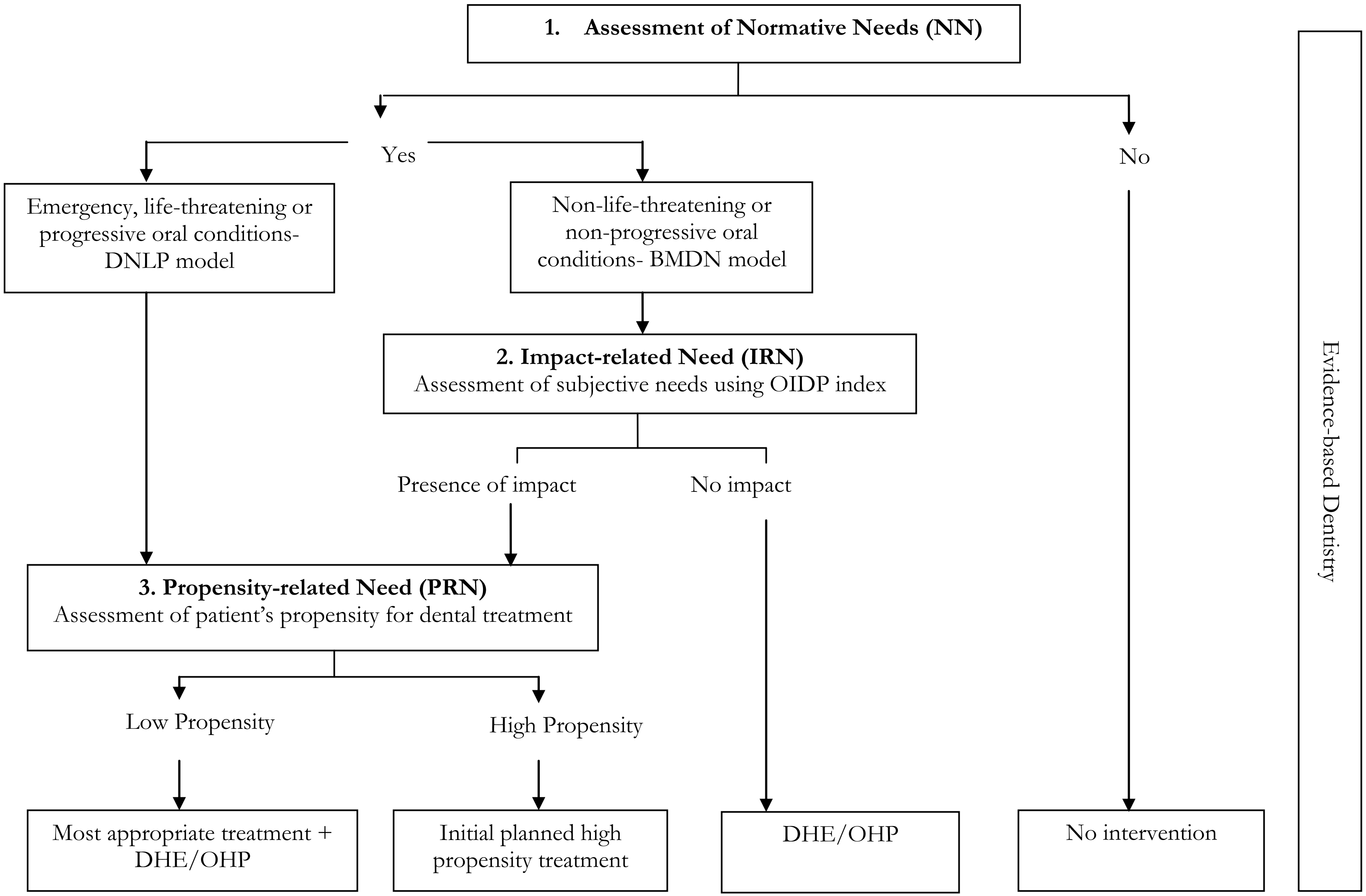

Figure 2.2: Oral health needs assessment pathway using the sociodental system (Modified from Adulyanon (1996))

World Health Organization (2000) defined skill mix as ‘the mix of posts in the establishment; the mix of employees in a post; the combination of skills available at a specific time; or alternatively the combinations of activities that comprise each role, rather than the combination of different job titles’. The type and the number of health workforce serving in each capacity on the team should reflect the specific needs and circumstances of the country (Nash et al. 2008a). The skills and competency of each member of the health team should be developed and their use must be maximized accordingly. It would be inappropriate and waste of resources if staffs are overqualified for the function they are required to perform. This could lead to job dissatisfaction and staff could feel undervalued.

Skill mix change can be achieved through i) enhancement of skills by increasing the depth of a job by extending the role of skills of a particular workers; ii) substitution of role by expanding the breadth of a job or exchanging one type of worker for another, iii) delegation of duties by moving tasks up or down a traditional unidisciplinary ladder; or iv) through innovation of new jobs by introducing a new type of worker (Sibbald et al. 2004). The type of skill mix approaches used will depend on the types of problems faced by the health service. Most of the time the drivers for change is the high cost of health labour, but other reasons that could stimulate the use of skill mix include skill shortages, technological innovation, health sector reform or changes in the professional regulations or legislation (Buchan et al. 2001).

Figure 2.4 shows the conceptual model of personnel mix (WHO 2000). Skill mix decisions should be based on information at each level shown in the model, starting from assessing the type of patient and the type of care in need and relating this with the health goals and the appropriate competencies and skills required to deliver the services (Buchan 1999). However, determining skill mix is not all about predicting the number or quantity of health workforce; the assessment of the quality, cost and competence of staff should also be considered (Buchan et al. 1996; Buchan 1999).

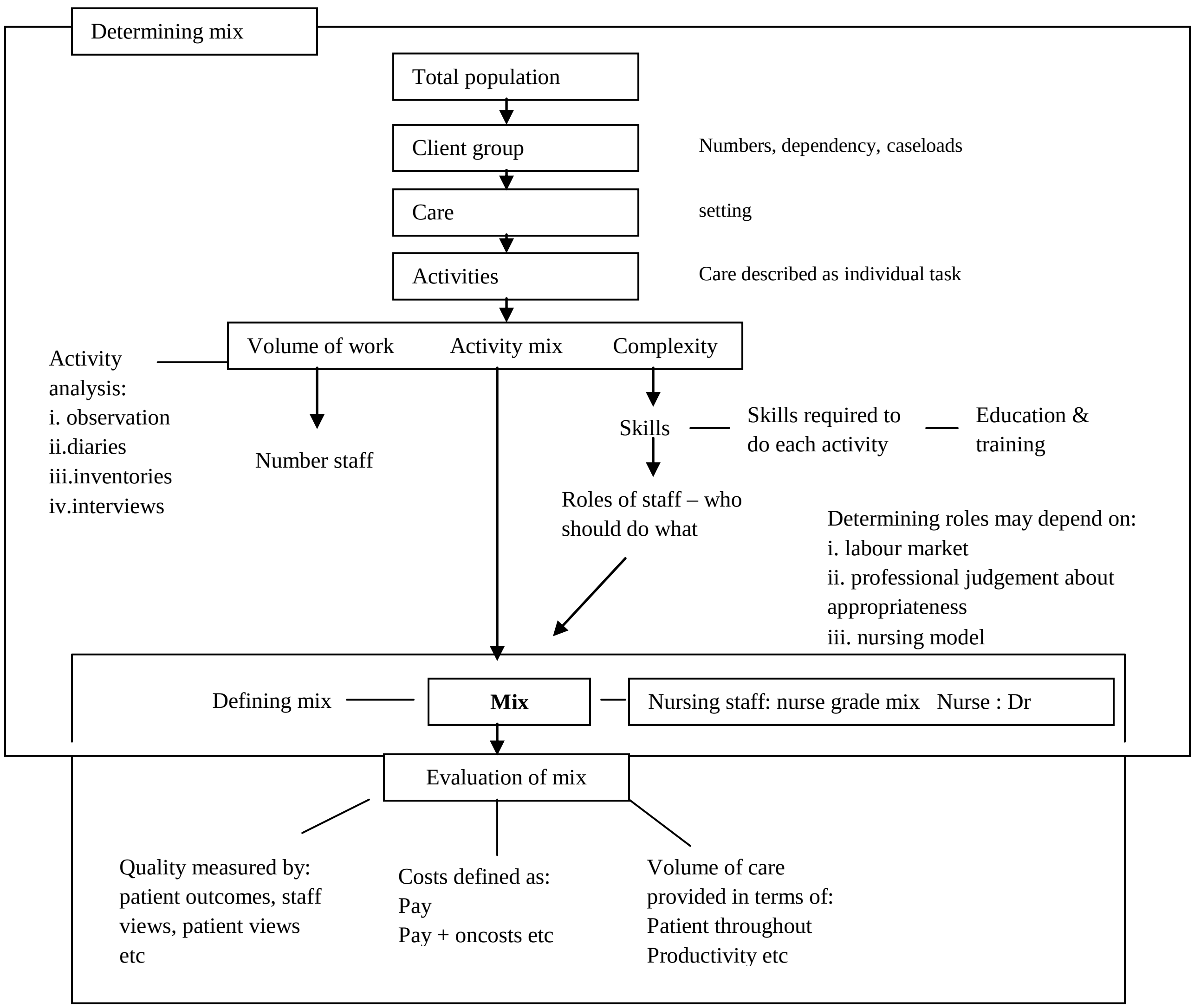

Figure 2.3: Conceptual model of personnel mix (WHO 2000).

2.6.2 Skill mix in the dental profession

In the past, only dentists were considered competent and capable to provide dental treatment. However it was found that the dentists alone could not cope with the dental needs and demands of the people that they serve. Compared to the medical field, team working is an area where the dental field has lagged behind (Gallagher and Wilson 2009; Brocklehurst and Tickle 2011b). In the UK, the reason was because the medical side was able to fully utilize and innovate new tasks for their nurses without central direction; whereas dentists had to strictly adhere to a listing of duties provided by the National Health Services on the tasks that the dental auxiliary can or cannot do (Harris and Haycox 2001). Recently, there have been some positive developments globally upon the potential role of using team working in dentistry. The drivers for this change include shortage of dentists, problems of access, changes in oral diseases (Kravitz and Treasure 2007) and perceived cost savings (Hay and Batchelor 1993; Gallagher and Wright 2003; Ross et al. 2007; Brocklehurst and Tickle 2011a).

The success of the New Zealand dental nurses scheme in considering the use of auxiliaries to assist in meeting oral health needs has motivated many countries to emulate the method. It is estimated that more than 50 countries, both developed and developing, are utilizing dental nurses, with over 14,000 existing worldwide (Nash et al. 2008b; Nash et al. 2012). However among them there is variation in terms of the job title, job description, the type of population covered and the degree of supervision they receive from the dentists. For example, in New Zealand, Australia and Canada, dental auxiliaries are allowed to provide care to the adults, whilst in Malaysia they are only permitted to treat those who are 17 years and below. Some of dental auxiliaries could develop their own treatment plan while others need to work under dentists' prescription. The supervision received could be a 'direct' or 'indirect' one where dentists' physical presence is required; or a 'prescriptive' or 'collaborative' guidance from a dentist who is remote from the site (Baltutis and Morgan 1998; Edelstein 2011; Nash et al. 2012). The degrees to which the various duties and responsibilities are delegated depend on the country legislation, the training of dental auxilliaries and the dentists' willingness to delegate task to them.

Generally, auxiliary personnel are divided into two main groups: operating auxiliary and non-operating auxiliary. Operating dental auxiliaries are those who are permitted to carry out certain procedures in the mouth under the direction and supervision of the dentists (WHO 1968). They include school dental nurses (New Zealand type), dental therapists and dental hygienists. The non-operating dental auxiliaries are those who assist the dentists in the clinic but do not do any independent procedures in the oral cavity. They include dental surgery assistants, dental technicians and the receptionists. The terms dental nurses and dental therapists are used interchangeably between countries although the nature of their work is the same. For example, the operating auxiliaries in Thailand and Malaysia are referred to as dental nurses, while in Canada and the United Kingdom they are known as dental therapists (Nash et al. 2008b). To further contribute to the complicated picture of roles and terminology, dental nurses in the United Kingdom are non-operating auxiliaries where they provide support and assistance to the dentists and patients, but in Malaysia personnel with almost the same role are called the dental surgery assistant. Recently in the United Kingdom the terms Professionals Complementary to Dentistry (PCDs) or Dental Care Professionals (DCPs) have been used to describe dental auxiliaries. A number of new dental personnel have also been introduced that fit into in this category for example the orthodontic therapist and the clinical dental technicians. More recently, the trend has been to integrate dental therapists and dental hygienists as oral health therapists (Nash 2005b). Throughout this thesis, the term Professionals Complementary to Dentistry or PCDs will be used to define the operating auxiliary, unless when described under the context of history development for specific countries.

2.6.3. Global deployment of PCDs

This section summarizes the development of PCDs in four different countries namely New Zealand, Britain, the United States and Malaysia. These countries were specifically chosen because there are differences in the types of training that the PCDs receive and the extent of their roles and responsibilities.

Dental therapists in New Zealand can independently provide care to children and adolescents up to 18 years of age without the physical presence of a dentist. They have a consultative relationship with the dentist that is supported by a written professional agreement between them (Dental Council of New Zealand 2004). Since 2003, dental therapists are allowed to provide care for adults after completing additional training, but they still require clinical guidance from the dentists (Dental Council of New Zealand 2003a). In 2006, a dual degree was introduced which enables graduates to register with the dental council of New Zealand as dental therapist and/or dental hygienist and permit them to work in both private and public practice (Coates et al. 2009). The competences of the New Zealand dental therapists have been reviewed when the scheme was in its initial stage with mostly positive results (Bradlaw et al. 1951; Fulton 1951; Saunders 1964).

In Britain, most dental therapists' programmes offer a combined dental hygiene and dental therapy curriculum (Nash 2004). The length of the programmes determines whether a diploma or a degree is obtained. The curriculum is governed and monitored by the General Dental Council. The positive development of skill mix dentistry in Britain was due to the endorsement of several governmental documents which recommended the practice of team-based dentistry to improve patient care (Nuffield Foundation 1993; General Dental Council 1998; Department of Health 2000a; Department of Health 2002). Prior to 2002, dental therapists in Britain are allowed to carry out similar dental tasks similar to their counterparts in New Zealand, but only in the National Health Services. But as of July 2002, they are permitted to work in all sectors of dentistry including the private practice. Their role has also been expanded where they are now allowed to carry out pulpotomy treatment, placing stainless steel crowns in deciduous teeth and administer the inferior dental block (British Association of Dental Therapist 2010). The new legislation also permitted them to treat both the children and adult, but only with a treatment plan developed by a dentist. However, dental therapists still have the autonomy in deciding the techniques and dental material to be used (Nash et al. 2008b).

Unlike their respective counterpart in New Zealand and Britain who acknowledge the potential contribution of a wider dental team, the introduction of PCDs has been strongly opposed by the American Dental Association (ADA) and some members of the dental profession in the United States (USA) who have persistently argued that dental care must be provided by the dentists who are highly trained (ADA 1973; Bramson and Guay 2005; ADA 2011a). The use of mid-level dental providers was criticized as providing sublevel dentistry. Nevertheless there have been two successful attempts to initiate the change in the delivery of US health care in Alaska and Minessota (Edelstein 2011; Evans et al. 2011). PCDs, or dental health aide therapist (DHAT) as they are being called in Alaska, are responsible for providing preventive and basic dental health care to children and families in remote native villages (Wetterhall et al. 2010). In Minnesota, two categories of dental therapists were introduced; a dental therapist who is only allowed to work under a direct supervision of the dentist and an advanced dental therapist who can work under general supervision and could undertake the extraction of mobile permanent teeth and prescribed limited medications. As the legislation was passed to enhance access to care, they are only allowed to provide care for low income and underserved populations (Nash et al. 2012). Studies carried out to assess the technical competencies of DHAT showed that they performed well within their scope of practice (Fiset 2005; Bolin 2008; Wetterhall et al. 2010).

Malaysia was among the pioneer countries that introduced PCDs which was patterned on the New Zealand model. The Malaysian PCDs are called the dental nurses. Up to 2005, there were 2090 dental nurses in Malaysia. 76 of them had been trained in post basic courses in the field of paediatric dentistry, orthodontic, periodontology and oral surgery (Ministry of Health Malaysia 2006). The dental nurses are allowed to treat children up to the age of 17 years only in the public settings. Their scope of practice includes diagnosis, simple fillings, scaling, extraction of deciduous teeth, application of topical fluorides, fissure sealants and oral health education. Dental cases that are beyond their skills and competency are referred to the dentists. Those with post basic qualification in periodontology are allowed to do root planing to school children and expecting mothers (Ministry of Health Malaysia 2006). After more than 60 years since its establishment, the achievements accomplished by the dental nurses in Malaysia are significant. The major improvement in the children's oral health since four decades ago (Ministry of Health Malaysia 2005) could be partly attributed to the dental nurses because, apart from societal and environmental influences, dental nurses spend more time rendering treatment and oral health promotion activities on school children compared to dentists (Abu Bakar 2007).

2.7 The evaluation of competencies and productivity of PCDs

There have been several experimental studies undertaken to assess the quality of work done by PCDs, the differences in productivity and the cost-effectiveness of using them in dental offices. These studies were carried out in both public (military, university and public health departments) and private settings, and also through computer simulation. Some researchers focused only on the quality of work done by the PCDs, some appraised on the changes of productivity in the dental clinic and others evaluated on both factors in addition to measuring cost-effectiveness. The summary of these findings is presented in Table 2.2.

Table 2.2: The competencies and productivity of PCDs in dental practices.

Outcome Measures	**General findings**	**Authors**
1. **Technical competence**		
a. reversible dental procedures such as taking alginate impression, application of rubber dam, matrix placement, amalgam placements and carving and polishing of restorations	The quality of work performed were comparable with senior dental students / dentists	Calache et al. (2009) Fulton (1951) Hammons et al. (1971) Hammons and Jamison (1967) Lotzkar et al. (1971) Rosenblum (1971) Nixon (1980)
	The quality of work was poorer than dentists	Gruebbel (1950) Bergner et al. (1983)
b. Atraumatic Restorative Treatment and fissure sealants placement	The quality of preventive restoration placed by trained schoolteachers were comparable with those placed with dentists	Phantumvanit et al. (1996) Songpaisan et al. (1995)
	The survival percentage were poor	Frencken et al. (1998)
c. irreversible dental procedures such as cavity preparation of Class I, II amalgam and Class III	The quality of work performed were comparable with senior dental students / dentists	Powell et al. (1974) Sisty et al. (1978) Wetterhall et al. (2010) Bolin (2008)
d. periodontal care: calculus and stain removal, root planning and curettage and skill acquisition to perform these procedures	The dental hygiene students scored satisfactorily as well as dental students	Sisty et al. (1978) Pelton et al. (1972) Wilson et al. (1985)
e. Administration of local anaesthesia	Dental hygiene students can satisfactorily deliver local anesthesia with high success rate	Sisty et al. (1986) Sisty et al. (1990) Sisty et al. (1992) DeAngelis and Goral (2000) Anderson (2002)
f. Denture provision	The denture produced and issued was comparable to that of dental students	Benson (1973)
	The denture issued had high unacceptable characteristics and subjects issued with denture had higher incidence of oral lesions	Tuominen (2003a) Tuominen (2003b)

g. Topical fluoride application	The performance of the newly trained assistants was comparable to that of the professional personnel	Tappan and Fitch (1975)
h. Orthodontic procedures eg removing of composite following debonding, placement of elastic separators, molar bands, archwire, Kobayashi hook and Bergman ligatures	The hygienists were able to perform as well as orthodontists	Oliver and Griffiths (1992) Mandall and Read (1999)
B. Competency in diagnosing dental condition		
a. Dental caries diagnosis through clinical examination	No statistically significant differences were found on the accuracy to diagnose and record dental decay between dentists and dental hygienists	Ohrn et al. (1996) Howat and Cannell (1979) Kwan et al. (1996) Mauriello et al. (1990) Disney et al. (1992) Beltran et al. (1997) Kwan and Prendergast (1998) Bolin (2008)
	The hygienists were not able to diagnose as well as the dentists on certain population group	Hawley et al. (1999) Kwan and Prendergast (1998)
b. Dental caries diagnosis through radiographic viewing	There was an acceptable level of agreement between the auxiliaries and dental students/dentists	Haugejorden (1976) Ohrn et al. (1996) Riordan et al. (1991)
	Dental hygienist tend to over register caries on radiograph	Espelid et al. (1994b)
c. Assessing periodontal treatment need	The interexaminer weighted kappa was high indicating good reproducibility	Markkanen et al. (1985)
d. Detection of oral cancer and precancer	a. The predictive value obtained was 58%, indicating a successful achievement	Warnakulasuriya and Pindborg (1990)
	b. Dentists detect cancer better than auxiliary through colour photographs	Jullien et al. (1996)
C. Competency in oral health promotion		
a. Oral health education, oral hygiene instruction	The group of patients given oral health education by dental	Tan et al. (1981) Blinkhorn et al. (1987)

	auxiliary showed improvement in knowledge, attitudes and behavior Patients who received oral hygiene instruction and oral prophylaxis from dental hygienist showed reduction of plaque scores, decreased gingivitis and decreased mean pocket depths	Wight and Blinkhorn (1988) Axelsson and Lindhe (1981) Axelsson and Lindhe (1978)
b. Smoking cessation advice	Dental hygienist take greater interest than dentists in asking about smoking history and giving cessation advice The percentage of dentist who asked about the history of smoking and offer cessation advice was higher than dental hygienist	Halling et al. (1995) Hastreiter et al. (1994) Secker-Walker et al. (1987) Secker-Walker et al. (1994) Dolan et al. (1997)
D. **Productivity.** Comparison of conventional dental team which consist of dentist and dental assistant and experimental teams which consist of different configuration of dentist, dental assistant and expanded-function dental auxiliary	There was an increase in productivity (range from 25% to 170%) in terms of number of procedures performed and number of patients seen. In private practice, increase of productivity through the use of expanded-function auxiliary was associated with increase of net revenue There was increased in productivity but the practice costs per unit of output was greater.	Baird et al. (1963) Sutcliffe (1969) Rosenblum (1971) Roemke (1971) Lotzkar et al. {, 1981 #364} Soricelli (1972) Kilpatrick et al. (1972) Pelton et al. (1973) Pelton et al. (1973) Allred and Hobdell (1974) Redig et al. (1974) Lipscomb and Scheffler (1975) Douglass et al. (1976) Allred (1977) Overstreet et al. (1978) Roemke (1971) Soricelli (1972) Kilpatrick et al. (1972) Pelton et al. (1973a) Pelton et al. (1973b) Allred and Hobdell (1974) Redig et al. (1974) Lipscomb & Scheffler (1975) Douglass et al. (1976) Mitry et al (1976) Allred (1977) Overstreet et al. (1978) Milgrom et al. (1983)

2.7.1 The technical competences of PCDs

The quality of PCDs' work had been assessed on factors such as their technical competence in performing reversible or irreversible dental procedures, their ability to diagnose dental conditions properly and their effectiveness in delivering oral health promotion. Earlier studies focused more on reversible tasks undertaken by expanded function dental assistants for example the placement of rubber dam and the fillings of dental cavity which have been prepared by dentists. Some studies made comparison on their competencies as compared to dentists (Hammons et al. 1971; Lotzkar et al. 1971; Sisty et al. 1978; Sisty et al. 1986; Sisty et al. 1990; Sisty et al. 1992; Phantumvanit et al. 1996), some as compared to dental students (Hammons and Jamison 1967; Rosenblum 1971; Pelton et al. 1972; Powell et al. 1974; Sisty et al. 1978; Wilson et al. 1985) and some studies did not make any valid comparison (Gruebbel 1950; Fulton 1951). Apart from the small studies that showed negative findings on the competency of PCDs, the majority of studies concluded that PCDs can diagnose and screen as effectively as dentists or dental students, can carry out a range of dental procedures at almost equal quality to that of the dentists or dental students and takes great interest in performing oral health education activities (Table 2.2).

Studies in the early 1970s mostly evaluated the competencies of expanded function dental assistants on reversible dental procedures. When trained dental assistants undertook dental tasks such as taking alginate impression, matrix placement, amalgam placements and carving and polishing of amalgam restorations, their performance was found to be comparable with that of dentists (Hammons et al. 1971; Lotzkar et al. 1971) or dental students (Rosenblum 1971). In fact, the performance of the expanded function dental assistants was found to be superior compared to the dentist in carving and polishing a simple amalgam restoration (Lotzkar et al. 1971) or compared to dental students in the application of rubber dam, insertion of matrix band and polishing Class II amalgam restorations (Rosenblum 1971) .

Dental hygienists' expanded role in periodontal care necessitate them to administer local anesthesia when dealing with patients who need deep scaling treatment, root planning or those with extreme tooth or soft tissue sensitivity. It has been shown that dental hygiene students can satisfactorily deliver local anesthesia with high success rates, comparable to dental students (Sisty et al 1978; Sisty et al. 1986) and dentists (Sisty et al. 1992; Sisty et al. 1986; Sisty et al. 1978; Sisty et al. 1990; Sisty 1975). Dentists were also satisfied with their dental hygienists local anesthesia skills and found that this expanded skill has a positive impact on scheduling, production, patient satisfaction and comfort and quality of care (DeAngelis and Goral 2000). Similarly, dental hygienists also reported high success rates in achieving adequate anesthesia with very low incidence of complication (Anderson 2002).

Expanded function dental assistant could carry out the clinical aspects of providing dentures when given adequate training. Dentures produced by assistants were comparable to those produced by dental students in relation to its retention, stability, vertical dimensions, centric relation, lateral excursion, phonetics and esthetics. It was concluded that the trainees' performance is comparable to that of dental students. (Benson 1973).

In 2003, Tuominen evaluated the quality of removable dentures prepared by dentists, denturists and dental laboratory technicians. Since 1964, denturists in Finland are licensed for the provision, relining and repair of complete dentures for persons aged 20 years and over. Laboratory technicians are only permitted to prepare dentures for dentists who in turn provide them to patients. The findings showed that complete dentures illegally provided by laboratory technicians had significantly poorer retention and goodness of fit than those provided by either dentists or denturists (Tuominen 2003a). However, as the technicians might not have received a formal training in clinical provision of dentures, the comparison made between them and the dentist or denturist in this study may not be appropriate.

In some countries such as Australia and New Zealand, the role of PCDs has been expanded to include the provision of care to adult. In Victoria, Australia, two studies conducted to evaluate the effectiveness of PCDs in providing care to adult aged above 26 showed positive results. 95% of restorations placed by the PCDs on patients aged between 26 to 82 years old were considered satisfactory and the standard were similar to that of young dentists (Calache et al. 2009). PCDs in Victoria with a university qualification were found to have a high knowledge in oral examination and dental restoration and were considered as clinically competent to provide care to adults of all ages (Calache and Hopcraft 2011).

A systematic review conducted to assess the evidence of the effectiveness and cost-effectiveness of PCDs concluded that despite the poor quality and the age of these studies, the positive evidence on the competency of PCDs were consistent (Galloway et al. 2002). However, the conclusion was based on the combined assessment of the expanded duty dental assistant, dental hygienist, expanded duty dental hygienist and dental therapists who have different training and different scope of practices. Nevertheless this review confirmed that when PCDs were trained on undertaking a wide range of simple clinical duties in an appropriate length of training, their performance were comparable with the dentists or dental students. Nash et al. in 2008 outlined the practices of PCDs in six countries (New Zealand, Great Britain, Australia, Canada, Malaysia and Tanzania) and in 2012, assessed the development of PCDs in another 13 more countries (United States, The Netherland, Hong Kong, Singapore, Thailand, Africa, Caribbean, Pacific Islands, Sri Lanka, Seychelles, Brunei, Guyana and Suriname). Their findings confirmed the conclusion made by Galloway et al. (2002) in that PCDs are effective in providing dental care within their scope of practice.

2.7.2 Changes in productivity when utilizing PCDs

Most of the studies conducted to measure the differences in the productivity when PCDs are included in the dental team were done in public settings (Baird et al. 1963; Sutcliffe 1969; Rosenblum 1971; Allred and Hobdell 1974; Allred 1977). Since the settings and the type of patients seen in private dental practice is different from the public sectors, the findings might not be generalizable to private settings. However, studies done in the private practice have consistently shown similar results with those carried out in public settings (Kilpatrick et al. 1972; Mitry et al. 1976). The addition of PCDs has been shown to increase the clinic productivity with no apparent loss of quality. The average of patients seen increased, and consequently so did the income of the clinic (Table 2.2). It was accounted that a dental clinic with two full time PCDs increased its' clinical expenses by 25% and income by 44%. In clinics where only one PCDs was used, the income was boosted by 38% (Redig et al. 1974). There was also a shift towards more restorative, crown and bridge, and preventive services (Douglass et al. 1976). This could be because the dentists delegated routine simple tasks to assistants and had more time to focus on complicated procedures that require the specialists' skill. In private practices employing hygienists, more diagnostic, periodontal and restorative services were provided (Spencer and Webster 1989; Brown et al. 1994) and dentists spent more time in managerial activities and less time in treatment as this duty was delegated to the auxiliaries (Tan and van Gemert 1977).

2.7.3 The cost-effectiveness of PCDs in dentistry

In the medical field, it was found that the use of expanded role nurses did not reduce cost as nurses made longer consultation times, carried out more investigation and had increased recall rate (Sibbald et al. 2004). Using skill mix will initially increases cost because staff needs to be retrained (Sibbald et al. 2004) but subsequently substitution may be cost effective if the salaries of the nurses remain lower than the doctors (Schneider and Foley 1977; Horrocks et al. 2002). Several studies indicated that the utilisation of PCDs in dentistry would be cost-effective (Galloway et al. 2002; Luciak-Donsberger 2003; Nash et al. 2008a; Nash et al. 2008b; Satur et al. 2009) as this is because their wages rates are lower and their training times is shorter compared to dentist (Baltutis and Morgan 1998). As illustrated by Croucher (2011), the average salary of PCDs is less than half of the average dentists' salary, but as PCDs provide 90% of basic dental care in New Zealand, their contribution to the delivery of oral health care is considered as cost-effective than using a dentist-based system. The cost of care was found to be significantly lower in dental services that uses a dental team approach (Martin 2002; Nash 2004) and this when teamed up with the decline of dental disease attributed to the preventive activities carried out by the PCDs provide evidence for cost-effectiveness (Martin 2002). The cost-effectiveness of PCDs may only exist if services are focused in prevention (Harris and Haycox 2001) and low to medium dental care (Riordan 1997; Baltutis and Morgan 1998) and if dentists made quality use of the time that has been saved by delegating tasks to PCDs (Sibbald et al. 2004). Most of the aforementioned literature only covers the potential cost-effectiveness when using PCDs. Hardly any convincing evidence is provided. This could be because it is difficult to calculate the cost-effectiveness of PCDs in isolation as they often work as part of a team. Nash (2012) suggested that studies on the cost-effectiveness of PCDs can be carried out by comparing services that do or do not employ PCDs, taking into account the cost of the dentists or other health team members in the analysis.

2.7.4 The acceptance of PCDs by dentists and patients

Unlike the medical profession where it is becoming the norm for doctors to work alongside qualified clinical nurses and other auxiliaries, in dentistry, the acceptance of working as a team has not been overwhelming. Dentists are more protective of their profession and are concerned that the delegation of some oral health care to the PCDs would lead them (the PCDs) hungry for more power by overstepping the boundaries put in place by legislations (General Dental Council 1989). Dentists were also criticized for their lack of knowledge of the PCDs' scope of practice, their inability to make appropriate use of the range of skills and their lack of confident of the PCDs technical abilities (Gallagher and Wright 2003; Csikar et al. 2009). There has been some negativity shown by the dentists towards the employment of PCDs in general practice (Jones et al. 1981; Ross et al. 2007). In the US, dentists and dental professional bodies opposed to the introduction of PCDs and described PCDs as a hazard in the occupation (Nash 2012). These interprofessional conflicts is shaped by occupational groups' efforts to attain and maintain professional status and authority (Adams 2004). Different interest, values and cultures between the two professions could affect the harmony of working in a team.

Proponents of PCDs felt that PCDs increase access to care and provide safety net for underserved populations (Nash 2012). Most dentists were supportive with the PCDs providing the care for children but there were resistance in delegating adult care to PCDs (Nash 2012). For example in Malaysia, the dentists were positive with the role played by the PCDs in providing care the child population. However, when asked whether the role of PCDs should be expanded, 53% dentists disagreed (Dolah et al. 2006). Kravitz and Treasure (2007) used an interview technique to gain the view of representatives of key informants in six countries towards the employment of PCDs. They found that apart from Belgium and Greece that had very few or no PCDs, other countries such as Canada, New Zealand, Finland and United Kingdom showed a positive development of utilizing PCDs in the delivery of oral health care. Similar findings on this positive reception by the dentists has also been documented in New Zealand (Brooking 1980;

Moffat and Coates 2011), Australia (Atkinson 1993; Edmunds and Tane 2011b) and the UK (Gallagher and Wright 2003; Dyer and Robinson 2006; Ross et al. 2007; Sun et al. 2010).

There was a high degree of patient acceptance on the expanded role of PCDs in dentistry (Lotzkar et al. 1971; Nixon 1980; Rantanen and Kononen 1979; Redig et al. 1974; Sisty and Henderson 1974; Soricelli 1972; Wetterhall et al. 2010; Calache and Hopcraft 2011; Calache et al. 2009; Sun et al.2010). It is believed that when dentists put a trust on the PCDsS to carry out certain dental procedures, the trust and confidence was gained automatically from the patients. Most of the studies were conducted on patients who had received care form the PCDs. If the use of PCDs is mainly to provide care to those with limited access, the perception of the latter should be taken into account. A public survey conducted both in the USA and UK showed that the majority of participants would support the provision of treatment by the PCDs (Dyer and Robinson 2009; Dyer et al. 2010; W.K.Kellogg Foundation 2011). However, about 40% of participants in the UK survey expected that the cost of treatment should be lower when received from the PCDs (Dyer and Robinson 2009).

On the other hand, increased delegation in private dental practice was associated with decreases in satisfaction with dentist-patient relations, patient waiting time and cost (Milgrom et al. 1983). The reasons could be because dentists were spending less time with the patient, patients had to wait longer in the reception area or in the operatory due to scheduling problems, and that patients felt that since they received treatment from the auxiliary, the fees should be lower.

2.7.5 Barriers to using PCDs

The success of implementing skill mix approach in dentistry can only be possible if dentists are willing to delegate some of their routine and appropriate tasks to PCDs and concentrate on the more complicated tasks (Douglass et al. 1976; Burman 1987; Gallagher and Wright 2003; Ward 2006). Yet it was postulated that dentists themselves might not want to do the complex dental treatment and instead prefer to do the routine simple dental tasks (Abelsen and Olsen 2008). This could be because there would be no difference in terms of monetary incentives and dentists wanting a work life balance by doing relaxing job which would results in higher job satisfaction, rather than a day filled with complex treatment challenges. Other reasons for dentists to not delegate their routine tasks include that they perceived treatment time by PCDs is higher (Kaplan 1980), they have negative perceptions about patients' acceptance and are unclear about the scope of PCDs (Jones et al. 1981; Hay and Batchelor 1993; Gallagher and Wright 2003; Harris and Burnside 2004; Ward 2006) or that there was too low demand for complex treatment (Abelsen and Olsen 2008). As dentistry is a business entity for private practitioners, the unclear evidence between cost and benefit could be a major barrier in the decision to use PCDs (Hay and Batchelor 1993; Harris and Haycox 2001; Gallagher and Wright 2003; Ross et al. 2007).

2.8 Summary: Limitations of health workforce models

Models of health workforce planning provide guidelines for planners and policy makers with regards to resource allocation, public funds and other related aspects of health care delivery. Most health workforce models concentrate on measuring current or future health needs based on normative needs. However, the limitation of using normative needs assessment has been widely documented. Health needs as determined by professionals invariably outstrip available resources. Therefore there must be a more appropriate definition of need as well as some form of prioritization when determining which group of population needs the most appropriate care. This would lead towards a situation where health gain (or met need) is maximized from the existing health care resources. Another important element ignored by many workforce models is the documentation of subjective measures and behavioural components. The inclusion of patients' subjective need, desires and expectations should improve the assessment of need and provide a more accurate projection of health resources. Effective use of health resources and success in treatment outcome would only be achieved when patients' compliance is improved by greater adherence to dental advice and when there are effective treatments available. Regrettably these measures are also not accounted for in most workforce models.

The sociodental approach to dental health needs takes into consideration the aforementioned issues. It includes the measurement of social impacts in defining needs and uses behavioural propensity in order to suggest appropriate treatment that maximizes health gain. Those with normative needs but without, or very little capacity to benefit from health care interventions are considered as having needs, but require different types of treatment. The sociodental approach incorporates all important components in determining needs: professional evaluation, subjective perception such as assessment of oral health related quality of life, propensity of patient and evidence-based concepts.

In addition to the importance of determining needs through a sound conceptual approach, planning for health workforce should also take into account the utilization of appropriate workforce categories to perform specific service objectives. It is important that health care is delivered in the most cost effective way as possible and this could be achieved through a better use of existing resources by employing a skill mix approach. This aspect is often overlooked by most workforce models. Numerous studies have indicated that the PCDs are technically competent and are able to operate safely and appropriately within their defined scope of practice. The productivity increased when PCDs are fully utilized in dental practice. In addition to that, the public supported the idea of being cared for by the PCDs and are very satisfied with the treatment they received. The incorporation of skill mix approach in addressing health needs could provide the answer to the perceived shortages of qualified medical/dental professionals.

The current study sets out to assess dental treatment needs of an adult population using two approaches. It compares findings on dental needs using the conventional normative methods with the sociodental system. Then comparison between the two approaches is also made on the differences of the number of dentists needed to treat and the differences in the configuration of dentists and PCDs needed when using different models of professional skill mix (Figure 2.5).

2.9 Aims:

To estimate and compare dental workforce requirements to meet the dental treatment needs of a sample of university employees in Malaysia aged 30-54 years, using two methods: the traditional normative approach and the sociodental approach. A second aim is to estimate workforce requirements to meet their dental treatment needs using a skill mix approach.

2.10 Hypothesis

2.10.1 Hypothesis 1

The proportion of adults with impact related need would be significantly smaller than the proportion of adults with normative need.

2.10.2 Hypothesis 2

The requirements for dentists are significantly lower when sociodental and skill mix approaches are used compared to when sociodental approach is used alone or when normative need assessment is used with the skill mix models.

2.11 Objectives:

i. To assess the oral health status and normative dental treatment need for restorative, prosthodontic and periodontal care in a sample of Malaysian university employees aged 30-54 years.

ii. To assess dental treatment needs using the sociodental approach in the aforementioned sample and compare the estimates obtained with the normative needs method.

iii. To compare the professional time and the number of dentists needed to provide dental treatment between the normative and the sociodental approaches.

iv. To review the potential for delegation of dental care from dentists to dental nurses and dental technicians based on levels of complexity of normative dental needs.

v. To estimate dental workforce requirements to meet the sociodental needs for a sample of Malaysian adults using different models of professional skill mix and to compare the findings when normative and skill mix approaches are used.

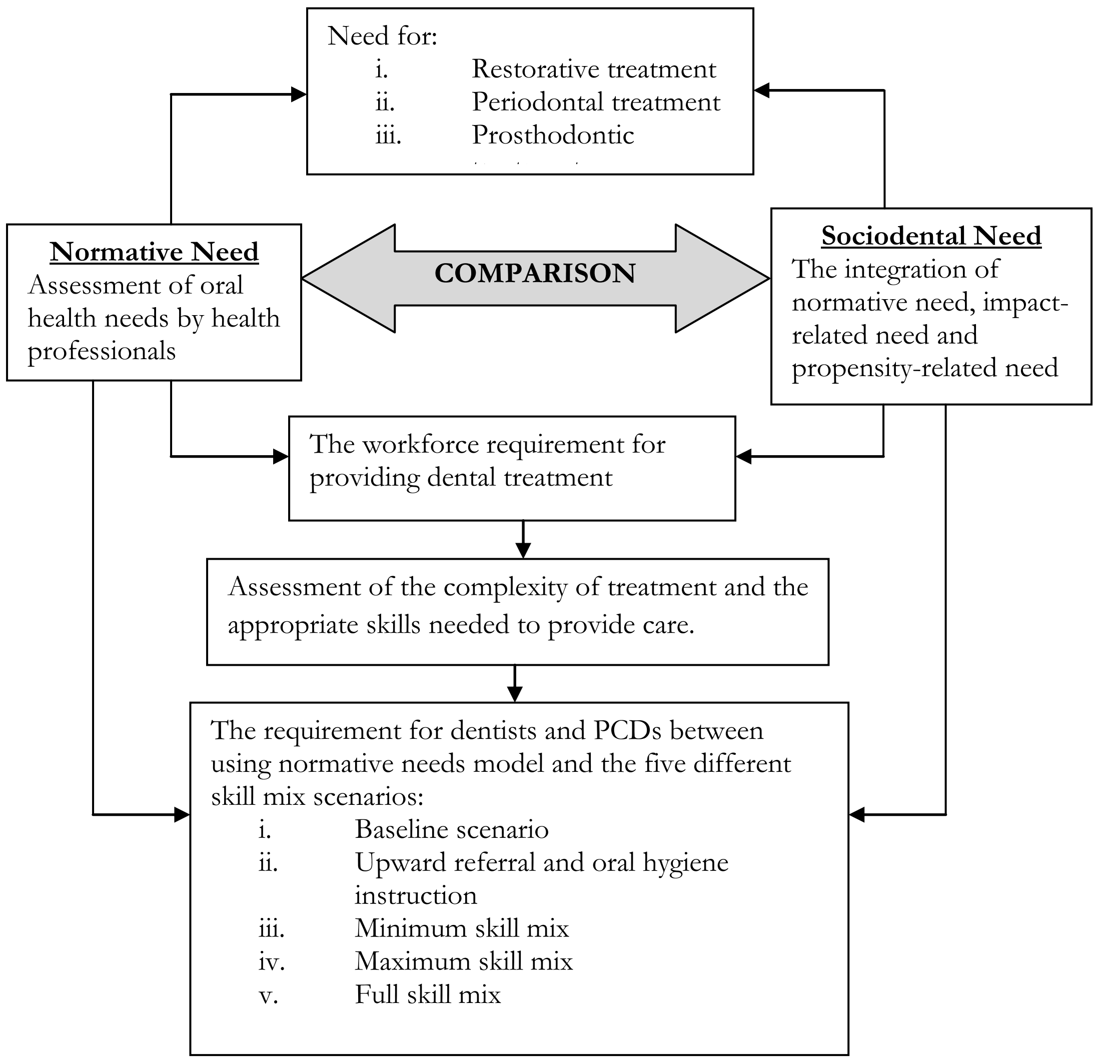

Figure 2.4: The comparison of normative needs and sociodental needs assessment in terms of the need for dental treatment and workforce requirements and the comparison of dental workforce requirements using different skill mix scenarios.

CHAPTER 3
METHODS AND MATERIALS

Chapter 3

Methods and Materials

3.1 Introduction

This was a cross-sectional study carried out on a selected adult population aged 30-54 years old in Malaysia. The main objectives were to compare dental treatment needs and dental workforce requirements between two different methods of assessing dental needs, namely the traditional normative method and the sociodental approach and also when considering additional use of different skill mix models.

Before the collection of data for the main study, two pilot studies were conducted over a four-month period (July 2009, December 2009 – February 2010) to assess the feasibility of the study design. The first pilot study was conducted to evaluate the psychometric properties of the Malay-OIDP index and the second pilot study was carried out to test the study's instruments and to assess the practicality of the planned data collection procedures.

Data collection for the main study was conducted over a period of 8 weeks during May to June 2010. Immediately after that, the assessment of the time taken by dentists to perform various dental procedures was carried out at selected private dental clinics. The author was involved in all parts of the data collection and analysis process and acted as a trainer for the interviewers and clinical data recorder, a moderator during the experts' inquiry in estimating dental treatment time and a clinical examiner.

3.2 Pilot Studies

3.2.1 Pilot Study 1: Assessment of psychometric properties for the Malay-OIDP index

Two OHRQoL measures, the OHIP and GOHAI, have been validated and are available for use among Malaysian adults (Saub 2004; Othman et al. 2006). However these two measures are not appropriate to be utilized in the current workforce study as they do not have the facility to determine the specific types of dental treatment needed by the populations based on the oral impacts reported. The OIDP index facilitates assessing dental needs for each dental condition from its Condition-Specific questions. As it had not been previously used in Malaysia, the cross-cultural adaptation and validation of the OIDP index to the Malaysian setting needed to be carried out. This involved the following procedures: i) a linguistic translation of the original English OIDP into Malay language, ii) the assessment of face and content validity of the Malay-OIDP and iii) the evaluation of the validity and reliability of the Malay-OIDP.

3.2.1.1 Linguistic translation of the original English OIDP into Malay language.

The process deals with the linguistic and cultural aspects of the Malay-OIDP versions. The original OIDP instruments underwent a linguistic validation process to ensure that the Malay version:

- was conceptually equivalent to the original instrument
- was culturally relevant and acceptable to the Malaysian population
- was psychometrically comparable to the original version.

(Acquadro et al. 2004)

The translation procedure was carried out based on the guidelines described by Acquadro et al. (2004) and The Kidscreen Group (2004). The steps involved in this process were:

<u>Stage 1: Forward translation</u>

The English version of the OIDP questionnaire was translated into the Malay language by two independent translators. The first translator was a senior lecturer at the Social Preventive Medicine Department of the University of Malaya's Faculty of Medicine who has some experience in research on health-related quality of life. It was advisable during this preliminary translation process to have at least one translator who was familiar with the objectives and the concepts involved so as to offer a more meaningful interpretation of the measurements (Del Greco et al. 1987; Guillemin et al. 1992). The second translator was an accountancy lecturer at a private university who taught English part-time at a private tuition centre. Both of the translators, one of whom was Malay and the other Chinese, are fluent in English and Malay languages. It was important to have translators of different ethnic background to ensure that the translated Malay version would be understood by all ethnic groups. The translators were briefed about the purpose of the work and guidelines on the translation were given. The translators worked independently at the initial stage. When both individual translations were completed, a reconciliation session was held where both forward translators and the author, who acted as a moderator, met and decided on the agreed Malay-OIDP version.

Stage 2: Backward translation

The reconciled forward translation was back-translated into English by a professor in the field of education who has vast experience in translating documents in both languages. The process was the same as in the one for forward translation but this time the backward translator work solely to produce a single back translated English version.

Stage 3: Committee review

The back-translated version was emailed to the research team in University College London which consisted of the developer of the original version of the OIDP (Professor Aubrey Sheiham) and the supervisors of the project. A report was prepared for them informing the difficulties encountered during the translation process. Problematic items were brought into their attention. The UCL research team made some minor comments and suggestions which were sent to the backward translator. The discussion, reconciliation and amendment of the instruments among the backward translator and the developer of the OIDP index went back and forth until the agreed backward-translated version was achieved. Since the changes made were minor, no further adjustments in the Malay version were needed. The original English version, the forward translated Malay version and the agreed backward translation documents are presented in Appendix 1.

3.2.1.2 Assessment of face and content validity of the Malay-OIDP

To ensure that the final Malay version of OIDP was culturally appropriate and sensitive to the Malaysian population, its face and content validity were assessed by i) discussions between two dental public health experts and ii) a small pilot study on 20 patients at the Faculty of Dentistry, University of Malaya. Content validity is concerned about the ability of the items in the questionnaire to adequately represent the relevant constructs being investigated while face validity involves checking whether the items appear to cover the intended objectives clearly and unambiguously (Fayers and Machin 2000) .

The two experts who were bilingual in both languages and have been involved in oral health related quality of life research were asked to evaluate whether the items in the questionnaire adequately represented the research concepts and whether it was valid for used in the population. The feedback received from the two experts only involved grammatical adjustment. The questionnaire was then tested on 20 patients using a probe technique. The respondents were encouraged to give their feedback about their level of understanding of each question and to clarify their answers.

3.2.1.3 The evaluation of the validity and reliability of the Malay-OIDP

After assessing content and face validity, the Malay-OIDP index was then applied to a Malaysian sample to assess its reliability and validity. The sampling frame was all patients and their accompanying family or friends who attended the University of Malaya Medical Centre in December 2009 and January 2010. Ethics clearance for this pilot study was obtained from the Medical Ethics Committee, Faculty of Dentistry, University of Malaya (Appendix 2).

The sample size for the pilot study was calculated based on the prevalence of oral functional limitations found in the Malaysian population which was 27.1% (Saub 2004). The formula used to calculate sample size is as described by Aday (1996):

$$N = \frac{z^2_{1-\alpha/2}\,[\,P\,(1 - P)\,]}{d^2}$$

where: z = 1.96, for the level of confidence of 95%

P = prevalence of oral functional limitation which is 27.1%

d = precision estimated at 0.05

Based on this formula, the number of sample size required for the pilot study was 302. Taking into account a non-response factor of 10%, 330 participants should be invited. The inclusion samples were drawn from the population of Malaysian adults aged 20-50 years old. The questionnaire was administered through both self-administered and interview approaches. A trained dental nurse was responsible for conducting the interview and a dental surgery assistant was responsible for distributing the self-administered questionnaire. These two individuals worked on different days at the medical centre. This meant that randomly selected patients who attended the clinic on a specific day or time were subjected to only one type of approach, depending on the person who was collecting data that time. The results of the validity and reliability of the Malay-OIDP index are presented in Chapter 4.

3.2.2 Pilot Study 2: Evaluation of research instruments and feasibility of data collection for the main study

The objectives of this pilot study were to assess the acceptability of the questionnaires among the respondents, familiarize the research team with the research instruments and procedures, measure the time required to complete the procedures and assess the feasibility of data collection in the field.

Staff members from two student residential hostels at the University of Malaya were selected to participate for this pilot study. It would have been more appropriate to use a different sampling frame or different setting, for example employees from other universities, to prevent the contamination of the pilot study. However, time and cost considerations did not permit this. To partly address this, the individuals who were involved in this pilot study were excluded from the main study.

Permission to conduct the study was obtained from the heads of the hostels. The participants were selected randomly from a list of names acquired from the administration offices. Invitation letters were given to 22 members of staff requesting their participation. On the day of data collection, one staff member was on leave and another did not want to participate. Therefore, the number of participants was 20.

3.2.2.1 Training and Calibration exercise

The research team comprised of one examiner, one recorder and three interviewers. The same examiner and recorder were present throughout the whole survey period, but because of work commitment, only one or two interviewers were scheduled at any one session.

The examiner (the author) went through a training and calibration exercise following a procedure recommended by WHO (1997). First, the examiner practised the dental examination on 10 subjects with varying oral health conditions. This process helped to familiarise both the examiner and the recorder with the oral health examination coding system. For the calibration procedure, a dental surgery assistant scanned the oral health records of patients who attended the main dental clinic at the Faculty of Dentistry. Fifteen patients with suitable oral health conditions were invited to participate. These patients were examined twice by the examiner with a time interval of between 1-3 hours. This time interval was far from ideal and could be partly subject to recall bias, however it was not possible to have a longer interval as some patients did not require an additional visit by their dentists and was not able to attend for the calibration process again. The calibration procedure focused only on the assessment of periodontal and coronal caries needs.

Intra-examiner reliability was measured using Cohen's Kappa (Cohen 1960). Intra-examiner agreement on assessing the need for coronal caries treatment was 0.75, indicating a perfect agreement (Landis and Koch 1977). However, intra-examiner agreement for the Community Periodontal Index of Treatment Needs (CPITN) score was only 0.59 which indicates a moderate agreement. To improve the Kappa score for periodontal assessment, the examiner underwent a calibration process again at the Periodontology Clinic using periodontal patients as subjects. Another 15 patients were examined twice during two three-hour sessions. Before the exercise, the examiner received advice from the clinical periodontal lecturers. This increased intra-examiner agreement for periodontal assessment to 0.70; a substantial level of agreement.

The interviewers consisted of two dental surgery assistants and one fourth-year dental student. They were trained by the author/examiner during a two-day intensive training session. They were first informed of the nature and purpose of the study and their role as interviewers. Next a 'round-robin' interviewing method was used among the three interviewers to practice the interviewing technique. At this time, the author observed the activities and gave immediate feedback when appropriate. They then practiced their interview skills on some of the dental staff who then provided feedback on their understanding of the questions asked. The recorder was a fourth-year dental student who was familiar with the WHO coding of oral health diseases. He was trained to familiarise himself with the oral health examination survey and assisted in the training and calibration exercise for the examiner.

During the survey, the two interviewers respectively re-interviewed 20 and 25 participants (6% of total sample) two weeks after the subjects' first interview session. The percentage agreement for the questions ranged from 84% in the subjective oral health data section, 92% in the behaviour section and 100 % in the demographic section. Due to work-related constraint, the third interviewer did not perform any re-interviews. The examiner performed duplicate examinations on a different set of 48 subjects (6% of total sample) during the survey period. The intra-examiner kappa score for caries was 0.89 and for periodontal examination was 0.82.

3.2.2.2 Time required for examination and interviews

The mean time required for registration, reading and signing the consent form, face-to-face interview and oral health examination was 18.5 (±3.8) minutes per subject. The pilot data collection process went as planned. All respondents reported verbally at the end of the procedure that they understood the questions well and were comfortable with the oral health examination process.

3.3 The Main Study

3.3.1 Study Population and Location

This was a cross-sectional study on Malaysian adult population aged 30 – 54 years who were employees of a public university in the state of Kuala Lumpur. The university population has been used in studies on the prevalence of coronary heart disease, obesity and neck pain (Chiu et al. 2002; Aa and Mr 2006; Amani and Boustani 2008). These studies reported that the prevalence of those conditions were comparable or slightly higher than the general population. Moy and Atiya (2003) assessed the prevalence of obesity, smoking and exercise in security guards who were working at University of Malaya. The prevalence of diabetes mellitus, cardiovascular and obesity found in this study were higher than the national figures, but this could be attributed to the respondents' older age. However, the prevalence of smoking was comparable with the national estimates.

There are two public universities in Kuala Lumpur; namely University of Malaya and National Defence University of Malaysia. The latter is located in a military camp, hence public access to the university may require complicated military approval and documentation. The University of Malaya was selected as the research site for this study because access to the campus is easily gained as the research team are staff of the university. The choice also addressed expected logistic problems, cost and time consumed. In addition, the employees in University of Malaya could provide a sample that had variability in terms of socioeconomic position and was also sufficient to cover the estimates sample size for this study. The main campus of University of Malaya is located in Kuala Lumpur, the capital of Malaysia. In 2010, the total number of staff working at the university was 6271.

The age band of 30-54 years was chosen for this study because adults of that age have established periodontal disease and a fair number of missing teeth that may need replacement. In addition, unlike the school children and the elderly group, this age group is not a priority group for oral health care in Malaysia. Hence, it is vital to assess their oral health needs and the workforce required to provide treatment for them.

3.3.2 Sample Size Calculation

The sample size calculation was based on the differences between the proportion of the population with normative needs and the proportion of people with impact-related needs. The differences between normative need and impact-related need was chosen and not the differences between normative need and propensity-related need because it was assumed that the differences in the former will be narrower. It was predicted that when there are any differences between impact-related need with normative need, the differences between propensity-related need with normative need would be automatically identified.

The hypothesis was that the proportion of adults with impact-related needs would be significantly smaller than those with normative needs.

P_o = The proportion of adults with normative treatment needs

P_a = The proportion of adults with impact-related treatment needs

H_o: $P_a = P_o$

H_a: $P_a < P_o$

Previous studies which used the sociodental approach in assessing needs in children, adolescents, adults and older people have demonstrated that the difference between oral health needs measured using the normative method and the sociodental method ranged from 40% to 90% (de Oliveira and Sheiham 2003; Srisilapanan et al. 2003; Gherunpong et al. 2006a; Ryu 2006). However these studies were conducted in different settings and with different population. Based on the above findings, a conservative proportion of normative needs of 0.70 and a reduction by up to 0.30 after combining with impact-related need were considered appropriate for this study.

To determine the sample size required for estimating the differences in proportions for both groups (the group with normative treatment need and the group with impact-related needs) the following formula is used (Aday 1996):

$$N = \frac{z^2_{1-\alpha/2}\,[\,P_1\,(1 - P_1) + P_2\,(1 - P_2)]}{d^2}$$

where: $z_{1-\alpha/2}$ = standard error (1.96)

P_1 = estimated proportion (larger)

P_2 = estimated proportion (smaller)

d = desired precision (0.05)

The sample size required for this study based on the above formula was 658. In the previous National Oral Health Survey for Adults held in 2000, the response rate was almost 90%. If a 10% non-response rate is expected from the chosen sampling frame, the minimum sample size required to show significant differences between two groups for this study would be 723 people.

3.3.3 Methods of Sample selection

The list of names of all staff working at the university was obtained from the Registrar of the University of Malaya. Preliminary letters were sent to all Heads of Faculties/Units in the university to inform them of the research and to gain permission to invite their staff to participate in the research. The majority of the heads of departments consented to the request and provided a contact person who would assist the research team during data collection at their offices. Permission was not obtained from four faculties/departments due to their work commitment during the survey period.

Inclusion criteria selected for this study are staffs who are Malaysian, aged between 30-54 years old and were present at their offices during survey period. Exclusion criteria and the number of samples excluded for the specified criteria were:

i. Staff from the department that did not give permission to conduct the survey (201)
ii. Hospital-based staff (596)
iii. Staff whose offices were outside the main campus (235)
iv. Staff who were not office-based, for example security guards on patrol and drivers (168)
v. Staff involved in the pilot study (22)
vi. Staff on sabbatical/study/research leaves (636)

Invitation letters were sent to all selected subjects about two weeks before the survey date to explain the nature of the study, the importance of their participation and the use of the results. In each letter, the date, time and place of data collection was also disclosed. During the survey period, posters regarding the survey and a map of survey locations were put up at strategic sites to encourage staff to participate. The research team approached the samples systematically. At the start of the day, the research assistants went to every office to remind and invite staff to take part in the survey. Then, research members remained in the survey room until mid-day when the research assistants went to the offices again to encourage staff to take part in the survey. Those who declined were asked the reasons of their refusal and this was recorded. Eligible subjects were included in the study if they came voluntarily to the survey location or if they agreed to participate when approached by the research team at their respective offices.

3.3.4 Implementation of Main Study

The research team set up survey sites at 34 different offices in the university within a period of 8 weeks. From the list of names of potential subjects, it was possible to establish how many subjects were available at different offices. A timetable which outlined the dates and survey venues was generated based on the number of potential subjects and the location of the offices (Appendix 3).

Before the start of data collection, the research team communicated with all contact persons at the respective offices to plan the survey sites arrangement. This was to ensure that the sites were accessible and convenient for the staff and appropriate for the survey activities. During the data collection, the contact persons also helped to publicise the survey and assisted in identifying and reminding potential subjects.

Subjects coming to the survey area were greeted by the interviewer who then gave them a Research Information Sheet (Appendix 4) which explained the objectives and the activities involved in the survey. If the subjects agreed to participate, they were asked to sign a consent form. The interview session preceded the oral health examination. The survey area was designed so that the interview area was at a reasonable distance from the examination area to minimize disturbances and to allow both activities to be conducted concurrently.

The oral examination was carried out with the subject seated on a portable dental chair and using a lightweight portable examination light (blue-white colour spectrum). Teeth were examined using WHO (PSR) Colour Coded periodontal probe and a disposable mouth mirror. The examiner sat behind and to the left of the subjects and the recorder sat to the left of the examiner. To minimise cross-infection during the survey, the examiner wore disposable masks and gloves and adequate number of dental instruments were used and sterilised after every session.

The research team employed several measures to ensure high participation during the survey. Two letters were sent to the deans or heads of each faculty. The first letter from the Dean of the Dental Faculty introduced the researcher and the survey and appealed for the support of his colleagues. A second letter was sent by the researcher to the same individuals explaining the nature of the study and requesting permission for their staff to be surveyed at their workplace. Finally a letter was sent to the potential participants requesting their participation in return for complimentary dental products and a free dental consultation.

3.3.6 Study Instruments

3.3.6.1 Oral Health Examination (normative need)

The oral health examination protocol followed the Oral Health Division of Malaysia format (Ministry of Health Malaysia 2004), which has been adapted and modified from the WHO Oral Health Assessment (WHO 1997). However, some modifications were made on the assessment of periodontal status and the treatment need for prosthodontic care (see Section 3.3.6.1 (b) and (c)). The procedures for oral health examination, the code for clinical conditions and treatment needs and the oral health examination form used in the survey are presented in Appendix 5.

Three assessments of normative oral health status and treatment needs were carried out:

a) Dental caries status and treatment needs

The DMFT index was used to determine subjects' caries status (Klein et al. 1938). Decayed teeth (D), missing teeth (M), filled teeth (F) and teeth indicated for extraction were recorded. When it was not possible for the subjects to distinguish the reason for their missing tooth or the reasons could not be established by the examiner, the missing (M) score took into account other possible reasons which include periodontal condition or traumatic injury.

Treatment requirements were assessed immediately after the status of each tooth was recorded. Treatment was indicated if there was initial, primary or secondary caries; discoloration or developmental defect; lesions due to trauma, abrasion, erosion or attrition; and unsatisfactory fillings which needed replacement (WHO 1997).

b) Periodontal status and treatment needs

Normative periodontal treatment needs assessment used in this study were a modification of the Community Periodontal index (CPI) (Ainamo et al. 1982). In the traditional CPITN, a hierarchical scoring system was used. The system recommended that only the worst periodontal condition is recorded on each of the 10 index teeth in the 6 segments. The traditional system implies that when the worst periodontal condition is observed (for example periodontal pocketing), the presence of conditions ranked lower in the scoring system (for example bleeding and calculus) is definite. However, studies have found that teeth with calculus overestimate the incidence of bleeding by 9% to 48%, depending on the population, age and the set of teeth examined

(Takahashi et al. 1988; Grytten et al. 1989; Holmgren and Corbet 1990; Baelum et al. 1993). Furthermore, the measurement of code 3 in the CPITN has been shown to overestimate the presence of bleeding (Grytten et al. 1989; Holmgren and Corbet 1990; Baelum et al. 1993). These findings cast doubt on the validity of the CPITN recommendations for scaling and polishing procedures for those with periodontal conditions Codes 2, 3 and 4, in the absence of bleeding.

In this study, the presence of bleeding, calculus and pocketing were recorded for all the index teeth examined (teeth 17, 16, 11, 26, 27, 47, 46, 31, 36 and 37). Thus, each tooth had a record about the presence or absence of each periodontal condition. The new scoring method should provide a better estimate of the distribution of the periodontal condition in the selected study population.

c) Prosthodontic status and treatment needs

Prosthodontic needs assessment was based on normative evaluation. Subjects were considered to have a need for prosthodontic treatment when they had missing teeth or if their existing dental prosthesis needed replacement due to being ill-fitting or aesthetically-compromised condition.

The criteria for assessing prosthodontic need has been developed by WHO (1997). However these criteria have not been frequently used by researchers because the classification of the criteria is not well-developed and there are no specific instructions for evaluating prosthodontic needs which may vary from a very extensive intervention to a minimal or no intervention (Spencer 1980; Nevalainen et al. 1997; Colussi et al. 2009).

The range of treatment choices for missing single or multiple teeth includes a removable denture, a tooth supported fixed prosthesis (bridges), an implant-supported prosthesis or no intervention at all (Owall et al. 1996; Shillingburg et al. 1997). The type of treatment provided will usually depend on the number and position of the missing teeth, the condition of any remaining teeth and the dentists' knowledge, skills and attitudes towards different treatment modalities. On a wider context, the treatments provided are also based on the national budget allocations on dental resources and dental policy.

Because there are a number of treatment options for replacement of missing teeth, this study proposed three different basic treatment scenarios. Subjects were assessed on their suitability for getting prosthodontic care for each scenario, and also on the type of care and the number of units provided. In the first scenario, only removable dentures would be offered to those with missing teeth. In the second scenario, either a removable denture or fixed bridges would be provided in either arch. The third scenario considers the provision of dental implants to replace missing teeth. The criteria or specific situations for each scenario are discussed further below.

<u>Scenario 1: Provision of only a removable denture</u>

The criteria for needing removable dentures followed the Ministry of Health's (2004) guidelines as described below.

For anterior segments (upper and lower jaws):

i. The loss of one or more tooth/teeth in the anterior segment.
ii. The need for extraction of one or more tooth/teeth in the anterior segment. (excludes loss due to orthodontic treatment).

iii. The space to be considered should be approximately the size of the corresponding tooth on the opposite side. If the space is less than this, it should be ignored.

For posterior segments (upper and lower jaws):

i. The loss of two or more teeth in any one segment.
ii. The need for extraction of two or more adjacent teeth in any one segment. This excludes loss due to orthodontic treatment.
iii. Loss of one tooth and the need for extraction of one or more tooth/teeth in any one segment.
iv. If the existence of any space is likely to lead to over-eruption of opposing tooth/teeth, or the drifting and/or tilting of adjacent teeth.

<u>Scenario 2: Provision of removable dentures and/or fixed bridges</u>

Although it is not uncommon to combine denture and fixed bridge prostheses or to provide multiple units of bridges in the same arch, the principle of '*treatment simplification*' (Shillingburg et al. 1997) is adopted in this scenario. This means that when there are multiple edentulous spaces where each may be restored with fixed bridges or a combination of bridge and a denture, the provision of only one type of prosthesis (in this case the removable denture) is more practical because of cost and technical complexity. The following criteria used in this scenario leant heavily on Shillingburg et al's. (1997) recommendations, but some other literature were also referred (Allan and Foreman 1986; Davenport et al. 1988).

In this scenario, a removable denture will be recommended if any of the following dental situations exist:

- Anterior edentulous spaces greater than 4 incisors
- Posterior edentulous space greater than 2 posterior teeth
- Edentulous spaces that include a canine and 2 other contiguous teeth (eg /123, /234, /345)
- Multiple edentulous spaces
- Bilateral edentulous spaces with more than 2 teeth missing on one side
- Edentulous space with no distal abutment

A fixed bridge is recommended under the following dental conditions:

- Posterior span of 2 or fewer teeth or anterior span of 4 or fewer
- Presence of distal abutment
- Good periodontal condition with no mobility

Scenario 3: Provision of dental implants

The Royal College of Surgeons of England (1997) provide guidelines on selecting appropriate patients for dental implants and recommended three groups who may benefit from the treatment:

i. Group 1: Edentulous patients in one or both jaws who had severe denture intolerance or have the possibility of severe alveolar bone loss

ii. Group 2: The partially edentate where dentures are not tolerated or who had an edentulous space considered too difficult to manage by other means. The teeth may be missing due to developmental, oligodontia or anodontia, cleft palate or trauma.

iii. Group 3: Patients with maxillofacial cranial defects.

The National Health Service in Scotland ranked the priorities for providing dental implants (NHS Health Scotland 2004). The highest priority is for oral cancer patients, then patients with total tooth loss and severe denture intolerance, followed by partial edentate patients with developmental defect and the lowest priority is for partial edentate due to trauma.

Based on the statements above from recognized dental bodies, dental implants can be considered as low priority treatment compared to other type of prosthodontic treatment and should only be provided to selected patients. They are expensive to manufacture and require specialized surgical instrumentations and expertise. Currently in Malaysia, the limited resources available cannot justify the provision of dental implants at both public and private dental clinics. In the future however, patients' treatment expectations and demands for dental implants may possibly rise, there could be more dentists specializing in implantology and the rapid advances of dental research may perhaps formulate a cheaper but high quality implants material. These could justify the prospect of widespread provision of dental implants in dental clinics.

For the third scenario for prosthodontic treatment need, only dental implants are offered for replacement of missing teeth. As this is not the standard oral health care currently being offered in Malaysia, the results of the assessment of dental treatment needs using this scenario are presented in the appendices section (Appendix 13 (xiii) to (xiv)).

The number of implants inserted depends on the site of the edentulous spaces. For implants in the aesthetic zones, usually only two implants are required (Jivraj and Chee 2006b). For posterior edentulous spaces, the number of implants depends on the number of tooth missing – one implant for each missing tooth (Jivraj and Chee 2006a). For edentulous maxilla, about 4-8 implant placements are recommended depending on the type of implant provided (Jivraj et al. 2006). In the case of edentulous mandibles, about 2-6 implants are required depending on the type of implant provided (Chee and Jivraj 2006).

3.3.6.2 Structure of Questionnaire

A questionnaire was constructed to assess respondents' self-perceived oral health and general health status, perceived dental treatment needs, their oral health-related quality of life using the Oral Impacts on Daily Performances (OIDP) indicator (Adulyanon and Sheiham 1997a) and their oral health behaviour. The information collected during the interview includes the following. The detailed information of the questionnaire is presented in Appendix 6 (Malay version) and Appendix 7 (English version).

A. <u>Demographic information</u>

The sociodemographic variables recorded were the subjects' age, ethnic group, gender, marital status, highest educational achievement and monthly salary.

B. Subjective oral health data

The following subjective sociodental data were collected:

i. Perceived dental treatment needs

ii. Perceived oral health status

iii. Oral Impacts on Daily Performances (OIDP)

From the results of the pilot study, the impacts of oral problems were assessed on ten common daily performances. These performances were: eating, speaking clearly, cleaning teeth or dentures, going out, performing light activities, performing main job or role, relaxing including sleeping, smiling, emotional stability and enjoying contact with people. Respondents were asked whether they experienced any of the ten oral health-related problems listed in the OIDP in the past 6 months. For each reported oral impact, its frequency and severity were assessed. The OIDP frequency scores were assessed on a 5 point scale: i) less than once a month, ii) once or twice a month, iii) once or twice a week, iv) 3-4 times a week and v) every day or nearly every day. The severity scores were also assessed on 5 point Likert scale as follows: i) very little effect, ii) little effect, iii) moderate effect, iv) severe effect and v) very severe effect.

C. Oral health behaviour

The following oral health related behaviours were recorded:

i. Frequency of sugar intake

The subjects were asked on the frequency of sugar intake daily. Response options include ‘once daily’, ‘2-3 times daily’, ‘more than 4 times daily’, ‘I don’t take sugars’ and ‘I don’t know’ (Holbrook et al. 1995; WHO 2003).

ii. Frequency of toothbrushing

Oral hygiene behaviour was measured through the frequency of brushing. Response options include 'twice or more daily', 'once daily', 'a few times a week', 'once a week' and 'irregularly or never' (Kuusela et al. 1997; Chestnutt et al. 1998; Gibson and Williams 1999; Honkala et al. 2007).

iii. Use of fluoridated toothpaste

The subjects were asked whether they used fluoridated toothpaste or not (Marinho et al. 2003; Twetman et al. 2003). If they were unsure, they were asked to state the name of the toothpaste.

iv. Pattern of dental attendance

The dental attendance pattern was based on their last visits to the dentist. Response options include 'less than one year ago', 'between 1-2 years ago', 'more than 2 years ago' and 'never visited a dentist' (Tan et al. 2006; Patel et al. 2010)

v. Smoking behaviour

Subjects were asked to describe their smoking behaviour. Response options include 'never smoked', 'non-smoker but have tried smoking', 'ex-smoker' and 'current smoker'. For those who smoked, they were asked to state the period of their last cigarette.

This information was used to determine the subjects' level of propensity for dental treatment. Most questions on behaviours were derived and modified from the previous Malaysian national oral health surveys which have been validated on the Malaysian adult population.

3.4 Assessment of Dental Treatment Time

One of the types of information required in calculating workforce requirements is the time needed to carry out dental treatment. Research has been done on the assessment of dental treatment time; however the findings were not adequate or accurate. For example, the timing for restoration indicated by WHO (1989) and Panthumvanich et al. (1986) did not take into account the number of tooth surfaces affected and the complexity of the treatment. The timing for root canal treatments or crowns which usually take longer than simple restoration were not specified accurately; instead they were pooled under the general timings for caries treatment (Bourgeois et al. 1993). It was also not stated whether the timing includes the time taken for examination and diagnosis procedure. The timing inquiry conducted by British Dental Association (Bearne and Kravitz 2000) was only based on dentists' estimation and might not be precise. The Windermere Inquiry (Nettley and Scarrott 1988) did not provide the absolute dental timings but instead gave results on relative timings which is the relation of time needed for one treatment item as compared to other treatment items in the group.

Most of the abovementioned timings might not represent the time taken by Malaysian dentists as the oral health status of the population and the technology employed could be different. Hence, it was considered essential to carry out a survey to assess the dental treatment time in Malaysia as part of this study.

Initially, the author planned to conduct the survey at both public and private dental clinic by using two different assessment methods; the observation and the activity analysis technique. Permission was obtained from the Director of Oral Health Services, Malaysia, to carry out the survey at public dental clinics in Selangor. However, the head dentist of Selangor informed the author that a similar nationwide survey had just been conducted by their research group based in Putrajaya, Kuala Lumpur. Another letter was then written to the Director of Oral Health Services to ask for the timing data that they had obtained. This request was granted, however the protocol that they used in attaining the results was not made available. The timings data obtained from the Ministry of Health are presented in Table 5.26.

3.4.1 Timings survey at private dental clinics

For reasons mentioned previously, the assessment of the time to perform dental treatment was carried out only at private dental clinics. A list of names and addresses of private dental clinics in Selangor and Kuala Lumpur was obtained from the Oral Health Division, Ministry of Health. A total of 25 dental clinics located within 35 miles from University of Malaya were randomly selected. The author sent an invitation letter to each clinic and sought the dentists' participation. Of these, 1 dentist refused to participate because she claimed of not having sufficient patients list, 3 declined because they were going away on a conference and 1 clinic could not be located. One dentist initially agreed to participate but then failed to return the survey form.

As there was only one dentist working at each clinic at any time, an observation technique was employed. Assistance was sought from the clinic's dental nurses to record the time that dentists spend on particular dental procedures. They were asked to record the time from the moment a treatment starts until its completion. The timing did not include the time taken for the preparation of patients or any post-treatment procedures. A standard form was used with instructions on how to complete it (Appendix 8). Telephone calls were made to remind the dentists or the assistants to record the timing. All clinics were given three weeks to complete the form. All participating clinics received monetary rewards at the end of the survey.

3.4.2 Estimation of dental treatment time using an expert committee review

The data obtained from the Ministry of Health and the results obtained from the private clinics were tabulated during an expert committee review. The experts were six dentists based at the Faculty of Dentistry, University of Malaya. They were selected because of their experiences of working at either the public or private dental clinics. The participants consisted of 4 females and 2 males. Of these, 4 were of Malays, 1 was of Chinese and another one of Indian ethnicity. Their age ranged from 37 to 55 years. Three had more than 10 years working with the Ministry of Health while two had more than 10 years working at private dental clinics. Four of them were dental academics and two were working with the Ministry of Defence.

At the start of the exercise, the experts were presented with the results of the dental treatment times obtained from the private and public dental clinics. All of them initially surveyed the results individually and noted down the treatment time that they thought is acceptable based on their experiences at respective dental clinics, the average Malaysian oral health condition and the standard dental technology in used. The experts then compared their notes and thoughts; and discussed the appropriate time needed to perform treatment for restoration, endodontic, periodontal, prosthodontics and extraction procedures. They were requested to give a range of minimum and maximum time estimates for each dental procedure based on different level of severity of the dental conditions commonly found in Malaysian patients. It was also emphasized that the estimates should consider the treatment time performed by dentists with different length of working experiences. The author acted as a moderator in the review.

3.5 Permission and ethics approval

The pilot study was ethically approved by the Ethics Committee of Faculty of Dentistry, University of Malaya (Appendix 2). The main study was ethically approved by the Ethics Committee of Faculty of Dentistry, University of Malaya (Appendix 9) and Ethics Committee of University College London (Appendix 10). A letter requesting permission to conduct the main study was sent to all the heads of offices in University of Malaya prior to data collection. An invitation and permission letter was sent personally to all dentists working at private dental clinics in Kuala Lumpur.

3.6 Data handling and analysis

The interview and clinical examination data recorded on the survey forms (Appendix 6 and 7) during the survey period were checked daily by one of the research team member. This was done before subjects were allowed to leave the survey area. Any missing data due to incomplete records was requested immediately by re-interviewing or re-examining the subject.

Data were entered and analysed using the Statistical Package for Social Sciences (SPSS) version 16.0. Data entry was done by a fourth-year dental student and was checked and cleaned by the author for any inconsistencies or presence of odd coding.

The first phase of data analysis assessed the distribution of subjects according to their sociodemographic characteristics, subjective assessment, oral health behaviours and oral impacts. Results were presented in terms of the percentages for categorical data and the mean (± SD) for quantitative data. The OIDP scores were calculated by multiplying the frequency and severity score of each performance. These figures were then divided with the maximum possible intensity score (250), and then multiplied by 100 which gave the final OIDP score in a range of 0 – 100. The Condition-Specific OIDP (CS-OIDP) for periodontal and prosthodontic treatment was analysed by relating the possible perceived impairments with the possible type of treatment (Table 3.4). The detail method of calculating CS-OIDP score is presented in Appendix 11. The CS-OIDP was not assessed on dental caries as the condition relies on normative needs assessment only. To give a clearer picture about the degree of the impacts, the 'intensity' and 'extent' of impacts are reported.

Table 3.4: Possible perceived oral conditions and the most probable type of dental treatment needed

Perceived oral conditions that give an impact on daily performances	The most probable type of dental treatment needed
Bleeding gums Swollen gums, gum abscess Receding gum Calculus Bad breath Loose tooth	Periodontal treatment
Tooth loss Loose ill-fitting denture	Prosthodontic treatment

The second phase assessed the oral health status and the normative dental treatment need for dental restoration, periodontal and prosthodontics treatment. The relationship between oral health status and sociodemographic variables was assessed using the Mann-Whitney or Kruskall-Wallis test where appropriate. Normative treatment need was described in terms of the percentage of people requiring the treatment and the number of teeth/sextants requiring treatment per 100 samples and per 100 samples with need.

The third phase involved integrating the results of the normative assessment, subjective assessments on oral impacts and oral health behaviours generating three different levels of need; i) Normative need, ii) Impact-Related Need (normative needs and presence of oral impacts) and, iii) Propensity-Related Need (normative needs, presence of oral impacts and behaviour patterns). For each type of dental treatment needs, two illustrative diagrams were presented to show the changes of needs at different levels of needs assessment. The first one illustrates the changes in the proportion of the whole sample with dental treatment needs and the second illustrates the changes in terms of the number of people with needs and the number of teeth/sextants requiring treatment per 100 subjects with normative needs. The percentage reductions between normative needs and sociodental needs were assessed using McNemar test for nominal variables or Wilcoxon Signed Ranks tests for measurements variables. The cut-off level for statistical significance chosen for this purposes was 0.001.

For each treatment need model, three different cut-off points of the CS-OIDP score (CS-OIDP >0, ≥ 6 and ≥ 12), chosen based on the distribution of the OIDP scores, and two criteria for the propensity level (strict and non-strict) were used. This provided health planners options as to the criteria that are more appropriate for their needs according to their policy for oral health care delivery, available oral health resources, level of disease prevalence and distribution of oral impacts in the population. Choosing the lowest cut-off points for the impact score (CS-OIDP>0) or using the non-strict propensity criteria would result in a higher level of need.

The type of oral health behaviour considered in the strict and non-strict criteria for each category of dental treatment is shown in Table 3.5. For ease of presentation, only the non-strict propensity criteria were presented in the Results section. The differences in the proportion of people needing treatment when either a strict or non-strict propensity criteria were used are shown in Appendix 13. Good behaviour includes brushing twice or more a day, use of fluoride toothpaste, consuming sugar not more than four times a day, visit to a dentist less than two years ago and have never been a smoker (see Section 2.5). The non-strict criteria for restorative, bridges and implants did not include the sugar consumption consideration. This is because regular brushing and usage of fluoride toothpaste have a greater impact on caries than sugar restriction (Gibson and Williams 1999). Sheiham (1983) also demonstrated that when fluoride toothpaste is used, the dose-effect curve of sugar and caries shifts to the right and the safe level of sugars increases. This does not deny the role of sugar in the incidence of caries, but the effect is weakened if one brushes well with fluoride toothpaste. The non-strict criteria for periodontal treatment consider those ex-smokers who quitted more than 10 years ago as having good propensity for treatment. This is based on evidence that the periodontal status of former smokers approximates that of non-smokers after 10 years of quitting (Tomar and Asma 2000; Warnakulasuriya et al. 2010).

Table 3.5: The 'Strict' and 'Non-strict' propensity criteria for dental treatment

Dental treatment	Strict criteria	Non-strict criteria
Restorative / extraction	Low Propensity Poor brushing behaviour OR high sugar intake	Low Propensity Poor brushing behaviour
	High Propensity Good brushing behaviour AND use of fluoride toothpaste AND low sugar intake	High Propensity Good brushing behaviour AND use of fluoride toothpaste
Periodontal treatment	Low Propensity Poor brushing behaviour OR smokers/ex-smokers	Low Propensity Poor brushing behaviour
	High Propensity Good brushing behaviour AND does not smoke	High Propensity Good brushing behaviour AND does not smoke or ex-smokers who quit more than 10 years ago
Prosthodontics treatment		
i.Dentures	Low Propensity Poor brushing behaviour OR poor dental attendance	The same as in the strict criteria as both behaviours are important in determining success in treatment
	High Propensity Good brushing behaviour AND good dental attendance	
ii.Bridges/dental implants	Low Propensity Poor brushing behaviour OR high sugar intake OR poor dental attendance	Low Propensity Poor brushing behaviour OR poor dental attendance
	High Propensity Good brushing behaviour AND use of fluoride toothpaste AND low sugar intake AND good dental attendance	High Propensity Good brushing behaviour AND use of fluoride toothpaste AND good dental attendance

The fourth stage involved calculating the time and the number of dentists required to perform dental treatments. First, the minimum and maximum treatment times needed for each type of dental treatment at different levels of OIDP scores were calculated. The treatment times used in the calculations were obtained during expert committee review (see Section 5.5.1). The treatment time obtained in minutes was converted to hours, and then it was computed to the time needed to treat 100,000 people. The number of dentists needed to treat 100,000 people was then computed by dividing the hours of treatment time to treat 100,000 people with the hours of dentists' annual working time. Four estimates of dentists' annual working hours were used. The first was the WHO estimation which stated that the average working hours of dentists are 1200, 1500 and 2000 (WHO 1989). The second is from the Oral Health Division Malaysia which estimated that Malaysian dentists work for 1760 hours annually (Phantumvanit and Oral Health Division Malaysia 2008). The differences between the Normative Need and Sociodental Need model in the time needed were measured using Wilcoxon Signed Rank test.

In the final stage, the number of dental personnel needed was assessed when different models of professional skill mix were used. The model proposed by Gallagher et al. (2010) was modified and used. The type of dental procedures that can be delegated to PCDs (dental therapists and dental technicians) were based on the results from experimental studies which assessed the competency of dental therapists in carrying out irreversible dental procedures (Pelton et al. 1972; Powell et al. 1974; Sisty et al. 1978), the suggestion by Evans et al (2007) who highlighted the level of simple and routine tasks that can be delegated to dental care professionals and the proposal made by Malaysian dentists (Phantumvanit and Oral Health Division Malaysia 2008).

CHAPTER 4

PSYCHOMETRIC PROPERTIES OF THE OIDP INDEX

Chapter 4

The reliability and validity of the Malay version of the Oral Impacts on Daily Performances (OIDP) index

4.1 Introduction

This chapter describes the results of the reliability and validity assessments of the Malay version of the Oral Impacts on Daily Performances (OIDP) index, both for the pilot study as well as the main study. The Malay-OIDP internal consistency and construct validity is examined. The overall performance of the Malay-OIDP is discussed in this chapter and not in the main discussion chapter. This is because, although the development and evaluation of the index is essential for generating the new system of dental treatment needs, its performance is not the main objective of this study.

4.2 The psychometric properties of the Malay-OIDP index- The Pilot Study

4.2.1 Response rate

The selection of the sample and the calculation of the sample size for this study were discussed in the previous chapter (Section 4.2.1.3). A total of 324 potential respondents were invited to participate in this study. Of these, only five declined to take part (response rate 98.4%). Three said they did not have time to participate, one refused because no incentives/gifts would have been given and one rejected the invitation. Among those who agreed to participate, five did not manage to finish the questionnaires as they had been called to see the doctor at the clinic and eight questionnaires were incomplete with more than half of the questions were unanswered. Hence only 306 completed questionnaires were included in data analysis. 143 questionnaires were completed through a face-to-face interview while 163 were self-administered.

4.2.2 Sample characteristics

The majority of the samples were female (55.6%) and of Malay ethnic origin (58.5%). The mean age was 34.7 ± 8.4 years. Slightly more than 50% rated their oral health as good, 65.7% felt that their oral health was equal to their general health and only 32.7% felt that they did not need any dental treatment at the moment. 37.9% reported that at least one oral impact affected their daily performances in the past six months. The most prevalent oral impacts were 'difficulty eating' (27.1%), 'difficulty cleaning' (21.2%) and 'difficulty sleeping' (17.4%). Descriptive results are presented in detail in Appendix 12.

4.2.3 Reliability assessment

The pilot study was conducted at a main hospital located in Kuala Lumpur city centre and the patients were from across Malaysia. Hence, it was not possible to carry out test-retest reliability as it was not known when or whether the patients would be at the hospital again and it would be costly to make contact with the patients at their own residences. In a situation where it is impractical or undesirable to assess test-retest reliability, split half reliability analysis would provide a useful alternative (Cohen and Swerdlik 2002). In this test, the items are divided into halves and scored separately, then the score of one half of the items are compared to the score of the remaining half to test the reliability (Kaplan and Saccuzzo 2001).

The Cronbach's alpha coefficient of the Malay-OIDP measured in the pilot study was 0.93. The standardised alpha, where all items' variances were standardized, was 0.94. Both the Cronbach's and the standardized item alpha were above the recommended levels of good internal consistency (Nunnally 1978). The corrected item-total correlation ranged from 0.54 (cleaning teeth) to 0.81 (physical activity and unstable emotion) (Table 4.1) and were above the recommended level of 0.20 (Kline 1986). The inter item correlations were positive indicating that the items were homogenous (Table 4.2). These results indicated that the Malay-OIDP has excellent reliability in a Malaysian population. When the standardized Cronbach's alpha was compared by mode of administration (interview versus self-administered), an almost similar value was observed for the interview-led questionnaire (0.95) compared to the self-administered questionnaire (0.92) (Table 4.3).

Table 4.1: Reliability analysis of the Malay-OIDP index: Corrected item-total correlation, Cronbach's Alpha, Standardised Alpha and Alpha if item deleted (N=306).

Performances	Corrected item-total correlation	Alpha if item deleted
1. eating	0.72	0.93
2. speaking	0.75	0.92
3. cleaning teeth	0.54	0.94
4. going out	0.78	0.92
5. light physical activities	0.81	0.92
6. performing main role	0.80	0.92
7. sleeping	0.76	0.92
8. smiling	0.79	0.92
9. emotional stability	0.81	0.92
10. enjoying contact	0.76	0.92
Standardised item alpha = 0.94		

Table 4.2: Reliability analysis: Inter-item correlation matrix (N=306).

Performances	1.eating	2.speaking	3. cleaning	4. going out	5. physical activity	6. perform main role	7. sleeping	8. smiling	9. emotional stability	10. enjoying contact
1. eating	1.00									
2. speaking	0.63	1.00								
3. cleaning	0.47	0.47	1.00							
4. going out	0.54	0.58	0.42	1.00						
5. physical activity	0.65	0.59	0.42	0.71	1.00					
6. perform main role	0.62	0.64	0.44	0.63	0.88	1.00				
7. sleeping	0.71	0.55	0.50	0.57	0.65	0.70	1.00			
8. smiling	0.61	0.79	0.48	0.68	0.58	0.63	0.61	1.00		
9. emotional stability	0.55	0.64	0.41	0.80	0.74	0.69	0.64	0.70	1.00	
10. enjoying contact	0.50	0.58	0.40	0.81	0.69	0.65	0.55	0.69	0.77	1.00

Table 4.3. Internal consistency for the Malay-OIDP index by mode of administration (N=306)

	Interview approach (N=143)		Self-administered (N=163)	
Performances	Corrected item-total correlation	Cronbach's alpha if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
1. eating	0.79	0.94	0.59	0.90
2. speaking	0.73	0.94	0.80	0.88
3. cleaning teeth	0.52	0.95	0.58	0.91
4. going out	0.84	0.94	0.67	0.90
5. light physical activities	0.83	0.94	0.75	0.89
6. performing main role	0.80	0.94	0.79	0.89
7. sleeping	0.85	0.93	0.52	0.90
8. smiling	0.83	0.94	0.76	0.89
9. emotional stability	0.85	0.94	0.72	0.89
10. enjoying contact	0.80	0.94	0.66	0.90
Standardised item alpha	0.95		0.92	

The recommended methods to split a test are through i) randomly assign items to one or the other half of the test, ii) assigning odd-numbered items to one half of the test and even-numbered items to the other half, or iii) dividing the test by content so that each half of the test contains items equivalent with respect to content and difficulty (Cohen and Swerdlik 2002). In this analysis, the third option was chosen where the items which are more closely related to physical impact (eating, speaking, cleaning, performing role and light physical activities) and those more closely related to psychosocial impact (going out, sleeping, smiling, emotional stability and enjoying contact) were clustered into two different group. Then the items were separated again into two groups of analyses for split half reliability testing. The result showed that the value for equal length Spearman-Brown was 0.877 (Table 4.4), indicating good reliability.

Table 4.4: Reliability analysis: Split half technique

	Mean	SD	N
Part 1	5.82	12.30	5[a]
Part 2	3.85	10.96	5[b]
Both parts	9.67	21.95	10

a. items: eating, sleeping, speaking, smiling, cleaning
b. items: emotional stability, perform role, going out, physical activity, enjoy contact

Alpha for Part 1: 0.863
Alpha for Part 2: 0.933

Spearman Brown Coefficient: Equal length: 0.877
Unequal length: 0.877

4.2.4 Validity assessment

There was a gradient in the OIDP scores between groups of self-rated oral health, perceived treatment need and satisfaction with oral health. The mean OIDP scores were lower, i.e. indicating better OHRQoL, for each higher level of satisfaction and for each group with better self-rated oral health or perceived treatment need ($p<0.001$). Similarly, a significant positive trend was also observed between OIDP scores and experience of dental pain and chewing difficulty. Those who had experienced severe pain in the last 6 months or had chewing difficulty had higher mean OIDP scores than their counterparts who had lesser or no pain and no chewing difficulty respectively ($p<0.001$). These results demonstrate the validity of the Malay-OIDP index.

4.3 Re-evaluation of psychometric properties of the Malay-OIDP index- The main study

The psychometric properties of the Malay-OIDP index were reassessed in the main study. The characteristics of the sample are as described in Section 5.2. Cronbach's alpha coefficient found in the main study was 0.76 and the standardized alpha was 0.81. The alpha coefficient was lower when any of the items was deleted. The corrected item-total correlations coefficients ranged from 0.35 (smiling, laughing, showing teeth without embarrassment) to 0.58 (emotional stability) (Table 4.6). The inter-item correlation coefficients ranged from 0.10 to 0.60 (Table 4.7). None of the scores were negative suggesting that the items were homogenous. Also, no correlations were high enough for any item to be redundant.

Table 4.5: The evaluation of construct validity of Malay-OIDP. Comparison of OIDP scores and subjective measures (N=306).

Variables	N	Mean(±SD) OIDP scores	P value
Perceived oral health status			
Very good	22	0.61 (0.46)	
Good	154	3.85 (0.81)	<0.001
Moderate	105	9.67 (1.85)	
Poor	25	14.05 (3.67)	
Satisfaction with teeth and gums			
Very satisfied	35	0.46 (0.31)	
Satisfied	181	4.12 (0.81)	< 0.001
Dissatisfied	88	13.11 (2.20)	
Very dissatisfied	2	25.00 (5.00)	
Perceived dental treatment need			
Not at all	100	2.36 (0.86)	
Yes, but very little	97	3.95 (0.90)	<0.001
Yes, to some extent	50	9.08 (2.64)	
Yes, a great deal	59	15.31 (2.77)	
Prevalence of pain in the last 6 months			
Never	183	0.86 (0.26)	
Yes, but not severe	88	7.99 (1.50)	
Yes, severe	31	29.61 (3.74)	<0.001
Yes, very severe	4	48.33 (16.47)	
Chewing ability			
All foods	266	5.14 (0.79)	<0.001
Soft and mashed foods only	40	15.17 (3.34)	

Table 4.6: Reliability analysis of the Malay-OIDP index in the main study: Corrected item-total correlation, Cronbach's Alpha, Standardised Alpha and Alpha if item deleted (N=732).

Performances	Corrected item-total correlation	Alpha if item deleted
1. eating	0.44	0.76
2. speaking	0.37	0.74
3. cleaning teeth	0.42	0.74
4. going out	0.44	0.74
5. light physical activities	0.57	0.73
6. performing main role	0.55	0.73
7. sleeping	0.58	0.71
8. smiling	0.35	0.75
9. emotional stability	0.58	0.71
10. enjoying contact	0.41	0.74
Standardised item alpha = 0.81		

Table 4.7: Reliability analysis: Inter-item correlation matrix (N=732).

Performances	1.eating	2.speaking	3. cleaning	4. going out	5. physical activity	6. perform main role	7. sleeping	8. smiling	9. emotional stability	10. enjoying contact
1. eating	1.00									
2. speaking	0.20	1.00								
3. cleaning	0.37	0.17	1.00							
4. going out	0.23	0.31	0.10	1.00						
5. physical activity	0.18	0.45	0.21	0.45	1.00					
6. perform main role	0.26	0.27	0.18	0.48	0.60	1.00				
7. sleeping	0.37	0.21	0.31	0.28	0.44	0.56	1.00			
8. smiling	0.13	0.21	0.20	0.26	0.34	0.21	0.25	1.00		
9. emotional stability	0.39	0.26	0.30	0.28	0.51	0.47	0.53	0.15	1.00	
10. enjoying contact	0.16	0.18	0.23	0.32	0.30	0.26	0.24	0.39	0.30	1.00

There was a significant negative trend in the relationship between OIDP scores and the perception and satisfaction of oral health; the OIDP scores were lower for each higher level of perception and satisfaction of oral health ($p<0.001$). A graded pattern of association was also observed between the prevalence of pain and chewing ability; those who had experienced severe dental pain or had chewing difficulty had higher OIDP scores than those who did not ($p<0.001$) (Table 4.8).

The OIDP was also able to discriminate between those with and without a need for dental treatment. Subjects with a restorative and/or prosthetic treatment need had higher OIDP scores than those without such treatment needs (Table 4.9). However this observation was not significant at the $p=0.001$ level.

Table 4.8: The evaluation of construct validity of Malay-OIDP. Comparison of OIDP scores and subjective measures (N=732).

Variables	N	Mean(±SD) OIDP scores	P value
Perceived oral health status			
Very good	15	1.52 (0.57)	
Good	272	1.54 (0.32)	<0.001
Moderate	393	2.78 (0.27)	
Poor	52	7.86 (1.69)	
Satisfaction with teeth and gums			
Very satisfied	32	0.86 (0.39)	
Satisfied	421	1.76 (0.19)	< 0.001
Dissatisfied	271	4.07 (0.52)	
Very dissatisfied	8	8.95 (3.00)	
Perceived dental treatment need			
Not at all	91	1.60 (0.40)	
Yes, but very little	242	1.83 (0.30)	<0.001
Yes, to some extent	237	2.02 (0.23)	
Yes, a great deal	162	5.42 (0.82)	
Prevalence of pain in the last 6 months			
Never	358	1.19 (0.19)	<0.001
Yes, but not severe	301	2.80 (0.28)	
Yes, severe	73	9.29 (1.55)	
Chewing ability			
All foods	685	2.39 (0.23)	<0.001
Soft and mashed foods only	47	6.50 (1.24)	

Table 4.9: The evaluation of construct validity of Malay-OIDP. Comparison of OIDP scores and clinical dental treatment needs (N=732).

Clinical dental treatment needs	N	Mean(±SD) OIDP scores	P value
Restorative need			
No need	429	2.44(0.30)	
Need restorative treatment	303	2.90(0.36)	0.07
Prosthetic need			
No need	508	2.43(0.27)	
Need denture	224	3.18(0.45)	0.05

In the main study, a second interview session to test the reproducibility of the index was conducted on 45 people, representing 6% of the sample. This was carried out approximately two to three weeks after the first interview session. Before the second interview session was carried out, the respondents were asked whether they had any dental treatment after their first interview. Those who had received treatment during the interval were deemed not eligible for the second interview session as their reported oral impacts could have changed because of the treatment. The weighted kappa statistic was 0.84 and the intraclass correlation coefficient was 0.88, indicating very good reliability.

4.4 Discussion

The OIDP index was developed in English and was initially intended to be used in a Thai adult population (Adulyanon 1996). Since then, the index has been widely used globally (Srisilapanan and Sheiham 2001; Tsakos et al. 2001; Astrom and Okullo 2003; Astrom et al. 2005; Kida et al. 2006; Dorri et al. 2007; Naito et al. 2007; Jung et al. 2008; Hobdell et al. 2009). In these aforementioned studies, the index underwent a cross cultural adaptation process to ensure that equivalence was achieved between the original and the translated versions and was culturally appropriate for the studied population. However, this process is not adequate for ensuring that the reliability and validity of the original index has been retained (Beaton et al. 2000). Further tests for assessing the psychometric properties of the translated questionnaire should be carried out.

As the OIDP index has never been used in Malaysian adult population, the index was translated into the official language of Malaysia (the Malay language) and its cultural and conceptual equivalence was reviewed following the steps described by Acquadro et al. (2004). The translation process was not without some difficulty. This is because Malaysia is populated by various ethnic groups namely the Malays, Chinese, Indians, the indigenous and aboriginal tribes and other ethnic minorities. Although most understands the Malay language, some common Malay phrases may not be understood by groups other than the Malays. In addition, within the Malay community, there are different Malay accents and colloquialisms. For example, the phrase of '*sensitive teeth*' was translated by the Malay translator in the forward translation process as '*gigi ngilu*'. During the discussion between the two forward translators, the Chinese translator stated that the word '*ngilu*' would not be recognized by the Chinese population. The Chinese translator instead suggested that '*gigi sensitif*' be used; however this was turned down by the Malay translator who felt that the older generation of Malays would not be familiar with the word *'sensitif'*. It was then agreed that both phrases (*gigi ngilu/gigi sensitive*) would be used to translate '*sensitive teeth*'.

While the translators were reminded to ensure that the Malay version of the index used familiar or common phrases that would be understood by all ethnicities in Malaysia, this goal was better achieved by ensuring that the translators were from the various ethnic groups. During the translation process of the Geriatric Oral Health Assessment Index (GOHAI) index into the Malay language, the authors overcame the linguistic and cultural diversity in Malaysia by conducting two studies on population residing at different regions of Peninsular Malaysia (north, east, south, west and central) before they carried out the main study (Othman et al. 2006). The majority involvement of the Malay community and recruitment of subjects from different areas where different phrases or dialects of the Malay language are used may possibly improve and maintain the content validity of the instrument used to measure this construct.

In the pilot study, the questionnaire was administered through two different methods; interview and self-administered technique. Both techniques have their own advantages and disadvantages. Interviews are useful for obtaining information in greater depth because the subjects can be probed for their views. This helps improve accuracy of the data obtained. Although interviews usually have a higher response rates compared to self-administered questionnaire, the former can be expensive and time consuming. In contrast, the latter enable a larger proportion of the population to be covered at a lower cost; however the response rate may be lower and this approach is not suitable for complex and long questionnaires (Aday 1996; Bowling 1997).

The standardized Cronbach's alpha across the two modes of administration was almost similar; 0.95 for the interview-led questionnaire and 0.92 for the self-administered questionnaire. This finding is similar to previous studies which demonstrated that the psychometric properties for the self-administered and interview-administered Child-OIDP were comparable (Robinson et al. 2001; Tsakos et al. 2008). Saub (2004) tested the internal consistency of the OHIP index among the adult population in Malaysia and concluded that the index had good reliability and validity regardless of the mode of administration. The initial proposal to nest the main study with the National Oral Health Survey 2010 (NOHSA) was not successful because the NOHSA team felt that the administration of OHRQoL measures through interviews would be costly in terms of time and money. This study showed that the self-administered Malay-OIDP gave comparable results to the interviewer-administered method, thus providing support for the use of this index in future national oral health surveys.

The results from the pilot study and the main study showed that the Malay-OIDP index has excellent psychometric properties with the standardized alpha being higher than the recommended level of 0.70 for group comparisons (Nunnally 1978; Nunnally and Bernstein 1994). A score of 0.90-0.95 has been considered as marginally acceptable for individual comparisons (Nunnally 1967). Kaplan and Saccuzzo (2001) supported this stance and stated that in clinical settings where a test is used to make decisions that affect some person's future, a reliability score greater than 0.95 must be obtained. However, Streiner (2003) argued that alpha values higher than 0.90 indicate redundancy more than homogeneity among items and proposed a maximum value of 0.90.

The alpha score obtained in this study is higher or almost similar to previous studies done on adult populations in other settings (Dorri et al. 2007; Jung et al. 2008; Naito et al. 2007; Ostberg et al. 2008; Tsakos et al. 2001). The alpha value was not higher when any item was deleted. This demonstrated that the ten daily performances were important in the construction of the OIDP index in the Malaysian adult population. This contrasts with other findings where the exclusion of some items improved the internal consistency of the measure (Adulyanon 1996; Tsakos et al. 2001). In terms of construct validity, a trend was observed between both subjective and clinical measures with the OIDP scores. In the main study, the OIDP scores were higher among those with a clinical need for restorative and/or prosthetic treatment. Other studies have found that not only was the index able to distinguish between people with or without a need for treatment; it was also able to differentiate between people with different degrees of treatment need (Jung et al. 2008).

In conclusion, the Malay-OIDP index has excellent internal consistency and good validity when used among adult population in Malaysia. It performed equally well in terms of its psychometric properties even when conducted using different administration mode. Further research are needed using the Malay-OIDP on a larger population in Malaysia to assess their oral health related quality of life.

CHAPTER 5
RESULTS

Chapter 5
Results

5.1 Introduction

In this chapter, results are presented as follows. First the distribution of subjects according to their sociodemographic characteristics, perception of oral health, oral health behaviours and oral impacts are described. Next, results on the oral health status and normative dental treatment need of the subjects are presented. This is followed with the assessment of sociodental needs by integrating normative needs with impact-related and propensity-related needs. The normative and sociodental needs are then compared in terms of the treatment time and the number of dentists needed to treat. Then, by using five different models of skill mix, the number and composition of the dental teams needed to treat populations of 100,000 is determined. The chapter ends by summarising the main findings for each objective of the study.

5.2 Sociodemographics characteristics, subjective measures, oral health behaviours and oral health impacts

5.2.1 Response rate and demographic background of subjects

5.2.1.1 Response rate

There were 3620 Malaysian staff members aged between 30-54 years old employed by the University of Malaya. From the list of names containing the information regarding the staffs' workplace and job positions, 1858 people were excluded from the study (see Section 3.3.3 for reasons and breakdown of numbers for exclusion). As the survey proceeded, an additional 843 people were found to be ineligible to participate as they were on leave or were undertaking official task away from their offices and therefore could not be examined. Therefore, the total number of eligible subjects was 919.

Of those, 732 people agreed to participate; a response rate of 79.6%. The research team made numerous efforts to establish the reasons for not participating. This was done by contacting non-respondents personally or through telephone calls or emails. The number of non-respondents with reasons for not participating is shown in Table 5.1.

Table 5.1: The number of non-respondents and their reasons for not participating (N=187)

Reasons for not participating	n	%
Personal reasons: fear (1 person), not interested (1 person), did not remember (5 persons), unwilling to have a dental examination (1 person), shy (5 persons)	13	6.9
Work-related reasons: too busy, lack of time, work commitment	68	36.4
Communication problem: not aware of the on-going research, did not receive invitation letters	29	15.5
Reasons unknown: subjects who meet the inclusion criteria but were non contactable or did not give any reasons	77	41.2

5.2.1.2 Sociodemographic characteristics

The majority of the subjects were females (66%) and Malay (83.2%). About 40% were between 45 and 54 years old. The mean age was 41.2 (SD ±7.9) years. More than half the subjects (59.1%) had low educational qualifications and slightly over 70% earned below Ringgit Malaysia 3000 a month (Table 5.2). The study sample differed substantially from the profile of the university's employees and from the Malaysian population of similar age groups. There were considerably more females in the study sample compared to both the university and the general Malaysian population. The majority of subjects in this study and the university employees were between 45 and 54 years old while the largest age group in the general Malaysian population is the 35-44 year age group. In terms of ethnicity, the Chinese were considerably under-represented in the study population while the Malays were over-represented when compared with the general Malaysian population.

Table 5.2: Sociodemographic characteristics of survey subjects (n=732) compared with university employees and general Malaysian population aged 30-54 years

Sociodemographic characteristics		**Survey Population** (N=732) n **(%)**	**University population in 2010*** (N=3620) n **(%)**	**Malaysian population in 2010#** (N=7,985,618) n **(%)**
Age	30-34 years	214 **(29.2)**	913 **(25.2)**	1,842,843 **(23.1)**
	35-44 years	217 **(29.6)**	1334 **(36.9)**	3,326,787 **(41.6)**
	45-54 years	301 **(41.2)**	1373 **(37.9)**	2,815,988 **(35.3)**
		Mean(±SD)=41.2(7.9) Median: 42	Mean(±SD)=41.2(7.3) Median=41	
Gender	Male	249 **(34.0)**	1669 **(46.1)**	4,056,276 **(50.8)**
	Female	483 **(66.0)**	1951 **(53.9)**	3,929,342 **(49.2)**
Ethnicity	Malay	609 **(83.2)**	2905**(80.2)**	4,109,804 **(51.5)**
	Chinese	33 **(4.5)**	352 **(9.7)**	2,251,491 **(28.2)**
	Indian	85 **(11.6)**	337 **(9.3)**	651,121 **(8.1)**
	Others	5 **(0.7)**	26 **(0.7)**	973,202 **(12.2)**
Educational level	Primary school	55 **(7.5)**	Not available	Not available
	Secondary school	378 **(51.6)**		
	Degree/Diploma	185 **(25.3)**		
	Masters/PhD	114 **(15.6)**		
Income	≤ 1500	170 **(23.2)**	Not available	Not available
	1501 – 3000	371 **(50.7)**		
	3001 – 5000	118 **(16.1)**		
	≥ 5001	73 **(10.0)**		

Sources: * The Registrar, University of Malaya #The Director, Statistics Department of Malaysia

5.2.2 Subjective oral health measures

Table 5.3 presents the distribution of subjects' perceptions of their oral health. The majority (53.7%) ranked their oral health as 'moderate' while almost 40% rated their oral health as 'excellent' or 'good'. Slightly more than half (51.1%) of the subjects reported having experienced dental pain in the past 6 months. Of these, 73 subjects (10%) had experienced severe dental pain. The majority of the subjects (57.5%) were satisfied with their dental appearance. Overall, almost all of the subjects were able to chew all kinds of foods with less than 7% reporting difficulty in chewing.

Table 5.3: Subjective oral health measure: Perception of oral health, problems with oral function and satisfaction with dental appearance (N=732)

Outcome measurement		Percentages of subjects	
		n	%
Rating of oral health	Excellent	15	2.0
	Good	272	37.2
	Moderate	393	53.7
	Poor/Very poor	52	7.1
Experience of dental pain	Never	358	48.9
	Yes, but not severe	301	41.1
	Yes, quite severe	67	9.2
	Yes, very severe	6	0.8
Chewing ability	Able to chew all kinds of food	685	93.6
	Only able to chew soft and mashed food	47	6.4
Satisfaction with dental appearance	Very satisfied	32	4.4
	Satisfied	421	57.5
	Not satisfied	271	37.0
	Very not satisfied	8	1.1

5.2.3 Perceived dental treatment need

437 subjects (59.7%) perceived that they had a dental treatment need. Of those who reported a need for dental treatment, 47.6% felt that the need was urgent while 52.4% thought that treatment could wait for six months' time. The most frequent perceived need was for scaling and polishing (42.8%) and restorative fillings (including crown) (30.7%). Perceived need for denture, extraction and pulp care were expressed by 5.9%, 8.7% and 2.1% subjects respectively (Table 5.4).

Table 5.4: Perceived need for dental treatment in Malaysian adult population (N=732) and the urgency and type of treatment needed in those who had perceived need (N=437)

Variables		Percentages of the subjects	
		n	%
Do you think you need a dental treatment (N=732)	Not at all	295	40.3
	Yes, a little	157	21.5
	Yes, to some extent	170	23.2
	Yes, very much	110	15.0
How soon is the treatment needed? (N=437)	As soon as possible	208	47.6
	Within 6 months from now	189	43.2
	After 6 months from now	40	9.2
What type of treatment do you need? (N=437)	Scaling and polishing	187	42.8
	Relieve of dental pain	19	4.3
	Filling/crown	134	30.7
	Denture	26	5.9
	Extraction	38	8.7
	Pulp care	9	2.1
	Orthodontic	9	2.1
	Teeth whitening	15	3.4

5.2.4 Oral health behaviours

The majority of subjects had good oral health behaviours (Table 5.5). More than 90% brushed teeth twice or more a day or used fluoridated toothpaste. Slightly more than 70% had visited a dentist in the last two years. 615 subjects (84%) ingested sugar not more than 4 times a day and almost 80% had never smoked.

Table 5.5: Oral health behaviours of 732 Malaysian adults

Variables		Percentages of the subjects	
		n	%
Brushing frequency	Twice or more a day	681	93.0
	Once a day	51	7.0
Usage of fluoride toothpaste	Yes	673	91.9
	No	59	8.1
Last dental visit	Less than a year ago	359	49.0
	Between 1-2 years ago	175	23.9
	More than 2 years ago	172	23.5
	Never visited a dentist	26	3.6
Frequency of sugar intake	Once a day or less	295	40.3
	2-3 times a day	320	43.7
	More than 4 times a day	91	12.4
	Do not take sugar	26	3.6
Smoking habit	Never smoked	585	79.9
	Smoker	78	10.7
	Ex-smoker	69	9.4

5.2.5 Oral Impacts on Daily Performances (OIDP)

5.2.5.1 Prevalence of oral impacts (OIDP index)

299 subjects (40.8%) experienced at least one OIDP impact in the past six months. The mean OIDP score was 2.67 (±6.25). The values ranged from 0 to 72, with the majority of subjects having OIDP scores equal to zero (Table 5.6).

The most prevalent oral impacts were 'difficulty eating' which was reported by 29.1% of subjects, followed by 'difficulty cleaning teeth/denture' (11.7%), 'problems in maintaining usual emotional state' (8.1%) and 'difficulty sleeping' (7.7%). The least common impacts were 'difficulty going out' and 'difficulty performing physical activity'.

Table 5.6: Oral impacts in 732 Malaysian adult: The prevalence of impact and the distribution of OIDP score

Oral Impacts on Daily Performance (OIDP)	
Prevalence of overall oral impacts (%)	40.8
Prevalence of impacts on performances (%)	
1. Eating	29.1
2. Speaking	4.2
3. Cleaning teeth	11.7
4. Going out	1.2
5. Physical activity	1.9
6. Performing main role	2.6
7. Sleeping	7.7
8. Smiling	7.0
9. Emotional stability	8.1
10. Contact with people	6.7
Range of oral impact scores	0 – 72
Oral impact score - 25th percentile	0
50th percentile	0
75th percentile	3.2
95th percentile	12.0
Mean oral impact score (±SD)	2.67 (±6.25)

5.2.5.2 Extent and intensity of oral impacts

Extent refers to the number of performances affected while intensity categorizes subjects into different groups according to the highest score reported on any performance (Gherunpong et al. 2004; Tsakos et al. 2012). Table 5.7 shows the classification of subjects into five different intensity groups (very severe, severe, moderate, little and very little).

Table 5.7: Classification of the intensity of oral impacts on a performance

The intensity of impacts	Severity score		Frequency score	Performance score
Very severe	Very severe (5)	*	Very frequently (5)	25
Severe	Very severe (5)	*	Frequently (4)	20
	Severe (4)	*	Very frequently (5)	20
	Severe (4)	*	Frequently (4)	16
	Very severe (5)	*	Occasionally (3)	15
	Moderate (3)	*	Very frequently (5)	15
Moderate	Severe (4)	*	Occasionally (3)	12
	Moderate (3)	*	Frequently (4)	12
	Little (2)	*	Very frequently (5)	10
	Very severe (5)	*	Rarely (2)	10
	Moderate (3)	*	Occasionally (3)	9
Little	Little (2)	*	Frequently (4)	8
	Severe (4)	*	Rarely (2)	8
	Moderate (3)	*	Rarely (2)	6
	Little (2)	*	Occasionally (3)	6
	Very severe (5)	*	Very rarely (1)	5
	Very little (1)	*	Very frequently (5)	5
	Little (2)	*	Rarely (2)	4
	Severe (4)	*	Very rarely (1)	4
	Very little (1)	*	Frequently (4)	4
Very little	Moderate (3)	*	Very rarely (1)	3
	Very little (1)	*	Occasionally (3)	3
	Little (2)	*	Very rarely (1)	2
	Very little (1)	*	Rarely (2)	2
	Very little (1)	*	Very rarely (1)	1
No impact	None (0)	*	None (0)	0

The extent of oral impacts varied from 1 to 10 performances (Table 5.8). 22% had only one performance with impact (PWI) while 16.5% had 2 to 4 PWI. Very few adults

(0.3%) had PWI of 7 or more. The mean number of performances affected per person is 1.3 (±0.8).

Only 0.3% subjects had a very severe intensity of impacts on ‘eating’, ‘cleaning’ and ‘smiling’ performances. 7.3% of subjects with impacts on ‘eating’ and 2.7% of subjects with impacts on ‘cleaning’ had severe intensity of impacts. Subjects who reported having oral impacts on ‘eating’, ‘speaking’, ‘cleaning’, ‘activity’, ‘main role’ and ‘emotion’ mostly had very little level of impact intensity (Table 5.9).

Table 5.8: The extent of oral impacts (N=732)

Number of daily performances with impact	Percentages of subjects	
	n	%
0 (no impact)	433	59.2
1	160	21.9
2	70	9.6
3	29	4.0
4	21	2.9
5	10	1.4
6	3	0.4
7	2	0.3
8	2	0.3
9	2	0.3
10	0	0

Table 5.9: The intensity of oral impacts in a sample of Malaysian adults (N=732)

	Oral Impacts of Daily Performances (% of adults with intensity of impact)									
Impact intensity	Eat	Speak	Clean	Going out	Activity	Main role	Relax	Smile	Emotion	Contact
Very little	8.5	1.6	3.1	0.4	0.7	1.0	1.7	1.4	2.9	1.5
Little	6.5	0.6	3.1	0	0.4	0.5	2.1	1.9	2.2	2.2
Moderate	6.6	0.6	2.4	0.5	0.2	0.6	1.8	1.6	1.5	2.0
Severe	7.3	1.2	2.7	0.3	0.5	0.4	1.7	1.6	1.5	0.9
Very severe	0.3	0	0.3	0	0	0	0	0.3	0	0

5.2.5.3 Condition-Specific Oral Impacts on Daily Performances (CS-OIDP)

The CS-OIDP scores were calculated for subjects who had oral impacts related to prosthodontic and periodontal treatment. Table 5.10 shows the percentage of subjects with oral impacts related to prosthodontic treatment. Thirty-one subjects (4.2% of total subjects) had impacts related to prosthodontic treatment. The CS-OIDP scores ranged from 0.4 to 38.4 and the mean score was 7.1 (±7.2). The most prevalent prosthodontic-related impacts were 'difficulty eating', 'problems smiling' and 'difficulty cleaning'. These were reported by 80.6%, 45.2% and 32.3% respectively of the 31 subjects with oral impacts related to prosthodontic treatment. Most reported that they experienced impacts 'frequently or very frequently' but the impacts had 'little or very little effect' in their daily living.

77 subjects (10.5% of total sample) had impacts relating to periodontal treatment. The CS-OIDP scores ranged from 0.4 to 26.4 and the mean score was 4.4 (±4.4). The CS-impacts affected all 10 performances (Table 5.11). The most prevalent periodontal-related impacts were 'difficulty eating', 'social contacts' and 'difficulty cleaning'. These were reported by 58.4%, 39% and 29.9% respectively of the 77 subjects with oral impacts related to periodontal treatment. Most reported that they experienced impacts 'frequently or very frequently'. However for 'eating' and 'cleaning' the severity of the impact was 'little or very little' while for 'social contacts' the severity was moderate.

Table 5.10: Condition Specific Oral Impacts on Daily Performances (CS-OIDP) relating to prosthodontic treatment need (N= 31)

Oral Impact of Daily Performances	Number (%) of subjects with CS-OIDP impact	Frequency of impact (%)			Severity of impact (%)		
		Rarely or very rarely	Occasionally	Frequently or very - frequently	Little or very little effect	Moderate effect	Severe or very severe effect
Eating	25 (80.6)	44.0	4.0	52.0	48.0	24.0	28.0
Speaking	9 (29.0)	33.3	11.1	55.5	55.5	11.1	33.3
Cleaning	10 (32.3)	40.0	20.0	40.0	70.0	20.0	10.0
Going out	0	0	0	0	0	0	0
Physical activity	2 (6.5)	50.0	0	50.0	50.0	0	50.0
Perform main role	0	0	0	0	0	0	0
Sleeping	5 (16.1)	80.0	0	20.0	40.0	0	60.0
Smiling	14 (45.2)	28.6	14.3	57.1	42.9	35.7	21.4
Emotional stability	2 (6.5)	100	0	0	0	50.0	50.0
Social contacts	3 (9.7)	33.3	33.3	33.3	0	66.7	33.3

Table 5.11: Condition Specific Oral Impacts on Daily Performances (CS-OIDP) relating to periodontal treatment need (N= 77)

Oral Impact of Daily Performances	Number (%) of subjects with CS-OIDP impact	Frequency of impact (%)			Severity of impact (%)		
		Rarely or very rarely	Occasionally	Frequently or very - frequently	Little or very little effect	Moderate effect	Severe or very severe effect
Eating	45 (58.4)	46.7	13.3	40.0	40.0	33.3	26.7
Speaking	7 (9.1)	57.1	0	42.9	85.7	14.3	0
Cleaning	23 (29.9)	52.2	21.7	26.1	56.5	17.4	26.1
Going out	3 (3.9)	100.0	0	0	33.3	0	66.7
Physical activity	3 (3.9)	100.0	0	0	66.6	33.4	0
Perform main role	7 (9.1)	57.2	42.8	0	28.6	28.6	42.8
Sleeping	12 (15.6)	66.7	16.7	16.6	25.0	25.0	50.0
Smiling	14 (18.2)	50.1	7.1	42.8	64.3	14.3	21.4
Emotional stability	15 (19.5)	73.3	20.0	6.7	33.3	40.0	26.7
Social contacts	30 (39.0)	46.7	30.0	23.3	36.7	46.7	16.6

5.2.5.4 Associations of oral impacts with sociodemographic variables

Table 5.12 presents the prevalence of oral impacts by sociodemographic characteristics. There was an association between oral impacts and ethnicity (p=0.002) with mostly Malays reporting impacts compared to the other ethnic. However there was no variation in oral impacts with gender, age, education and income.

Table 5.12: The prevalence of oral impacts by sociodemographic variables (N=732).

Sociodemographic characteristics		Oral impact (%)	p-value*
Gender	Male	42.6	0.496
	Female	40.0	
Age	30-34	44.9	0.360
	35-44	39.6	
	45-54	38.9	
Ethnicity	Malay	43.7	0.002
	Chinese	30.3	
	Indian	25.0	
Education	Primary school	36.4	0.815
	Secondary school	42.3	
	Degree/diploma	40.0	
	Masters/PhD	39.5	
Income	≤1500	23.7	0.965
	1501 –3000	50.5	
	3001 –5000	16.4	
	≥5001	9.4	

* Chi-square test

5.3 Oral Health Status and Normative Dental Treatment Need (Objective 1)

This section presents the results of the assessment of oral health status and normative need for restorative, periodontal and prosthodontic treatment. The need for each dental treatment is presented in terms of the percentage of people having needs in the whole samples and among subjects with needs. This is followed by the mean and number of teeth or dental sextants requiring treatment per 100 people and per 100 people with that particular need. The association between different types of dental treatment need and sociodemographic characteristics is also reported.

5.3.1 Normative need for restorative treatment

5.3.1.1 Dental caries status and retention of natural teeth

Of the 732 subjects examined, only 3 (0.4%) were edentulous. 5% of the sample had a DMFT of 0. The number of teeth present ranged from 0 – 32 teeth, with a median of 28 teeth (Table 5.13). The number of decayed teeth ranged from 0 to 6; the majority (63%) had no decayed teeth. The median DMFT was 8 and the mean (±SD) was 8.67(±6.06). The largest contributing component to the DMFT was missing teeth with a median of 4.

The mean number of teeth present decreased and the mean DMFT increased with advancing age (p=0.000). Males had significantly more teeth and lower DMFT score than females. Chinese had significantly higher DMFT scores mainly because of higher number of filled teeth. In contrast, Indians had the lowest DMFT score but the highest number of decayed teeth (Table 5.14).

Table 5.13: Frequency distribution of the natural teeth present, DMFT and DMFT components in 732 Malaysian adults

Variable	Range	25^{th} percentile	Median (50^{th} percentile)	75^{th} percentile	Mean(±sd)
Teeth present	0 - 32	25	28	30	26.52(5.28)
Decayed teeth (DT)	0 - 6	0	0	1	0.58 (0.95)
Filled teeth (FT)	0 - 21	0	2	5	3.47(3.72)
Missing teeth (MT)	0 - 32	0	2	5	3.88 (5.33)
DMFT	0 - 32	4	8	12	8.67(6.06)

There was a social gradient in the number of teeth present and the number of filled teeth with income and education; those with higher income and better education had more teeth present and more teeth with fillings than those with lower income and lower education respectively (p=0.000). DMFT also varied by education with those educated to primary school level having the highest DMFT, though no stepwise pattern emerged.

Table 5.14: Mean number of teeth present and mean DMFT (and its components) by sociodemographic characteristics (N=732)

Variables	Teeth present	DMFT	DT	MT	FT
	Mean (±sd)				
Gender[a]					
Male	27.54 (4.40)	7.39 (5.32)	0.61 (0.99)	3.01 (4.43)	3.11 (3.61)
Female	26.00 (5.61)	9.34 (6.31)	0.57 (0.94)	4.34 (5.69)	3.65 (3.77)
	p <0.001	p <0.001	p =0.650	p=0.006	p =0.035
Age[b]					
30 – 34	29.05 (2.33)	5.30 (3.86)	0.50 (0.89)	0.95 (1.75)	2.81 (2.78)
35 – 44	27.38 (4.38)	8.01 (5.09)	0.60 (1.00)	3.18 (4.36)	3.43 (3.47)
45 - 54	24.11 (6.28)	11.55 (6.59)	0.62 (0.96)	6.48 (6.34)	3.96 (4.37)
	p <0.001	p <0.001	p =0.169	p <0.001	p =0.214
Ethnicity[b]					
Malay	26.39 (5.38)	8.64 (5.97)	0.59 (0.97)	3.96 (5.40)	3.36 (3.48)
Chinese	27.24 (5.01)	11.48 (7.47)	0.21 (0.60)	2.91 (5.16)	7.24 (5.91)
Indian	27.18 (4.64)	7.86 (5.85)	0.62 (0.95)	3.70 (4.90)	2.80 (3.60)
	p =0.227	p <0.001	p =0.016	p =0.141	p <0.001
Education[b]					
Primary	21.38 (8.20)	11.36 (7.47)	0.69 (1.03)	9.29 (8.30)	1.47 (2.26)
Secondary	25.89 (5.52)	8.97 (6.10)	0.65 (1.02)	4.78 (5.47)	3.02 (3.30)
Degree	28.25 (3.35)	7.19 (5.25)	0.50 (0.85)	1.92 (3.21)	3.74 (3.42)
Postgraduate	28.30 (2.49)	8.82 (5.87)	0.40 (0.81)	1.48 (2.32)	5.49 (5.01)
	p <0.001	p <0.001	p =0.016	p <0.001	p <0.001
Income[b]					
≤1500	25.09 (6.19)	8.68 (6.16)	0.78 (1.16)	5.31 (6.14)	1.92 (2.56)
1501 –3000	26.54 (5.44)	8.40 (6.08)	0.56 (0.89)	4.05 (5.54)	3.26 (3.21)
3001 –5000	27.71 (3.79)	8.89 (5.48)	0.84 (0.08)	2.53 (3.49)	4.85 (4.16)
≥5001	27.82 (2.99)	9.74 (6.55)	0.48 (0.87)	1.90 (3.29)	5.89 (5.45)
	p <0.001	p =0.308	p =0.014	p <0.001	p <0.001

[a] Mann-Whitney test [b] Kruskall-Wallis test

5.3.1.2 Normative treatment need for dental restorations and extractions

More than half (58.6%) of the subjects did not require any restorative treatment (Table 5.15). The treatment that was needed the most was for a two or more-surface restoration which was required by 21% of the subjects. For subjects with restorative needs, the mean number of teeth requiring two or more surfaces fillings was 0.67. Less than 10% of the total subjects required endodontic care and crown. Per 100 people in the whole samples; 41.80 fillings, 2.32 crowns, 4.51 endodontic and 27.32 extractions were needed.

Table 5.15: Normative treatment need for restorative treatment and extraction in total subjects and in subjects with dental needs (N=732)

Type of treatment	Percentage of people and mean number of teeth requiring care		Number of teeth requiring care	
	% total subjects Mean (±sd)	% subjects with restorative needs Mean (±sd)	Teeth needing treatment per 100 people	Teeth needing treatment per 100 people in needs
No treatment	58.6			
1 surface filling	12.8 0.16 (±0.47)	31.0 0.38(±0.67)	15.30	38.28
2 or more surfaces filling	21.0 0.28 (±0.61)	50.9 0.67 (±0.80)	26.50	67.33
Crown	2.0 0.02 (±0.17)	5.0 0.06 (±0.26)	2.32	5.61
Endodontic	4.2 0.05 (±0.23)	10.2 0.11 (±0.34)	4.51	10.89
Extraction	14.8 0.27 (±0.88)	35.6 0.66 (±1.27)	27.32	66.34

Males had more teeth indicated for extraction compared to females (p=0.004). And the same was the case for the lowest educated groups compared to those with a degree or postgraduate qualification (p=0.008). The need for a two or more surfaces restorations was more prevalent among those with the lowest income level (p=0.009). However, these significant differences in the number of teeth needing treatment between the sociodemographic variables groups were actually very small (Table 5.16).

Table 5.16: Mean number of teeth per person with normative needs for dental restorations, by sociodemographic background.

Variables	1-surface	2-surfaces	Endodontic	Crown	Extraction
	Mean (SD)				
Gender[a]					
Male	0.15 (0.46)	0.30 (0.67)	0.05 (0.26)	0.02 (0.16)	0.38 (1.02)
Female	0.16 (0.48)	0.27 (0.58)	0.04 (0.20)	0.03 (0.17)	0.22 (0.78)
	p=0.958	p=0.536	p=0.842	p=0.250	p=0.004
Age[b]					
30 – 34	0.14 (0.40)	0.26 (0.60)	0.05 (0.22)	0.02 (0.15)	0.21 (0.82)
35 – 44	0.18 (0.53)	0.25 (0.58)	0.03 (0.18)	0.01 (0.12)	0.25 (0.82)
45 – 54	0.16 (0.47)	0.31 (0.64)	0.05 (0.26)	0.03 (0.21)	0.34 (0.95)
	p=0.959	p=0.374	p=0.613	p=0.708	p=0.152
Ethnicity[b]					
Malay	0.17 (0.49)	0.28 (0.61)	0.05 (0.24)	0.02 (0.16)	0.29 (0.92)
Chinese	0.00 (0.00)	0.15 (0.51)	0.00 (0.00)	0.00 (0.00)	0.06 (0.24)
Indian	0.15 (0.42)	0.33 (0.69)	0.02 (0.15)	0.02 (0.21)	0.22 (0.67)
	p=0.076	p=0.204	p=0.261	p=0.545	p=0.326
Education[b]					
Primary	0.27 (0.85)	0.36 (0.65)	0.02 (0.14)	0.02 (0.14)	0.35 (1.08)
Secondary	0.17 (0.48)	0.30 (0.63)	0.06 (0.26)	0.01 (0.09)	0.39 (1.08)
Degree	0.14 (0.36)	0.25 (0.61)	0.04 (0.19)	0.04 (0.23)	0.11 (0.34)
Postgraduate	0.11 (0.31)	0.20 (0.52)	0.04 (0.18)	0.04 (0.24)	0.14 (0.51)
	p=0.856	p=0.125	p=0.653	p=0.072	p=0.008
Income[b]					
≤1500	0.22 (0.57)	0.38 (0.71)	0.04 (0.20)	0.01 (0.11)	0.40 (1.23)
1501 –3000	0.15 (0.48)	0.27 (0.59)	0.05 (0.26)	0.02 (0.13)	0.26 (0.79)
3001 –5000	0.10 (0.33)	0.19 (0.58)	0.02 (0.13)	0.03 (0.22)	0.20 (0.63)
≥5001	0.16 (0.47)	0.22 (0.53)	0.05 (0.23)	0.07 (0.30)	0.16 (0.58)
	p=0.214	p=0.009	p=0.141	p=0.473	p=0.715

[a] Mann-Whitney test [b] Kruskall-Wallis test

5.3.2 Normative need for periodontal treatment

5.3.2.1 Prevalence of periodontal conditions

Less than one-quarter (22.5%) of the sample had healthy periodontal tissues in all six sextants (Table 5.17). The most prevalent periodontal condition was the presence of calculus only, without bleeding or periodontal pocket. Almost half (46.3%) of subjects had calculus (without pocketing or bleeding), 27.3% had calculus with the presence of bleeding and only less than 8% had calculus with the presence of pocketing. The mean number of sextants per subjects where calculus was presence with or without bleeding was 0.43 and 0.84 respectively. The prevalence of periodontal pockets was small; 11.9% had pocketing between 4-5 mm and only 2.6% had pocketing of more than 6 mm, with or without bleeding and/or calculus.

Table 5.17: Periodontal status and mean number of sextants affected in 732 Malaysian adults

Periodontal status	Percentage of subjects with periodontal condition		Mean number of sextants affected per subject
	N	%	Mean (±SD)
Healthy on all 6 sextants*	165	22.5	3.80 (±1.80) Median = 4.0
Bleeding on probing only	205	28.0	0.39 (0.73)
Bleeding plus calculus	200	27.3	0.43 (0.83)
Bleeding plus pocket 4-5 mm	36	4.9	0.07 (0.47)
Bleeding plus pocket > 6 mm	9	1.2	0.01 (0.13)
Bleeding, calculus plus pocket 4-5 mm	27	3.7	0.04 (0.23)
Bleeding, calculus plus pocket > 6 mm	8	1.1	0.01 (0.10)
Calculus only	339	46.3	0.84 (1.13)
Calculus plus pocket 4-5 mm	17	2.3	0.03 (0.18)
Calculus plus pocket > 6 mm	1	0.1	0.00 (0.37)
Pocket 4-5 mm only	20	2.8	0.03 (0.19)
Pocket > 6 mm only	3	0.4	0.01 (0.09)

* All sextants scored 0, does not include excluded sextants

Table 5.18 presents the mean number of sextants with the aforementioned periodontal conditions by sociodemographic characteristics. Overall, Chinese (p=0.006) and those aged 30 - 34 (p=0.000) had more healthy sextants. Although young people had more healthy sextants, they also had more sextants where bleeding was present.

There was a significant positive trend in the number of healthy sextants by education and income; the number of healthy sextants was higher for each higher level of education and income. Conversely, the mean number of sextants with calculus was negatively associated with income (p=0.021) and education level (p=0.000). The number of dental sextants with periodontal pockets was not significantly associated with any sociodemographic variable possibly because there were very few of them.

Table 5.18: Mean number of sextants with the highest CPI score by sociodemographic characteristics.

Variables	Mean (SD) number of sextants				
	Healthy (CPI 0)	Bleeding on probing (CPI 1)	Calculus (CPI 2)	Shallow pockets (4-5 mm) (CPI 3)	Deep pockets (> 6mm) (CPI 4)
Gender [a]					
Male	3.82(1.74)	0.30(0.58)	1.50(1.56)	0.13(0.43)	0.03(0.19)
Female	3.78(1.82)	0.43(0.79)	1.13(1.38)	0.18(0.51)	0.03(0.22)
	p=0.943	p=0.071	p<0.001	p=0.408	p=0.172
Age [b]					
30-34	4.23(1.54)	0.56(0.87)	1.08(1.35)	0.09(0.34)	0.01(0.12)
35-44	3.88(1.83)	0.35(0.69)	1.34(1.58)	0.19(0.55)	0.04(0.27)
45-54	3.43(1.87)	0.29(0.61)	1.32(1.42)	0.19(0.52)	0.04(0.21)
	p<0.001	p<0.001	p=0.088	p=0.284	p=0.895
Ethnicity [b]					
Malay	3.79(1.78)	0.38(0.73)	1.27(1.42)	0.16(0.50)	0.03(0.21)
Chinese	4.70(1.49)	0.61(0.97)	0.27(0.67)	0.06(0.24)	0.03(0.17)
Indian	3.53(1.91)	0.33(0.60)	1.53(1.69)	0.17(0.48)	0.06(0.23)
	p=0.006	p=0.397	p<0.001	p=0.944	p=0.374
Education [b]					
Primary	2.45(1.97)	0.22(0.60)	1.75(1.77)	0.22(0.57)	0.04(0.19)
Secondary	3.61(1.80)	0.35(0.70)	1.38(1.47)	0.18(0.53)	0.04(0.26)
Degree	4.12(1.65)	0.48(0.83)	1.18(1.40)	0.12(0.44)	0.02(0.13)
Postgraduate	4.52(1.45)	0.47(0.72)	0.75(1.13)	0.12(0.36)	0.01(0.09)
	p<0.001	p<0.001	p<0.001	p=0.735	p=0.787
Income [b]					
<1500	3.40(1.72)	0.28(0.60)	1.52(1.47)	0.15(0.46)	0.02(0.13)
1500-3001	3.80(1.87)	0.75(0.04)	1.26(1.50)	0.17(0.51)	0.04(0.25)
3001-5000	4.03(1.68)	0.72(0.07)	1.14(1.33)	0.16(0.47)	0.03(0.22)
>5001	4.34(1.61)	0.85(0.10)	0.82(1.19)	0.12(0.47)	0.00(0.00)
	p<0.001	p=0.037	p=0.021	p=0.148	p=0.541

a Mann-Whitney test

b Kruskall-Wallis test

5.3.2.2 Normative periodontal treatment need

About 28% of subjects had no normative needs for periodontal treatment. The periodontal treatment that was most required was scaling and prophylaxis. The number of dental sextants needing scaling and polishing was 126.78 per 100 people or 175.76 per 100 people with normative needs. Root planing was needed by 12.6% of the sample while complex periodontal surgery was required by less than 3% of subjects. The number of dental sextants requiring root planning or complex surgical per 100 people was 15.98 and 3.14 respectively. Per 100 people in the whole sample, a total of 145.90 dental sextants required any type of periodontal treatment.

Table 5.19: Periodontal treatment need in total samples (N=732) and in sample with periodontal needs (N=528)

Type of treatment needed	Percentage of subjects and mean number of dental sextants requiring treatment		The number of dental sextants requiring treatment	
	% subjects Mean (±sd)	% subjects with needs Mean (±sd)	Dental sextants requiring treatment per 100 subjects	Dental sextants requiring treatment per 100 people with needs
No treatment	27.9			
OHI only	10.5	14.5		
SP & OHI	55.9 1.27(1.45)	77.5 1.76 (1.40)	126.78	175.76
RP & OHI	7.3 0.09(0.36)	10.2 0.13(0.40)	9.15	12.69
CT & OHI	1.7 0.02(0.16)	2.3 0.03 (0.18)	1.91	2.65
SP, RP & OHI	5.3 0.07 (0.31)	7.4 0.09 (0.36)	6.83	9.47
SP, CT & OHI	1.2 0.01 (0.11)	1.7 0.02 (0.13)	1.23	1.70
Total number of sextants requiring periodontal treatment			**145.9**	**202.27**

OHI: Oral hygiene instruction, SP: Scaling and polishing, RP: Root planing, CT: Complex treatment (periodontal surgery)

Assessment of the type of normative periodontal treatment needs by sociodemographic background showed significant results only for scaling and polishing procedures. Males, Indians and people with lowest educational qualifications had a higher number of dental sextants that required scaling and polishing treatment (Table 5.20). The difference in the mean number of dental sextants requiring scaling between Chinese (the least prevalent) and Indian (the most prevalent) was more than fivefold. The number of dental sextants that required scaling and polishing was lower for each higher level of education and income.

Table 5.20: Mean number of dental sextants requiring periodontal treatment, by socio-demographic variables (N=732)

Variables	Mean number (±sd) of dental sextants requiring periodontal treatment				
	SP	RP	CT	SP & RP	SP & CT
Gender [a]					
Male	1.51(1.56)	0.06(0.28)	0.02(0.14)	0.07(0.30)	0.01(0.09)
Female	1.14(1.37)	0.11(0.40)	0.02(0.16)	0.07(0.32)	0.01(0.12)
	p=0.002	p=0.104	p=0.579	p=0.809	p=0.453
Age [b]					
30-34	1.09(1.35)	0.06(0.25)	0.01(0.12)	0.04(0.21)	0.00(0.00)
35-44	1.35(1.57)	0.08(0.39)	0.02(0.18)	0.11(0.41)	0.01(0.12)
45-54	1.34(1.41)	0.12(0.41)	0.02(0.16)	0.06(0.28)	0.02(0.14)
	p=0.110	p=0.077	p=0.935	p=0.156	p=0.126
Ethnicity [b]					
Malay	1.28(1.42)	0.09(0.37)	0.02(0.15)	0.07(0.32)	0.01(0.11)
Chinese	0.27(0.67)	0.06(0.24)	0.03(0.17)	0.00(0.00)	0.00(0.00)
Indian	1.57(1.67)	0.10(0.31)	0.03(0.18)	0.33(0.35)	0.02(0.15)
	p=0.000	p=0.566	p=0.288	p=0.344	p=0.540
Education [b]					
Primary	1.80(1.74)	0.07(0.26)	0.02(0.14)	0.15(0.52)	0.02(0.13)
Secondary	1.39(1.47)	0.10(0.39)	0.02(0.18)	0.08(0.34)	0.02(0.14)
Degree	1.17(1.38)	0.09(0.37)	0.02(0.12)	0.03(0.21)	0.00(0.00)
Postgraduate	0.75(1.13)	0.08(0.30)	0.01(0.94)	0.04(0.21)	0.00(0.00)
	p=0.000	p=0.941	p=0.912	p=0.212	p=0.097
Income [b]					
<1500	1.54(1.45)	0.06(0.26)	0.01(0.11)	0.09(0.38)	0.01(0.07)
1500-3001	1.27(1.51)	0.11(0.40)	0.02(0.18)	0.06(0.30)	0.02(0.14)
3001-5000	1.14(1.32)	0.09(0.32)	0.02(0.12)	0.07(0.28)	0.01(0.09)
>5001	0.82(1.19)	0.08(0.43)	0.01(0.94)	0.04(0.20)	0.00(0.00)
	p=0.001	p=0.367	p=0.561	p=0.808	p=0.401

a Mann-Whitney test b Kruskall-Wallis test

5.3.3 Normative need for prosthodontic treatment

5.3.3.1 Prosthetic Status

Fifteen percent of subjects wore or reported that they had a dental prosthesis. The most common type of prosthesis was upper partial denture; 11.5% of the subjects were using one. The number of subjects with full dentures was relatively small; less than 2% had either an upper or lower full denture. Less than 4% had single or multiple units of bridges in the upper or lower jaw. Most types of prosthesis were worn in the upper jaw (Table 5.21).

Table 5.21: The percentage of subjects with dental prosthesis among 732 Malaysian adults

Type of prosthesis	N	%
No prosthesis	626	85.5
Has and wore:		
Upper partial denture	84	11.5
Lower partial denture	21	2.9
Upper full denture	12	1.6
Lower full denture	4	0.5
Has but was not wearing:		
Upper partial denture	3	0.4
Lower partial denture	6	0.8
One bridge on upper jaw	11	1.5
One bridge on lower jaw	6	0.8
More than one bridge on upper jaw	8	1.1
More than one bridge on lower jaw	3	0.4

A greater proportion of females (17.2%) than males (8.8%) wore dentures (p=0.002). There was a gradient between age and the proportion of denture-wearers; with increasing age the number of people with dentures increased (p=0.000). Finally, the proportions of subjects with dentures varied significantly with education level; there were more denture-wearers among the lowest education level compared to their counterpart (p=0.000) (Table 5.22)

Table 5.22: The proportion of denture-wearers by sociodemographic characteristics (N=732)

Variables	With denture		Chi square p-value
	N	%	
Gender			
Male	22	8.8	0.002
Female	83	17.2	
Age			
30 – 34	5	2.3	p<0.001
35 – 44	27	12.4	
45 – 54	73	24.3	
Ethnicity			
Malay	88	14.4	0.975*
Chinese	4	12.1	
Indian	13	14.8	
Education			
Primary	16	29.1	p<0.001
Secondary	73	19.3	
Degree	9	4.9	
Postgraduate	7	6.1	
Income			
≤1500	34	20.0	0.130
1501 – 3000	55	14.8	
3001 – 5000	12	10.2	
≥5001	4	5.5	

* Fisher Exact test.

5.3.3.2 Normative prosthetic treatment need

5.3.3.2.1 Scenario I: Provision of removable denture only

In this scenario, prosthetic treatment need was normatively assessed only for partial or full dentures. The criteria used in assessing the need for removable prostheses have been discussed previously (see Section 3.3.6.1(c)).

Overall, 30.6% subjects required one or two removable dentures in either one or both upper or lower jaws. In subjects with need for prosthetic treatment, 52.4% required upper partial denture and 80.9% needed a lower partial denture. Per 100 people in the whole sample, 41.5 dentures were required (Table 5.23).

As the number of people needing full dentures was small, the need for dentures was re-categorized into need or no need for any type of dentures. The need for a denture increased with increasing age for either upper or lower denture ($p=0.000$) (Table 5.25). Variations in the need for dentures were observed by income and education level; those who had lower income and were secondary school leavers had higher need for prosthetic treatment compared to their other counterpart.

Table 5.23: Scenario 1: Normative prosthodontic treatment need in 732 Malaysian adults

Type of treatment	Percentage of subjects requiring denture		Number of denture required (per unit)	
	% subjects	% subjects with need	per 100 subjects	per 100 subjects with needs
Upper jaw:				
No denture needed	83.5			
Need full denture	0.4	1.3		
Need partial denture	16.1	52.4		
Total need for upper removable	16.5	53.7	16.5	53.7
Lower jaw:				
No denture needed	75.0			
Need full denture	0.1	0.4		
Need partial denture	24.9	80.9		
Total need for lower removable	25.0	81.3	25.0	81.3
Overall need for removable denture:				
No need	69.4			
1 removable (upper or lower)	19.7	64.3		
2 removable (upper and lower)	10.9	35.7		
Total need for removable	**30.6**	**100.0**	**41.5**	**135.7**

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5.3.3.2.2 Scenario II: Provision of removable denture and/or fixed bridges

In this scenario, prosthodontic treatment need was normatively assessed for both removable dentures and fixed bridges. The criteria used to assess the need for either or both removable dentures and fixed bridges have been discussed previously (see Section 3.3.6.1(c)).

Per 100 people in the whole sample, 11.5 people needed an upper denture and 16.8 people needed upper fixed bridges. For every 100 people with prosthodontic needs, a total of 21.9 upper dentures and 44.9 upper bridges were required. The number of subjects who needed lower prosthesis was higher than for those who needed upper prosthesis. Per 100 people in the whole sample, 20.3 needed a lower denture and 26.4 people needed lower fixed bridges. In subjects with prosthodontic treatment needs, 38.9% needed lower denture and 50.4% needed lower bridges. The total number of dentures and bridges needed per 100 people with prosthodontic needs were 60.8 and 121.1 units respectively (Table 5.24).

When prosthodontic treatment was restricted only to subjects with missing anterior teeth and/or with more than one tooth missing in the posterior region, the number of subjects needing treatment and the number of dental prosthesis required were lower. The percentage of subjects needing upper dentures decreased from 11.5% to 10.8% and the percentage needing lower denture decreased from 26.1% to 18%. The reduction was more in subjects needing fixed bridges. For upper bridges, the reductions were from 16.8% to 10.2% and for lower bridges from 35.7% to 9.8%. In this scenario, the total number of dentures required per 100 people in the whole sample decreased from 31.8 to 28.8 and the total number of fixed bridges needed decreased from 68.1 to 25.4.

Table 5.24: Scenario 2. Normative prosthodontics treatment need in 732 Malaysian adults

Type of treatment	Percentage of sample requiring need		Number of prosthesis needed (per unit)	
	% sample	% sample with need	per 100 sample	per 100 sample with needs
Upper jaw:				
No prosthesis needed	71.7	46.0		
Need partial denture	11.1	21.1		
Need full denture	0.4	0.8		
Need bridge	16.8	32.1		
Total need for upper denture	11.5	21.9	11.5	21.9
Total need for upper bridge	16.8	32.1	23.5	44.9
Lower jaw:				
No prosthesis needed	53.3	10.7		
Need partial denture	20.2	38.6		
Need full denture	0.1	0.3		
Need bridge	26.4	50.4		
Total need for lower denture	20.3	38.9	20.3	38.9
Total need for lower bridge	26.4	50.4	39.9	76.2
Overall need for prosthesis:				
Removable denture:				
1 removable (upper or lower)	20.4	38.9		
2 removable (upper and lower)	5.7	11.0		
Total need for denture	**26.1**	**49.9**	**31.8**	**60.8**
Bridges (upper and lower)				
1 unit	17.1	32.6		
2 unit	12.3	23.5		
3 unit	4.1	7.8		
4 unit	1.5	2.9		
5 unit	0.7	1.3		
Total need for bridges	**35.7**	**68.1**	**63.4**	**121.1**
Mean (±sd)	0.63(±1.03)	1.21(±1.14)		

The need for dentures and/or bridges in Scenario II was evaluated across sociodemographic characteristics and the results were similar as those in Scenario I (Table 5.25). Subjects in the oldest age group, those with secondary school qualifications and income between 1501-3000 had a higher need for dentures and bridges. The need for dentures or bridges increased with age (p=0.000). As with Scenario I, gender and ethnicity were not significantly related to the need for prosthodontic in Scenario II.

Table 5.25: Scenario I and II. Normative prosthodontic treatment need by sociodemographic variables (N=732)

Variables	**Scenario I**	**Scenario II**	
	Need Dentures N (%)	Need Dentures N (%)	Need Bridges N (%)
Gender			
Male	71(9.7)	55(7.5)	88(12.0)
Female	154(21.0)	136(18.6)	173(23.6)
	p=0.349	p=0.076	p=0.899
Age			
30-34	17(2.3)	8(1.1)	51(7.0)
35-44	62(8.5)	57(7.8)	78(10.7)
45-54	146(19.9)	126(17.2)	132(18.0)
	p<0.001	p<0.001	p<0.001
Ethnicity			
Malay	197(26.9)	169(23.1)	225(30.7)
Chinese	5(0.7)	5(0.7)	6(0.8)
Indian	23(3.1)	17(2.3)	30(4.1)
	p=0.071	p=0.085	p=0.088
Education			
Primary	36(4.9)	31(4.2)	22(3.0)
Secondary	149(20.4)	127(17.3)	155(21.2)
Degree	26(3.6)	22(3.0)	56(7.7)
Postgraduate	14(1.9)	11(1.5)	28(3.8)
	p<0.001	p<0.001	p=0.003
Income			
≤1500	79(10.8)	59(8.1)	66(9.0)
1501-3000	109(14.9)	102(13.9)	137(18.7)
3001-5000	27(3.7)	22(3.0)	40(5.5)
≥5001	10(1.4)	8(1.1)	18(2.5)
	p<0.001	p<0.001	p=0.171

5.4 Comparison of needs for restorative, periodontal and prosthodontic treatment between Normative Needs (NN) and Sociodental Needs (SDA) assessment (Objective 2)

In this section, the Sociodental Needs for restorative, periodontal and prosthodontic treatments were assessed by integrating subjective measures (IRN) and behavioural propensities (PRN). Then these estimates are compared with Normative needs (NN) assessment. Two sociodental models of dental need assessment were used to differentiate the need for emergency or life threatening and progressive oral conditions from the need for treatment of non-progressive dental conditions (see Section 2.5.1).

The first model namely Dental Needs for Life-threatening and Progressive oral conditions (DNLP) is, as the name implies, used for emergency or life threatening and progressive oral conditions and is used for assessments of restorative treatments and extraction needs. In the DNLP model only the NN and PRN is assessed. The second model is called the Basic Model of Dental Needs (BMDN). This model is for dental conditions other than those stated in the DNLP model and is used in assessing periodontal and prosthodontic treatment needs. It assesses three level of needs; NN, IRN and PRN.

The data for each treatment are presented in terms of (i) the prevalence of sociodental needs in the whole sample, and (ii) the amount of sociodental needs per 100 people with normative needs, in relations to the number of people with needs and the number of teeth/sextants requiring treatment. To simplify and enhance the comprehension of the illustrated diagrams, only the proportion of subjects assigned to the low or high propensity group using the non-strict propensity criteria will be shown. The illustrated figures depicting the proportions of subjects allocated to different propensity group using both strict and non-strict propensity measures are shown in Appendix 13.

5.4.1 Comparison of needs for restoration and extractions using Normative Needs (NN) and Sociodental Needs (SDA) assessments

The DNLP model was used to assess sociodental needs for restorative treatment and extraction. Therefore, the SDA estimates refer to PRN and not to IRN.

i. Normative Needs (NN)

The percentage of subjects needing restorative treatment and the type of normative treatment required has been presented in Section 5.2.2 and is reproduced in Figure 5.1. Some subjects needed more than one type of restorative treatment, which explains why when the percentages for each individual treatment are summed up, the figure is higher than the overall percentage of people with normative needs. Per 100 people with normative need, 91.42 people needed non-complex treatment and 14.52 people needed crowns and endodontic treatment. The number of teeth requiring treatment per 100 people with NN was 171.95 and 16.50 teeth for non-complex and complex treatment respectively (Figure 5.2).

ii. Propensity - Related Need (PRN)

PRN was assessed among the 6% of subjects who required complex restorative treatment. Subjects who needed non-complex intervention were only assessed for their propensity for caries prevention. The need for complex restorative treatment is strongly influenced by the behavioural propensity of the subject towards dental treatment. One would not recommend complex treatments for persons with poor propensity. For example, people who were normatively assessed as requiring crowns should not be prescribed the treatment if they have poor brushing habit or consume high sugar as it could affect the longevity and success of the intervention. Instead they should be provided with other types of fillings or a temporary crown. Their behavioural propensity should then be reassessed before a crown is placed. However those who needed endodontic treatment would still be provided with the palliative treatment regardless of their behavioural propensity towards treatment.

Almost all subjects (29 out of 31) who needed endodontic treatment had a high propensity for treatment, while only 0.3% had poor propensity. Both groups should be provided with root canal treatment but DHE/OHP should also be provided for those in the poor propensity group. Per 100 people with normative need, 10.23 people and 10.89 teeth required endodontic treatment. That is 4.23 people and 4.51 teeth per 100 people in the whole sample.

When PRN assessment was used to consider the need for crowns, the number of subjects per 100 people with needs who required treatment decreased slightly from 4.95 (NN) to 4.29 (PRN) and the number of teeth needing a crown decreased from 5.61 (NN) to 4.95 (PRN). In terms of need per 100 in the whole sample, 1.77 people and 2.04 teeth required a crown when PRN assessment was used.

With 37.8% of subjects normatively assessed as requiring non-complex restorative treatments, most (34.4%) had a high propensity and less than 4% had a low propensity (Figure 5.1). Subjects in both propensity groups would receive the prescribed treatments considering the progressive nature of their dental conditions. However, subjects in the low propensity group should receive additional DHE/OHP to increase the probability of success and long term survival of the restorative treatment. The total number of teeth requiring non-complex treatment per 100 people with normative needs for subjects with both low and high propensity was 171.95 (Figure 5.2). Per 100 people in the whole sample, 75.95 teeth required treatment.

Summary: There was a decrease of 15% (p<0.001) in the proportion of people who needed crowns when NN was compared with SDA. Less than a quarter of the subjects who needed a crown did not have good behavioural propensity and needed other forms of treatment and DHE/OHP. Their propensity level would be re-evaluated in the future and crowns would be provided when the prognosis for treatment was better. For endodontic treatments, SDA prevalence was 7% lower than NN. However, subjects in both propensity groups should be given the planned treatment.

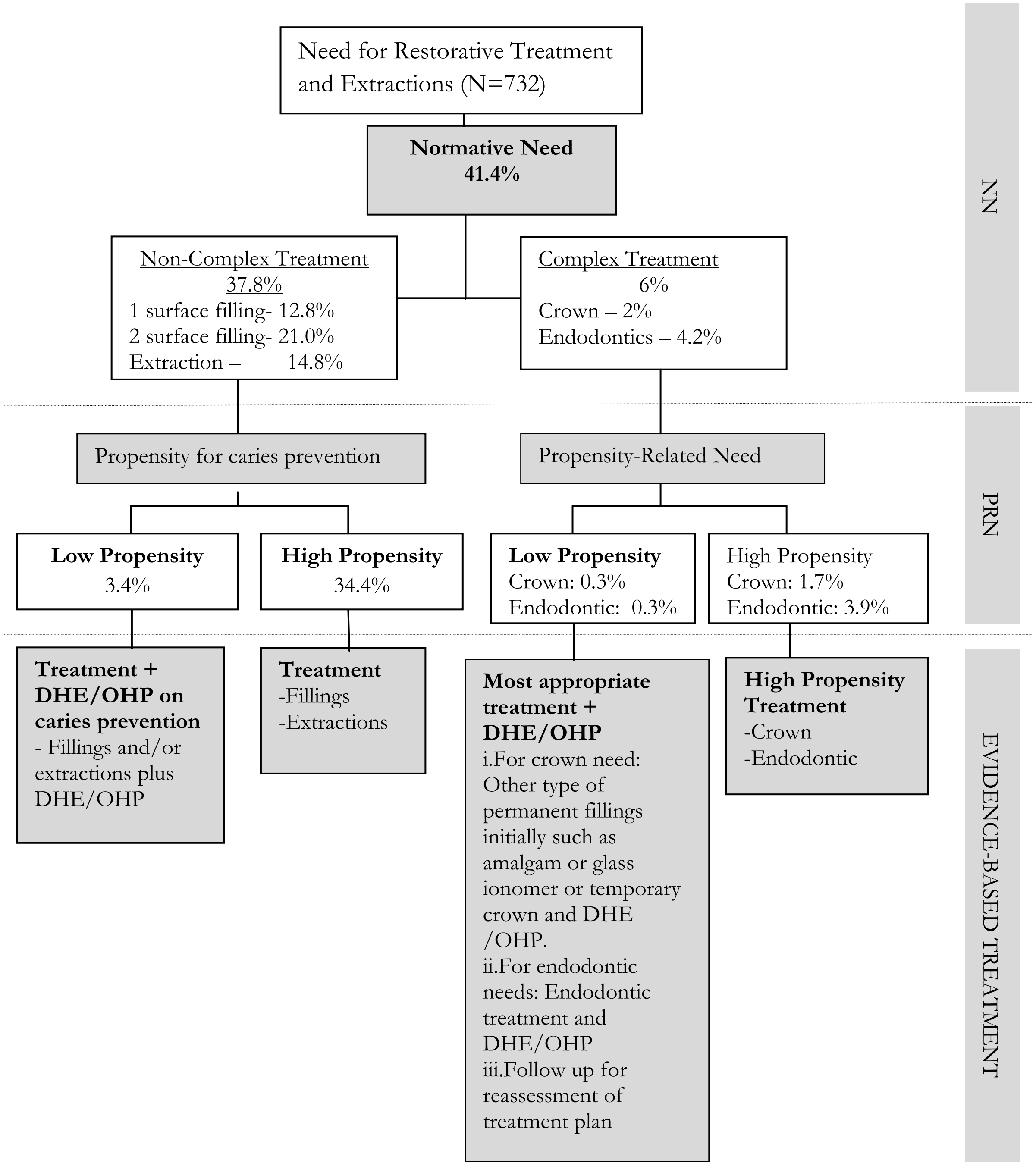

Figure 5.1: Percentages of Malaysian adults aged 30-54 years with treatment needs for restorations and extractions using the sociodental approach (N=732 people).

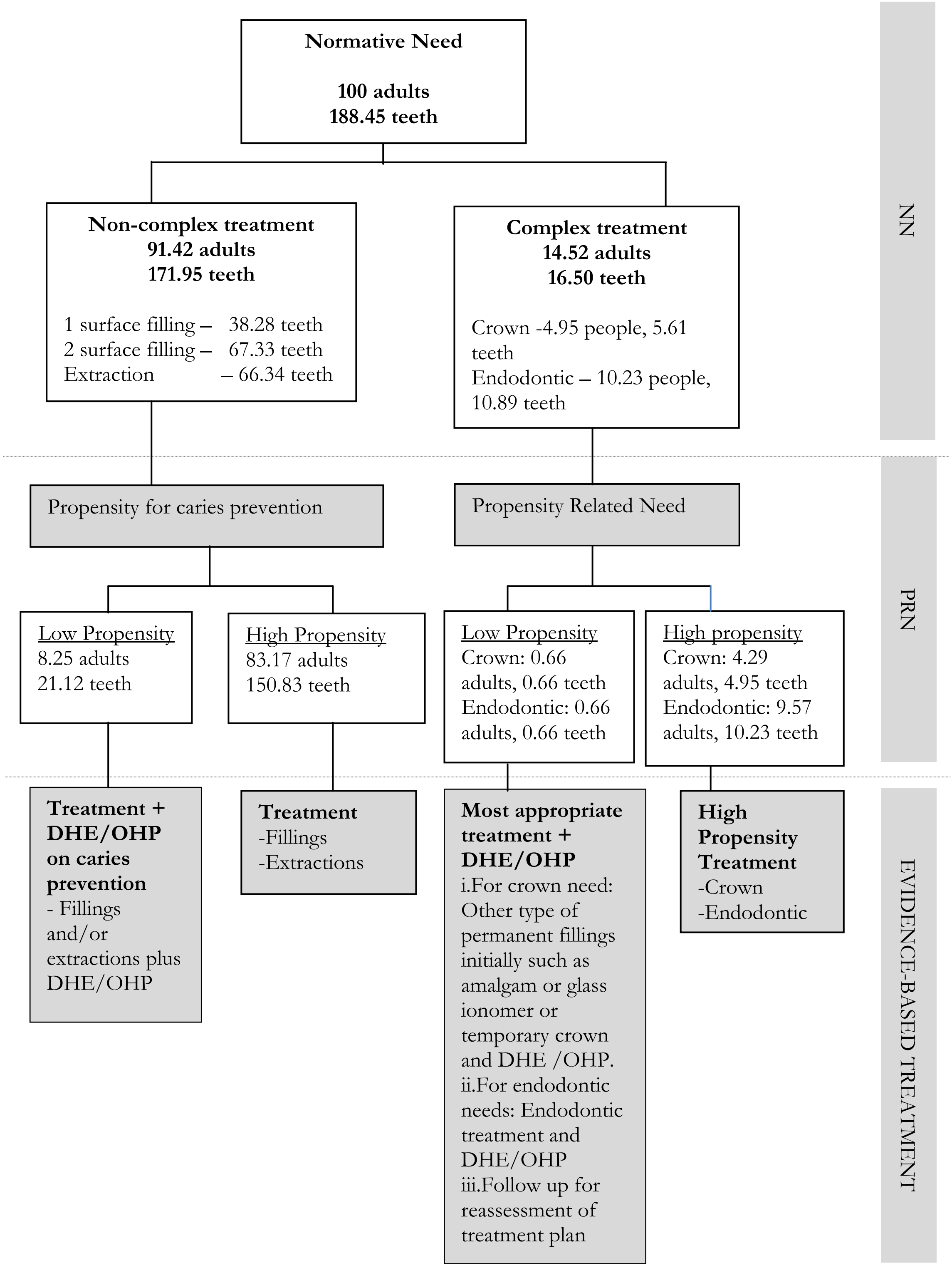

Figure 5.2: Number of teeth per 100 adults requiring restorative and extraction assessed using the sociodental approach (N=303)

5.4.2 Comparison of needs for periodontal treatments using Normative Needs (NN) and Sociodental Needs (SDA) assessments

For the assessment of sociodental needs for periodontal treatment, the Basic Model of Dental Needs (BMDN) model was used. This means both IRN and PRN were considered and the results were compared to NN estimates.

i. Normative Needs (NN)

Almost three-quarters (72.1%) of the subjects had NN for periodontal treatment (Figure 5.3). Of them, 8.9% had specific chronic conditions (diabetes and/or heart disease) that could be affected by their periodontal condition if periodontal treatment was not provided. This group was not considered for the next level of assessment but was eligible for the most appropriate periodontal treatment. The remainder of the subjects (63.2%) had normative needs without the presence of heart disease or diabetes. They were included in the following pathways of sociodental needs assessment. Per 100 people with normative needs and per 100 people in whole sample, the numbers of dental sextants requiring treatment in subjects were 172.53 and 145.90 respectively.

ii. Impact - Related Need (IRN)

IRN was measured among subjects with normative needs who had no diabetes or heart disease. When applying the IRN criterion, the percentages of subjects requiring periodontal treatment decreased from 63.2% (NN) to 8.3% (IRN). The numbers of subjects varied when different CS-OIDP cut-off points were used. Using a cut-off point of CS-OIDP ≥6 and ≥12, the proportions of subjects were even smaller, 2.2% and 0.4% respectively (Figure 5.3).

Per 100 subjects with normative needs for periodontal treatment, the number of subjects requiring periodontal treatment decreased from 87.7 people (NN) to 11.55 people (IRN) and the number of dental sextants needing treatment decreased from 172.53 (NN) to 24.43 (IRN) (at CS-OIDP>0). The breakdown of the type of periodontal treatment needed was 19.89 sextants for scaling, 2.27 sextants for root planning, 0.19 sextants for periodontal surgical, 1.32 for scaling and root planning and 0.76 sextants for scaling and complex therapy. Per 100 subjects in the whole sample, 8.33 had IRN and 17.62 dental sextants required periodontal intervention using CS-OIDP>0.

Among those without NN for periodontal treatment, some (8.8%) reported having CS-OIDP related to their periodontal condition. They should be further investigated on the actual reasons for their reported impact. In addition, 2.9% of subjects without IRN had a normative need for complex periodontal therapy or surgical periodontal procedure. Their propensities for periodontal treatment would be assessed and treatment given if they have good oral health behaviour. If their propensities are poor, they should be monitored and provided with DHE and treatment given if their periodontal condition deteriorates.

iii. Propensity – Related Need (PRN)

Among the 8.3% of subjects who had IRN, most (7.24%) had high propensity for treatment and could thus receive the evidence-based periodontal treatment that was initially planned for (Figure 5.3). The number of subjects per 100 people with normative needs who required periodontal treatment decreased from 11.55 (IRN) to 10.03 (PRN) and the number of dental sextants needing treatment decreased from

24.43 (IRN) to 21.78 (PRN) (Figure 5.4). Per 100 people in the whole sample, a total of 15.71 dental sextants required periodontal interventions.

Among those who had normative needs but did not have CS-impacts for periodontal treatment, some had perceived need for periodontal treatment. Appendix 13(v) and (vi) show the changes in the proportion of subjects needing treatment when perceived-need for periodontal treatment were integrated into the sociodental pathway. 27.4% of the whole samples or 38.64 people per 100 people with NN had both normative need and perceived need, but did not have CS-impact relating to periodontal disease. For them, 84.29 sextants required periodontal treatment. When these numbers were incorporated into the sociodental system as in Figures 5.3 and 5.4, the proportion of subjects needing high propensity periodontal treatment increased from 7.2% to 28.7% and the number of dental sextants requiring treatment increased from 21.78 dental sextants to 86.37 sextants. As the group now consisted of both subjects with and without oral impacts, the varying level of impacts score was not measured. The difference between NN and PRN in the model where perceived need was included was significant ($p<0.001$)

Summary: The prevalence of periodontal treatment need decreased by 88.5% between NN and IRN and by 13.2% between IRN and PRN, when SDA was considered. Overall, the percentage reduction between NN to SDA was 90% ($p<0.001$). There was a significant reduction for each type of periodontal treatment need between NN and SDA except for complex periodontal therapy. Overall, 85.8% fewer sextants required treatment when SDA was used ($p<0.001$).

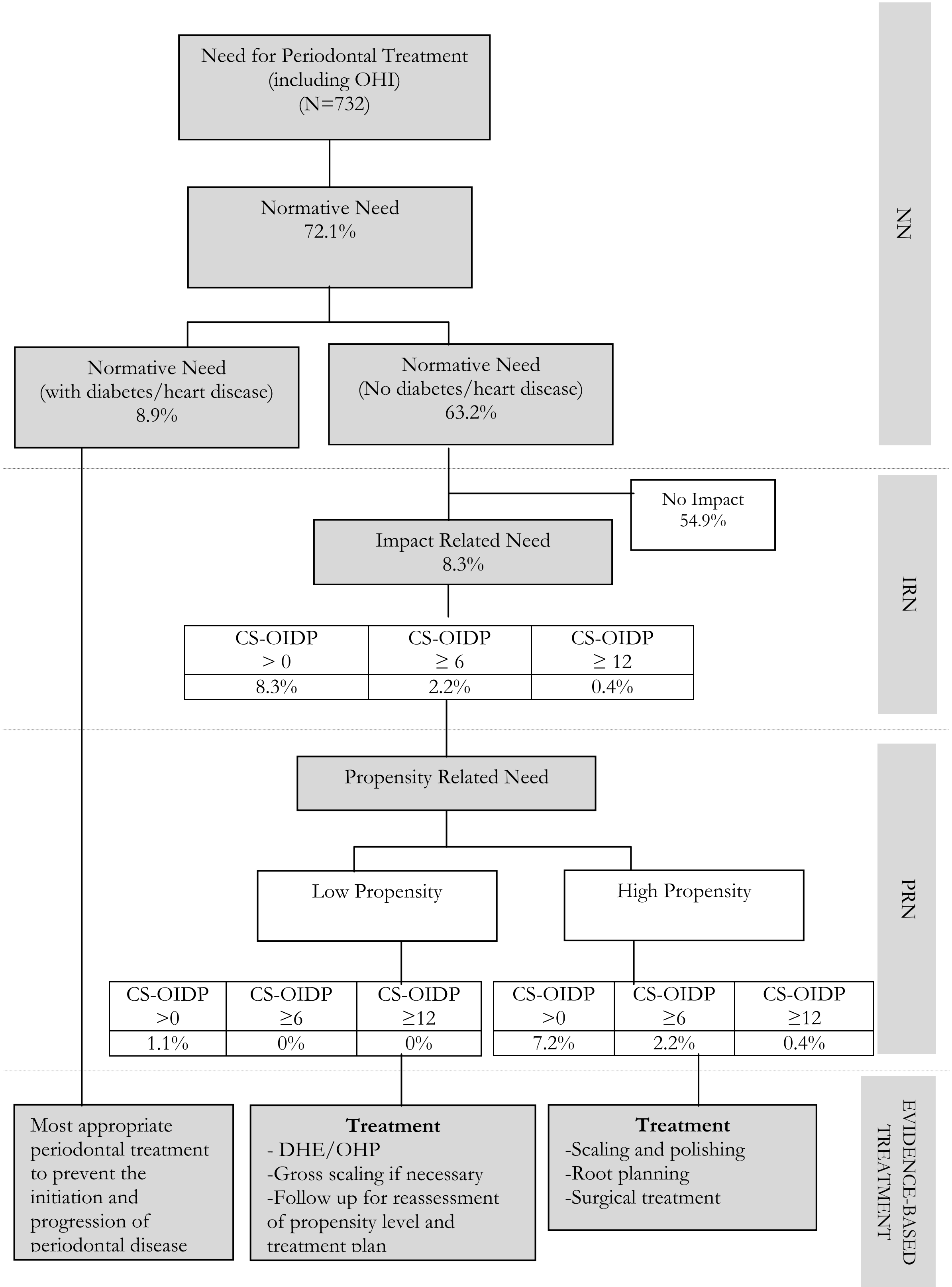

Figure 5.3: Comparison of the percentages of Malaysian adults aged between 30 and 54 years with periodontal treatment need at different CS-OIDP cut off points using the Normative Needs and the Sociodental Needs approaches (N=732).

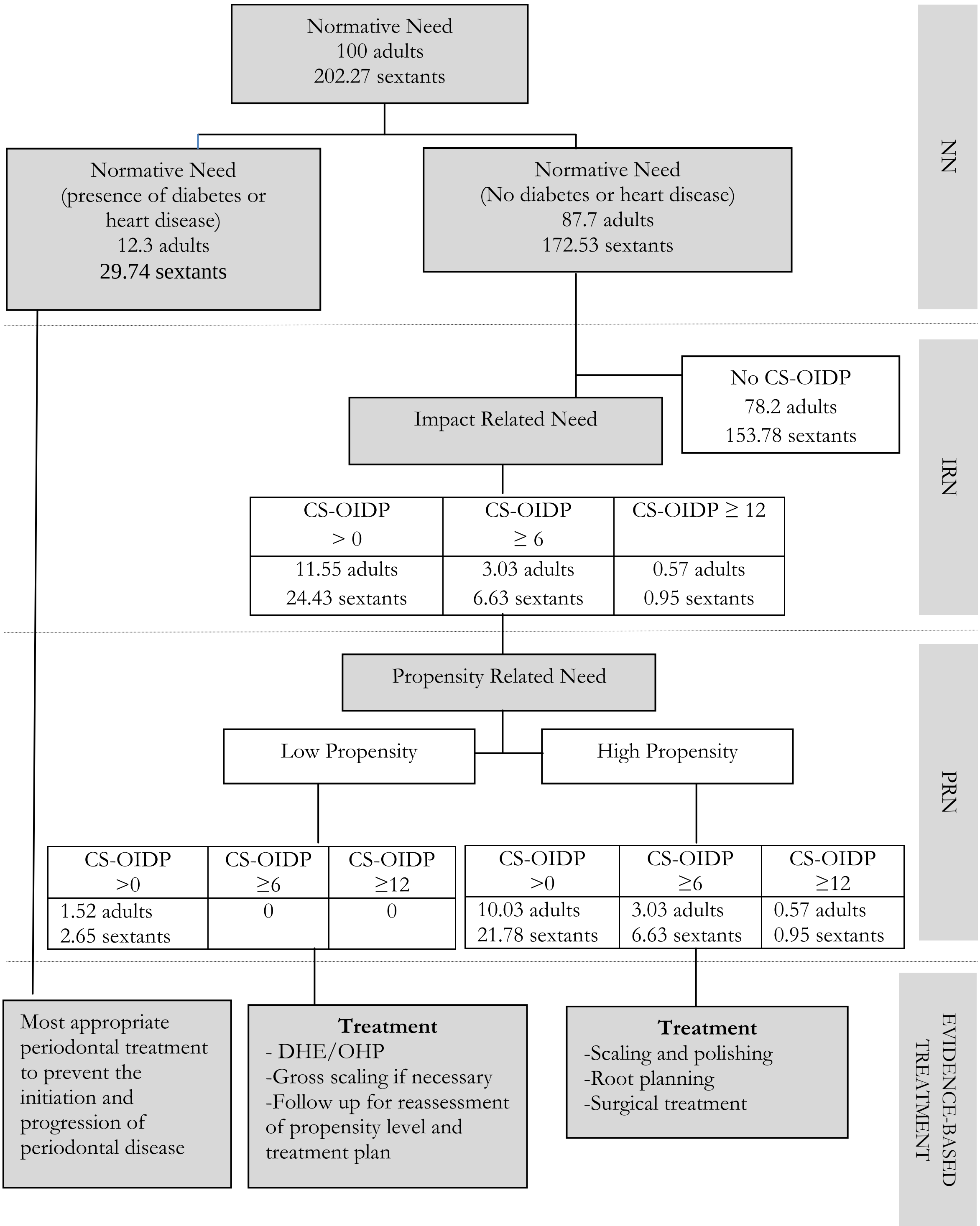

Figure 5.4: Comparison of the number of sextants per 100 adults requiring periodontal treatment at different CS-OIDP cut off points assessed using the Normative Needs and the Sociodental Needs approaches.

5.4.3 Comparison of needs for prosthodontic treatment using Normative Needs (NN) and Sociodental Needs (SDA) assessments

Prosthodontic treatment focuses on the replacement of missing teeth and follows the BMDN model. Two different scenarios will be presented: 1) provision of dentures only, 2) provision of dentures and/or bridges. For the provision of dentures, there is only one propensity criterion as both tooth brushing behaviour and dental attendance influence success of treatment (see Section 3.5). For bridges, only the non-strict propensity criterion is discussed. The changes in the proportion of subjects needing high propensity treatment of bridges when both strict and non-strict criteria were used are shown in Appendix 13 (ix) and (x).

5.4.3.1 Scenario I- Provision of Dentures only

i. Normative needs (NN)

Around one-third (30.6%) of subjects required removable dentures (Figure 5.5). The total number of dentures needed was 135.71 per 100 people with normative prosthodontic needs (Figure 5.6).

ii. Impact – related needs (IRN)

3.14% of the subjects with normative prosthodontic needs had both NN and IRN (when impacts were assessed at the CS-OIDP>0 level). When the cut-off points of CS-OIDP≥6 and ≥12 were used, the proportions of subjects with IRN changed from 3.14% at CS-OIDP>0 to 1.78% and 0.68% respectively (Figure 5.5).

Per 100 people with normative need, 10.27 subjects had IRN and 16.96 dentures were required (at CS-OIDP >0) (Figure 5.6). Per 100 people in the whole sample, 5.19 dentures were required when using IRN. 1.1% of the subjects who were considered not to have a normative need for replacement of teeth had a CS-OIDP related to missing teeth. Further studies should be carried out to clarify the reasons why oral impacts exist in some subjects without the need for treatment.

iii. Propensity – Related Needs (PRN)

The percentage of subjects that required treatment decreased from 3.14% (IRN) to 2.73% (PRN). This decreased to 1.64% and 0.68% respectively when 6 and 12 were used as the cut-off points for the CS-OIDP impact score (Figure 5.5). Subjects with low propensity would require DHE/OHP to improve their behavioural propensity before prosthodontic treatment is provided.

Per 100 people with normative need, 8.93 people had a high propensity for treatment and a total number of 14.74 dentures would be needed for them (Figure 5.6). This was a slight reduction from 10.27 people and 16.96 dentures when the assessment was done using IRN. Per 100 people in the whole samples, 2.73 people required prosthodontic treatment and 4.51 dentures were needed when PRN assessment was used.

Some health planners might feel the need to address the demands of patients who have perceived need for replacement of missing teeth, although they do not have oral impacts that disrupt their daily performances. The dental workforce that is required to render treatment for these additional needs should be accounted for during dental care planning. In this study, it was found that 1.78% of normatively needs subjects who did not have CS impact, had perceived treatment needs for dentures (Appendix 13 (vii and viii)). When these needs were integrated into the BMDN model, there was an increase of 39.9% in the proportions of high propensity subjects requiring prosthodontic treatment. The number of subjects per 100 people with needs who have high propensity increased from 8.93 to 12.5 people and the number of required denture increased from 14.74 to 20.54.

Summary: The proportion of subjects who had prosthodontic treatment needs decreased by 89.9% between NN and IRN ($p<0.001$) and by 12.9% between IRN and PRN ($p=0.250$), when all levels of impact were considered. The overall reductions from NN to SDA was 91.2% ($p<0.001$). In terms of the numbers of dentures required for every 100 people with normative need, the percentage reductions from NN to SDA was 89.1% ($p<0.001$).

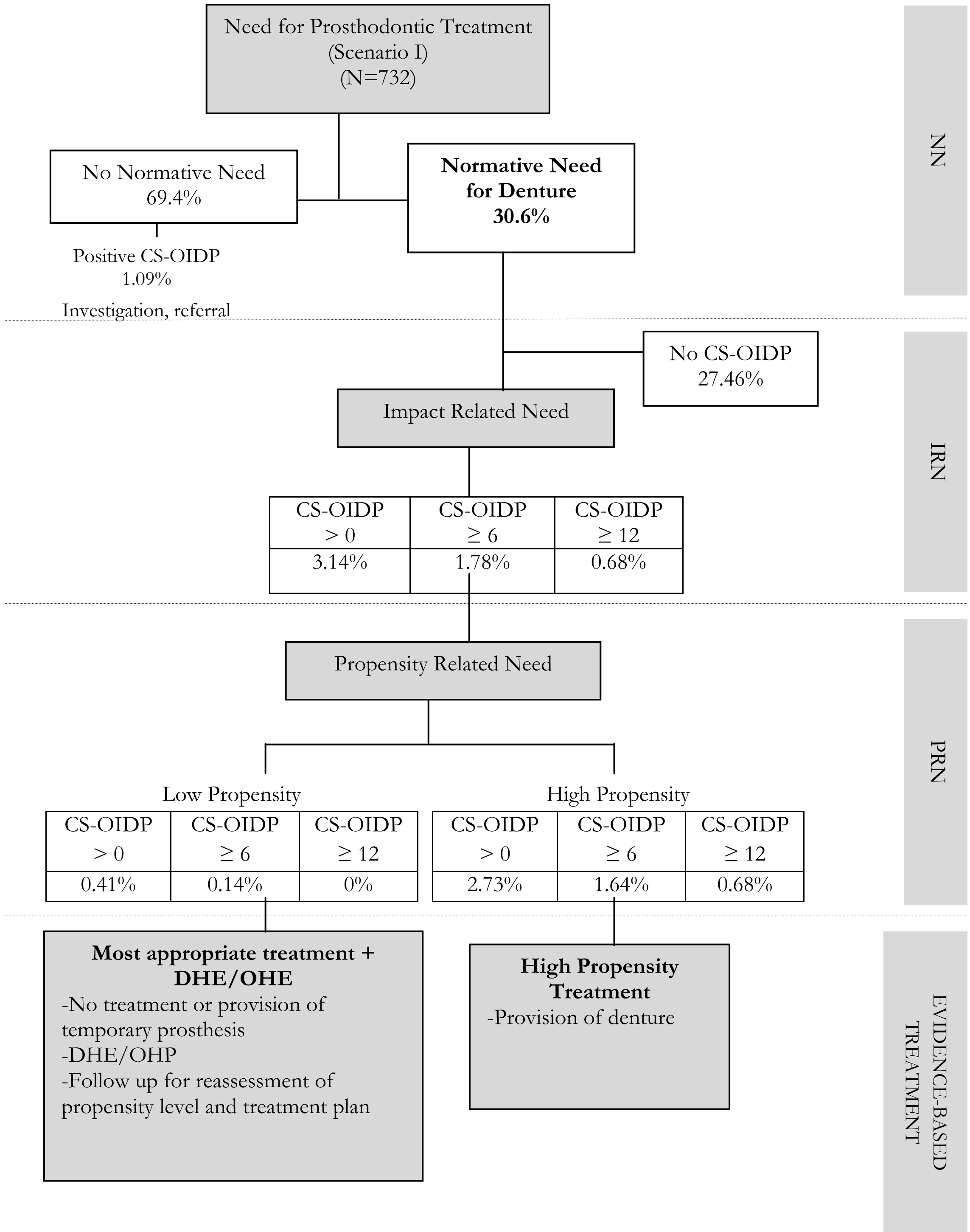

Figure 5.5: Comparison of the percentages of Malaysian adults aged 30-54 years who needed dentures at different CS-OIDP cut-off points using the Normative Needs and the Sociodental Needs approaches (N=732).

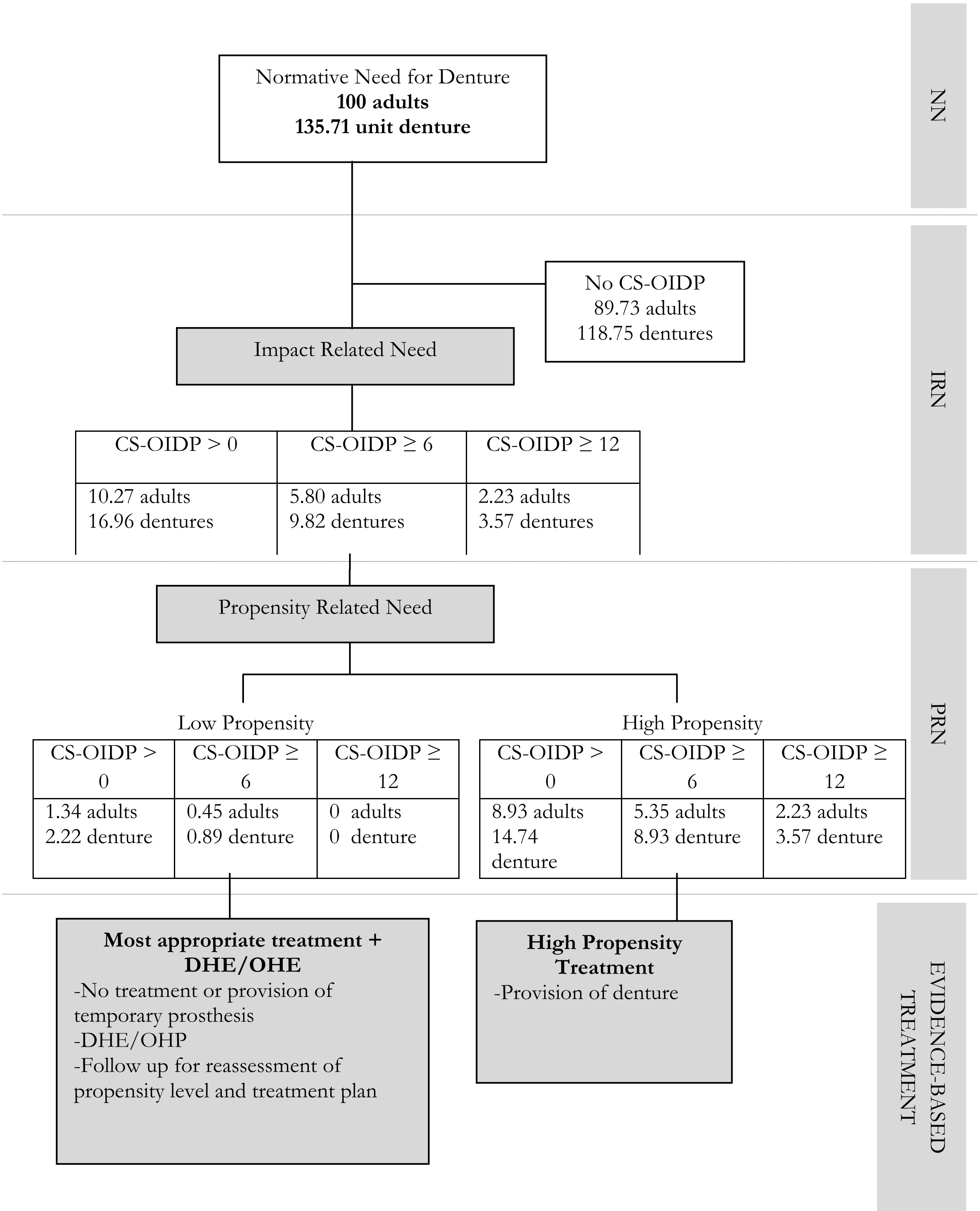

Figure 5.6: Comparison of the number of dentures needed per 100 adults at different CS-OIDP cut off points assessed using the Normative Needs and Sociodental Needs approaches

5.4.3.2 Scenario II- Provision of Dentures and/or Bridges

i. Normative Needs (NN)

Slightly more than half (52.3%) of the subjects had NN for either removable dentures or fixed bridges, or both of them (Figure 5.7). This proportion is higher than for Scenario I because in the previous scenario, the provision of dentures was not considered appropriate for subjects who had posterior spaces of one or less than a tooth size on either side of quadrant/jaw (Davenport et al. 1988; Shillingburg et al. 1997). The number of dentures and bridges needed per 100 people with prosthodontic needs were 60.84 and 121.15 respectively (Figure 5.8).

ii. Impact – Related Need (IRN)

The proportions of subjects having needs for treatment decreased significantly when IRN assessment was used. Less than 4% of subjects had IRN when all levels of impacts were considered. Using a cut-off point of CS-OIDP>0, 7.57 subjects per 100 subjects with normative needs needed treatment and 9.40 dentures and 4.18 bridges were required for them. When different cut-off points of the CS-OIDP score were used, the proportions of subjects with IRN changed (Figure 5.7). Per 100 people in the whole sample, 3.9 people required prosthodontic treatment under IRN assessment.

iii. Propensity – Related Need (PRN)

Assessment of propensity-related needs was done separately for dentures and bridges because different types of oral health behaviours were taken into account. For dentures, only brushing frequency and dental attendance were considered. For bridges, brushing frequency, usage of fluoride toothpaste, dental attendance and sugar intake were assessed (see Table 3.5).

When all levels of severity of impacts were considered, 2.6% of subjects who needed dentures and 0.68% who needed bridges had a high behavioural propensity (Figure 5.7). Thus, prosthodontic treatment would be provided for them. The remaining 1.23% should receive DHE/OHP to modify their behaviour and other preliminary treatments such as the provision of temporary dental prosthetics before high propensity treatment is provided. Of 7.57 people in 100 people with normative need for prosthodontic treatment, 4.96 had a high propensity for dentures and 1.31 had a high propensity for bridges. Per 100 people in the whole sample, 3 needed dentures and 0.7 needed bridges. The numbers of dentures and bridges needed per 100 people with prosthodontic needs were 8.09 and 2.09 respectively at CS-OIDP>0 (Figure 5.8). When cut-off points of CS-OIDP≥12 were chosen, all subjects with IRN had a high propensity level. The numbers of dental prostheses required at the CS-OIDP>12 level of impacts were 2.09 for dentures and 0.26 for bridges per 100 people with prosthodontic NN.

1.9% subjects did not have CS-impacts for prosthodontic treatment but had perceived treatment need for replacement of missing teeth. Using the baseline of 100 subjects with normative needs, 3.65 had perceived need for prosthodontic treatment and 4.70 dentures and 2.35 bridges were needed. When these subjects were incorporated in the BMDN model for prosthodontic treatment, the number of subjects with high propensity increased from 2.6% to 3.69% for dentures and from 0.68% to 1.09% for bridges (Appendix 13 (xi-xii)).

Summary: Overall for Scenario II, the proportion of subjects that needed dentures decreased by 95.8% and the proportion of subjects who needed bridges decreased by 98.7%, when SDA was used instead of NN ($p<0.001$). The reductions were higher between NN to IRN (92.4% reduction) compared to between IRN to PRN (17.4% reduction in need for dentures and 30% reduction in need for bridges). Compared to NN estimates, there were 86.7% fewer dentures and 98.3% fewer bridges per 100 people with prosthodontic need ($p<0.001$).

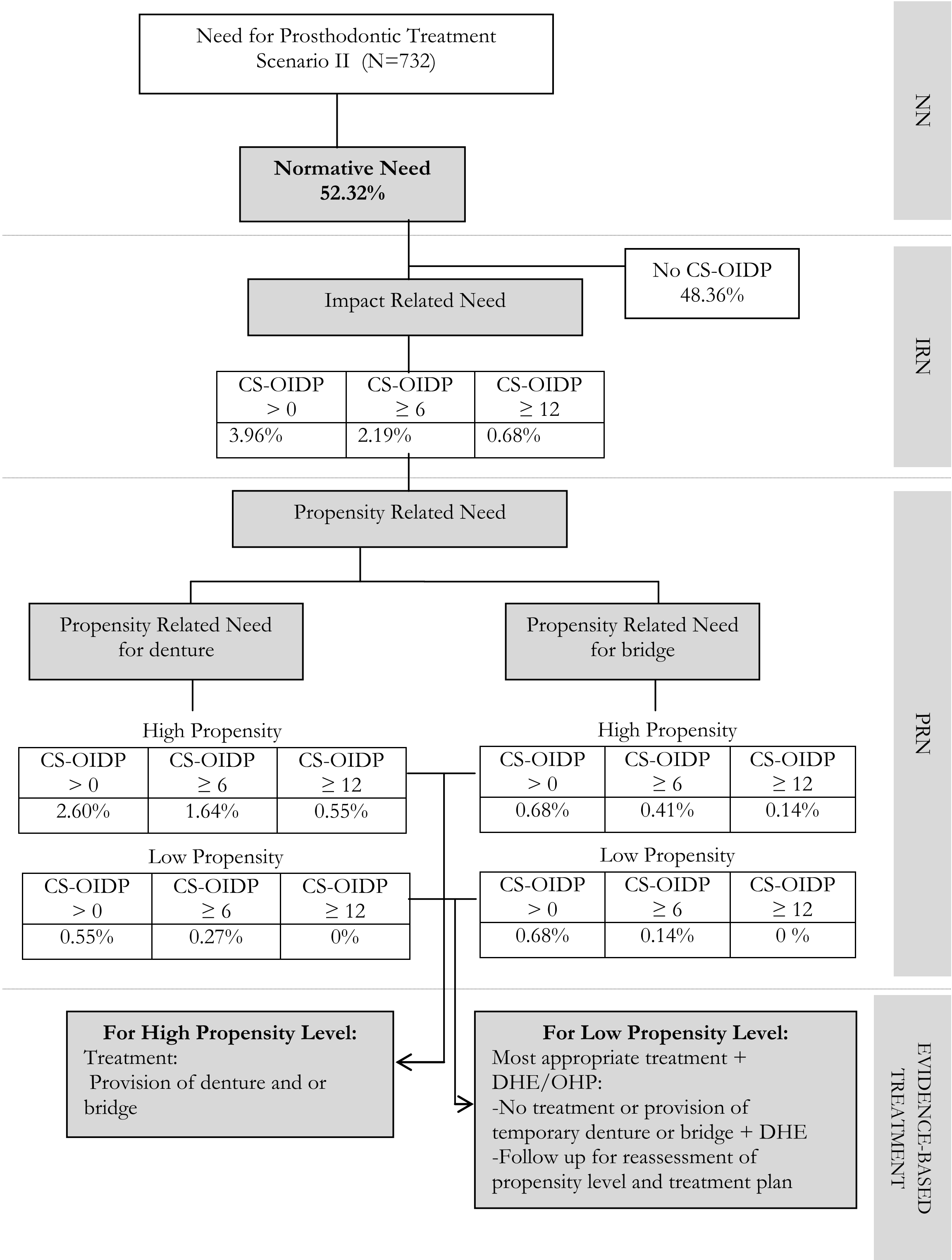

Figure 5.7: Comparison of the percentages of Malaysian adults aged 30-54 years who needed dentures and/or bridges using Normative Needs and Sociodental Needs assessments (N=732).

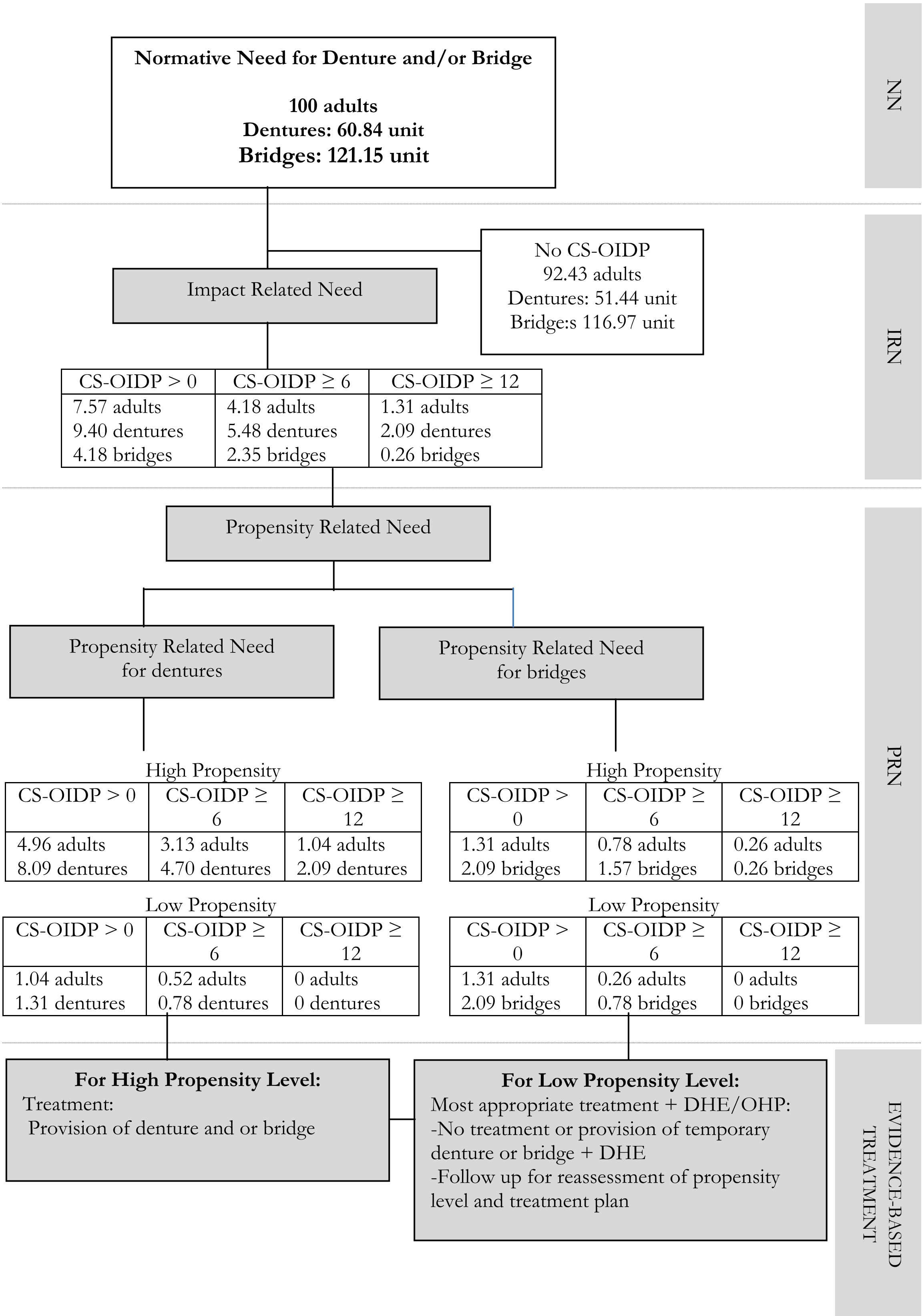

Figure 5.8: Comparison of the number of dentures and bridges needed per 100 adults at different level of CS-OIDP score assessed using the Normative Needs and Sociodental Needs approaches.

5.5 Comparison between Normative Needs and Sociodental Needs Assessment: Treatment times and the number of dentists needed to treat (Objectives 3)

This section presents the results of the assessment of dental treatment times and the comparisons of the treatment time and the number of dentists needed to provide specific dental treatments when using normative and sociodental needs assessments. For each type of dental treatment, the time needed to treat the study population was converted into the hours needed to treat a population of 100,000 adults. From these calculated times, the number of dentists needed to perform the treatment was calculated based on several assumptions of dentists' annual working hours. The presented results are mainly those based on the following two assumptions for oral impacts and personnel workload: 1) using the lowest cut off point for oral impacts (CS-OIDP>0) as it is conceptually more relevant to define presence or absence of oral impacts, and 2) using the annual estimate of 1760 working hours recommended by the Ministry of Health, Malaysia.

5.5.1 Treatment times for dental procedures

The timings for particular dental procedures were obtained from the Oral Health Division of Malaysia, from an observation survey conducted at various private dental clinics and from the panel of experts' inquiry (see Section 3.4). The calculations of the time needed to carry out each type of dental treatment used in this study were based on the minimum and maximum treatment times provided by a panel of experts (bolded and underlined in Table 5.26). Although there was a wide range between the minimum and maximum times for certain dental procedures, the results from the experts' inquiry were considered to provide a reasonable estimate of the dental treatment time used by Malaysian dentists under local circumstances. Hence that was used in this study.

5.5.2 Comparison between Normative Needs (NN) and Sociodental Needs (SDA) assessments in relation to the times and the numbers of dentists needed to carry out restorative treatment

For restorative treatment, the DNLP sociodental model was used in which only NN and PRN were assessed. Table 5.27 shows the comparisons of time needed for non-complex and complex restorative treatment per 100,000 people using NN and SDA assessments. Needs for non-complex restorations were based only on NN.

There were significant differences in the times needed for the treatment of crown and endodontic when using NN and SDA. For endodontic and crowns treatment, the minimum time required decreased by 8.1% from 9255.45 hours (NN) to 8504.09 hours (SDA). When maximum time estimates were used, it decreased by 1.5% from 15,277.77 hours (NN) to 14,048.27 hours (SDA). The treatment time needed for each crown and endodontic treatment decreased significantly by about 12% and 6% respectively from NN to SDA (p=0.020 for crowns and p=0.001 for endodontic treatment).

Table 5.26: Dental treatment time for restoration, prosthodontic and periodontal treatment from three different investigations: observation survey at private clinic, data from Oral Health Division on surveys done at public clinic and panel of experts inquiry

Type of treatment	Treatment time (in minutes)			
	Observation survey at private dental clinics	**Data from Oral Health Division Malaysia**	**Panel of Experts Inquiry**	
Restoration				
Class I	Mean: 13.72 Range: 5 – 25 mins Mode: 15 mins	10 mins	**5 – 20 mins**	
Class II	Mean: 20.05 mins Range: 8 – 45 mins Mode: 15 mins	10 mins	**10 – 30 mins**	
Class III	Mean: 17.80 mins Range: 9 – 30 mins Mode: 15 mins	10 mins	**10 – 20 mins**	
Class IV	Mean: 27.38 mins Range: 9 – 30 mins Mode: 21 mins	10 mins	**15 – 30 mins**	
Crown				
1st visit (crown prep)	Mean: 31.67 mins Range: 20-50 mins Mode: 20 mins	240 mins per case	60 – 90 mins	
2nd visit (issue)	Mean: 25.63 mins Range: 15-35 mins Mode: 30 mins		15 – 40 mins **Total time for crown treatment: 75-130 mins**	
Bridges	Not available	240 mins per cases	**150 – 240 mins**	
Root Canal Treatment (RCT)			Anterior teeth	Posterior teeth
Access and canal prep	Mean: 49.38 mins Range: 20-80 mins Mode: 60 mins	120 mins per tooth	30-60 mins	45-80 mins
Cleaning and Obturation	Mean: 56.20 mins Range: 18-105 mins Mode: 87 mins		30-60 mins **Total time for anterior RCT treatment: 60 – 120 mins**	45-60 mins **Total time for posterior RCT treatment: 90 – 140 mins**
Prosthetic Removable prosthetics case		100 mins per case Average 3 visits	Partial denture: 3 visits Full denture: 4 visits (includes secondary impression)	
Impression taking (primary)	Mean: 15.47 mins Range: 5 – 30 mins		10 – 15 mins	

Secondary impression	Not available		30 – 45 mins
MMR	Mode: 10 mins Range: 4-30 mins Mode: 15 mins		15 – 30 mins
Try-in	Mean: 17.11 mins Range: 2-35 mins Mode: 10 mins		5 – 15 mins
Issue	Mean: 18.81 mins Range: 2-35 mins Mode: 30 mins		5 – 30 mins
Denture repair	Mean: 21.11 mins Range: 10 – 35 mins Mode: 20 mins		**Total time for denture case:** **Partial: 35 – 90 mins** **Full: 65 – 135 mins**
Periodontal treatment			
Scaling and Polishing	Full mouth scaling: Mean: 25.03 mins Range: 6 – 65 mins Mode: 30 mins	Scaling per sextant: CPI 2 = 3 mins /sextant	Full mouth treatment: **CPI 2 = 10 -20 mins**
Root planning	Not available	CPI 3 = 10 mins /sextant	**CPI 3 = 30 – 45 mins**
Complex periodontal surgery	Not available	CPI 4 = 150 mins per case, 4-5 visits	**CPI 4 = 150 mins**
Extraction			
Simple extraction (anaest + extract + arrest bleeding)	Mean: 15.74 mins Range: 4 – 45 mins Mode: 15 mins	15 mins per tooth	**15 mins (anterior) – 30 mins (posterior)**
Surgery cases (trauma, minor surgery, impaction)		120 mins	**30 – 60 mins**
Dental implants and prosthesis	Not available	300 mins	**300 – 400 mins per mouth**
Examination and diagnosis	Mean: 16.84 Range: 2-30 mins Mode: 15 mins	Dental screening = 5 mins per person	**10 – 15 mins**
Oral health education	Not available	Oral health education: 25 mins Oral hygiene instruction: 6 mins	**15-25 mins**

Overall, the minimum treatment time needed for restorative treatment (both complex and non-complex treatments) decreased slightly (3.4%) from 22,085.60 hours (NN) to 21,334.24 hours (SDA). The maximum treatment time needed also decreased slightly (2.5%) from 48,224.04 hours (NN) to 46,994.54 hours (SDA). Both these reductions were statistically significant (p≤0.001).

Table 5.27: Comparison of minimum and maximum time, in hours, needed for restorative treatment per 100,000 adults for Normative Needs and Sociodental Needs approaches

Type of restorative treatment needed	Minimum treatment time, in hours, needed per 100,000 adults				Maximum treatment time, in hours, needed per 100,000 adults			
	NN	IRN	PRN	% difference NN-PRN	NN	IRN	PRN	% difference NN-PRN
Non-complex treatment	12830.15	-	12830.15	0	32946.27	-	32946.27	0
Complex treatment								
i. Crown	2903.00	-	2561.47	11.8% p=0.020	5031.87	-	4439.89	11.8% p=0.020
ii. Endodontic	6352.45	- -	5942.62	6.4% p=0.001	10245.90	-	9608.38	6.2% p=0.001
Total time for complex treatment	9255.45	-	8504.09	8.1% p=0.000	15,277.77	-	14,048.27	1.5% p=0.000
Total time for restorative treatment (complex + non-complex)	**22085.60**		**21334.24**	3.4% p=0.000	**48224.04**	**-**	**46994.54**	**2.5%** p=0.000

NN=Normative Needs, IRN=Impact Related Needs, PRN=Propensity Related Needs

Table 5.28 presents the comparison of the number of dentists needed to perform restorative treatment per 100,000 people for different lengths of annual working hours, using NN and SDA approaches. As expected, the number of dentists needed decreased when annual working hours increased. At 1760 hours per year, the number of dentists needed to perform crowns on 100,000 people, using the minimum times estimates, decreased from 1.65 (NN) to 1.45 (PRN). When the maximum treatment time was used, the number of dentists needed to perform crowns decreased from 2.86 (NN) to 2.52 (SDA). For endodontic treatment, the number of dentists needed decreased from 3.60 (NN) to 3.38 (SDA) using minimum time estimates; and from 5.82 (NN) to 5.46 (SDA) using maximum time estimates.

Overall, assuming that dentists work for 1760 hours annually, the minimum number of dentists needed to perform complex treatment decreased slightly from 5.25 dentists when using NN to 4.83 dentists when using SDA. When maximum time estimates were used, the respective numbers of dentists needed to perform complex treatment were 8.65 for NN and 7.98 for SDA.

Table 5.28: Comparison of the number of dentists needed using minimum or maximum treatment time for restorative treatment per 100,000 adults, by different annual working hours for Normative and Sociodental approaches.

Annual working hours:	Number of dentists needed (using minimum treatment time) per 100,000 adults			Number of dentists needed (using maximum treatment time) per 100,000 adults		
	NN	IRN	PRN	NN	IRN	PRN
			Non-complex treatment			
1200	10.69		10.69	27.45		27.45
1500	8.55		8.55	21.96		21.96
1760	7.29	-	7.29	18.72	-	18.72
2000	6.42		6.42	16.47		16.47
			Complex treatment			
i. Crown						
1200	2.42		2.13	4.19		3.70
1500	1.94		1.71	3.35		2.96
1760	1.65		1.45	2.86		2.52
2000	1.45		1.28	2.52		2.22
		-				
ii. Endodontic					-	
1200	5.29		4.95	8.54		8.01
1500	4.24		3.96	6.83		6.40
1760	3.60		3.38	5.82		5.46
2000	3.18		2.97	5.12		4.80

5.5.3 Comparison between Normative Needs (NN) and Sociodental Needs (SDA) assessments in relation to the times and the numbers of dentists needed to carry out periodontal treatment

Table 5.29 shows the comparisons of the time needed to perform periodontal treatment per 100,000 adults at different levels of sociodental impact using NN and SDA approaches. The time that would be needed to perform periodontal treatment decreased when stricter cut-off points for oral impacts were used. At a cut-off point of CS-OIDP>0, the minimum time needed for periodontal treatment decreased from 25,403 hours (NN) to 4086.97 hours (SDA) and the maximum time needed decreased from 36,892.07 hours (NN) to 5680.77 hours (SDA). These reductions were considerable, being around 84% ($p \leq 0.001$). The differences were substantially larger between NN and IRN (about 83%) compared to differences between IRN to PRN (a reduction of 7% to 9%). Using cut-off point of CS-OIDP of more than 6 or 12, the percentage reductions from NN to SDA was about 96% and 98% respectively.

Table 5.30 shows the comparison of the number of dentists needed for periodontal treatment when NN and SDA approaches were used. As expected, the number of dentists needed to perform periodontal treatments decreased when dentists' working hours increased and when higher cut-off points of CS impact were used. Using CS-OIDP>0 and annual working hours of 1760, the minimum number of dentists needed to perform periodontal treatment per 100,000 people decreased from 14.43 (NN) to 2.32 (SDA) and the maximum number of dentists needed decreased from 20.96 (NN) to 3.23 (SDA). When higher cut-off points were used, the number of dentists needed for periodontal treatment, assuming that the annual working hours is

1760, decreased from 2.32 (CS-OIDP>0) to 0.57 dentists (using CS-OIDP≥6) and to 0.26 dentists (using CS-OIDP≥12).

Table 5.29: Comparison of minimum and maximum time, in hours, needed for periodontal treatment per 100,000 adults between Normative and Sociodental approaches

	Minimum treatment time, in hours, needed per 100,000 adults				Maximum treatment time, in hours, needed per 100,000 adults			
CS-OIDP	NN	IRN	PRN	% differences NN-PRN	NN	IRN	PRN	% differences NN-PRN
i. >0	25,403	4430.78	4086.97	83.9% p=0.000	36,892.07	6247.72	5680.77	84.6% p=0.000
ii. ≥ 6		1054.19	1006.37	96.0% p=0.000		1518.67	1441.26	96.1% p=0.000
iii. ≥12		464.48	464.48	98.2% p=0.000		548.72	548.72	98.5% p=0.000

Table 5.30: Comparison of number of dentists needed using minimum or maximum treatment time for periodontal treatment per 100,000 adults, by different annual working hours between Normative and Sociodental approaches.

	Minimum number of dentists needed per 100,000 adults			Maximum number of dentists needed per 100,000 adults		
CS-OIDP and annual working hours	NN	IRN	PRN	NN	IRN	PRN
i. CS>0						
1200	21.17	3.69	3.41	30.74	5.21	4.73
1500	16.94	2.95	2.72	24.59	4.16	3.79
1760	14.43	2.52	2.32	20.96	3.55	3.23
2000	12.70	1.22	2.04	18.45	3.12	2.84
ii. CS ≥ 6						
1200		0.88	0.84		1.26	1.20
1500		0.70	0.67		1.01	0.96
1760		0.60	0.57		0.86	0.82
2000		0.53	0.50		0.76	0.72
iii. CS ≥12						
1200		0.39	0.39		0.46	0.46
1500		0.31	0.31		0.36	0.36
1760		0.26	0.26		0.31	0.31
2000		0.23	0.23		0.27	0.27

5.5.4 Comparison between Normative Needs (NN) and the Sociodental Needs (SDA) assessments in relation to the times and the numbers of dentists needed to carry out prosthodontic treatment

5.5.4.1 Scenario 1 – Provision of dentures only

The calculation of treatment time and the number of dentists for this scenario was based on the assumption that oral health providers were only providing removable dentures for the treatment of missing teeth (see criteria in Section 3.3.6.1 (c)). Table 5.31 presents the comparison of the time needed to provide removable dentures per 100,000 people at varying levels of sociodental impact using NN and SDA. At CS-OIDP>0, the minimum time needed for prosthodontic treatment decreased from 18,055.60 hours (NN) to 1730.42 hours (SDA). When the maximum estimate was used, the treatment time needed decreased significantly from 46,209.02 hours (NN) to 4303.28 hours (SDA). When a higher impact threshold was used, the time needed for prosthodontic treatments decreased accordingly. Using CS-OIDP≥6, the minimum time needed for the Sociodental approach was 1092.90 hours and the maximum time needed was 2663.93 hours, a decrease from the 1730.42 hours and 4303.28 hours required respectively when CS-OIDP>0 was used.

Overall, the time needed to provide dentures decreased by more than 90% when SDA was compared to NN at all levels of sociodental impact. The reduction is higher between NN to PRN (almost 90%) compared to between IRN to PRN (about 12%).

Table 5.31: Comparison of minimum and maximum time, in hours, needed for prosthodontic treatment (Scenario 1) per 100,000 adults for Normative Need and Sociodental Need

CS-OIDP	Minimum treatment time, in hours, needed per 100,000 adults				Maximum treatment time, in hours, needed per 100,000 adults			
	NN	IRN	PRN	% differences NN-PRN	NN	IRN	PRN	% differences NN-PRN
i. >0	18,055.60	1969.49	1730.42	90.4% p=0.000	46,209.02	4918.03	4303.28	90.7% p=0.000
ii. ≥ 6		1172.59	1092.90	93.9% p=0.000		2868.85	2663.93	94.2% p=0.000
iii. ≥ 12		535.06	535.06	97.0% p=0.000		1229.51	1229.51	97.3% p=0.000

The comparison of the number of dentists needed for prosthodontic treatment (Scenario I) between NN and SDA assessments is shown in Table 5.32. At CS-OIDP>0 and annual working hours of 1760, the minimum number of dentists needed to provide dentures per 100,000 adults decreased substantially from 10.26 (NN) to 0.98 (SDA) and the maximum number of dentists needed decreased from 26.26 (NN) to 2.44 (SDA). With a longer annual working hours assumption or when using a higher threshold for oral impacts score, the number of dentists needed for prosthodontic treatment decreased. The number of dentists needed decreased by 38% and 70% when CS-OIDP≥6 and CS-OIDP≥12 was used respectively compared to when CS-OIDP>0 was used.

Table 5.32: Comparison of the number of dentists needed using minimum or maximum treatment time for prosthodontic treatment (Scenario 1) per 100,000 adults, by different annual working hours for Normative Needs and Sociodental Needs.

	Minimum number of dentists needed per 100,000 adults			Maximum number of dentists needed per 100,000 adults		
	NN	IRN	PRN	NN	IRN	PRN
i. CS>0						
1200	15.05	1.64	1.44	38.51	4.10	3.59
1500	12.04	1.31	1.15	30.81	3.28	2.87
1760	10.26	1.12	0.98	26.26	2.79	2.44
2000	9.03	0.98	0.86	23.10	2.46	2.15
ii. CS ≥ 6						
1200		0.98	0.91		2.39	2.22
1500		0.78	0.73		1.91	1.78
1760		0.67	0.62		1.63	1.51
2000		0.59	0.55		1.43	1.33
iii. CS ≥12						
1200		0.44	0.44		1.02	1.02
1500		0.36	0.36		0.82	0.82
1760		0.30	0.30		0.70	0.70
2000		0.27	0.27		0.61	0.61

5.5.4.2 Scenario II – Provision of dentures and/or bridges

In Scenario II, the treatment of missing teeth was by the provision of dentures and bridges (see criteria in Section 3.3.6.1 (c)). There was a very large reduction of more than 98% in the time needed to provide bridges when NN was compared to SDA (Table 5.33). For dentures, the percentage reduction from NN to PRN was more than 89% at all levels of sociodental impact. At CS-OIDP>0 and using annual hours of 1760, the minimum time needed to provide bridges decreased from 158,469.94 hours (NN) to 2732.24 hours (SDA) and the maximum time decreased from 253,551.90 (NN) to 4371.58 hours (SDA). For dentures, the minimum time needed decreased from 15,425.77 (NN) to 1650.73 (SDA) and the maximum time needed decreased from 39,446.72 (NN) to 4098.36 (SDA).

Overall, using CS-OIDP>0 and working hours of 1760, the total minimum time needed to provide prosthodontic care (both dentures and bridges) normatively was 173,895.71 hours compared to only 4,382.97 hours when using sociodental assessment. The total maximum time needed decreased from 292,998.62 hours (NN) to 8469.94 (SDA).

In a scenario where prosthodontic treatment was restricted to subjects with missing anterior teeth and/or with more than one tooth missing in the posterior region and when a shortened dental arch approach (Kayser 1981) was applied whenever possible, the treatment time (NN) required to provide dentures decreased from 15,425.77 hours to 13,672.59 hours and the treatment time (NN) for providing bridges decreased from 158,469.94 to 63,524.59 hours (using minimum treatment time). The total treatment time (NN) for prosthodontic treatment using minimum treatment time decreased by more than 50% from 173,895.71 hours to 77,197.18 hours. However, the treatment time required when Sociodental approach was used for both dentures and bridges remained the same as in the previous scenario.

Table 5.33: Comparison of minimum and maximum time, in hours, needed for prosthodontic treatment (Scenario II) per 100,000 adults for Normative Needs and Sociodental Needs assessments

CS-OIDP	Minimum treatment time, in hours, needed per 100,000 adults				Maximum treatment time, in hours, needed per 100,000 adults			
	NN	IRN	PRN	% differences NN-PRN	NN	IRN	PRN	% differences NN-PRN
Need Denture								
>0	15,425.77	1969.49	1650.73	89.3% p=0.000	39,446.72	4918.03	4098.36	89.6% p=0.000
≥6		1252.28	1092.90	92.9% p=0.000		3073.77	2663.93	93.2% p=0.000
≥12		455.37	455.37	97.0% p=0.000		1024.59	1024.59	97.4% p=0.000
Need Bridge								
>0	158,469.94	5464.48	2732.24	98.3% p=0.000	253,551.90	8743.17	4371.58	97.0% p=0.000
≥6		3073.77	2049.18	98.7% p=0.000		4918.03	3278.69	98.7% p=0.000
≥12		341.53	341.53	99.8% p=0.000		546.45	546.45	99.8% p=0.000

The comparison of the number of dentists needed to provide dentures and fixed bridges per 100,000 adults at different levels of impact using NN and SDA assessments is shown in Table 5.34. At CS-OIDP>0, assuming that dentists work for 1760 hours annually and using the minimum treatment time, the number of dentists needed normatively to provide dentures decreased from 8.76 to 0.94 (SDA). If maximum treatment time was used, the number of dentists decreased from 22.41 (NN) to 2.33 (SDA). For bridges, the minimum number of dentists needed decreased from 90.04 (NN) to only 1.55 (SDA) and the maximum number of dentists needed decreased greatly from 144.06 (NN) to 2.48 (SDA). When the annual working hours increased or when a higher threshold for oral impact scores was used, the number of dentists that were needed decreased accordingly.

Overall the total minimum number of dentists needed for prosthodontic treatment (Scenario II) assessed using NN was 98.8 compared to only 2.49 dentists when SDA was used. When maximum timings were used, the total number of dentists needed for prosthodontic treatment decreased from 166.47 (NN) to 4.81 (SDA). These estimates were made using CS-OIDP>0 and 1760 annual working hours.

Table 5.34: Comparison of the number of dentists needed using minimum or maximum treatment time for prosthodontic treatment (Scenario II) per 100,000 adults, by different annual working hours for Normative Needs and Sociodental Needs assessments.

	Minimum number of dentists needed per 100,000 adults			Maximum number of dentists needed per 100,000 adults		
	NN	IRN	PRN	NN	IRN	PRN
			Need for Denture			
i. CS>0						
1200	12.85	1.64	1.38	32.87	4.10	3.41
1500	10.28	1.31	1.10	26.30	3.28	2.73
1760	8.76	1.12	0.94	22.41	2.79	2.33
2000	7.71	0.98	0.82	19.72	2.46	2.05
ii. CS ≥ 6						
1200		1.04	0.91		2.56	2.22
1500		0.83	0.73		2.05	1.78
1760		0.71	0.62		1.75	1.51
2000		0.63	0.55		1.54	1.33
iii. CS ≥12						
1200		0.38	0.38		0.85	0.85
1500		0.30	0.30		0.68	0.68
1760		0.26	0.26		0.58	0.58
2000		0.23	0.23		0.51	0.51
			Need for Bridge			
i. CS>0						
1200	132.06	4.55	2.28	211.29	7.28	3.64
1500	105.65	3.64	1.82	169.03	5.83	2.91
1760	90.04	3.10	1.55	144.06	4.97	2.48
2000	79.23	2.73	1.37	126.78	4.37	2.18
ii. CS ≥ 6						
1200		2.56	1.71		4.10	2.73
1500		2.05	1.37		3.28	2.18
1760		1.75	1.16		2.79	1.86
2000		1.54	1.02		2.46	1.64
iii. CS ≥12						
1200		0.28	0.28		0.45	0.45
1500		0.23	0.23		0.36	0.36
1760		0.19	0.19		0.31	0.31
2000		0.17	0.17		0.27	0.27

5.5.5 Summary of the comparison between Normative Needs (NN) and Sociodental Needs (SDA) assessments in relation to the times and number of dentists needed for restorative, periodontal and prosthodontic treatment.

In Section 5.5, prosthodontic treatment need was examined using two different scenarios; the provision of dentures only or the provision of dentures and/or bridges. The other factors that were varied were the cut off points for the assessment of CS-OIDP impact (CS-OIDP>0, CS-OIDP≥6 and CS-OIDP≥12) and the number of hours that dentists worked in a year (1200, 1500, 1760 and 2000). These options were created to provide dental service planners with flexibility in selecting the most appropriate criteria based on their populations' oral health status, perceived needs, sociodental impacts, propensity behaviour and their resources and financial plan.

In the next section, the results will focus on criteria that are relevant for the current Malaysian oral health care system. Focusing on specific criteria will permit a clearer picture for assessing the changes of the distribution of different dental personnel when different skill mix models are used.

Currently both removable dentures and bridges are being provided in the public and private dental sectors in Malaysia. Therefore, Prosthodontic Scenario II where dentures and bridges are provided represents the current state of Malaysian prosthodontic care. Only this scenario will be used in the next section. In terms of working hours, 1760 hours will be used because that was the estimate used by the Malaysian Ministry of Health during the 2008 Oral Health Manpower Conference (Ministry of Health Malaysia 2009).

The appropriate choice of the cut-off points for the OIDP scores can be determined either through a conceptual approach or through the distribution of the OIDP scores found in the study. The conceptual approach recommends that the categorisation of the subjects be made according to whether the subjects have or do not have oral impact that affected their everyday life (Tsakos 1998). This means that a cut-off point of CS-OIDP equals to zero is recommended according to the approach. In this study, the distribution of oral impact scores indicated that 60% of subjects scored 0 (50^{th} percentile=0, 75^{th} percentile=3.2). Based on this finding and following the theoretical approach, the cut-off point for OIDP scores deemed appropriate for this study is greater than zero. Hence the cut-off point of greater than zero is used in the next section.

Table 5.35 and 5.36 present the summary of the timings and the number of dentists needed to treat a population of 100,000 based on the criteria selected. These figures are used in the next section to estimate the changes in the composition of the dental team when using different skill mix scenarios.

Table 5.35: Summary of the treatment time needed for restorative, periodontal, prosthodontic, examination and diagnosis and oral health education, in hours, per 100,000 adults

Type of treatment	Minimum treatment time, in hours, needed per 100,000 adults		Maximum treatment time, in hours, needed per 100,000 adults	
	Normative needs	Sociodental needs	Normative needs	Sociodental needs
Restorative	22,085.60	21,334.24	48,224.04	46,994.54
Periodontal	25,403.00	4086.94	36,892.00	5680.77
Prosthodontic	173,895.71	4382.97	292,998.62	8469.94
#Exam & Diagnosis	14,321.49	14,321.49	21,482.24	21,482.24
OHE/OHP	1806.69	10,689.89	3011.16	17,816.48
Total hours:	**237,512.49**	**54,815.53**	**402,608.06**	**100,443.97**

#The timing for Examination and Diagnosis is based on the number of adults with needs for any type of dental treatment.

Table 5.36: Summary of the number of dentists needed for restorative, periodontal, prosthodontic, examination and diagnosis and oral health education, in hours, per 100,000 adults

Type of treatment	Minimum number of dentists needed per 100,000 adults		Maximum number of dentists needed per 100,000 adults	
	Normative needs	Sociodental needs	Normative needs	Sociodental needs
Restorative	12.54	12.12	27.40	26.70
Periodontal	14.43	2.32	26.96	3.23
Prosthodontic	98.8	2.49	166.47	4.81
Exam & Diagnosis	8.14	8.14	12.20	12.20
OHE/OHP	1.03	6.07	17.11	10.12
Total number of dentists needed:	**134.94**	**31.14**	**234.17**	**57.06**

If all subjects in the low propensity group improved their oral health behaviour after being given dental health education or after being exposed to oral health promotion intervention, they would eventually get the initial treatment planned for them. Tables 5.37 and 5.38 present the timings and the number of dentists per 100,000 adults needed to treat this group of people in the future under the selected criteria.

Table 5.37: Summary of the future treatment time needed for restorative, periodontal, prosthodontic, in hours, for subjects in the low propensity group, per 100,000 adults

Type of treatment	Minimum treatment time, in hours, needed per 100,000 adults	Maximum treatment time, in hours, needed per 100,000 adults
Restorative	751.37	1229.50
Periodontal	341.53	648.91
Prosthodontic	3051.00	5191.25
Total number of hours:	**4143.90**	**7069.66**

Table 5.38: Summary of the future number of dentists needed for restorative, periodontal, prosthodontic, in hours, for subjects in the low propensity group, per 100,000 adults

Type of treatment	Minimum number of dentists needed per 100,000 adults	Maximum number of dentists needed per 100,000 adults
Restorative	0.42	0.70
Periodontal	0.19	0.37
Prosthodontic	1.73	2.94
Total number of dentist:	**2.34**	**4.01**

5.6 The potential delegation of dental care from dentists to dental auxiliaries (Objective 4)

Numerous studies have highlighted the levels of simple and routine dental tasks that PCDs are able to undertake (Pelton et al. 1972; Powell et al. 1974; Sisty et al. 1978; Howat and Cannell 1979; Mauriello et al. 1990; Kwan et al. 1996; Ohrn et al. 1996; Evans et al. 2007; Abu Bakar 2007; Phantumvanit and Malaysian Oral Health Division 2008). Based on these findings, this study proposed that the following dental tasks can be delegated to dental nurses: simple fillings, scaling and polishing, root planing, examination and diagnosis and oral hygiene education. Dental technicians could be allowed to provide dentures direct to patients and to conduct oral health examinations and all other clinical work relating to providing dentures. Previous studies have shown that the quality of work done by dental nurses and dental technicians when those additional clinic tasks were delegated to them, were up to the standard of dental students or dentists (Benson, 1973; Pelton, 1972; Powell, 1974; Sisty, 1978; Wilson, 1985).

In the next section, different skill mix scenarios are presented where different types of dental tasks are delegated gradually in each scenario to dental nurses and technicians. Simpler tasks such as examination, restorations of a one-surface tooth or scaling and polishing are delegated initially (for example in Skill Mix Scenario 1 or 2) and more difficult tasks such as restoration of two-or-more tooth surfaces are delegated in the subsequent scenarios.

5.6.1 Skill mix scenarios

Five different skill mix scenarios were developed to assess the changes in the distribution of dental personnel when dental tasks are delegated from dentists to other dental personnel. These scenarios were adapted and modified from those proposed by Gallagher et al. (2010). In each scenario from 'baseline or no skill mix' to 'full skill mix', dental tasks are delegated gradually to dental auxiliaries. Table 5.39 summarizes the type of dental treatment that the dentist and the Professionals Complementary to Dentistry (PCDs) are allowed to do in each scenario. The PCDs considered in this section is the dental nurses (otherwise known as dental therapists in the UK and New Zealand) and the dental technicians.

Scenario 1: Baseline scenario. This is the current scenario in the Malaysian oral health care system where only dentists are allowed to treat adults. Currently, dental nurses with post basic degree qualifications are allowed to assist dental specialists and treat adults at specialist hospitals. Presently, there are very few of them. Although dental nurses do give dental health education to adults, they mainly focus on targeted groups such as expectant mothers. Dental technicians are only based in the laboratory and do not have any contact with patients.

Scenario 2: Upward referral and OHI. In this scenario, dental nurses and technicians will provide the 'front end care' in which they will do the examination and diagnosis and refer patients to the appropriate dentist/specialist. They will also undertake all chair-side oral health education activities and oral health promotion for adults.

Scenario 3: Minimum skill mix. In this scenario, simple dental interventions such as one-surface restoration and scaling and polishing are delegated to dental nurses.

Dental technicians will provide only full dentures and be involved in all clinical procedures related to providing full denture care.

Scenario 4: Maximum skill mix. This scenario allows the delegation of both simple and intermediate dental interventions such as 1, 2 or more surfaces restoration, scaling and root planning to dental nurses. For prosthodontic care, dental technicians will provide all dentures in clinical settings, while only dentists provide bridges.

Scenario 5: Full skill mix. This is a combination of Scenario 2 and 4.

Table 5.39: Dental personnel competency matrix for restorative, periodontal, prosthodontic treatment, examination and diagnosis and dental health education for five different skill mix scenarios

Type of treatment		Skill Mix Scenarios														
		Scenario 1 (Baseline)			Scenario 2 (Upward referral & DHE)			Scenario 3 (Minimum skill mix)			Scenario 4 (Maximum skill mix)			Scenario 5 (Full skill mix)		
	Staff	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT
Exam & Diagnosis		1	0	0	0	1	1	1	0	0	1	0	0	0	1	1
Restorative	1 surface	1	0	0	1	0	0	0	1	0	0	1	0	0	1	0
	2 or more surface	1	0	0	1	0	0	1	0	0	0	1	0	0	1	0
	Extraction	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
	Crown	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
	Endodontic	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
Periodontal	Scaling & Polishing	1	0	0	1	0	0	0	1	0	0	1	0	0	1	0
	Root planning	1	0	0	1	0	0	1	0	0	0	1	0	0	1	0
	Periodontal surgical	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
Prosthodontic	Partial dentures	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1
	Full denture	1	0	0	1	0	0	0	0	1	0	0	1	0	0	1
	Bridges	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
OHI/OHP		1	0	0	0	1	1	0	1	0	0	1	0	0	1	1

1: treatments that staff can perform in each scenario 0: treatments that staff cannot perform in each scenario
*D=Dentist, DN=Dental nurse, DT=Dental technician

5.7 Changes in dental workforce requirements using different skill mix scenarios (Objective 5)

To calculate the number of dental nurses and dental technicians needed to perform the delegated dental tasks, the data required are the time taken by them to perform the aforementioned dental procedures. Currently there are no local data available on the timings for PCDs when performing treatment on adult patients. This is because they are not legally allowed to treat adult patients directly at the present. Esa (1985) measured the time taken by the Malaysian dentists and dental nurses when performing amalgam restorations on permanent teeth in schoolchildren. The results showed that the mean time taken by dentists was 9.92±4.2 minutes and that of dental nurses was 10.3±4.4 minutes. The timings were comparable even though at that time dental nurses were only allowed to use slow-speed dental instruments. Presently, Malaysian dental nurses are permitted to use high-speed dental instruments. Thus it can be assumed that the time needed for them to perform amalgam restorations is similar to that of the dentists. As there are no data available on the timings of other dental procedures, it is assumed in this study that dental nurses' timings for other dental procedures are the same as dentists'. It is also assumed that the annual working hours of all dental personnel are the same (1760 hours per year).

Tables 5.40 to 5.43 show a comparison between NN and SDA in relation to the minimum and maximum number of dentists, dental nurses and dental technicians needed to treat 100,000 populations for different skill mix scenarios.

As expected, the results indicate that the number of dentists needed decreased when more dental task were delegated to other dental personnel when either using normative or sociodental model. When the normative model and minimum treatment time were used (Table 5.40), the total number of dentists needed to treat 100,000 adults decreased from 134.94 dentists in Scenario 1 to 125.77 dentists in Scenario 2, 123.69 dentists in Scenario 3, 111.79 dentists in Scenario 4 and 103.65 dentists in Scenario 5. The differences were highest for periodontal care. When scaling and polishing and/or root planing were delegated to dental nurses (Scenario 3, 4 and 5), the number of dentists needed for periodontal care per 100,000 adults decreased from 17.69 (Scenario 1) to 8.30 (Scenario 3) and 7.72 (Scenario 4 and 5), a reduction of between 65.1% and 69% from the baseline scenario. The lowest reduction from normative models was in prosthodontic care where the reductions ranged from 0.1 to 8.9% when using minimum treatment time (Table 5.40) and between 0.1% and 13.5% when using maximum treatment time (Table 5.41).

Conversely, the number of dental nurses and dental technicians needed increased when more dental tasks were delegated to them (Tables 5.40 and 5.41). When the normative model and minimum treatment time were used, the number of dental nurses needed increased from 9.17 (Scenario 2) to 22.53 (Scenario 5). When the full dentures procedure was delegated (Scenario 3), the number of dental technicians needed was 0.08 using the minimum treatment times or 0.17 using the maximum treatment times. When dental technicians were allowed to undertake both full and partial dentures in clinics (Scenario 5), the number of dental technicians needed to treat 100,000 adults normatively using minimum or maximum treatment times was 8.76 and 22.41 respectively (Table 5.40 and 5.41).

When a normative model of need and either minimum or maximum treatment times were used (Table 5.40 and 5.41), the number of dentists needed in each scenario was substantially higher than the number of dental nurses or dental technicians. This is in contrast to when sociodental assessment was used. In Scenario 1, 2, 3 and 4 in the sociodental model (Table 5.42 and 5.43), the total numbers of dentists that were needed still exceeded the total number of dental nurses and technicians. But in Scenario 5, the shape of the dental team changed; the largest group were dental nurses, followed by dentists and the smallest group were dental technicians.

When comparing normative and sociodental models in each skill mix scenario, the reductions in the numbers of dentists needed to treat the population were higher than 75%. For example, in Scenario 1, the number of dentists needed per 100, 000 adults using minimum treatment time decreased from 134.94 dentists (Table 5.40) to 31.14 dentists (Table 5.42). This was a reduction of 77%. More dental nurses are needed for Scenario 2 when sociodental model was used instead of normative model (Table 5.40 and 5.42). However, the number of dental nurses needed decreased in Scenario 3, 4 and 5 when comparing between normative model and sociodental model. The percentage reductions for dental nurses were smaller than that for dentists and ranged from 16% to 55%.

Table 5.40: The minimum number of dentists, dental nurses and dental technicians needed per 100,000 adults, for different skill mix scenarios, assessed using Normative Needs model

Type of treatment	The minimum number of personnel needed per 100,000 adults for different skill mix scenarios														
	Scenario 1 Baseline, no skill mix			**Scenario 2 Upward referral + OHI**			**Scenario 3 Minimum skill mix**			**Scenario 4 Maximum skill mix**			**Scenario 5 Full skill mix:**		
	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT
Restorative	12.54	0	0	12.54	0	0	11.79	0.75	0	9.15	3.39	0	9.15	3.39	0
Periodontal	17.69	0	0	17.69	0	0	8.30	9.39	0	7.72	9.97	0	7.72	9.97	0
Prosthodontic	98.80	0	0	98.80	0	0	98.72	0	0.08	90.04	0	8.76	90.04	0	8.76
Exam & Diagnosis	8.14	0	0	0	8.14	0	8.14	0	0	8.14	0	0	0	8.14	0
OHI	1.03	0	0	0	1.03	0	0	1.03	0	0	1.03	0	0	1.03	0
Total personnel	**134.94**	**0**	**0**	**125.77**	**9.17**	**0**	**123.69**	**11.17**	**0.08**	**111.79**	**14.39**	**8.76**	**103.65**	**22.53**	**8.76**

Table 5.41: The maximum number of dentists, dental nurses and dental technicians needed per 100,000 adults, for different skill mix scenarios, assessed using Normative Needs model

Type of treatment	The maximum number of personnel needed per 100,000 adults for different skill mix scenarios														
	Scenario 1 Baseline, no skill mix			**Scenario 2 'Upward referral'+ OHI**			**Scenario 3 Minimum skill mix**			**Scenario 4 Maximum skill mix**			**Scenario 5 Full skill mix: upward referral + maximum skill mix**		
	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT
Restorative	27.40	0	0	27.40	0	0	24.40	3.00	0	16.48	10.92	0	16.48	10.92	0
Periodontal	26.39	0	0	26.39	0	0	11.15	15.24		9.89	16.50	0	9.89	16.50	0
Prosthodontic	166.47	0	0	166.47	0	0	166.30	0	0.17	144.06	0	22.41	144.06	0	22.41
Exam & Diagnosis	12.20	0	0	0	12.20	0	12.20	0	0	12.20	0	0	0	12.20	0
OHI	1.71	0	0	0	1.71	0	0	1.71	0	0	1.71	0	0	1.71	0
Total personnel	**234.17**	**0**	**0**	**214.83**	**13.91**	**0**	**208.62**	**19.95**	**0.17**	**177.20**	**29.13**	**22.41**	**165.00**	**41.33**	**22.41**

D=Dentist, DN= Dental nurse, DT= Dental technician

Table 5.42: The minimum number of dentists, dental nurses and dental technicians needed per 100,000 adults, for different skill mix scenarios, assessed using the Sociodental Needs model

Type of treatment	The minimum number of personnel needed per 100,000 adults for different skill mix scenarios														
	Scenario 1 Baseline, no skill mix			**Scenario 2 'Upward referral'+ OHI**			**Scenario 3 Minimum skill mix**			**Scenario 4 Maximum skill mix**			**Scenario 5 Full skill mix: upward referral + maximum skill mix**		
	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT
Restorative	12.12	0	0	12.12	0	0	11.37	0.75	0	8.73	3.39	0	8.73	3.39	0
Periodontal	2.32	0	0	2.32	0	0	1.16	1.16	0	1.16	1.16	0	1.01	1.31	0
Prosthodontic	2.49	0	0	2.49	0	0	2.41	0	0.08	1.55	0	0.94	1.55	0	0.94
Exam & Diagnosis	8.14	0	0	0	8.14	0	8.14	0	0	8.14	0	0	0	8.14	0
OHI	6.07	0	0	0	6.07	0	0	6.07	0	0	6.07	0	0	6.07	0
Total personnel	**31.14**	**0**	**0**	**16.93**	**14.21**	**0**	**23.08**	**7.98**	**0.08**	**19.58**	**10.62**	**0.94**	**11.29**	**18.91**	**0.94**

Table 5.43: The maximum number of different type of dentists, dental nurses and dental technicians needed per 100,000 adults, for different skill mix scenarios, assessed using the Sociodental Needs model

Type of treatment	The minimum number of personnel needed per 100,000 adults for different skill mix scenarios														
	Scenario 1 Baseline, no skill mix			**Scenario 2 'Upward referral'+ OHI**			**Scenario 3 Minimum skill mix**			**Scenario 4 Maximum skill mix**			**Scenario 5 Full skill mix: upward referral + maximum skill mix**		
	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT	D	DN	DT
Restorative	26.70	0	0	26.70	0	0	23.70	3.00	0	18.78	7.92	0	18.78	7.92	0
Periodontal	3.23	0	0	3.23	0	0	0.91	2.32	0	0.91	2.32	0	0.66	2.57	0
Prosthodontic	4.81	0	0	4.81	0	0	4.64	0	0.17	2.48	0	2.33	2.48	0	2.33
Exam & Diagnosis	12.20	0	0	0	12.20	0	12.20	0	0	12.20	0	0	0	12.20	0
OHI	10.12	0	0	0	10.12	0	0	10.12	0	0	10.12	0	0	10.12	0
Total personnel	**57.06**	**0**	**0**	**34.74**	**22.32**	**0**	**41.45**	**15.44**	**0.17**	**34.37**	**20.36**	**2.33**	**21.92**	**32.81**	**2.33**

D=Dentist, DN= Dental nurse, DT= Dental technician

5.8 Summary of the main findings

The summary of the main findings are presented according to the objectives of this study.

Objective 1: To assess the oral health status and normative dental treatment need for restorative, prosthodontic and periodontal care in a sample of Malaysian university employees aged 30-54 years.

Main findings:

i. Oral health status of the sample population

Caries prevalence was 95% with a mean DMFT of 8.67. The mean number of teeth present was 26.5. Only 3 subjects (0.4%) were edentulous. Less than one-quarter (22.5%) of the subjects had healthy periodontal tissues in all six sextants. Calculus was the most prevalent periodontal condition; almost half the subjects (46.3%) had calculus without pocketing or bleeding.

ii. Normative dental treatment needs

About 41% of the study population needed restorative care. This included 14.8% who had teeth indicated for extractions. Periodontal treatment was required by 72.1% of subjects. However, the majority (55.9%) required only scaling and polishing. 52.32% required either dentures or bridges if both treatments were provided as in Scenario II.

Objective 2: To assess dental treatment needs using the sociodental approach in the aforementioned sample and compare the estimates obtained with the normative needs method.

Main findings:

i. For restorative treatment, there was a reduction of 15% of subjects needing crown when SDA was used compared to NN. The mean number of teeth needing crown decreased slightly from 5.61 teeth (NN) to 4.95 teeth (SDA).

ii. For periodontal treatment, the percentages of subjects requiring intervention decreased from 72.1% (NN) to 8.3% (IRN) to 7.2% (PRN). The overall reductions of subjects needing treatment using SDA compared to NN was 91.2% ($p<0.001$). The number of dental sextants requiring treatment per 100 people with normative needs decreased from 172.53 sextants (NN) to 21.78 sextants (SDA).

iii. The highest reduction in treatment need when SDA was used in comparison with NN was for prosthodontic treatment. The percentage of subjects requiring dentures or bridges decreased from 52.3% (NN) to 3.9% (SDA). Assessing the need for dentures and bridges separately using SDA, 2.6% and 0.68% subjects respectively had a high propensity and should get the planned treatment.

Objective 3: To compare the professional time and the number of dentists needed to provide dental treatment between the Normative Needs and the Sociodental Needs approaches.

Main findings:

i. For all types of dental treatment assessed, there was a reduction of treatment times required when using SDA compared to NN assessment. For restorative treatment, the reduction from NN to SDA for crowns was 11.8%. For periodontal treatment,

treatment times decreased from 25,403 hours (NN) to 4086.97 hours (SDA); a reduction of almost 84%. For prosthodontic treatment (Scenario II), the treatment times for dentures decreased by almost 90% and the treatment time for bridges decreased by almost 99% from NN to SDA.

ii. The number of dentists needed to treat 100,000 people decreased when using SDA compared to NN assessment. The decline was from 12.54 (NN) to 12.12 (SDA) for restorative treatment and from 14.43 (NN) to 2.32 (SDA) for periodontal treatment. For prosthodontic treatment (Scenario I) the number decreased from 10.26 dentists (NN) to 0.98 dentists (SDA) and for Scenario II the respective figures were 98.8 dentists (NN) to 2.49 dentists (SDA). These figures were calculated based on the minimum treatment time, annual working hours of 1760 and a cut-off CS-OIDP score of 0.

Objective 4: To review the potential for delegation of dental care from dentists to dental nurses and dental technicians based on the levels of complexity of normative dental needs.

Based on literature review and proposals made by Malaysian dentists and dental nurses, the dental procedures that can be delegated to dental auxiliaries include simple fillings (one and two-or-more surfaces restoration), scaling and polishing, root planning, provision of dentures, examination and diagnosis and oral hygiene education.

Objective 5: To estimate dental workforce requirements to meet the sociodental needs for a sample of Malaysian adults using different models of professional skill mix and to compare the findings when normative and skill mix approaches are used.

Main findings:

i. The number of dentists needed decreased and the number of PCDs increased when more dental tasks were delegated to dental nurses and dental technicians.

ii. Using Normative Needs model and minimum treatment times, the number of dentists needed to treat 100,000 people decreased from 144.17 in Scenario 1 to 125.77 dentists in Scenario 2, 123.69 dentists in Scenario 3, 111.79 dentists in Scenario 4 and 103.65 dentists in Scenario 5.

iii. Using Sociodental Needs model and minimum treatment times, the number of dentists needed to treat 100,000 people decreased from 31.14 in Scenario 1 to 16.93 dentists in Scenario 2, 23.08 dentists in Scenario 3, 19.58 dentists in Scenario 4 and 11.29 dentists in Scenario 5.

iv. Using Normative Needs model and minimum treatment times, the number of dental nurses needed to treat 100,000 people increased from 18.40 in Scenario 2 to 20.40 in Scenario 3, 23.62 in Scenario 4 and 31.76 in Scenario 5. When partial dentures were delegated (Scenario 3), the number of dental technicians needed was 0.08 per 100,000 people. When both partial and full dentures were delegated (Scenario 4 and 5), the number of dental technicians needed was 8.76 per 100,000 people.

v. When using the Full Skill Mix scenario (Scenario 5) the shape of the dental team changed into one that involved a higher number of dental nurses than dentists.

CHAPTER 6
DISCUSSION

Chapter 6

Discussion

6.1 Introduction

This chapter discusses the findings related to the two main aims of this study. They are: 1) to estimate and compare the dental treatment needs and dental workforce requirements of a sample of Malaysian university employees aged 30-54 years by using two different methods of needs assessment namely the traditional normative approach and the sociodental approach, and 2) to estimate workforce requirements to meet their dental treatment needs using a skill mix approach. There then follows a discussion on some methodological issues arising from this study and implication of the findings on workforce planning.

6.2 The comparison of dental treatment and dental wokforce requirements using Normative Needs and Sociodental Needs assessments.

The main findings were that there were significant differences in dental treatment needs and dental workforce estimates using the two approaches. The need for restorative, periodontal and prosthodontic treatments was much lower using the sociodental needs assessments compared to the normative needs approach. Tables 6.1 and 6.2 show the extent of the differences between sociodental need and normative need assessment for dental treatment and workforce estimates. The proportion of subjects that needed periodontal and prosthodontic treatment decreased by more than 90% when sociodental need assessment was used instead of normative need (Table 6.1). For workforce estimates, the percentage reduction between normative and sociodental assessments for periodontal and prosthodontic treatment (Scenario I and II) ranged from 85% to 97%. The respective difference in workforce estimates for restorative treatment was slightly lower because dentists were required to treat all subjects with restorative treatment need irrespective of the behavioural propensity level.

The difference in the number of dentists needed between normative and sociodental approaches was extremely high in Scenario II when both dentures and bridges were provided compared to Scenario I when only dentures were provided. This is because the proportion of people who had both normative need and oral impacts related to bridges was much smaller when compared to the respective estimates for dentures.

For dental health education / oral health promotion, the number of dentists needed would be higher by almost 500%, from a minimum number of dentists needed estimate of 1.03 when using only the normative assessment to 6.07 per 100,000 adults when using the sociodental approach. The reduction in the need for treatment and the increase in the need for dental health education demonstrate the orientation of sociodental dental needs assessment towards preventive oral health care.

Table 6.1: Normative need (NN), Impact-related need (IRN) and Propensity-related need (PRN) estimates for different types of dental treatment need *.

Type of treatment needed	Percentage of samples requiring treatment using NN, IRN and PRN assessments			Percentage differences between NN and SDA
	NN	IRN	PRN	
Crown	2.0	-	1.7	15.0
Periodontal	72.1	8.3	7.2	90.0
Prosthodontic				
i) Scenario I- Provision of dentures only	30.6	3.1	2.7	91.2
ii) Scenario II Provision of dentures/bridges	52.3	3.9	2.6	95.0

*Summary of Figures 5.1, 5.3, 5.5 and 5.7

Table 6.2: Normative need (NN), Impact-related need (IRN) and Propensity-related need (PRN) estimates for the number of dentists needed per 100,000 adults*.

Type of treatment	Minimum number of dentists needed per 100,000 adults			Maximum number of dentists needed per 100,000 adults		
	NN	SDA	% differences NN-SDA	NN	SDA	% differences NN-SDA
Restorative	12.54	12.12	-3.3	27.40	26.70	-2.5
Periodontal	14.43	2.32	-83.9	20.96	3.23	-84.6
Prosthodontic						
i) Scenario I- Provision of denture only	10.26	0.98	-90.4	26.26	2.44	-90.7
ii) Scenario II Provision of denture/bridge	98.8	2.49	-97.5	166.47	4.81	-97.1
Dental health education	1.03	6.07	+489.3	1.71	10.12	+491.8

*Summary of Tables 5.28, 5.30, 5.32, 5.34 and 5.36
(-) denotes decrease in percentages, (+) denotes increase in percentages

The findings in relation to the differences in dental treatment needs are consistent with previous studies comparing dental needs assessment for specific populations and age groups between the normative and sociodental approaches amongst children (Gherunpong et al. 2006a; Gherunpong et al. 2006b; Gherunpong et al. 2006c; Mtaya et al. 2008; Korwanich 2011), adult (Ryu 2006; Ryu et al. 2008) and elderly populations

(Srisilapanan and Sheiham 2001; Srisilapanan et al. 2003; Astrom and Kida 2007). All these studies found lower levels of need for dental treatment using sociodental approach compared to normative assessment for all different types of dental treatment. For example, for periodontal treatment needs, the differences ranged from 61% to 93% and for prosthodontic treatment it ranged between 70% and 95%. Although the criteria used to assess prosthodontic treatment need were different in previous studies on adult or elderly populations, the differences in the reductions between normative and sociodental approach were similarly large. This may be because different normative need criteria generally recommended that all tooth spaces due to missing teeth should be filled. This led to high prevalence of prosthodontic treatment need when assessed normatively. However, in most studies there were small proportions of people with oral impacts related to dental prosthesis. This explains the large difference between normative and sociodental assessment used in different settings.

The needs for crowns in the present study was similar to that in a Korean adult population, where the difference in needs between normative and sociodental needs assessment was 9.1% (Ryu 2006). Adulyanon (1996) found that the difference between impact-related need and normative needs for restorative and prosthodontic treatment in an adult Thai population differed by 38% and 66% respectively. That study also found a large difference between normative and sociodental approach for periodontal treatment need, a figure which is comparable to the current study as well as that of Ryu (2006). However, it is not appropriate to directly compare Adulyanon's findings to that of the current or Ryu's study because, although these studies were carried out on adult population, the sociodental needs assessment system was not well developed when Adulyanon's study was done.

Amongst studies that have used the sociodental approach to assess dental treatment needs, only Ryu (2006; 2008) used the estimates to calculate the number of dentists needed to treat a population. She then compared the workforce estimates between the normative and sociodental approach. Ryu's study was carried out on a sample of 30-64 year old adult population who were a subsample of the 2003 Korean National Oral Health Survey sample. That study used the WHO (1997) criteria to evaluate prosthodontic treatment need and those criteria are different from the one used in the current study. In addition, the annual working hours of dentists used by Ryu were not similar to those in the current study. The current study generated its own prosthodontic criteria based on recommendations from the literature and used 1760 hours working annual hours based on recommendations from the Malaysian Ministry of Health. Furthermore, the current study used three different CS-OIDP thresholds for determining oral impacts and two different sets of propensity criteria, thereby expanding on the aforementioned Korean study.

Despite these differences, the Korean study is the closest methodologically with this one and therefore it is feasible to attempt comparisons. Ryu (2006) found that the number of dentists needed for restorative treatment decreased from 8.8 to 6.6 per 100,000 people, a reduction of 25%. In the current study the decrease was 3.3%. The reason for the difference between the estimates was that Ryu did not consider root canal treatment for those with poor health behaviour while in the current study, root canal treatment was included regardless of behavioural propensity level because it was considered that people with non-vital teeth needed treatment whatever their health behaviour. However in both studies the sociodental approach indicated comparable lower estimates in terms of workforce requirements. The dentists needed to treat periodontal disease in the

Korean study decreased from 22.5 (normative) to 2.7 (sociodental) and for prosthodontic treatment from 87.1 (normative) to 18.9 (sociodental) (Ryu 2006; Ryu et al. 2008). This was a reduction of 88% and 78% respectively compared to 90% and 95% in the Malaysian sample of the current study.

The findings from this and other studies that have used the sociodental approach indicate that normative needs assessment yields unrealistic estimates of dental treatment needs and workforce requirements. The treatment needs assessed using normative assessment were very high and the associated cost of providing all dental care necessary will most probably be beyond the human and financial resources of most countries (US Department of Health 1998; Yee and Sheiham 2002; Widstrom and Eaton 2004; Petersen et al. 2005). More importantly, and apart from the economic reasons mentioned above, the sole use of normative need assessment is also conceptually inappropriate as it does not incorporate the broader measurement of health and needs which include the assessment of subjective impact of oral conditions on the quality of life of people.

Studies that have compared dental treatment needs using normative and sociodental approaches have found that there were large differences between normatively assessed needs and people's oral impacts on daily living. In the current study, of the 63% people considered as having normative needs for periodontal treatment, only 8.3% reported having an oral impact related to their periodontal condition (Figure 5.3). Similarly for the need for dentures in the current study, of the 30.6% who had a normative need, only 3% had oral impacts related to having missing teeth (Figure 5.5). The reason for the large differences between normative and sociodental approach may be partly due to the fact that normative assessments do not consider factors that might influence treatment need such as subjective measures of function and social impacts arising from oral diseases (Locker 1988; Kay 1993; Gilbert et al. 1994; Leles and Freire 2004; Sheiham and Tsakos 2007). However, caution is needed when associating epidemiological findings with the actual clinical situation. Participants in epidemiological studies differ from those attending dental clinics. Patients seeking treatment at dental clinics usually have some oral impacts arising from their oral conditions (Gilbert et al. 1994; Adams et al. 1997; Chisick et al. 1997; Atchison and Dubin 2003). Therefore the differences between the normative needs assessed by dentists and perceived oral impact reported by patients found in dental clinics might be smaller compared with the findings from epidemiological studies. In addition, the cross-sectional method used in the current study is vulnerable to several types of bias. Selection bias occurs when there is a difference between the characteristics of the people who participated in the study and the characteristics of those who did not (dos Santos Silva 1999).

The findings of this study may have been influenced by the exclusion of non working adult population. Different findings could be obtained if non-working adults or adults living in the rural areas were included as evidence has shown that the less educated and lower income individuals are more likely to have needs for treatment and to report impact from their oral condition (Ministry of Health Malaysia 2004; Fuller et al. 2011; Steele and O'Sullivan 2011). All these factors could reduce the differences between normative need and reported oral impact. Furthermore, the samples in the current study differ from the Malaysian population (Table 5.2) and this limits generalization of the findings to the adult population in Malaysia. If the differences between normative and sociodental assessments found in actual clinical situation are smaller, the number of dentists needed to treat according to the sociodental approach would be higher than reported.

Studies have shown that there were weak correlations between normatively assessed oral health conditions with self-reported gingival health (Brunswick and Nikias 1975; Tervonen and Knuuttila 1988; Kallio et al. 1994; Gilbert and Nuttall 1999; Ostberg et al. 2003; Vered and Sgan-Cohen 2003; Blicher et al. 2005) and subjective assessment of dental prosthesis need (Tervonen 1988; Tervonen and Knuuttila 1988; Meeuwissen et al. 1995; Nevalainen et al. 1997; Colussi et al. 2009). People are often unaware of having periodontal disease as it is a chronic and mainly symptom free and painless condition (Henry and Sinkford 1979; Lang 1984). Having severe periodontal attachment loss with deep periodontal pocket may cause loosening of teeth and then negatively affect quality of life. However this severe form of periodontal disease only occurs in 5% to 15% of people in many countries (Albandar 2002; Baelum and Scheutz 2002; Sheiham and Netuveli 2002; Dye 2012). Likewise in the current study the proportion of subjects with periodontal pockets was small; 11.9% had periodontal pockets between 4 to 5 mm and 2.6% had pockets more than 6 mm depth (Section 5.3.2). Prevalence of periodontal pocketing in this study was slightly lower than national Malaysian estimates which were 20% for shallow pockets and 5.2% for deep pockets (Ministry of Health Malaysia 2004). In the UK, 45% of adults had evidence of periodontal pockets, but only 8% had pocket depths of more than 6 mm (White et al. 2011). The higher estimates found in both Malaysia and the UK compared with the current study may be due to the inclusion of older age groups who have higher prevalence of deep periodontal pockets in the national surveys.

Despite evidence that there is a small proportion of population with severe periodontal disease (Baelum et al. 2007), workforce estimates for treating periodontal disease have always been based on the crude prevalence of the diseases which consists mainly of people having gingivitis and calculus, conditions that are usually symptomless and do not cause loss of function and have little or no impacts on quality of life. The provision of scaling to those with calculus but without sociodental impacts and/or with low behavioural propensity could be questioned as calculus is not a direct cause of periodontal diseases (Sheiham 2002). In addition, there is limited evidence on the long term benefits of scaling and polishing procedures, particularly if subjects have poor toothbrushing habits. The professional removal of plaque should be limited as patient's home care has been shown to give the same results in the reduction of plaque (Beirne et al. 2007). Moreover the provision of repeated oral hygiene advice has the same effect in reducing plaque level as scaling and polishing procedures (Needleman et al. 2005). The contemporary 'burst theory' on the progression of periodontal disease indicates that most gingival inflammation does not progress thus further questioning periodic professional removal of dental plaque and calculus. However, subjects with gingivitis who do not have oral impacts should be provided with dental health education or oral health promotion to enable them to increase their propensity level and improve their periodontal health. Treatment and oral health education are also required for those with severe periodontitis with deep periodontal pockets regardless of whether they have an impact or not to prevent the progression of the disease. As there are different levels of severity in periodontal disease and because it is not possible to reliably predict progression of the condition, different levels of periodontal disease may be considered to be in a different sociodental model. For example, people with gingivitis, calculus and shallow periodontal pocket may follow the pathway of the Basic Model for Dental

Treatment (BMDN) as it is unlikely for the condition to progress or worsen. People with deep periodontal pocket may follow the Dental Treatment Needs for Life-threatening and Chronic Progressive Oral Conditions (DNLP) model as the condition could progress if early intervention is not provided. The abovementioned developments in theories on progression of periodontal diseases have important service implications in terms of determining who should get priority in treatment, the type of treatment needed and the appropriate type of workforce to treat periodontal condition.

The assessment of prosthodontic treatment has predominantly been based on professional judgment which feels that an incomplete dentition will result in functional deficits and dysfunctional disorders of the masticatory system. Dental prosthesis is often recommended for persons with less than 28 teeth to improve their function, enhance esthetics and improve psychological well-being. However, numerous studies have shown that people are able to perform well in life despite not having a full complement of teeth (Aukes et al. 1988; Witter et al. 1988; Witter et al. 1990; Witter et al. 1994; Rich and Goldstein 2002; Leles and Freire 2004). Patients with shortened dental arches have masticatory function, comfort and occlusal stability that is satisfactory to fulfill their needs (Witter et al. 1999).

Patients' subjective needs for denture is closely associated with the position of the lost teeth (Elias and Sheiham 1998). Adulyanon (1996) showed that the difference between normative need and impact-related need for missing anterior teeth was less than the difference for missing posterior teeth. This suggests that psychological and social impact arising from the loss of anterior teeth is higher than the respective oral impacts related to missing posterior teeth. The high level of disagreement between health professionals and lay people on the needs for dental prosthesis suggests that a sociodental approach should be adopted in assessing such needs as that approach takes into account both normative and perceived needs. This is supported by a study by Nevalainen and colleagues (1997) who assessed the need for replacement of complete dentures on 144 inhabitants of Helsinki using five different criteria. They found that the most justifiable replacement percentage was achieved when the dentist assessed treatment need together with the patient. Another important issue that should be considered in prosthodontic treatment planning is patients' preferences for treatment. This is related to patients' subjective perception, socioeconomic status, cultural factors (Leles and Freire 2004), issues related to access and cost (Narby et al. 2007; Leles et al. 2011) and technical concerns such as complexity and risk (Leles et al. 2011). Allen et al. (2001) observed that patients who received the treatment of their choice reported significant satisfaction with their dental prosthesis and improvement of their oral health-related quality of life compared to those who did not receive their preferred treatment option.

As indicated earlier, using a sociodental approach in oral health needs assessment shifts the treatment philosophy from one that focuses on clinical treatment to one that emphasizes prevention and health promotion. The current study demonstrates that the minimum number of workforce needed per 100,000 adults for dental health education (DHE) increased from 1.02 using normative approach to 6.07 if the sociodental approach is used (Table 5.36). The estimation of normative needs for DHE was made on the assumption that only 10% of dentists provide DHE to those who needed it. This was based on studies on smoking cessation practices in a dental clinic which showed that although more than 60% of dentists asked about patients' smoking status, less than 15% actively assisted patients to quit (Jones et al. 1993; Hastreiter et al. 1994; Brothwell and Armstrong 2004; Shelley et al. 2005; Crews et al. 2008; Saito et al. 2010). Evidence on the proportion of dentists' involvement on other DHE activities such as counseling about sugar and plaque control was less clear.

The DHE activity described here is not the standard generic advice that most dentists usually offer to patients in the clinic. Instead it refers to tailor-made dental health education that is provided based on each patient's characteristics. The information derived from the individual and the specific outcome of interest are then used to construct health messages matched to each individual's needs and psychosocial characteristics (Kreuter et al. 1999b; Wanyonyi et al. 2011). This customization is considered to increase patients' interest and positively affect their cognitive responses to dental health information (Stellefson et al. 2008). Cognitive responses stimulated by tailored health messages are significantly associated with subsequent behavioural intention and actual behaviour change (Kreuter et al. 1999a). Bull et al. (1999) reviewed studies that compared tailored to untailored health messages and found that tailored messages are more likely to be read and remembered, saved, discussed with others and perceived by receptors as interesting and personally relevant.

Systematic reviews on dental health education showed that it is not effective in producing sustained improvements in oral health (Schou and Locker 1994; Kay and Locker 1996; Sprod et al. 1996). On the other hand, a systematic review on face-to-face communication of tailored health messages demonstrated that the approach has a positive effect in enhancing health behaviours (Wanyonyi et al. 2011). The relevant meta-analysis confirmed a positive and long term effect of behaviour change with an overall effect size of 0.49 which indicates a moderate change in behaviour. In that review, only six studies were included and only two achieved a borderline positive effect, therefore its findings should be viewed with caution. Stellefson et al. (2008) pointed out that most studies that attempted to compare the effectiveness of tailored versus non-tailored messages may be criticised for potential Type 1 errors. In addition, this approach might not be cost-effective or suitable for addressing health problems for which awareness is low in the population. However, the review by Stellefson et al. (2008) consisted of studies on printed health education materials which are different from tailor-made health education delivered face-to-face in practice settings.

Despite the debate on the effectiveness of the different preventive approaches, both standard and tailor-made DHE are based on psychological theories and models which focus on changes in behaviour and lifestyle at an individual level (Watt 2002). Oral disease is related to social, economic, political and cultural determinants such as poor living, low education, lack of beliefs and cultural support (Petersen 2003). DHE alone, be it the standard practice or tailor-made, would not suffice to alter these underlying determinants of health and could instead increase oral health inequalities (Schou and Locker 1994). A complementary and strategic oral health promotion approach is thus needed to address the broader determinants of oral health through the adoption of the framework outline in the Ottawa Charter (Watt and Sheiham 1999; Watt 2005), the common risk factor approach (Sheiham 2000; Sheiham and Watt 2000; Watt and Sheiham 2012) and the whole population approach (Rose 1993; Sheiham and Watt 2000). Marmot (2003) considered that to change the individuals' behaviour one needs to change the environment. Focusing on the social determinants of health will improve health and satisfy some human needs (Doyal and Gough 1991).

6.2.1 A critique of health workforce models

Health workforce models that are primarily based on normative needs assessment, for example the Health Needs and the WHO/FDI JWG6 models, and models that are based on health targets set by health professionals for example the Service Target model, might not provide the true estimate of the number of dentists needed for a population. These models neglect subjective health perceptions that affect utilization of dental services (Lo et al. 2001) and fail to appreciate the importance of including oral health behaviours that affect the success of treatment. People who have low propensity should be supported through various oral health promotion activities to improve the outcomes of treatment. Wastage of resources will occur if re-treatment is needed to those who fail to comply with dental health advices.

Health workforce models that neglect to assess perceived needs provide unreasonable workforce estimates. The Manpower to Population Ratio method (Hornby et al. 1980), has numerous limitations (discussed in detail in Section 2.3.4). In Malaysia, the dental workforce target was set at the ratio of one dentist to every 4000 population by the year 2020 (Krishnamoorthy and Navaneetham 2006). As there was a perceived shortage of dentists in Malaysia, the government made efforts to increase the number of dentists including the establishment of seven new dental schools (Malaysian Dental Council 2006). The student intake of the three established public dental schools was also increased. This sudden increase in the number of dental schools and dental student intake mirrored the action taken by American, European and Scandinavian countries in the 1960s when they observed a shortage of dentists to meet the increasing demand of the population. However in the following decades, in view of oversupply of dentists which led to increased rate of dentist unemployment and underutilization in those countries, actions were taken to reduce the supply of dentists (Special Committee on the Future of Dentistry 1984; Moore 1986; Chaudhry and Scully 1988). Consequences of dentist oversupply include a decrease in salary, decrease in treatment fees, increased competition among dentists, decrease in employment possibilities for auxiliaries and dentist substituting their free time doing auxiliaries' work (Harrison-Stewart et al. 1984), overtreatment and unnecessary dental treatment (Schanschieff et al. 1986).

Having a high number of dentists does not necessarily mean that all needs and demands will be met. Despite having the highest dentist to population ratio amongst the European countries, Greece still has problems of access to dental care (Damaskinos and Economou 2012). In the USA, the ratio is high at one dentist to 2242 people (FDI 2007), but children especially those from low poverty areas still have large unmet dental care needs (Vargas et al. 1998; Newacheck et al. 2000). This shows that the ratio method is not the best measure of adequacy of dental services. In fact, supplier induced demand could occur in areas with high dentist to population ratio whereby dentists initiate demand and utilization by increasing the patients' demands and the amount of care provided per patient (Grytten 1992). Studies have shown a positive association between dentist to population ratio and demand for dental services (Birch 1988; Grembowski and Milgrom 1988; Grytten et al. 1990; Grytten 1992). Patients in areas where dentists were abundant received more treatment compared to patients living in low supply areas (Birch 1988). It is unclear whether the increased amount of treatment received will benefit the patients more, and if so, whether the value of the benefit would be lower than the opportunity cost (Birch 1988; Grytten 1992).

Health care budgets will always be limited, so prioritization is important to ensure that only interventions justified by scientific evidence are provided. The estimation of dental workforce requirements should reflect the populations' actual needs and demands and their ability to achieve maximum health gain. This could be facilitated through the use of the sociodental needs assessment approach. There may be conflicting views amongst both the dental profession and the public regarding decisions taken to prioritize needs. Dentists may feel that they have an ethical obligation to render treatment to all those who need or demand it, whatever the evidence of effectiveness and wants of the public; while some members of the population may feel that the policies of restricting dental needs based on health related behaviours are poor. Thus they may feel the professional decisions are too judgmental and discriminatory. Policy makers need to make clear that only intervention that brings about benefit to oral health and gives a health gain should be provided. People who need these effective treatments but were considered as having low propensity towards the intervention should be given health education to change their behaviours to a level appropriate to their treatment need. A clinical guideline or service protocol that provide reliable and valid information about the efficacy, effectiveness and efficiency of dental care interventions should be developed and disseminated to health professionals and members of the public so that they understand why certain treatment are not provided because of the inadequacy of the patient's health related behaviours. Such a practice is in line with good dental care provision as it focuses on the outcome of interventions.

6.2.2 Dental workforce required to treat a sample of Malaysian adults

The dental workforce required to treat a sample of Malaysian adults through the use of the sociodental approach reported here is the number of dentists needed to initially provide treatment to subjects with the highest priority of needs (Table 5.36). When individuals with Impact-Related Need but with low behavioural propensity change their health behaviours, more workforces will be needed to treat them. That has been accounted for in this study (Table 5.38). However, this calculation was based on the assumption that this low behavioural propensity group needed only one session of tailor-made DHE. If more DHE sessions were needed to increase their propensity for treatment, an additional number of dental workforces would be required.

Subjects who had normative needs for dental treatment but had not experienced any oral impacts would initially need DHE if their behaviour is poor. The workforce needed for this and for their future treatment needs, if their oral conditions or their experiences of oral impact changed, should be projected. The main aim of this study was to demonstrate the difference of dental workforce needs when normative assessment is compared with the sociodental approach at a single point in time. Hence, the workforce required for this group or the projected possibility of any new increment or recurrent of dental diseases or the needs for replacement in any previously failed dental interventions was not considered. However, the sociodental approach is designed to be flexible enough to adapt to such situations.

6.3 The estimation of workforce requirements for a sample of Malaysian adult using different skill mix models

The second aim of this thesis was to estimate workforce requirements to meet the dental treatment needs of a sample of Malaysian adults when different skill mix models were used. As expected, the findings showed that the required number of dentists decreased and the required number of Professionals Complementary to Dentistry (PCDs) increased when more dental tasks were delegated to dental nurses and dental technicians. When the sociodental approach was used and dental procedures were delegated to the PCDs, the need for dentists decreased significantly for each skill mix scenario between the normative model and sociodental model, ranging from 78% to 89% lower estimates (Table 5.42). Dentists' time gained through delegation of care could be used on providing complex dental treatment or activities that will maximize their use of skills as team managers and leaders.

Previous studies have shown similar decreases in the requirements for dentist time if appropriate dental care is delegated to PCDs. Looking at data on treatment provision for 850 patients at 17 selected dental practices in the UK, Evans et al. (2007) showed that if PCDs were permitted to undertake simple and intermediate restorative interventions, 43% of dentists' time would be saved and if PCDs undertook diagnostic and treatment planning tasks, saving of 58.3% of clinical time could be made. They also found that only 27.5% of dentists' time was dedicated to complex restorative care while most of their time was devoted to routine procedures such as examinations, scaling and simple restorations. A similar survey undertaken by the American Dental Association (2007) showed that 75% of dental procedures could potentially be delegated to PCDs. In the Public Dental Services in Norway, the PCDs provide reversible dental care to children aged 5 to 18 years old. If PCDs also performed first line-services (or upward referral) and only referred to the dentists children whom they were not qualified to care for, 44% of dentists treatment time would be saved (Wang 1994). In the Netherlands, delegation of basic preventive and restorative care to PCDs would decrease the need for dentists by 20% (The Institute for Research of Public Expenditure 2006).

The skill mix scenario used in this study is modified from Gallagher and colleagues (2010). Modifications were made related to the range of duties delegated to PCDs in each scenario in order to suit the local situation. For example, in Gallagher's study, some dental tasks were already being delegated in the 'baseline scenario' and dental technicians were also assumed to be involved in performing examinations in the 'upward referral scenario' as that was already standard practice in the United Kingdom at that time. As Malaysian PCDs have never treated adults, no delegation of tasks was made in the baseline scenario for the current study. Gallagher (2010) showed that the number of dentists needed to meet future needs of older people in England in 2028 decreased from 8,668 using a 'no-skill mix scenario' where no dental tasks are delegated, to 5277 dentists using the 'opening door scenario' where PCDs provide examinations, preventive care and simple periodontal treatment. When PCDs are required to undertake the aforementioned care plus the provision of all dentures in the 'maximum skill mix scenario', the number of dentists needed dropped to 2623. The need for PCDs increased from 4328 in 'opening door scenario' to 7714 for the 'maximum skill mix scenario'. Gallagher's findings and those in the current study were similar in terms of the reduction of the requirements for dentists and the increased need for PCDs when skill mix models are used. However it is not possible to directly compare the results as Gallagher's study used predicted demand for assessing requirements for treatments while the current study used need assessment method. In addition, Gallagher used an operational research method to assess varying competencies for each scenario at two different points in time, while the current study's comparisons are cross-sectional.

The findings in this study provide evidence that there is a significant potential for delegation of dental tasks from dentists to PCDs in Malaysia. The number of PCDs needed depends on how much care is delegated to them. The proportion of workload defined as 'simple task' or 'routine dentistry' is high especially for periodontal care. The need for simple fillings and scaling and polishing is substantially higher than the needs for complex periodontal treatment, crown or endodontic (Table 5.15 and 5.19). However, the results of this study are based on the assumption that PCDs are able to perform all care delegated to them. In reality, such an assumption can be questioned as there will be medically compromised patients with simple dental treatment needs or patients with a combination of simple and complex treatment needs that are outside the range of PCDs clinical roles. Such patients will be more appropriately and cost-effectively treated by dentists (Gallagher et al. 2010). Nevertheless, this study provides a rough estimation on the proportion of dental care that is within the range of the PCDs' duties and the number of PCDs needed to carry out the care. In real life, there is a need to develop effective diagnostic and referral procedures to ensure efficient delegation of care from dentists to PCDs.

The composition of the dental team depends on the range and level of care delegated to the PCDs. An ideal structure of a country's health workforce supply is a pyramid shaped where the apex consists of highly trained health professionals, the central is occupied by middle level health workers and the base comprises trained auxiliaries and other health personnel (Hall 1969). This shape is attained in this study using the 'full skill mix scenario' in the sociodental model where the number of PCDs needed is higher than the required number of dentists. A similar finding is also shown by Gallagher and colleagues (2010) where more PCDs were needed than dentists when skill mix was fully utilized. They also found that the maximum skill mix scenario will require the largest number of personnel. Yet, this ideal shape of a health care team is not the vision of most countries. When there is a perceived shortage of dental workforce, the preferred remedy is to find solutions on how to train more dentists in the system. Similarly, when there is an oversupply of dental personnel as occurred with the decline in the UK and New Zealand, instead of decreasing the numbers of dentists being trained, schools for dental nurses were closed in the UK and there were fewer dental nurses trained in New Zealand (Nash et al. 2012). This could be due to the popular misconception that the health status of a country is determined by the number of doctors available (Hall 1969).

Interestingly, a different and radical approach was taken by the Netherlands to address the scarcity of dental workforce. Rather than increasing the production of dentists, they have reduced it by 20% and instead increased the production of PCDs (Heuvel 2009, cited in Nash et al. 2012). Changes in the dental epidemiological and population demographics in the Netherlands assured health planners that increasing the number of health workforce to solve the problem is not sufficient, a change in the way oral health care is delivered is also essential. The new system requires that patients are cared for by health professionals that have been trained specifically for the needed treatment. Dentists in the Netherlands are now required to focus on general diagnosis, coordinate overall patients' care and perform complicated dental tasks, supported by PCDs who will provide basic care and prevention of oral diseases.

Changes in the pattern of oral disease occurred not only in the Netherlands but also in most other countries (Petersen 2003; Treasure 2004; Petersen et al. 2005; Baelum et al. 2007). Globally, oral diseases trends have shown a dual pattern with need for minimal simple intervention amongst mostly younger cohorts and complex dental treatment need amongst mostly the older cohorts who might also have complex medical problems (Barmes and Tala 1987; Gallagher and Wilson 2009). Comparison between the recent (2009) and the earlier (1998) Adult Dental Health Survey showed a decline in coronal caries and the prevalence of shallow periodontal pockets but an increased in the prevalence of deep periodontal pockets amongst adults in England (White et al. 2011). The oral health of adults below 45 years old in the UK has markedly improved compared with the previous generations. It is predicted that the overall oral health of the adult population will improve in the future, however the 'baby boomers' will still need complex dental care as they age (Steele et al. 2011). In the USA, although there have been dramatic improvements in oral health, some population groups, such as the elderly, ethnic minority children, people with disabilities and complex health conditions and people without knowledge and access to oral health care, still had low levels of oral health (US Department of Health and Human Services 2000).

Strategies need to be put forward to address those changes in oral health needs and the problem of access to dental services. The role of the PCDs should be expanded especially in low-income and rural settings to enhance access to care. Dentists should be trained as oral physicians to allow them to cope with increasing number of patients with special needs (WHO 1992; Gallagher and Wilson 2009). Suggestions have also been made to expand dentists' role in primary health care activities such as screening for hypertension and diabetes, obesity intervention and smoking prevention and cessation as this will provide opportunities for placing dentistry in the broader health care environment (Lamster and Eaves 2011). The sociodental model of needs assessment emphasise that care should include the prevention of oral diseases and hence dentists should take a greater role in health promotion activities and work as oral health advocates to tackle the social determinants of health. These changes in the role of dentists should be complemented with the expansion of PCDs' clinical and health promotion roles. With comprehensive additional training, PCDs should be able to undertake the provision of minimal simple intervention and at the same time put emphasis on clinical prevention.

Unfortunately, the practice of team working in dentistry has hardly changed since the 19th century. It is still lagging behind the field of medicine where the use of clinical auxiliaries has spread in both primary and secondary care environments (Brocklehurst and Tickle 2011b). As dentistry is a business entity for private practitioners, the uptake of PCDs is probably slow because evidence on the cost-effectiveness of their utilization in dental practice is not convincing (Hay and Batchelor 1993; Harris and Haycox 2001; Gallagher and Wright 2003; Ross et al. 2007). Another reason for the slow uptake of the skill mix idea is probably due to dentists' attitudes towards protecting their professional role, their lack of knowledge of the roles and responsibilities of the PCDs, reservation about PCDs clinical skills and lack of experience of working as a team with other health auxiliaries (Jones et al. 2007; Ross et al. 2007; Edmunds and Tane 2011a). This negativity is more towards the provision of care by PCDs to adults than to children (Nash et al. 2012). This issue could be resolved if both dentists and PCDs were trained together in the same learning environment. This would develop mutual understanding and respect towards each other's roles and skills at an early stage. There is also a need to establish appropriate career pathways and remuneration for both dentists and PCDs to ensure that skilled members are recruited and retained (Baltutis and Morgan 1998; Sibbald et al. 2004; Ayers et al. 2007).

6.4 Methodological issues

In this cross-sectional study, a total of 732 Malaysian adult participated in the examination and interview process. As the study was carried out only in an urban setting, the generalization of the findings to the whole population is limited. The comparison of the subjects in this study with the Malaysian population showed that there was a selection bias towards the Malay ethnic group and an under representation of those age between 35 to 44 years old (Table 5.2). The university is a government agency and under the Malaysian government affirmative policy, 50% of governmental jobs are reserved for the Malays (Husna 2009). Constraints on budget and time prevented this study from expanding to other working sectors. The distribution of the samples in this study is nevertheless representative of the university staff population in terms of gender and age. The majority of the subjects were secondary school leavers with incomes between Ringgit Malaysia 1501 to 3000. This is probably because the data collection was conducted during students' long semester break when most academics and executives were either on leave or busy with work-related commitment outside the university. In the initial development of the study, collaboration with the team of the Malaysian National Survey of Adult (NOHSA) was attempted to obtain a more representative sample. However, the plan had to be abandoned as the NOHSA team would only allow the dissemination of self-administered questionnaires to their participants.

The estimation of the required number of PCDs was made on the assumption that the time they take to perform the different dental treatments is similar to dentists. The data received from the Ministry of Health on the time taken by its oral health staff to perform dental treatments did not include data on dental nurses. Dental nurses in Malaysia can only legally treat children up to the age of 17, so it was not possible to accurately obtain the time that they would take to perform various treatment items on adults. In Thailand, dental nurses took less time than dentists to perform restoration and extraction on permanent teeth and scaling and polishing on children (Korwanich 2011). However, those figures were based on estimates provided by dentists and dental nurses and thus may not be accurate. If the treatment times for dental nurses in this study were different from the dentists, the estimate of the required number of PCDs would change. An increase in the treatment time taken by the PCDs would increase the number of PCDs needed to perform the treatment, and vice versa. This could subsequently alter the shape and the magnitude of the dental team. In the future, it may perhaps be possible to get a rough estimate of the time taken by the Malaysian PCDs in performing treatment on adults by assessing their performance on 17 year-old patients who are closer to adults from the ages treated by PCDs in Malaysia. This was not considered during the planning of this study as it was assumed that the data from the Ministry of Health, obtained at the later stage of data collection, would consist of the treatment times taken by both dentists and PCDs.

The literature review was based on a conventional approach and scientific publications were searched, summarized and synthesized in a non-systematic and explicit manner. A 'citation searching' technique was mostly used where leads were followed from useful and prominent articles, books and reading materials. Searches were also performed on

PubMed and Medline databases using similar keywords with those of the relevant important scientific papers for this study. As expected, these keywords were specific for certain aspects of the study and they collectively covered all different concepts used in this research. However, the complete search strategy (with the exact combinations of keywords used) was not recorded systematically making it difficult to justify whether all relevant articles have been included. The lack of systematic structured approach adopted also might not support a comprehensive literature review as some important materials such as government, community organisations and institutions documents may be overlooked as they may not be indexed in these databases. Furthermore, the search was also limited to journals in English language subscribed by the University of London's library which further impose limits in the search strategy.

The strengths of this study is that it applies new concepts of assessing dental care needs used on selected samples that was not too different from a national sample, and the findings were applied to 100,000 people. The estimation of needs for dentists using the newly integrated system of needs should provide a more realistic estimate of workforce needs as it is based on normative and impact-related needs of a population.

The different cut-off points of the CS-OIDP score and the different criteria of assessing oral health behaviour used in this study should provide flexibility and options for health planners when deciding the volume of service provision. When resources are scarce it may be more relevant to limit the number of those in the highest priority group and this could be done using a higher cut-off point of CS-OIDP score and stricter propensity criteria. This would ensure that only those people who had the highest impacts on their daily performances and who are more likely to benefit from the interventions will be treated first.

It is difficult to justify conceptually the acceptable cut-off points or the description of the mean scores obtained from oral health-related quality of life measures. In the current study, the cut-off points were derived from the distribution of the OIDP scores. Most studies that assess patient outcome measures present their data in terms of mean scores or thresholds. That may not be meaningful as it does not provide valid measures of the relevance of the impact to the patients (Wyrwich et al. 2005; Copay et al. 2007; Tsakos et al. 2012). To overcome these shortcomings, the concept of minimally important difference (MID) was developed. The MID is a threshold value which can be used to judge if the scores obtained are meaningful or important to the patients, or in other words, whether they are clinically significant (Wyrwich et al. 2005; Copay et al. 2007; Tsakos et al. 2012). This is important in the assessment of health needs as it could be used as a meaningful threshold whereby higher scores would indicate excessive oral impacts. Until now there has been no consensus on the acceptable threshold value for MID (Norman et al. 2003). If available, such a score could also be useful for determining an alternative cut-off point for oral impacts.

This study also developed three different criteria for assessing prosthodontic treatment needs based on recommendations from the literatures. The WHO (1997) has developed criteria for replacement of missing teeth however it has not been universally accepted. Health planners may choose the prosthodontic scenario that would best present their country's oral health budget and treatment goals. In Malaysia, both dentures and bridges are being provided, therefore the criteria used in Scenario 2 is more appropriate. At this moment, very few, if any, countries would be able to provide dental implants to all those who needs replacement of missing teeth as proposed in Scenario 3. However in the future, there may be more dentists with skills and knowledge to provide dental implants and the evolution of technology might possibly make dental implants more affordable. In addition, the five different skill mix scenarios presented in this study can give health planners a sense of the number and composition of dental workforce that is required when dentists delegate some of their routine dental tasks to other personnel. The choice of the appropriate skill mix model will depend on the number of available dentists and PCDs, the possibility of expanding the PCDs role and the legislation or regulation related to it, the acceptability of the dentists and patients regarding the provision of treatment by the PCDs and oral health care budget.

6.5 Conclusions

Based on the aims and objectives of this study, it can be concluded that:

1. There were significant differences in the estimates of dental treatment needs between Normative Needs (NN) and Sociodental Needs (SDA) assessment. The percentage differences between NN and SDA for periodontal and prosthodontic treatment ranged from 90% to 95%.
2. The number of dentists needed for clinical intervention decreased when sociodental needs assessment was used compared to normative needs approach. However for dental health education / oral health promotion, the number of dentists needed increased by 500% when sociodental approach was used. This indicates that sociodental needs assessment could shift the philosophy of health care provision towards prevention.

3. There is a potential for delegation of dental care from dentists to PCDs. The number of dentists decreased and the number of PCDs increased when more dental tasks were delegated to the PCDs. Using the sociodental model and the Full Skill Mix scenario where all the tasks that the PCDs were able to do were delegated, the shape of the dental team changed into one that involved higher number of dental nurses than the number of dentists.

6.6 Implications of the findings and recommendations for future research

6.6.1 Implications for workforce development

1. In determining the number of dental workforce, the choice of health workforce planning model is important to ensure that the supply of workforce is appropriate for the population's actual needs and other available resources. The sociodental needs method provides a more appropriate estimate of workforce needs and should be applied in national oral health surveys to prevent any imbalance in future workforce estimates.
2. Planning of dental workforce should consider the potential of substitution between dental health professions. Changes in the pattern of dental diseases indicate the need to reassess the future role of dental workers. Dentists should spend more time providing treatment to an increasing number of individuals who have complex dental needs or are medically compromised. They should be supported by dental auxiliaries who should provide basic dental care and minimal simple intervention.
3. There is a need to develop dentists' skills and knowledge that would allow them to function as effective oral health advocates. The oral health care system should

encourage this shift by providing appropriate incentives and better remuneration to staff involved in health promotion activities.

6.6.2 Implication for future research

1. Previous studies comparing the dental treatment needs using normative and sociodental assessment have mostly been conducted on Asian countries. It would be interesting to apply the sociodental approach in other continents and to assess whether the differences in needs are similar as those in Asian countries.
2. The use of cross-sectional method in this study limits the assessment of the changes in oral impacts or health gain when dental treatment is provided to those in the high priority group or when dental treatment is not provided to lower priority groups. In future, longitudinal studies should be conducted to assess the differences in the estimation of needs using the sociodental approach.
3. This study did not consider any health economic appraisals of needs assessment. Health economic issues such as willingness to pay or health utilities might affect utilization of services. These economic aspects should be considered in future studies and be integrated into the sociodental approach to acquire a more comprehensive needs assessment system.
4. As this study was carried out on a non-random urbanized working adult population, it was not possible to generalise the findings to the Malaysian population of adults aged 30 to 54 years. Further studies should be conducted on different section of the populations for example non-working adults, adult populations in rural areas, child and elderly population. A stratified and randomized sampling strategy should be adopted to improve population representativeness in the study and subsequently allow future generalisation of

the findings. Efforts must also be made to maximize response rate and reduce non-response bias.

5. Future research should look into the potential for implementing this new conceptual approach towards need assessments presented in this study in oral health care planning. This implies incorporating and operationalizing the sociodental approach into standard practice and procedures. With that in mind, a key piece of future work would be to conduct a professional dialogue amongst key oral health planners and both private and public dentists with the aim to identify the barriers that would be faced in implementing this evidence-based needs assessment system. The inclusion of these key stakeholders is important as they are in a position to influence or oppose changes in the policy. In essence, it requires a planned and structured process to manage change from the current outdated model of needs assessment to incorporate a more relevant approach to needs assessment into the planning process for service provision and workforce requirements.

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APPENDICES

Appendix 1

Linguistic translation and cultural adaptation of the OIDP index

The linguistic translation involves several steps as described below:

Step 1: Analysis of the original instruments with the developer of the OIDP index and the research team. Potentially problematic items were identified. This is important to prevent the likelihood of misinterpreting further certain items.

Step 2: Forward translation process in which the English version of the OIDP questionnaire was translated into the Malay language by two independent translators. The first translator is a senior lecturer at the Social Preventive Medicine Department, Faculty of Medicine, University of Malaya and has some experience in the research fields concerning health-related quality of life. The second translator is an accountant lecturer at a private university who teaches English part time at a private tuition centre. Both translators, who is one a Malay and another a Chinese, are fluent in both the English and Malay language. It is important to have different ethnicity involve in this process to ensure that the translated Malay version would be understood by all races. The translators were briefed about the purpose of the work and guidelines on the translation were given. The translators worked independently at this stage. When both individual work were received and compiled, a reconciliation session was held where both the forward translators and the investigator met and decided on the agreed final Malay version of the OIDP. Some of the problematic words are:

Original - English	Translator 1	Translator 2	Agreed final version
Difficulty in carrying out your major work or role	Kesukaran untuk membuat kerja hakiki	Kesukaran dalam menjalankan kerja atau fungsi utama	Kesukaran dalam menjalankan kerja atau peranan utama
Problems in enjoying the contact of other people, such as relatives, friends or neighbours	Masalah untuk menghiburkan hati dengan berhubung dengan orang lain, seperti saudara mara, kawan dan jiran	Masalah dalam menikmati kontak dengan orang lain, seperti saudara mara, sahabat atau jiran	Masalah dalam menikmati hubungan/kontak dengan orang lain, seperti saudara-mara, sahabat atau jiran
Position of teeth, for example crooked, projecting, gap	Kedudukan gigi, sebagai contoh herot, jongang dan jarang	Posisi gigi, sebagai contoh sengit, jarang	Kedudukan gigi, sebagai contoh herot, jongang dan jarang
Receding gums, periodontal disease	Gusi menyusut, penyakit berkaitan dengan tisu atau struktur gigi	Gusi menurun, penyakit periodontal	Gusi menurun, penyakit gusi

Stage 3: The reconciled forward translation was back-translated into English language by a retired associate professor in the field of education who has vast experience in translating documents in both languages. The same process as in the forward translation was carried out but this time the backward translator work solely to come out with a single back translated English version.

Stage 4: The back translated version was emailed to research team in University College London who consist of the developer of the original OIDP version and the supervisors of the project to get their comments on the translated English version. A report was prepared for them informing all the potential difficulties encountered during the process. Items that were problematic were brought into their attention.

Stage 5: Comments and suggestions made by the UCL research team were emailed back to the backward translator. The document went to and fro both the research team and the backward translator until mutual agreement were received from both the research team and the translator. The problematic items are as shown below:

Final forward translation	Forward translation	Developer's comment	Final forward translation version
Masalah untuk senyum, ketawa dan menunjukkan gigi tanpa malu	Problem in smiling, laughing and showing teeth without feeling shy	Could 'feeling shy' be replaced with self-conscious or shame?	Problem in smiling, laughing and showing teeth without feeling embarassed
Masalah dengan emosi yang tidak stabil sebagai contoh lebih mudah runsing berbanding biasa	Problem with unstable emotion for example feeling more worried than usual	Could the word 'feeling' be changed to 'incline to feel'?	Problem with unstable emotion for example incline to feel more worried than usual.
Tampalan atau sarung gigi (crown) yang sudah rosak, contohnya pecah dan berubah warna	Damaged filling or crown, for example broken and has changed colour	Could 'damaged' be changed to 'broken'?	Broken filling or crown, for example broken and has changed colour

Stage 6: The Malay OIDP index then underwent a cultural adaptation by testing the questions on 20 walk in patients at the main dental clinic and requesting comments from two dental public health experts.

Original document	**Forward Translation**	**Backward Translation**
1. Difficulty in eating food	1. Kesukaran untuk memakan makanan	1. Difficulties in eating
2. Difficulty in speaking clearly	2. Kesukaran untuk bercakap dengan jelas	2. Difficulties in speaking clearly
3. Difficulty in cleaning your teeth or dentures	3. Kesukaran untuk membersihkan gigi atau gigi palsu	3. Difficulties in cleaning your teeth or your false teeth
4. Difficulty in going out, for example to shop or visit someone	4. Kesukaran untuk keluar, contohnya membeli-belah atau melawat seseorang	4. Difficulties in going out, for example going shopping or visiting someone
5. Difficulty in doing light physical activities (such as household cleaning, cooking, walking)	5. Kesukaran untuk membuat aktiviti fizikal yang ringan (seperti mengemas rumah, memasak dan berjalan)	5. Difficulties in performing light physical activities (such as tidying home, cooking and walking)
6. Difficulty in carrying out your major work or role	6.Kesukaran untuk menjalankan kerja utama atau peranan utama	6.Difficulties in performing the main job or play the main role
7. Difficulty in relaxing (including sleeping)	7. Kesukaran untuk relaks (termasuk tidur)	7. Difficulties in relaxing (including sleeping)
8. Problems in smiling, laughing and showing teeth without embarrassment	8. Masalah untuk senyum, ketawa dan menunjukkan gigi tanpa malu	8. Problem in smiling, laughing and showing teeth without <u>feeling shy could this be self-conscious or shame</u> <u>* 'Self- conscious' is a better choice but 'shame' in inappropriate.</u>
9. Problems with emotional instability, for example becoming more easily upset than usual	9. Masalah dengan emosi yang tidak stabil, sebagai contoh lebih mudah runsing berbanding dengan biasa	9. Problem with unstable emotion for example <u>incline to feel</u> more worried than usual
10. Problems in enjoying the contact of other people, such as relatives, friends or neighbours	10. Masalah dalam menikmati hubungan/kontak dengan orang lain, seperti saudara-mara, sahabat atau jiran	10. Problem with enjoying relationship/contact with other people, such as relatives, friends or neighbours

Original – different condition	Forward translation	Backward translation
Toothache	Sakit gigi	Toothache
Sensitive tooth	Gigi sensitif/ngilu	Sensitive teeth
Tooth decay, hole in a tooth	Kerosakan gigi, gigi yang berlubang	Damaged teeth, caries
Fractured tooth	Gigi patah	Broken teeth
Tooth loss	Kehilangan gigi	Lost of teeth
Loose tooth	Gigi longgar	Loose teeth
Colour of teeth	Warna gigi	Colour of teeth
Position of teeth, for example crooked, projecting, gap	Kedudukan gigi, sebagai contoh gigi sengit, jongang dan jarang	Position of teeth, for example slanting teeth, buckteeth and gap
Shape or size of teeth	Bentuk atau saiz gigi	Teeth shape or size
Bleeding gums	Gusi berdarah	Bleeding gum
Swollen gums, gum abscess	Gusi bengkak, gusi bernanah	Swollen gum, pus in gum
Receding gums, periodontal disease	Gusi menurun, penyakit gusi	Receding gum, gum disease
Calculus, tartar	Karang gigi	Teeth tartar
Oral ulcer or sore spots	Ulser mulut atau tompokan yang sakit	Mouth ulcer or painful blister

Bad breath	Nafas berbau	Bad breath
Deformity of mouth or face eg cleft lip palate	Kecacatan pada mulut atau muka, contoh bibir dan lelangit sumbing	Mouth or face deformity, for example harelip and deformed palate
Clicking or grating noise in jaw joint	Bunyi 'klik' atau bunyi geseran di sendi rahang	'Click' sound or friction sound caused by jaw joint
Defective filling or crown eg broken, colour	Tampalan atau sarung gigi (crown) yang sudah rosak, contohnya pecah dan berubah warna	Broken filling or crown, for example broken and has changed colour
Loose ill fitting denture	Gigi palsu yang longgar	Loose false teeth
Orthodontic appliance, wires or bands for straightening teeth, braces	Alat, wayar atau band ortodontik untuk meluruskan gigi, braces	Device, Wires or Orthodontic band for straightening the teeth, and braces

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Ruj: UM.D/PD/211/09

Tarikh: 2 September 2009

Dr. Norintan Ab. Murat
Jabatan Pergigian Masyarakat
Fakulti Pergigian

Puan,

KELULUSAN ETIKA

Dengan hormatnya perkara tersebut di atas dirujuk.

Sukacita dimaklumkan bahawa Jawatankuasa Etika Perubatan, Fakulti Pergigian (JKEP) telah meluluskan projek puan bertajuk "Psychometric Properties of the Oral Impacts on Daily Performances (OIDP) in Malaysian Adult Population". Nombor kelulusan MEC projek tersebut ialah **DF CO0903/0041(L)**.

Sekian, terima kasih.

Yang benar,

PROF. DR. ROSNAH MD. ZAIN
Pengerusi
Jawatankuasa Etika Perubatan, Fakulti Pergigian

s.k. Dekan, Fakulti Pergigian
Ketua Jabatan Pergigian Masyarakat

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APPENDIX 3:

RESEARCH SCHEDULES- May 2010

Monday	10 May	17 May	24 May	31 May
	AM: Preparation PM: Faculty of Dentistry (Administrative staff)	AM/PM: Academy of Islamic Studies	AM/PM: Faculty of Languages and Linguistics	AM/PM: Faculty of Business and Accountancy
	Venue: Dept. of Community Dentistry	Venue: VIP Room, Block B Academy of Islamic Studies	Venue: GL25, Main Building	Venue: Room BS6, Block B

Tuesday	11 May	18 May	25 May	
	PM: Faculty of Dentistry (Administrative staff)	AM: Faculty of Science Computer PM: Academy of Malay Studies	AM/PM: Faculty of Built Environment	
	Venue: Dept. of Community Dentistry	Venue: VIP Room	Venue: Room BS4, Main Building	

Wednesday	12 May	19 May	26 May	
	AM/PM: Faculty of Engineering	AM: Centre for Foundation Studies PM: Institute of Graduate Studies	AM/PM: Faculty of Arts and Social Sciences	
	Venue: Room BS3, 2nd Floor	Venue: Room ADK2	Venue: Dean's Meeting Room	

Thursday	13 May	20 May	27 May	
	AM/PM: Faculty of Engineering	AM/PM: Faculty of Education	Research Committee Meeting	
	Venue: Room BS3, 2nd Floor	Venue: Room Cemerlang		

Friday	14 May	21 May	28 May	
		AM: Faculty of Medicine (Administrative Staff)	Public Holiday Wesak Day	
		Venue: Multipurpose Room		

RESEARCH SCHEDULES- JUNE 2010

Monday		7 June	14 June	21 June
		AM/PM: Faculty of Science	AM: 1st, 2nd and 6th College PM: 3rd, 4th, 7th, 8th, 10th College	AM/PM: Dept. of Development and Asset Maintenance
		Venue: Lecture Room 2	Venue: 2nd and 4th College	Venue: Meeting Room

Tuesday	1 June	8 June	15 June	22 June
	AM/PM: Faculty of Economy and Administration	AM/PM: Faculty of Science	AM/PM: Vice Chancellor's Office	AM: JPPHB PM: Centre for IT
	Venue: Room BS1	Venue: Lecture Room 2	Venue: Rumah Universiti	Venue: Meeting Room

Wednesday	2 June	9 June	16 June	23 June
	AM/PM: The Main Library	AM/PM: Faculty of Science	AM/PM: Vice Chancellor's Office	AM/PM: Faculty of Medicine
	Venue: Meeting Room	Venue: Room ADK2	Venue: Rumah Universiti	Venue; Multipurpose Room

Thursday	3 June	10 June	17 June	24 June
	AM/PM: The Main Library	AM: Sports Centre PM: 5th, 11th, 12th College	AM/PM: Registrar's Office	AM/PM: Faculty of Medicine
	Venue: Meeting Room	Venue: Meeting Room	Venue: Rumah Universiti	

Friday		11 June	28 May	
		AM: Security Office	AM: Security Office	
		Venue: Multipurpose Room	Venue: Multipurpose Room	

Appendix 4

Title of Project **Estimating Oral Health Manpower Requirements for treating Malaysian Adults**

This study has been approved by the UCL Research Ethics Committee [Project ID Number]:

Name, Work Address and Contact Details of the Principal Researcher and applicant

Norintan Abdul Murat
Department of Community Dentistry
Faculty of Dentistry, University of Malaya,
50603 Kuala Lumpur. No tel: 012-3990542

We would like to invite ………………………you…………. to participate in this research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

What is the purpose of this study?
The main purpose of this research is the estimate the oral health workforce (the number of dentists and dental nurses) required to treat the dental needs of the Malaysian adult population (age 30-54 years old).

What are the procedures to be followed?
This research will involve a clinical oral health examination and a questionnaire. A dentist will examine the health status of your mouth, which include the teeth, oral tissue and gums. The questionnaire will be asked through an interview style by our trained interviewer. You only need to listen carefully to all the questions that are posed to you and answer them honestly. You can ask the interviewer to clarify further anything that is not clear to you. You will be given feedback on your oral health condition and information on where to get further advice, if necessary.
If you agree to take part, you will be given this information sheet to keep and be asked to sign a consent form.

Who should not enter the study?
Those who are not Malaysian, and are below 30 years old or above 54 years old are not eligible to participate in this survey. Please inform the researcher if you have any history of rheumatic fever, valvular heart disease, endocarditis or joint replacement as although you are still eligible to participate, we will skip the assessment of your gum condition to prevent risk of infection.

What will be the benefits of the study:
(a) to you as a subject?
Directly, you will receive information on your current oral health status and indirectly the information that you give us will enable us to plan a better oral health service for you in the future
(b) to the investigator?
It will allow us to estimate the best approach and combination of oral health workforce to meet the oral health needs of Malaysian adult.

What are the possible drawbacks?
You might feel a bit of discomfort during the clinical examination of your mouth.

Can I refuse to take part in the study?
You can tell the dentist or the interviewer that you do not want or no longer want to proceed at the beginning, the middle or near the end of the session. However, as participation is anonymous it will not be possible for us to withdraw your data once you have left the data collection area. All data will be collected and stored in accordance with the Data Protection Act 1998.

Informed Consent Form for ………Adult………………………………… in Research Studies
(*define target group i.e. Parent/Guardian/Child/Teacher*)

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Project: **Estimating Oral Health Manpower Requirements for treating Malaysian Adults**

This study has been approved by the UCL Research Ethics Committee [Project ID Number:]

Thank you for your interest in taking part in this research. Before you agree to take part the person organising the research must explain the project to you.
If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you to decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Participant's Statement

I …………………………………………… Identity Card No: ………………………………..
of (home address) : ……………………………………………………………………………………

- have read the notes written above and the Information Sheet, and understand what the study involves.
- understand that if I decide at any time that I no longer wish to take part in this project, I can notify the researchers involved and withdraw immediately.
- consent to the processing of my personal information for the purposes of this research study.
- understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.
- agree that the research project named above has been explained to me to my satisfaction and I agree to take part in this study.

Signed: Date:

IN THE PRESENCE OF

Name ……………………………………..…..……..…

Identity Card No. ……………………….……..…… Signature …………………………
(*Witness for Signature of Patient)*

Designation …………………………….……………

I confirm that I have explained to the patient the nature and purpose of the above-mentioned clinical research.
Date ……………………………. Signature ………………………………………
(Researcher / Attending Doctor)

Appendix 5

Oral Health Examination Procedures, Code for Clinical Conditions and Treatment Needs and Oral Health Examination Form

General instructions:

1. Subject is to be examined on a portable dental chair and portable dental light
2. The examiner should be seated behind the subject and the recorder should be seated in front of the examiner so that examiner can ensure accuracy of entry.
3. When in doubt as to the presence or absence of a disease or condition, record it as absent.
4. For both periodontal conditions and dental caries, examination is to begin from the upper right sextant proceeding to the upper left, lower left and ending with the lower right.
5. Examination for periodontal conditions must precede examination for dental caries to avoid accidental gingival bleeding during caries examination.

Examination Procedures for Periodontal Condition

1. The dentition is divided into six sextants: 18-14, 13-23, 24-28, 34-38, 33-43 and 44-48. Index teeth that are examined are 17,16,11,26,27,36,37,31,46,47.
2. All 10 index teeth should be examined, but records are only made on 6 teeth. All periodontal condition that is observed should be recorded. For example, if bleeding, calculus and shallow pockets are observed on any of the tooth site, these signs should be recorded in the examination form.
3. A sextant should be examined only if there are two or more teeth present that are not indicated for extractions. If there is only one tooth or no teeth present, the sextant should be excluded.
4. A tooth indicated for extraction, either due to caries or periodontal conditions is excluded from CPI examination.
5. The two molars in the posterior sextants are paired for recording. If one is missing or excluded from examination, there is no substitution for the missing index tooth. The recording will be based on the remaining index tooth.
6. If no index tooth/teeth are present in a sextant or qualify for examination, all the remaining teeth in the sextant are examined and all periodontal condition that is observed (bleeding/calculus/pocketing) should be recorded. However, if the index teeth are missing and there is only one other remaining tooth, exclude the sextant. Distal surfaces of third molars should not be scored.
7. In the anterior maxillary sextant, if the index tooth 11 is absent or is excluded from examination, use 21 as its substitute. If 21 is also absent or excluded, then examine all the remaining teeth in the sextant (13-23).

8. Similarly in the anterior mandibular sextant, if the index tooth 31 is absent or is excluded from examination, examine 41. If 41 is also absent or excluded, then examine all the remaining teeth in the sextant (33-43).
9. False pockets due to non-inflammatory causes should not be recorded.
10. Probing should be done using WHO periodontal probe or CPITN probe. Probing should be carried out on at least 6 points around the tooth at the mesio-buccal, mid-buccal, disto-buccal, disto-lingual, mid-lingual and mesio-lingual points.
11. The sensing force should not be more than 20 grams. A practical test for establishing this force is to place the probe under the thumbnail and press until blanching occurs.
12. When the probe is inserted, the ball tip should follow the anatomical configuration of the tooth root. The probe should be moved gently with short upward and downward movements.

Coding for periodontal condition:

Codes	**Periodontal Condition**
0	No bleeding, calculus or periodontal pocket
1	Presence of bleeding
2	Presence of calculus
3	Presence of pocket with 4-5 mm depths
4	Presence of pocket with more than 6 mm depths
X	Excluded sextant
9	Not recorded

Coding for periodontal treatment:

Codes	**Periodontal treatment**
0	No treatment required
1	Oral hygiene instruction
2	Scaling and prophylaxis
3	Root planing
4	Complex periodontal surgery

Example of a recording: If a subject has bleeding and calculus on one of his index tooth, his periodontal condition should be recorded as ‘1,2’ and the type of treatment needed as ‘ 1,2’. If he has only shallow pocket without the presence of calculus or bleeding, his periontal condition should be recorded as ‘3’ and the treatment required as ‘1,3’.

<u>Examination Procedures for Dental Caries</u>

1. Only permanent teeth are to be examined. Supernumeraries or presence of deciduous teeth should be ignored.
2. The use of CPI probe and plane mouth mirror is recommended for coronal and root caries examination.
3. The recording of the each tooth status should be followed with the recording of the type of treatment required (if any).
4. Considerable care should be taken to diagnose tooth-coloured fillings that may be extremely difficult to detect.
5. A crown should be recorded as sound if it shows no evidence of treated or untreated clinical caries. A crown with white chalky spots, stained pits or fissures in the enamel, arrested caries that does not catch on probing, abrasion or attrition should be recorded as sound.
6. Caries is recorded as present when a lesion in a pit or fissure, or on a smooth tooth surface has an unmistakable cavity into dentine, with undermined enamel or softened wall or a detectable softened floor. A tooth that has temporary filling/dressing, dislodged filling and which has been sealed but carious should be recorded as decayed.
7. In cases where the crown has been destroyed by caries and only the root is left, the caries is judged to have originated from the crown.
8. For decayed root, caries is recorded as present when a lesion feels soft or leathery to probing with the CPI probe. If the root is discrete from the crown and will require a separate treatment, it should be recorded as root caries.
9. A crown/root is recorded as <u>filled with decay</u> when it has one or more restorations and also one or more areas that are decayed. A crown is also recorded as filled with decay if it has a partially dislodged restoration and the cavity is into dentine.
10. A crown/root is recorded as <u>filled, no decay</u> when one or more permanent restorations are present and there is no caries anywhere on the crown/root.
11. As it may be difficult to distinguish between permanent teeth that is <u>missing due to caries</u> or missing due to other reasons, an examination of the rest of the dentition or obtaining a dental history of the tooth from the patient should be undertaken to elicit the reason for the loss of the teeth/tooth.
12. Missing teeth replaced by bridge pontics are coded as 4 (missing due to caries) or 5 (missing due to other reasons) under coronal status, while the root status is scored '9' (not recorded).
13. Code 9 (not recorded) is used when a crown cannot be examined for any reason (hypoplasia, covered by calculus, etc) or when a root examination is not possible for any reason (tooth has been extracted or calculus is present to such an extent that a root examination is not possible).

Codes for crown and root caries status

Crown Caries Status	Root caries Status
0 = Sound 1 = Decayed 2 = Filled, with decay 3 = Filled, no decay 4 = Missing due to caries 5 = Missing, other reasons 6 = Fissure sealant 7 = Bridge abutment, special crown or veneer 8 = Unerupted tooth 10 = Trauma (fracture) 9 = Not recorded	0 = Sound 1 = Decayed 2 = Filled with decay 3 = Filled, no decay 7 = Implant 8 = Unexposed root 9 = Not recorded

Codes for Treatment Needs for Caries

Type of treatment required
0 = None P = Preventive, caries arresting care F = Fissure sealant 1 = One surface filling 2 = Two or more surface fillings 3 = Crown for any reason 4 = Veneer or laminate 5 = Pulp care or restoration 6 = Extraction

Prosthodontic Status and Treatment Need Assessment

Prosthodontic need assessment is based on using solely professional judgment (normative need). Three different scenario has been generated; i) Scenario 1: Provision of dentures only, ii) Scenario II: Provision of dentures and/or bridges, iii) Scenario III: Provision of dental implants. The criteria involved are different for each scenario.

<u>Scenario I: Provision of dentures only</u>:

For anterior segments (upper and lower jaws):

iv. The loss of one or more tooth/teeth in the anterior segment.

v. The need for extraction of one or more tooth/teeth in the anterior segment. (excludes loss due to orthodontic treatment).

vi. The space to be considered should be approximately the size of the corresponding tooth on the opposite side. If the space is less than this, it should be ignored.

For posterior segments (upper and lower jaws):

v. The loss of two or more teeth in any one segment.

vi. The need for extraction of two or more adjacent teeth in any one segment. This excludes loss due to orthodontic treatment.

vii. Loss of one tooth and the need for extraction of one or more tooth/teeth in any one segment.

viii. If the existence of any space is likely to lead to over-eruption of opposing tooth/teeth, or the drifting and/or tilting of adjacent teeth.

<u>Scenario II: Provision of removable dentures and/or fixed bridges</u>

In this scenario, a removable denture will be recommended if any of the following dental situations exist:

- Anterior edentulous spaces greater than 4 incisors
- Posterior edentulous space greater than 2 posterior teeth
- Edentulous spaces that include a canine and 2 other contiguous teeth (eg <u>/123</u>, <u>/234</u>, <u>/345</u>)
- Multiple edentulous spaces
- Bilateral edentulous spaces with more than 2 teeth missing on one side
- Edentulous space with no distal abutment

A fixed bridge is recommended under the following dental conditions:

- Posterior span of two or fewer teeth or anterior span of 4 or fewer
- Presence of distal abutment
- Good periodontal condition with no mobility

<u>Scenario III: Provision of dental implants</u>

In this scenario, all edentulous spaces will be filled with dental implants provided the surrounding periodontal tissues and bone are healthy. The number of dental implants depends on the site of the edentulous spaces. For implants in the aesthetic zone, usually only two implants are required. For posterior edentulous spaces, the number of implants depends on the number of teeth missing- one implant for each missing tooth (Jivraj and Chee 2006). For edentulous maxilla, about 4-8 implants are recommended depending on the type of implant provided (Jivraj, Chee and Corrado 2006). In the case of edentulous mandible, about 2-6 implants are required depending on the type of implant provided (Chee and Jivraj 2006).

Codes for Prosthesis Status:

1. Codes for denture status

0	Not wearing any denture
1	Wearing partial denture
2	Wearing full denture
3	Full denture, not using
4	Partial denture, not using

2. Codes for bridge status:

0	No bridge
1	One bridge
2	More than one bridge

The prosthodontic treatment need is assessed separately for each scenario. The need for prosthesis is assessed and recorded separately for each quadrant.

1. Scenario 1:

0	No denture needed
1	Require full denture
2	Require partial denture
3	Require repair of existing denture

2. Scenario 2:

0	No denture or bridge needed
1	Need denture only
2	Need bridge only
3	Need a combination of denture and bridge

3. Scenario 3:

0	No implants needed
1	Require upper implants
2	Require lower implants
3	Require upper and lower implants

Oral Health Examination Format

1. Date of examination: | | | | | | |

2. Subject ID No: | | | | | | |

3. Subject's Location(Department / Faculty / College): ____________________

4. Gender: ☐ 1. Male ☐ 2. Female

5. Date of birth: | | | | | | |

6. Location of examination: ____________________

A. Denture and Bridge Status

1. Denture Status

U	L

0 =	No denture
1=	Wearing, partial denture
2=	Wearing, full denture
3=	Full denture, not using
4=	Partial denture, not using

1. Bridge Status

U	L

0 =	No bridge
1=	One bridge
2=	More than one bridge

B. Need for Prosthesis

1.Need for denture (Scenario 1)

U	L	U	L

0 =	No denture needed
1=	Require full denture
2=	Require partial denture
3=	Require repair, full denture

2.Need for denture and/or bridge (Scenario II)

U	L	U	L

0	No denture or bridge needed
1	Need denture only
2	Need bridge only
3	Need a combination of denture and bridge

3. Need for dental implants (Scenario III)

U	L

0	No implants needed
1	Require upper implants
2	Require lower implants
3	Require upper and lower implants

C. Community Periodontal Index

1. Periodontal Conditions

17/16	11	26/27
47/46	31	36/37

0=	Healthy
1=	Bleeding
2=	Calculus
3=	Pocket 4-5 mm
4=	Pocket 6 mm or more
X=	Excluded sextant
9=	Not recorded

28. Highest Score: ________

D. Caries Status and Treatment Need

UPPER JAW

	18	17	16	15	14	13	12	11		21	22	23	24	25	26	27	28
Crown																	
Root																	
Treatment Need																	

LOWER JAW

	48	47	46	45	44	43	42	41		31	32	33	34	35	36	37	38
Crown																	
Root																	
Treatment Need																	

Crown Caries Status		Root Caries Status	
0=	Sound	0=	Sound
1=	Decayed	1=	Decayed
2=	Filled, with decay	2=	Filled, with decay
3=	Filled, no decay	3=	Filled, no decay
4=	Missing due to caries		
5=	Missing, other reasons		
6=	Fissure sealant		
7=	Bridge abutment, special crown or veneer	7=	Implant
8=	Unerupted tooth	8=	Unexposed root
10=	Trauma (fracture)		
9=	Not recorded	9=	Not recorded

Treatment Need	
0=	None
P=	Preventive, caries-arresting care
F=	Fissure sealant
1=	One surface filling
2=	Two or more surface fillings
3=	Crown for any reason
4=	Veneer or laminate
5=	Pulp care or restoration
6=	Extraction
7=	Need for other care (specify): ______________________________
8=	Need for other care (specify): ______________________________

Other Condition:

0=	None
1=	PreCa/Ca
2=	Jaw problem
3=	Pain/infection
4=	Gross anomaly
5=	Cleft lip/palate
6=	Trauma/surgery defect
7=	Others. Specify:____________________ ________________________________

Referral for care:

0=	No
1=	Yes

Appendix 6: Questionnaire (Malay version)

Arahan kepada penemuramah: Sila tandakan (√) di dalam kotak jawapan yang menandakan jawapan responden untuk setiap soalan.

Kegunaan Pejabat

Bahagian A: Kesihatan Umum dan Kesihatan Gigi

1. Adakah anda mempunyai sebarang penyakit berkaitan dengan jantung?
   - ☐ Tidak
   - ☐ Ya
   - ☐ Pernah, tetapi sudah sembuh

A1 ☐

2. Adakah anda mempunyai penyakit kencing manis?
   - ☐ Tidak
   - ☐ Ya
   - ☐ Pernah, tetapi sudah sembuh

A2 ☐

3. Adakah anda mempunyai masalah kesihatan yang lain?
   - ☐ Tidak
   - ☐ Ya. Sila nyatakan:

     ____

     ____

A3 ☐

4. Bagaimana anda menilai tahap kesihatan keseluruhan anda:
   - ☐ Amat baik
   - ☐ Baik
   - ☐ Agak baik/sederhana
   - ☐ Buruk
   - ☐ Amat buruk

A4 ☐

5. Apakah pendapat anda tentang tahap kesihatan gigi dan gusi anda?
   - ☐ Amat baik
   - ☐ Baik
   - ☐ Agak baik/sederhana
   - ☐ Buruk
   - ☐ Amat buruk

A5 ☐

6. Bagaimana anda menilai tahap kesihatan mulut anda berbanding dengan tahap kesihatan keseluruhan diri anda?
   - ☐ Lebih baik (tahap kesihatan mulut saya lebih baik daripada tahap kesihatan keseluruhan diri saya)
   - ☐ Sama (tahap kesihatan mulut saya adalah sama dengan tahap kesihatan keseluruhan diri saya)
   - ☐ Kurang baik (tahap kesihatan mulut saya kurang baik berbanding dengan tahap kesihatan keseluruhan diri saya)
   - ☐ Tidak dapat dibandingkan

A6 ☐

7. Sepanjang 6 bulan yang lepas, pernahkah gigi atau gusi anda menyebabkan anda berasa sakit?

A7 ☐

- ☐ Tidak pernah
- ☐ Pernah, tetapi tidak teruk
- ☐ Pernah, agak teruk
- ☐ Pernah, amat teruk

8. Bolehkah anda beritahu kami tentang kebolehan mengunyah anda?

A8 ☐

- ☐ Saya boleh mengunyah hampir semua jenis makanan
- ☐ Saya hanya boleh mengunyah makanan yang lembik dan yang sudah dilecek

9. Sepanjang 6 bulan yang lalu, sejauh manakah anda berpuas hati dengan rupa gigi dan gusi anda?

A9 ☐

- ☐ Amat berpuashati
- ☐ Berpuas hati
- ☐ Tidak berpuashati
- ☐ Sangat tidak berpuas hati

10. Adakah anda rasa anda perlukan rawatan gigi sekarang?

A10 ☐

- ☐ Tidak langsung (Terus ke soalan 10 (c))
- ☐ Ya, tetapi sedikit sahaja
- ☐ Ya, untuk takat tertentu
- ☐ Ya, amat perlu

a) Jika Ya, secepat manakah anda perlukan rawatan itu?

A10(a) ☐

- ☐ Secepat mungkin / sekarang
- ☐ Di dalam 6 bulan dari sekarang
- ☐ Lebih dari 6 bulan dari sekarang

b) Jika Ya, apakah jenis rawatan yang anda perlukan?

A10(b) ☐

- ☐ Pemeriksaan gigi
- ☐ Pencucian dan penggilapan gigi
- ☐ Rawatan untuk hilangkan sakit gigi
- ☐ Rawatan tampalan /korona / bridge
- ☐ Gigi palsu
- ☐ Cabutan
- ☐ Rawatan akar
- ☐ Orthodontik (untuk meluruskan gigi)
- ☐ Memutihkan gigi
- ☐ Lain-lain.Sila nyatakan: ______________________
  ____

c) Jika Tidak, kenapa anda rasa anda tidak perlu sebarang rawatan gigi? A10(c) ☐

☐ Kerana gigi dan mulut saya sihat
☐ Kerana masalah gigi itu boleh ditangguhkan

<u>Bahagian B: Oral Health Behaviour Pattern</u>

11. Berapa kali anda memberus gigi setiap hari? B11 ☐

☐ Dua kali atau lebih dalam sehari
☐ Sekali sehari
☐ Beberapa kali seminggu
☐ Seminggu sekali
☐ Jarang-jarang atau tidak pernah

12. Adakah anda menggunakan ubat gigi berfluorida? B12 ☐

☐ Ya
☐ Tidak
☐ Tidak pasti
Nyatakan nama ubat gigi: …………………………….
☐ Tidak pernah memberus gigi

<u>Section C: Oral Health-Related Behaviour Pattern</u>

13. Bilakah kali terakhir anda pergi ke klinik gigi? C13 ☐

☐ Kurang dari setahun yang lalu (Sila ke soalan 15)
☐ Di antara 1-2 tahun lalu (Sila ke soalan 15)
☐ Lebih dari 2 tahun yang lalu (Sila ke soalan 14)
☐ Tidak pernah ke klinik gigi (Sila ke soalan 14)

14. Nyatakan sebab kenapa anda tidak pernah/ jarang ke klinik gigi. C14 ☐

☐ Tiada masa
☐ Tidak sakit
☐ Kos rawatan mahal
☐ Malas
☐ Sibuk
☐ Masalah gigi yang tidak teruk
☐ Mengharap masalah gigi sembuh sendiri
☐ Susah mendapat temujanji
☐ Terpaksa pergi jauh untuk mendapatkan rawatan
☐ Tidak tahu bagaimana untuk ke klinik gigi
☐ Tiada sesiapa boleh menjaga anak atau ahli keluarga lain
☐ Takut
☐ Sebab lain: Sila nyatakan: __________________
____

<u>(Sila terus ke soalan 16)</u>

15. Secara umum, apakah sebab utama anda pergi ke klinik gigi? C15

- ☐ Untuk mendapatkan pemeriksaan gigi
- ☐ Untuk menghilangkan rasa sakit berkaitan dengan gigi dan mulut

16. Apa perasaan anda mengenai lawatan berjumpa doktor gigi? C16

- ☐ Peristiwa yang amat menakutkan
- ☐ Peristiwa yang agak menakutkan
- ☐ Peristiwa yang tidak menakutkan langsung

17. Berapa kerapkah anda mengambil snek bergula (contohnya kuih tradisional, biskut manis) atau minuman bergula (contohnya air bergas, sirap, the tarik) pada hari-hari biasa (sepanjang 6 bulan yang lepas)? C17

- ☐ Sekali sehari
- ☐ 2-3 kali sehari
- ☐ Lebih dari 4 kali sehari
- ☐ Tidak mengambil makanan/minuman bergula
- ☐ Saya tidak tahu

18. Yang manakah di antara berikut menggambarkan habit merokok anda? C18

- ☐ Tidak pernah merokok ……Sila terus ke soalan 20
- ☐ Tidak merokok tetapi pernah mencuba
- ☐ Bekas perokok
- ☐ Light smoker (kurang dari 5 rokok sehari)
- ☐ Heavy smoker (lebih dari 20 rokok sehari)

19. Bilakah anda menghisap rokok yang terakhir? C19

- ☐ Kurang dari 48 jam yang lalu
- ☐ Kurang dari sebulan yang lalu
- ☐ Lebih dari sebulan yang lalu
  Sila nyatakan berapa minggu/bulan/tahun yang lalu:
  ……………………………….

Section D : Oral Impacts on Daily Performances Assessment

20. Sepanjang 6 bulan yang lepas, adakah anda pernah mengalami kesukaran atau masalah yang berpunca dari mulut, gigi atau gigi palsu anda semasa anda menjalankan aktiviti harian seperti yang tertera di bawah? Jika anda jawab 'Ya' terhadap mana-mana aktiviti harian tersebut, bolehkah anda maklumkan kepada kami berapa kerap anda mengalami masalah tersebut.

Dimensi	Tidak pernah	Kurang dari sekali sebulan	Sekali atau dua kali sebulan	Sekali atau dua kali seminggu	3-4 kali seminggu	Setiap hari atau hampir setiap hari
1. Kesukaran untuk memakan makanan						
2. Kesukaran untuk bercakap dengan jelas						
3. Kesukaran untuk membersihkan gigi atau gigi palsu						
4. Kesukaran untuk keluar, contohnya membeli-belah atau melawat seseorang						
5. Kesukaran untuk membuat aktiviti fizikal yang ringan (seperti mengemas rumah, memasak dan berjalan)						
6.Kesukaran untuk menjalankan kerja utama atau peranan utama						
7. Kesukaran untuk relaks (termasuk tidur)						
8. Masalah untuk senyum, ketawa dan menunjukkan gigi tanpa malu						
9. Masalah dengan emosi yang tidak stabil, sebagai contoh lebih mudah runsing berbanding dengan biasa						
10. Masalah dalam menikmati hubungan/kontak dengan orang lain, seperti saudara-mara, sahabat atau jiran						

21. Jika anda pernah mengalami sebarang masalah di dalam melaksanakan aktiviti harian seperti yang ditanyakan di soalan 15, bolehkah anda beritahu seteruk manakah kesan tersebut terhadap kehidupan seharian anda?

Dimensi	**Tiada kesan**	**Kesan yang sangat sedikit**	**Kesan yang sedikit**	**Kesan yang sederhana**	**Kesan yang teruk**	**Kesan amat teruk**
1. Kesukaran untuk memakan makanan						
2. Kesukaran untuk bercakap dengan jelas						
3. Kesukaran untuk membersihkan gigi atau gigi palsu						
4. Kesukaran untuk keluar, contohnya membeli-belah atau melawat seseorang						
5. Kesukaran untuk membuat aktiviti fizikal yang ringan (seperti mengemas rumah, memasak dan berjalan)						
6.Kesukaran untuk menjalankan kerja utama atau peranan utama						
7. Kesukaran untuk relaks (termasuk tidur)						
8. Masalah untuk senyum, ketawa dan menunjukkan gigi tanpa malu						
9. Masalah dengan emosi yang tidak stabil, sebagai contoh lebih mudah runsing berbanding dengan biasa						
10. Masalah dalam menikmati hubungan/kontak dengan orang lain, seperti saudara-mara, sahabat atau jiran						

22. Jika anda mempunyai sebarang masalah untuk menjalankan aktiviti harian tersebut di soalan sebelum ini, apakah keadaan yang menyebabkan kesan/impak tersebut?

Dimensi	Nombor kod keadaan yang menunjukkkan sebab impak
1. Kesukaran untuk memakan makanan	
2. Kesukaran untuk bercakap dengan jelas	
3. Kesukaran untuk membersihkan gigi atau gigi palsu	
4. Kesukaran untuk keluar, contohnya membeli-belah atau melawat seseorang	
5. Kesukaran untuk membuat aktiviti fizikal yang ringan (seperti mengemas rumah, memasak dan berjalan)	
6.Kesukaran untuk menjalankan kerja utama atau peranan utama	
7. Kesukaran untuk relaks (termasuk tidur)	
8. Masalah untuk senyum, ketawa dan menunjukkan gigi tanpa malu	
9. Masalah dengan emosi yang tidak stabil, sebagai contoh lebih mudah runsing berbanding dengan biasa	
10. Masalah dalam menikmati hubungan/kontak dengan orang lain, seperti saudara-mara, sahabat atau jiran	

Kod	**Keadaan yang mungkin**
1	Sakit gigi
2	Gigi sensitif/ngilu
3	Kerosakan gigi, gigi yang berlubang
4	Gigi patah
5	Kehilangan gigi
6	Gigi longgar
7	Warna gigi
8	Kedudukan gigi, sebagai contoh gigi sengit, jongang dan jarang
9	Bentuk atau saiz gigi
10	Gusi berdarah
11	Gusi bengkak, gusi bernanah
12	Gusi menurun, penyakit gusi
13	Karang gigi
14	Ulser mulut atau tompokan yang sakit
15	Nafas berbau
16	Kecacatan pada mulut atau muka, contoh bibir dan lelangit sumbing
17	Bunyi ‘klik’ atau bunyi geseran di sendi rahang
18	Tampalan atau sarung gigi (crown) yang sudah rosak, contohnya pecah dan berubah warna
19	Gigi palsu yang longgar
20	Alat, wayar atau band ortodontik untuk meluruskan gigi, braces

Bahagian E: Latarbelakang Sosiodemografi:

23. Jantina: E23 ☐

- ☐ Lelaki
- ☐ Perempuan

24. Kaum: E24 ☐

- ☐ Melayu
- ☐ Cina
- ☐ India
- ☐ Lain-lain. Sila nyatakan: ……………………….

25. Umur pada hari jadi terakhir : ☐ tahun E25 ☐

26. Status: E26 ☐

- ☐ Belum berkahwin
- ☐ Berkahwin
- ☐ Bercerai
- ☐ Janda/duda

27. Pencapaian pendidikan tertinggi: E27 ☐

- ☐ Sekolah rendah
- ☐ Sekolah Menengah
- ☐ Ijazah dasar / Diploma / Sijil
- ☐ Masters / PhD
- ☐ Lain-lain. Sila nyatakan ___________________________

28. Gaji bulanan anda: E28 ☐

- ☐ Kurang daripada RM 1500
- ☐ RM 1501 – RM 3000
- ☐ RM 3001 – RM 5000
- ☐ RM 5000 – RM 10,000
- ☐ Lebih daripada RM 10,000

29. Gred Jawatan : ………………….. E29 ☐

Sesi Temuramah Tamat. Sila ucapkan terima kasih kepada responden dan arahkan mereka ke bahagian pemeriksaan gigi.

Appendix 7: Questionnaire (English version)

Office Use:

Instruction to interviewer: Please tick (√) in the appropriate box that indicate the respondents' response for each of the question.

Section A: General Health and Oral Health

1. Do you have any heart problem?

- [ ] o
- [ ] Yes
- [ ] I had a heart disease before but I have recovered now

A1 [ ]

2. Are you a diabetic?

- [ ] No
- [ ] Yes
- [ ] I had diabetes before but I have recovered now

A2 [ ]

3. Do you have any other health problem?

- [ ] No
- [ ] Yes. Please state your health problem/condition:

____

____

A3 [ ]

4. How would you rate your overall health:

- [ ] Excellent
- [ ] Good
- [ ] Poor
- [ ] Very Poor

A4 [ ]

5. What is your opinion on the health of your teeth and gum?

- [ ] Excellent
- [ ] Good
- [ ] Poor
- [ ] Very Poor

A5 [ ]

6. How would you rate your oral health compare to your overall general health?

- [ ] Superior (my oral health is superior to my general health)
- [ ] Equal (my oral health is equal to my general health)
- [ ] Inferior (my oral health is inferior to my general health)
- [ ] Not comparable

A6 [ ]

7. In the last 6 months, have your teeth or gums caused you any pain?

- [ ] No
- [ ] Yes, but not severe
- [ ] Yes, severe
- [ ] Yes, very severe

A7 [ ]

8. Can you tell us about your chewing ability?

- [ ] I can chew on almost all kinds of foods
- [ ] I can chew on soft and mashed foods only

A8 [ ]

9. In the last 6 months, how satisfied were you with the appearance of your teeth and gums?

- [ ] Very Satisfied
- [ ] Satisfied
- [ ] Dissatisfied
- [ ] Very Dissatisfied

A9 [ ]

10. Do you think you need a dental treatment now?

- [ ] Not at all (Please go to 10 (c)
- [ ] Yes, but very little
- [ ] Yes, to some extent
- [ ] Yes, a great deal

A10 [ ]

a) If 'Yes', how soon do you think you need treatment?

- [ ] Immediately
- [ ] Within 6 months from now
- [ ] More than 6 months from now

A10(a) [ ]

b) If 'Yes', what kind of treatment do you think you need?

- [ ] Dental check up
- [ ] Scaling and polishing (cleaning of teeth)
- [ ] Dental pain release
- [ ] Teeth filled or replace (for example fillings, crown and/or bridges)
- [ ] Denture
- [ ] Tooth extraction
- [ ] Root canal treatment
- [ ] Orthodontic (straightening of teeth)
- [ ] Tooth whitening
- [ ] Other. Please specify: ______________________ ____

A10(b) [ ]

c) If 'No', why do you feel you don't need any dental treatment?

- [ ] Because my oral cavity is healthy
- [ ] Because the dental problems can wait

A10(c) [ ]

Section B: Oral Health Behaviour Pattern

11. How often do you usually brush your teeth? B11 ☐

- ☐ Twice or more daily
- ☐ Once daily
- ☐ A few times a week
- ☐ Once a week
- ☐ Irregularly or never

12. If you brush your teeth, do you use a fluoridated toothpaste? B12 ☐

- ☐ Yes
- ☐ No
- ☐ Not sure
- ☐ State the name of toothpaste that you uses: …………………………….
- ☐ I never brush my teeth

Section C: Oral Health-Related Behaviour Pattern

13. When was your last visit to the dental clinic? C13 ☐

- ☐ Less than one year ago (Please go to Question 15)
- ☐ Between 1-2 years ago (Please go to Question 15)
- ☐ More than 2 years ago (Please go to Question 14)
- ☐ Never had a dental treatment before (Please go to Q 14)

14. Please tick possible reasons why you have not been visiting your dentist: C14 ☐

- ☐ Never have the time
- ☐ No pain
- ☐ Would cost too much
- ☐ Lazy
- ☐ Busy
- ☐ Dental problems not serious enough
- ☐ Expect dental problems to heal itself
- ☐ Difficult to get an appointment
- ☐ Would have to travel too far
- ☐ Don’t know how to get to the dental clinic
- ☐ Didn’t have anyone to care for children or any family members
- ☐ Fear
- ☐ Other reasons: Please state: __________________ ____

(Now please go to Question 16)

15. In general, what is usually your main reason for going to the dental clinic? C15 ☐

- ☐ To get a regular check up
- ☐ To help alleviate my dental pain (any problems associated with teeth and mouth)

16. How do you feel about visiting a dentist? C16

- [ ] A very frightening event
- [ ] A frightening event to some extent
- [ ] Not a frightening event at all

17. How often do you have sugary snacks (for example sweet traditional delicacies, cookies, candy) or sugary drink (for example carbonated drink, syrup, *teh tarik*) on a typical day? C17

- [ ] Once daily
- [ ] 2-3 times daily
- [ ] More than 4 times daily
- [ ] I don’t take any sugary food or drink
- [ ] I don’t know

18. Which of the following categories best describe your smoking behaviour? C18

- [ ] Never smoked ……GO TO QUESTION 20
- [ ] Non-smoker but have tried smoking
- [ ] Ex- smoker
- [ ] Light smoker (less than 5 cigarettes a day)
- [ ] Heavy smoker (more than 20 cigarettes a day)

19. How long has it been since you last had your last cigarette? C19

- [ ] Less than 48 hours ago
- [ ] Less than 1 month ago
- [ ] More than 1 month ago
  Please state number of weeks ago:
  ……………………………….

Section D : Oral Impacts on Daily Performances Assessment

20. In the last 6 months, have you had any difficulties or problems, caused by your mouth, teeth or denture, in carrying out any of the daily performances stated below?
If you answer ‘Yes’ to any of the daily performances stated, can you tell us how often you had the problem.

Dimension	**Never**	**Less than once a month**	**Once or twice a month**	**Once or twice a week**	**3-4 times a week**	**Every day, or nearly everyday**
1. Difficulty in eating						
2. Difficulty in speaking clearly						
3. Difficulty in cleaning your teeth or your false teeth						
4. Difficulty in going out, for example going shopping or visiting someone						
5. Difficulty in performing light physical activities (such as tidying home, cooking and walking)						
6. Difficulty in performing the main job or play the main role						
7. Difficulty in relaxing (including sleeping)						
8. Problem in smiling, laughing and showing teeth without feeling shy or sub-conscious						
9. Problem with unstable emotion for example incline to feel more worried than usual						
10. Problem with enjoying relationship/contact with other people, such as relatives, friends or neighbours						

21. If you have had any problem performing the daily performances mentioned in the previous question, can you tell us the severity of the effect this problem gives to your daily life?

Dimensions	No effect	Very little effect	Little effect	Moderate effect	Severe effect	Very severe effect
1. Difficulty in eating						
2. Difficulty in speaking clearly						
3. Difficulty in cleaning your teeth or your false teeth						
4. Difficulty in going out, for example going shopping or visiting someone						
5. Difficulty in performing light physical activities (such as tidying home, cooking and walking)						
6. Difficulty in performing the main job or play the main role						
7. Difficulty in relaxing (including sleeping)						
8. Problem in smiling, laughing and showing teeth without feeling shy or sub-conscious						
9. Problem with unstable emotion for example incline to feel more worried than usual						
10. Problem with enjoying relationship/contact with other people, such as relatives, friends or neighbours						

22. If you have had any of the problems in the daily performances activities stated in the previous question, to which conditions do you attribute this impact?

Dimensions	The code number of the conditions that attribute to this impact
1. Difficulty in eating	
2. Difficulty in speaking clearly	
3. Difficulty in cleaning your teeth or your false teeth	
4. Difficulty in going out, for example going shopping or visiting someone	
5. Difficulty in performing light physical activities (such as tidying home, cooking and walking)	
6. Difficulty in performing the main job or play the main role	
7. Difficulty in relaxing (including sleeping)	
8. Problem in smiling, laughing and showing teeth without feeling shy or sub-conscious	
9. Problem with unstable emotion for example incline to feel more worried than usual	
10. Problem with enjoying relationship/contact with other people, such as relatives, friends or neighbours	

Code	**Different condition**
1	Toothache
2	Sensitive teeth
3	Damaged teeth, caries
4	Broken teeth
5	Lost of teeth
6	Loose teeth
7	Colour of teeth
8	Position of teeth, for example slanting teeth, buckteeth and gap
9	Teeth shape or size
10	Bleeding gum
11	Swollen gum, pus in gum
12	Receding gum, gum disease
13	Teeth tartar
14	Mouth ulcer or painful blister
15	Bad breath
16	Mouth or face deformity, for example harelip and deformed palate
17	‘Click’ sound or friction sound caused by jaw joint
18	Broken filling or crown, for example broken and has changed colour
19	Loose false teeth
20	Device, Wires or Orthodontic band for straightening the teeth, and braces

Section E: Sociodemographic Characteristics:

23. Gender: E23 ☐

☐ Male
☐ Female

24. Ethnicity: E24 ☐

☐ Malay
☐ Chinese
☐ Indian
☐ Others. Please state: ……………………….

25. Age on last birthday : ☐ years old E25 ☐

26. Marital status: E26 ☐

☐ Single
☐ Married
☐ Divorced
☐ Widowed

27. Highest Educational Attainment: E27 ☐

☐ Primary School
☐ Secondary School
☐ Degree / Diploma / Certificate
☐ Masters Degree / PhD
☐ Others. Please state ___________________________

28. Your monthly income salary: E28 ☐

☐ Less than RM 1500
☐ RM 1501 – RM 3000
☐ RM 3001 – RM 5000
☐ RM 5000 – RM 10,000
☐ More than RM 10,000

29. Your occupational grade: ………… E29 ☐

End of interview session. Please thank the respondent and guide them to the oral health examination area.

Appendix 8
Dental Treatment Time Recording Form

Name of clinic: ____

Dentist's particulars:

i. Date of birth (ddmmyyyy): _________________

ii. Gender :

☐ Male ☐ Female

iii. Ethnicity:

☐ Malay
☐ Chinese
☐ Indian
☐ Others, please state: _____________

Instructions:

1. Please record the time that you take to carry out dental procedures such as restorative, prosthetic and periodontal treatment on all your walk in or appointment patients for the duration of two weeks.
2. Please start the timing from the moment you start the procedures (for example cavity preparation for filling procedures or giving local anaesthetic for extraction procedures and etc) until the procedures are completed (for example until the carving is completed or the tooth has been extracted and etc).
3. If you are doing different dental procedures at the same time, for example preparing and carving Class I, Class II and Class V at the same time, please give the estimation of the time taken for each procedure.
4. If you have any queries, please do not hesitate to contact me (Dr. Norintan) at 012-3990542.
5. I would like to thank you for your participation and I hope you can return the form or call me to collect the form after the two weeks duration is over.

Thank you

Restorative Treatment

No. of patients	Tooth Restored	Type of treatment (Class I/II/III/IV, crown, pulp care etc)	Type of procedure involved (for crown and pulp care only, eg cavity prep for crown or issuing of crown)	Time taken for each restorative procedure (in minutes)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Prosthetic Treatment

No. of patients	Tooth restored	Type of treatment (Bridge, full or partial denture)	Type of procedure involve (impression taking / bite record / try-in / issue / repair etc)	Time taken for each procedure (in minutes)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Extraction

No. of patients	Tooth Extracted	Time taken for the procedure (in minutes)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Periodontal Treatment

No. of patients	No. of quadrants treated	Procedures involve (scaling and polishing / root planning / minor surgery etc)	Time taken for each visit (in minutes)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

UNIVERSITY OF MALAYA
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يونيبرسيتي مالايا

Ruj: UM.D/PD211/09
Tarikh: 21 Disember 2009

Dr. Norintan Ab. Murat
Jabatan Pergigian Masyarakat
Fakulti Pergigian

Puan,

KELULUSAN ETIKA

Dengan hormatnya perkara tersebut di atas dirujuk.

Sukacita dimaklumkan bahawa Jawatankuasa Etika Perubatan Fakulti Pergigian (JKEP) telah bersetuju meluluskan projek penyelidikan puan bertajuk "Estimating Health Manpower Requirements for Malaysian Adult Through Socio-Dental and Skill Mix Approaches".Nombor kelulusan MEC projek tersebut ialah **DF CO0909/0051(L)**.

Sekian, terima kasih.

Yang benar,

PROF. DR. ROSNAH MOHD ZAIN
Pengerusi
Jawatankuasa Etika Perubatan, Fakulti Pergigian

s.k. Dekan, Fakulti Pergigian
Ketua Jabatan Pergigian Masyarakat

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Email: dekan_dental@um.edu.my ● http://www.um.edu.my

UCL RESEARCH ETHICS COMMITTEE
GRADUATE SCHOOL OFFICE

UCL

Professor Richard Watt
Department of Epidemiology & Public Health
UCL – Gower Street Campus
1-19 Torrington Place
London
WC1E 6BT

21 January 2010

Dear Professor Watt

Notification of Ethical Approval:
Ethics Application: 2156/001: Estimating oral health manpower requirements for Malaysian adults through socio-dental and skill mix approaches

I am pleased to confirm that, further to your satisfactory responses to his comments, the Vice-Chair of the UCL Research Ethics Committee has approved your research proposal for the duration of the study (i.e. until September 2010).

Approval is subject to the following conditions:

1. You must seek Chair's approval for proposed amendments to the research for which this approval has been given. Ethical approval is specific to this project and must not be treated as applicable to research of a similar nature. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing the 'Amendment Approval Request Form'.

The form identified above can be accessed by logging on to the ethics website homepage: http://www.grad.ucl.ac.uk/ethics/ and clicking on the button marked 'Key Responsibilities of the Researcher Following Approval'.

2. It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. Both non-serious and serious adverse events must be reported.

   Reporting Non-Serious Adverse Events.
   For non-serious adverse events you will need to inform Ms Helen Dougal, Ethics Committee Administrator (h.dougal@ucl.ac.uk), within ten days of an adverse incident occurring and provide a full written report that should include any amendments to the participant information sheet and study protocol. The Chair or Vice-Chair of the Ethics Committee will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.

   Reporting Serious Adverse Events
   The Ethics Committee should be notified of all serious adverse events via the Ethics Committee Administrator immediately the incident occurs. Where the adverse incident is unexpected and serious, the Chair or Vice-Chair will decide whether the study should be terminated pending the opinion of an

independent expert. The adverse event will be considered at the next Committee meeting and a decision will be made on the need to change the information leaflet and/or study protocol.

On completion of the research you must submit a brief report (a maximum of two sides of A4) of your findings/concluding comments to the Committee, which includes in particular issues relating to the ethical implications of the research.

Yours sincerely

Angela Poulter

p.p. **Sir John Birch**
Chair of the UCL Research Ethics Committee

Cc: Norintan Abdul Murat

UCL Research Ethics Committee, c/o The Graduate School, North Cloisters, Wilkins Building
University College London Gower Street London WC1E 6BT
Tel: +44 (0)20 7679 7844 Fax: +44 (0)20 7679 7043
h.dougal@ucl.ac.uk
www.ucl.ac.uk/gradschool

Appendix 11

The calculation of Condition-Specific OIDP score (CS-OIDP)

The CS-OIDP score for periodontal and prosthodontic treatment was calculated by only taking into account the possible perceived impairments related to the dental treatment required. For example, the possible causal impairment for periodontal treatment include bleeding gums, swollen gum, gum abscess, receding gum, calculus, bad breath and loose tooth. For prosthodontic treatment, the possible related perceived impairments are tooth loss and loose ill-fitting denture. The calculation of the CS-OIDP score involves the summing up of the OIDP score of 10 daily performances which is caused by these perceived impairments.

For example, the steps involve in calculating the CS-OIDP score for prosthodontic treatment:

1. Identify the possible causal impairment for prosthodontic treatment. In this case, it is tooth loss and loose ill-fitting denture.

2. Calculate the CS-OIDP score for each of the 10 oral impacts due to each possible impairments:

    i. Oral impact 1= Eating

        a. Calculate CS-OIDP score due to tooth loss

        b. Calculate CS-OIDP score due to loose ill-fitting denture

    ii. Oral impact 2: Speaking

a. Calculate CS-OIDP score due to tooth loss

b. Calculate CS-OIDP score due to loose ill-fitting denture

The process continues until the last CS-OIDP score for the 10^{th} oral impact (Contact) is calculated.

3. Sum up the CS-OIDP score for prosthodontic treatment from each oral impact:

CS-OIDP score for prosthodontic treatment = {('eating score' due to tooth loss + 'eating score' due to ill-fitting denture)} + {('speaking score' due to tooth loss + 'speaking score' due to ill-fitting denture)} + {('cleaning score' due to tooth loss + 'cleaning score' due to ill-fitting denture)} + ………+ {('contact score' due to tooth loss + 'contact score' due to ill-fitting denture)}.

Appendix 12

Descriptive Result for the Pilot Study

Table 1 shows the socio-demographic characteristics of the participants. Most respondents have a monthly salary of below RM3000 and highest educational achievement of primary or secondary school only. This is because the data collection was done during office hours when some of the staff with higher educational level or higher scale of salary are at their department or faculties in the universities.

Table 1: Sociodemographic characteristics of the respondents

Variables	N	Percentage	Mean
Gender			
Male	6	30	
Female	14	70	
Ethnicity			
Malay	20	100	
Chinese	0	0	
Indian	0	0	
Age		Minimum = 30 Maximum= 54	42.9 (±8.1)
Marital Status			
Not married	5	25	
Married	14	70	
Divorced	0	0	
Widow	1	5	
Highest Educational Attainment:			
Primary school	4	20	
Secondary school	14	70	
Degree/Diploma/Certificate	2	10	
Masters/PhD	0	0	
Monthly Salary:			
Less than RM1500	10	50	
RM1501-RM3000	9	45	
RM3001-RM5000	1	5	
RM5001-RM10,000	0	0	
More than RM10,000	0	0	

Table 2 describes respondents' perceived oral health/health status and dental treatment need, satisfaction with the appearance of teeth and gums, chewing ability, and history of dental pain in the last 6 months. 90% perceived need for dental treatment. Of these, 15% said that they need the treatment immediately, 65% need the treatment within 6 months' time and 10% stated that the treatment can be deferred after 6 months' time. 40% perceived need for scaling and polishing procedure and 40% said they needed a dental check-up.

Table 2. Self-perceived of health and treatment need

Variables	N	Percentage
Perception of overall health:		
Good	9	45
Moderate	11	55
Perception of oral health:		
Good	6	30
Moderate	14	70
Comparison of oral health to health:		
Superior	1	5
Equal	14	70
Inferior	5	25
Prevalence of dental pain last 6 months:		
Never	10	50
Yes, not severe	8	40
Yes, severe	1	5
Yes, very severe	1	5
Chewing ability:		
All foods	17	85
Soft and mashed foods only	3	15
Satisfaction with appearance of teeth and gum:		
Very satisfied	1	5
Satisfied	8	40
Dissatisfied	11	55
Perceived dental treatment need:		
Not at all	2	10
Yes, but very little	7	35
Yes, to some extent	4	20
Yes, a lot	7	35

Table 3 presents the respondents' propensity behaviour towards dental treatment. All variables are dichotomized into 'good' or 'poor'. Those who brush once or twice and more daily, who uses fluoridated toothpaste, whose last visit to the dentist was not more than 2 years ago, who take sugar not more than 4 times a day and who never smoked or had the last cigarette more than 6 months ago are all are categorized as having good propensity, while others are categorized as poor.

Table 3: Propensity towards dental treatment

Variables	N	Frequency
Brushing frequency:		
Good	20	100
Poor	0	0
Usage of fluoridated toothpaste:		
Good		
Poor	18	90
	2	10
Dental attendance:		
Good	10	50
Poor	10	50
Sugar intake:		
Good	15	75
Poor	5	25
Smoking Behaviour:		
Good	18	90
Poor	2	10

Table 4 shows the prevalence of oral impacts on daily performances. 55% (11) reported of having at least one OIDP impact in the last 6 months. The mean OIDP score was 2.18(±3.2). The most prevalent OIDP impact was 'difficulty in eating' and 'problem in smiling and showing teeth without embarrassment', reported by 25% of the respondents.

Table 4: Oral impacts on daily performances

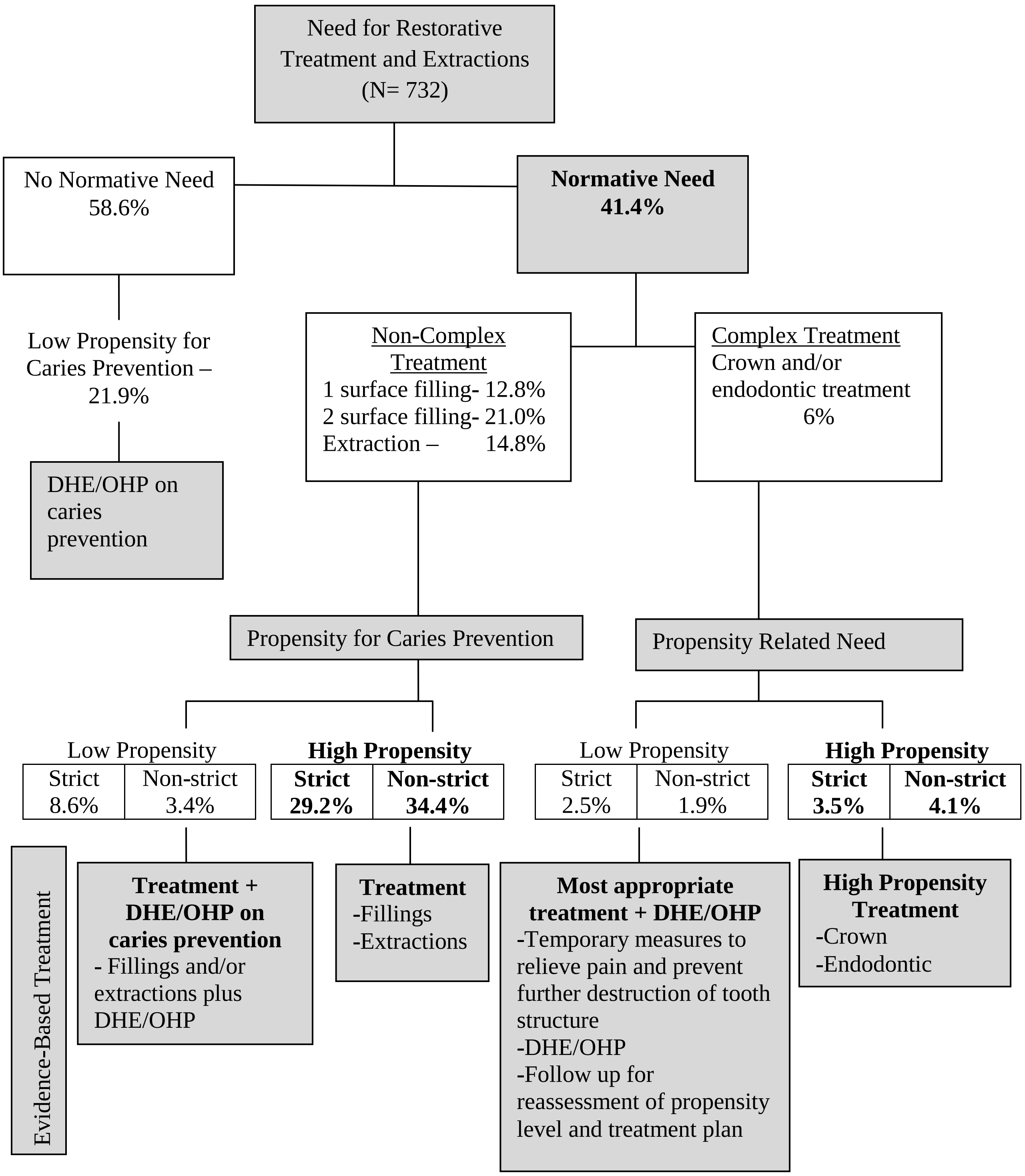
Performances	N	Percent
Difficulty in eating	5	25
Difficulty in speaking	2	10
Difficulty in cleaning teeth/denture	4	20
Difficulty in going out	0	0
Difficulty in doing light physical activities	0	0
Difficulty in performing main job	0	0
Difficulty in sleeping	1	5
Problem in smiling	5	25
Problem with emotional stability	0	0
Problem with enjoying contact	1	5

Table 5 presents the normative needs of the sample population. Caries prevalence was 95% with mean DMFX(T)of 8.85 (±7.47). 55% required prosthesis but only 15% were found having prosthesis. 19 participants need a scaling and polishing procedure and only one need a complex periodontal treatment. Seven teeth need to be extracted and 1 needs a root canal treatment.

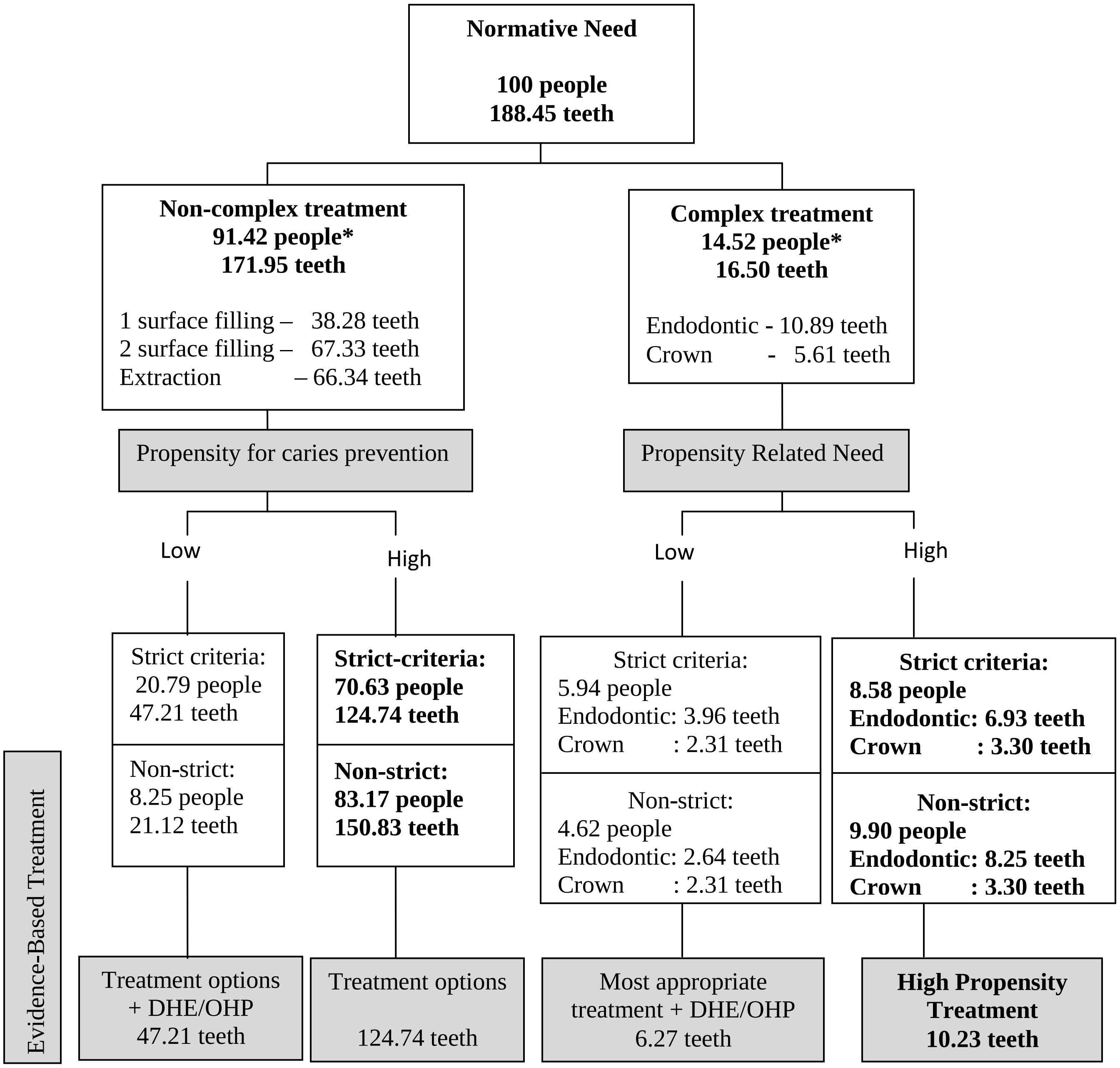
Table 5: Normative needs for prosthodontics, restorative, extraction and periodontal treatment

Type of treatment needed	Number of teeth/treatment procedure
Prosthodontic need:	
Upper jaw:	
i. one unit prosthetic	4
ii.combination of one and multi unit prosthetic	4
Lower jaw:	
i. one unit prosthetic	1
ii.multi unit prosthetic	4
iii. combination of one unit and multi unit prosthetic	5
Restorative need:	
i.One surface restoration	11
ii.Two or more surface restoration	5
iii. crown	1
iv. Pulp care	1
Extraction	7
Periodontal care	
i.Oral hygiene instruction	19
ii.Scaling and polishing	17
iii. Complex treatment	1

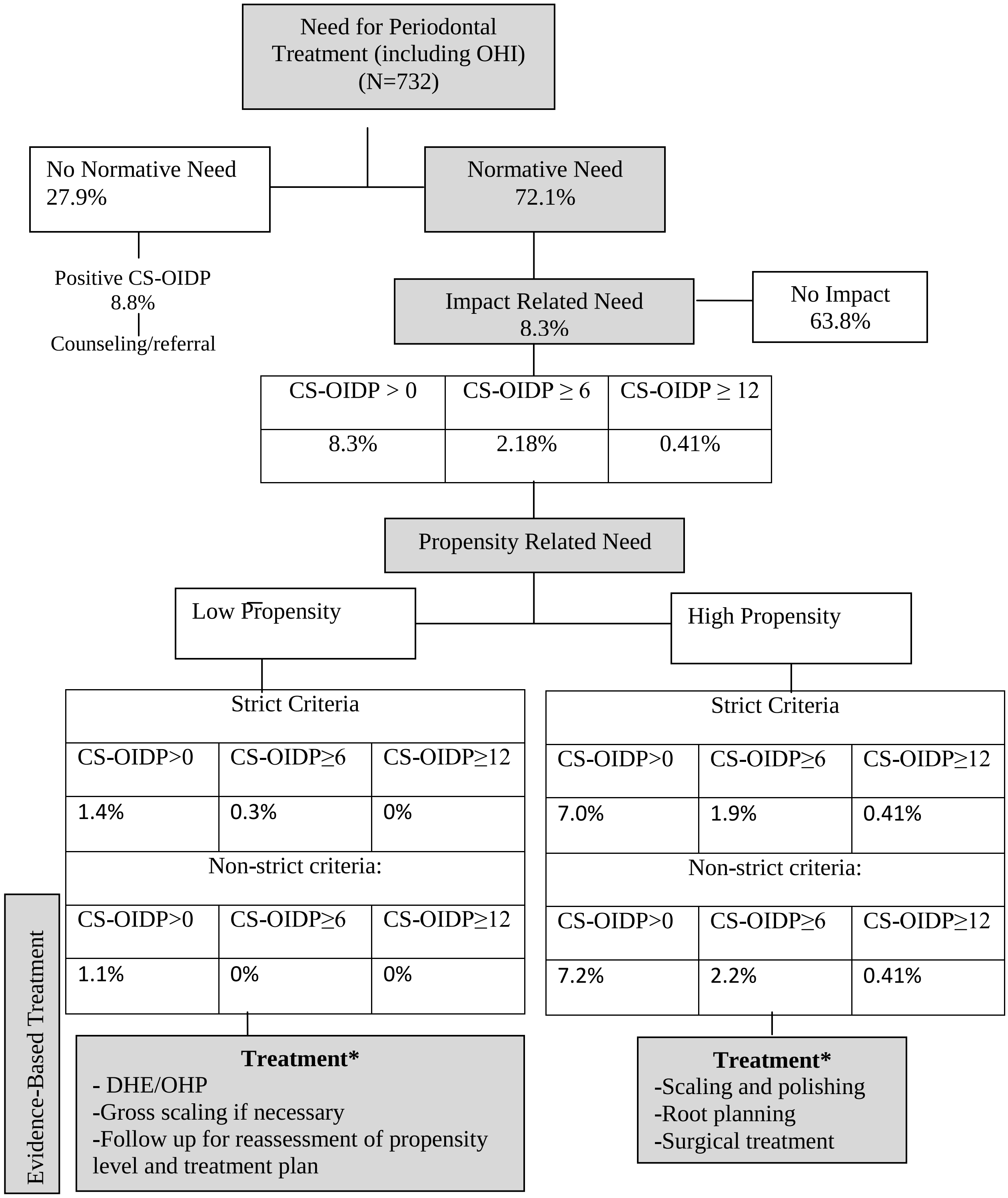
Appendix 13



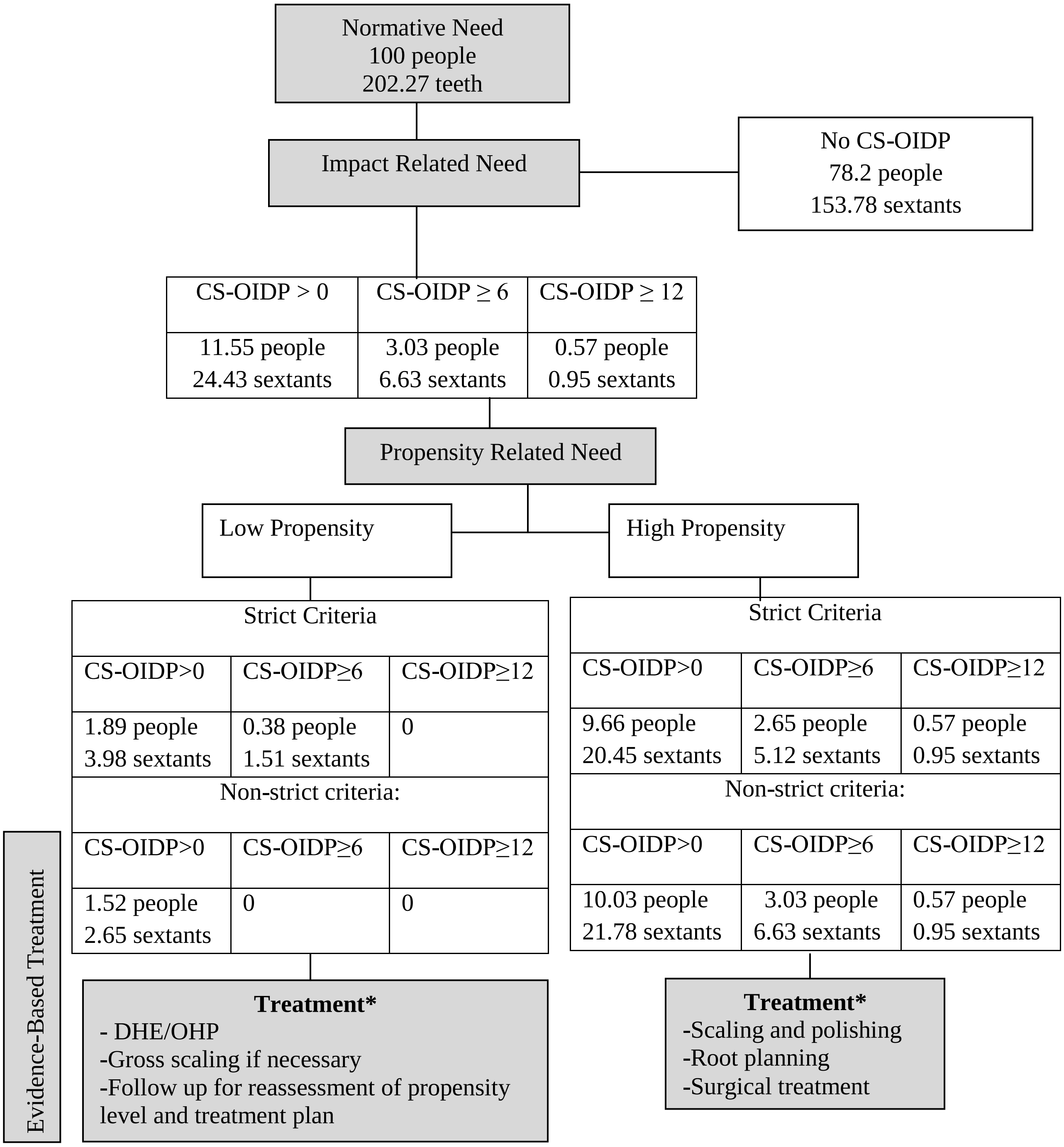
(i): Percentages of Malaysian adults (aged 30-54) with treatment needs for restorative and extraction using the sociodental approach at different propensity level (N=732 people).



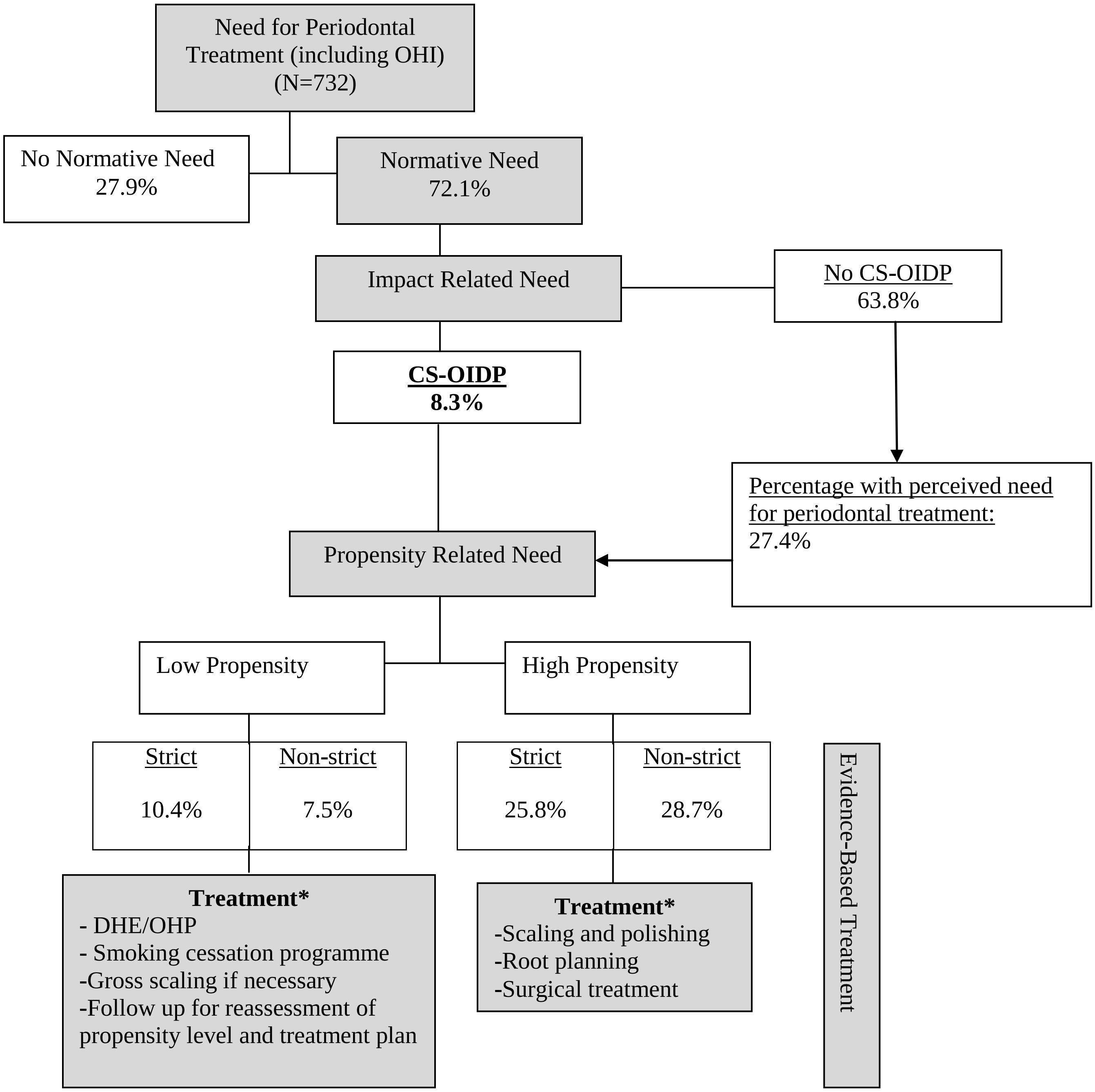
(ii): Number of teeth per 100 adult requiring restorative and extraction assessed using the sociodental approach, at different propensity level



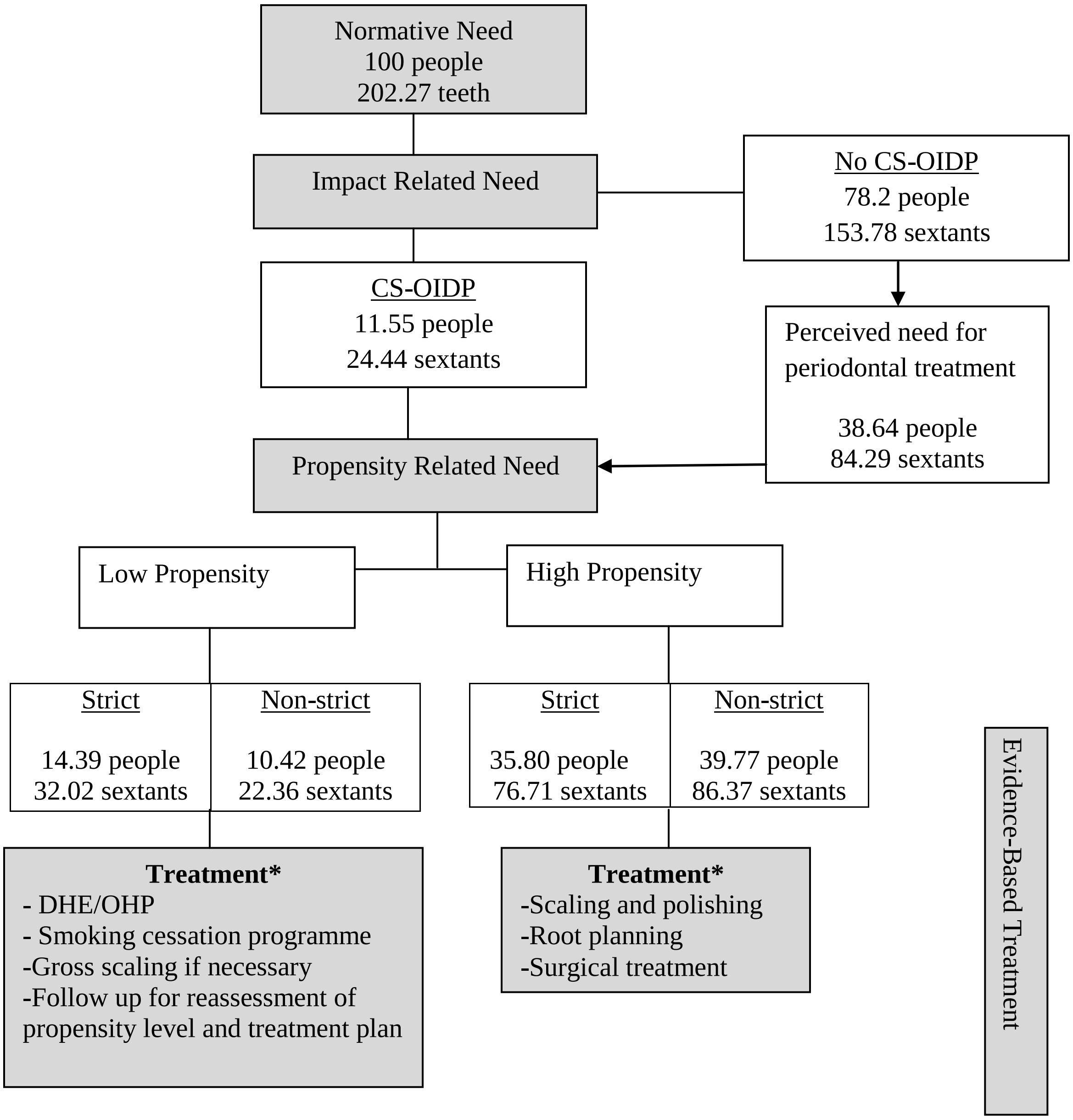
(iii): Comparison of the percentages of Malaysian adults aged between 30 and 54 years with periodontal treatment need at different CS-OIDP cut off points and different propensity criteria using the normative need and the sociodental needs approaches (N=732).



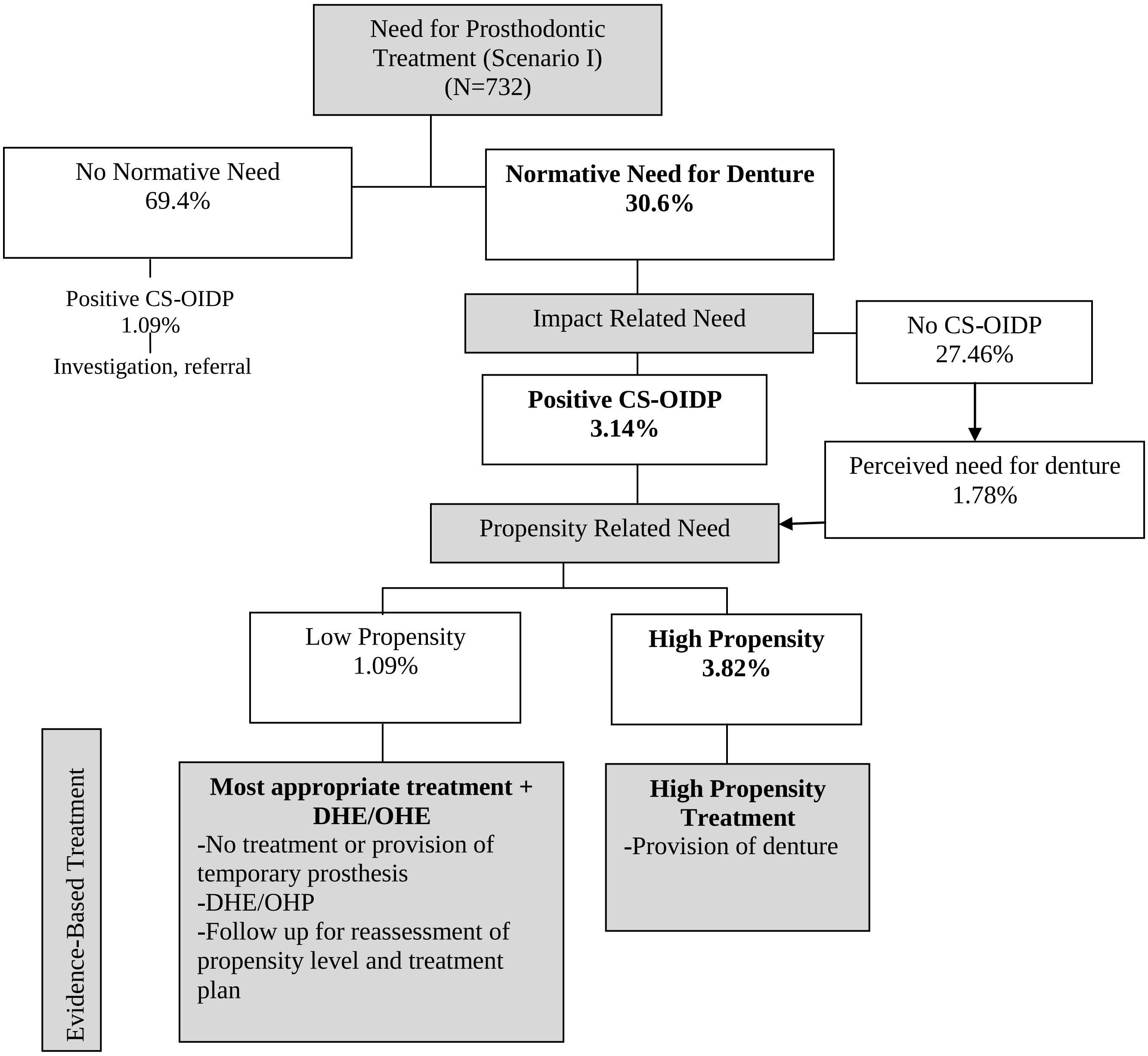
(iv): Comparison of the number of sextants per 100 adult requiring periodontal treatment (at different CS-OIDP cut off points and propensity criteria) assessed using the normative needs and sociodental needs approaches (N=528)



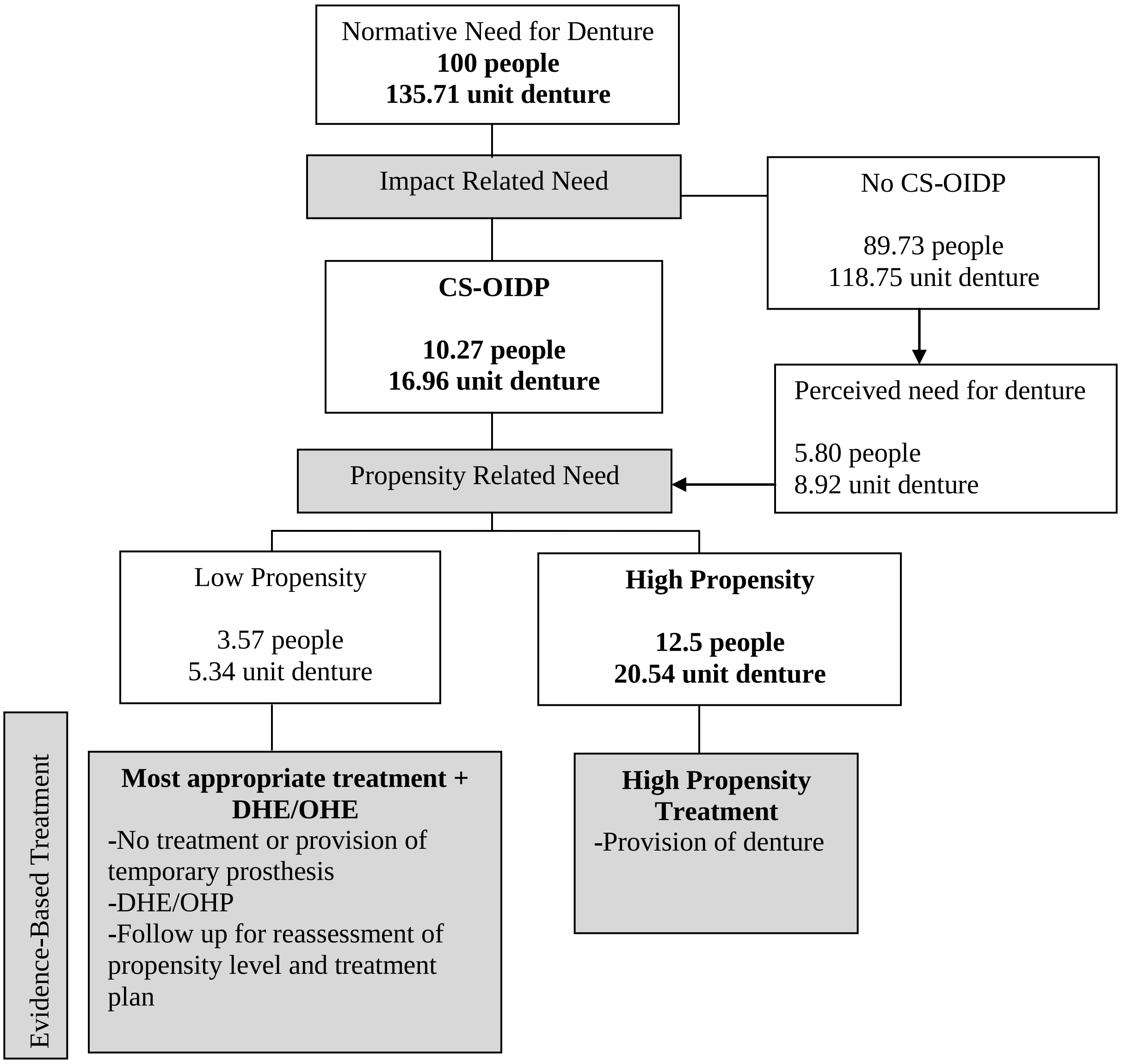
(v): Comparison of the percentages of Malaysian adults (aged 30-54 years) with periodontal treatment using the sociodental approach with the integration of perceived need for treatment (N=732 people).



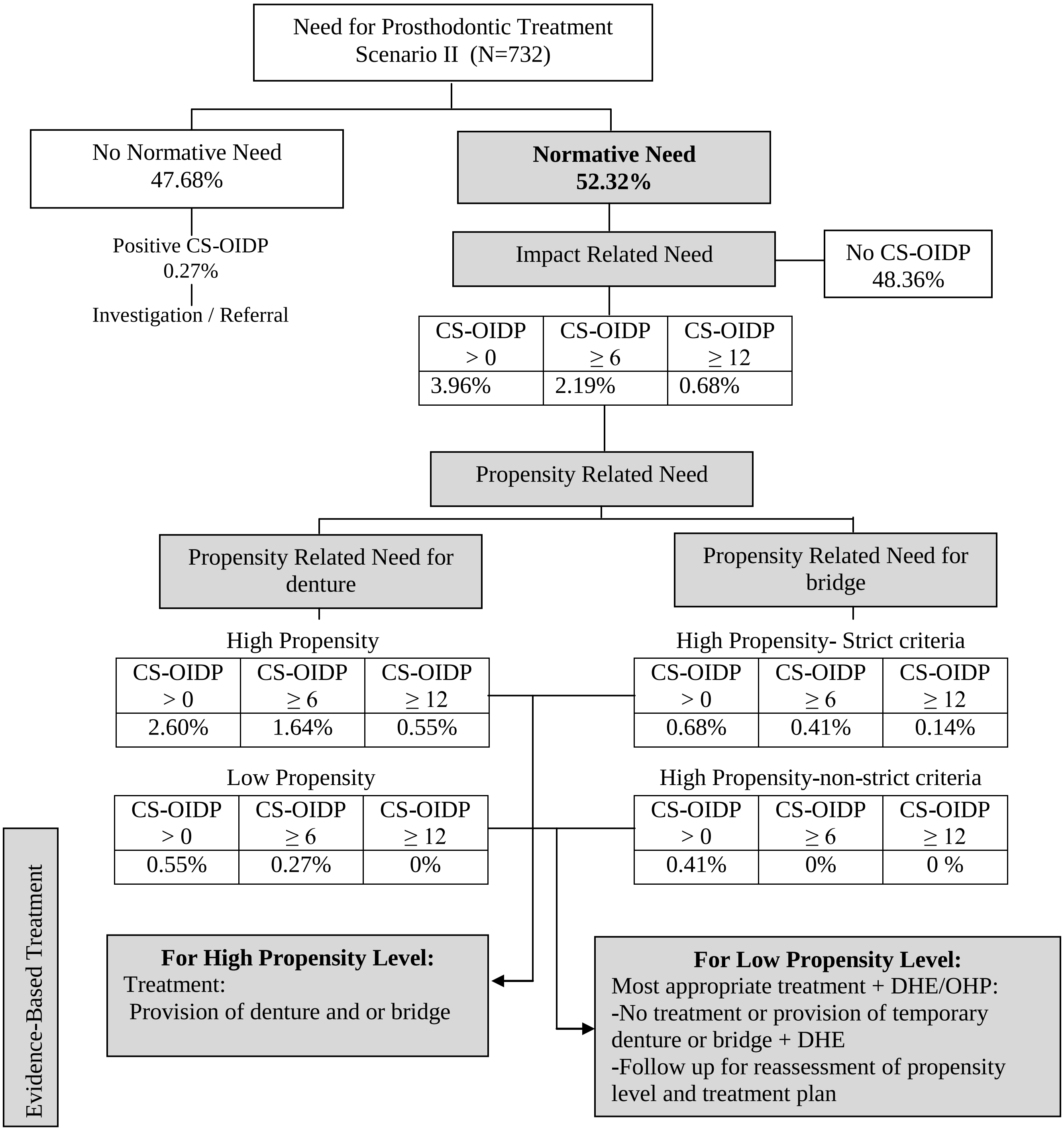
(vi): Comparison of the number of sextants per 100 adult requiring periodontal treatment assessed using the sociodental approach with the incorporation of perceived need for periodontal treatment.



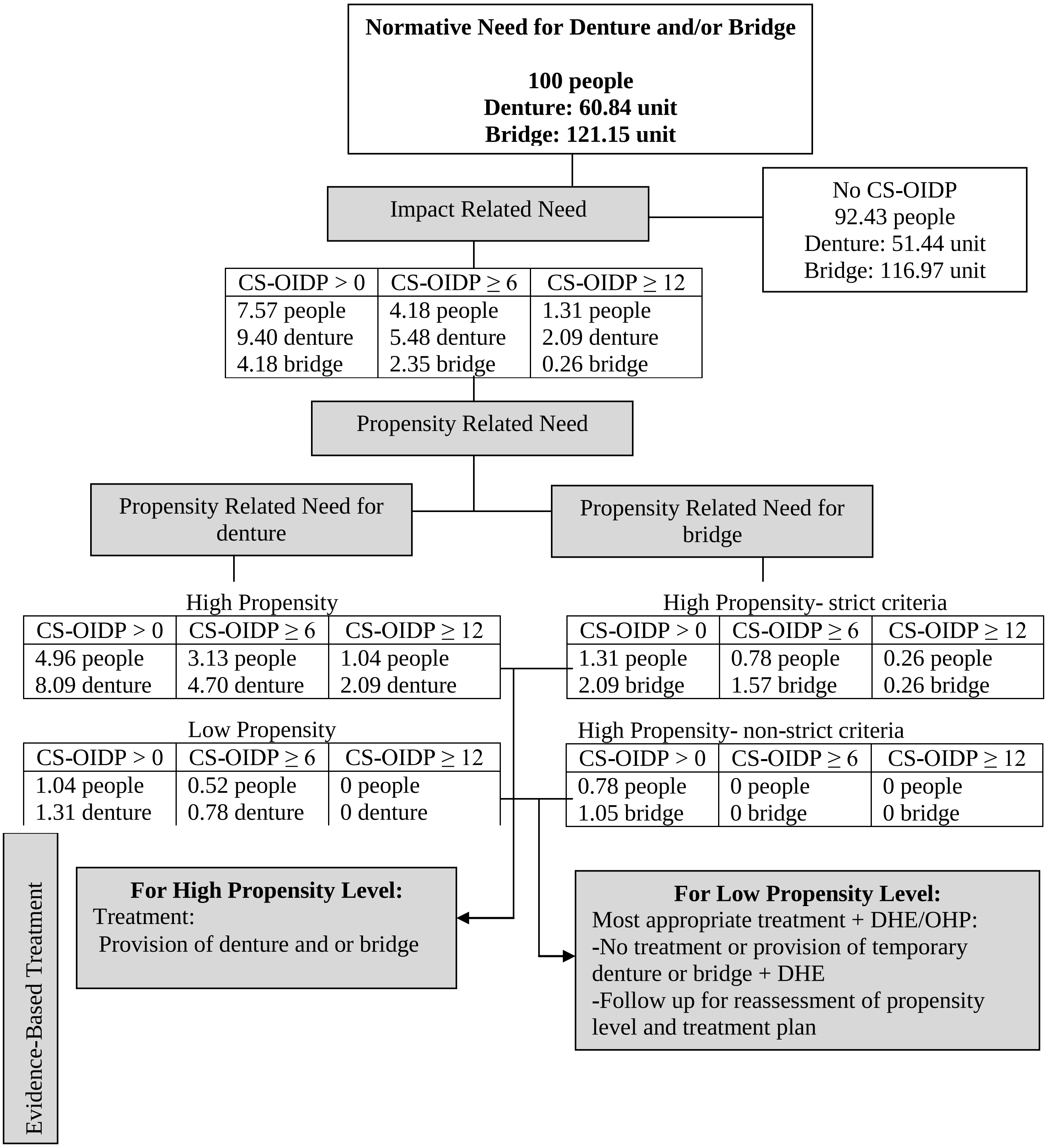
(vii): Comparison of the percentages of Malaysian adults (aged 30-54) who needed dentures assessed using the sociodental approach (incorporating perceived need for dentures) (N=732 people).



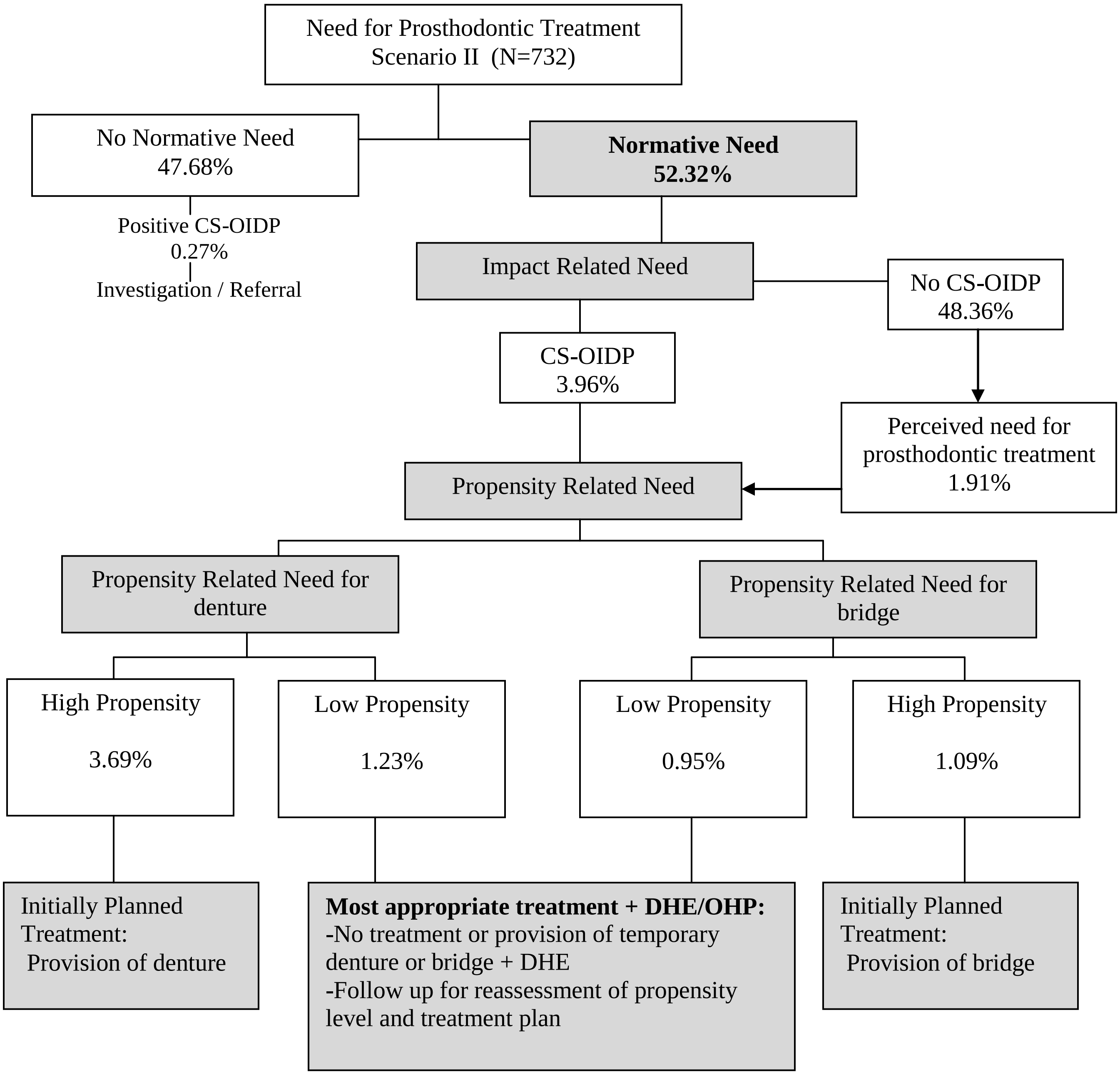
(viii): Number of dentures needed per 100 adult assessed using the sociodental approach (incorporation of perceived need for dentures) (N=224)



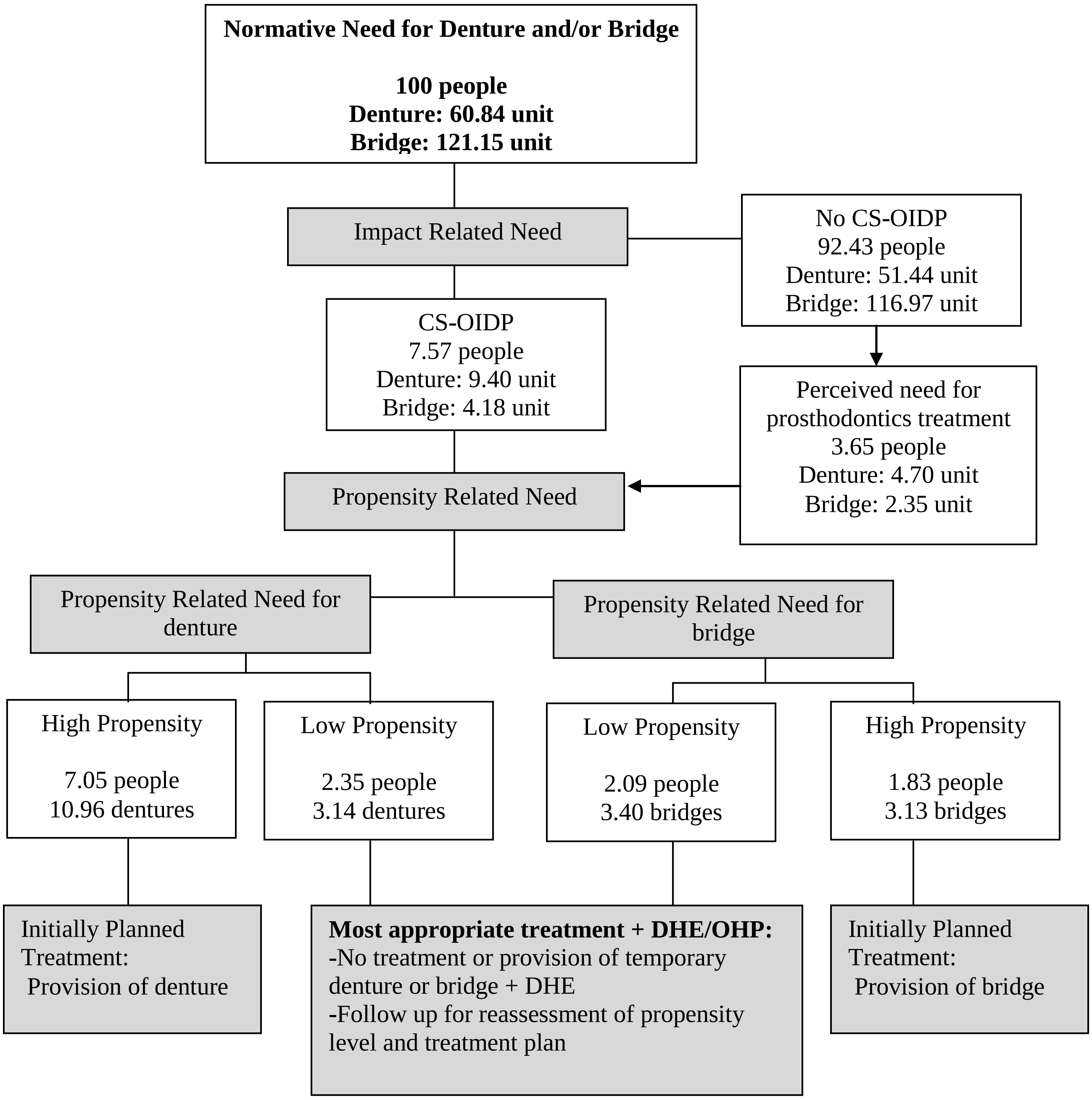
(ix): Percentages of Malaysian adults (aged 30-54) who needed dentures and/or bridges, assessed using the sociodental approach (at different level of CS-OIDP score and propensity criteria) (N=732 people).



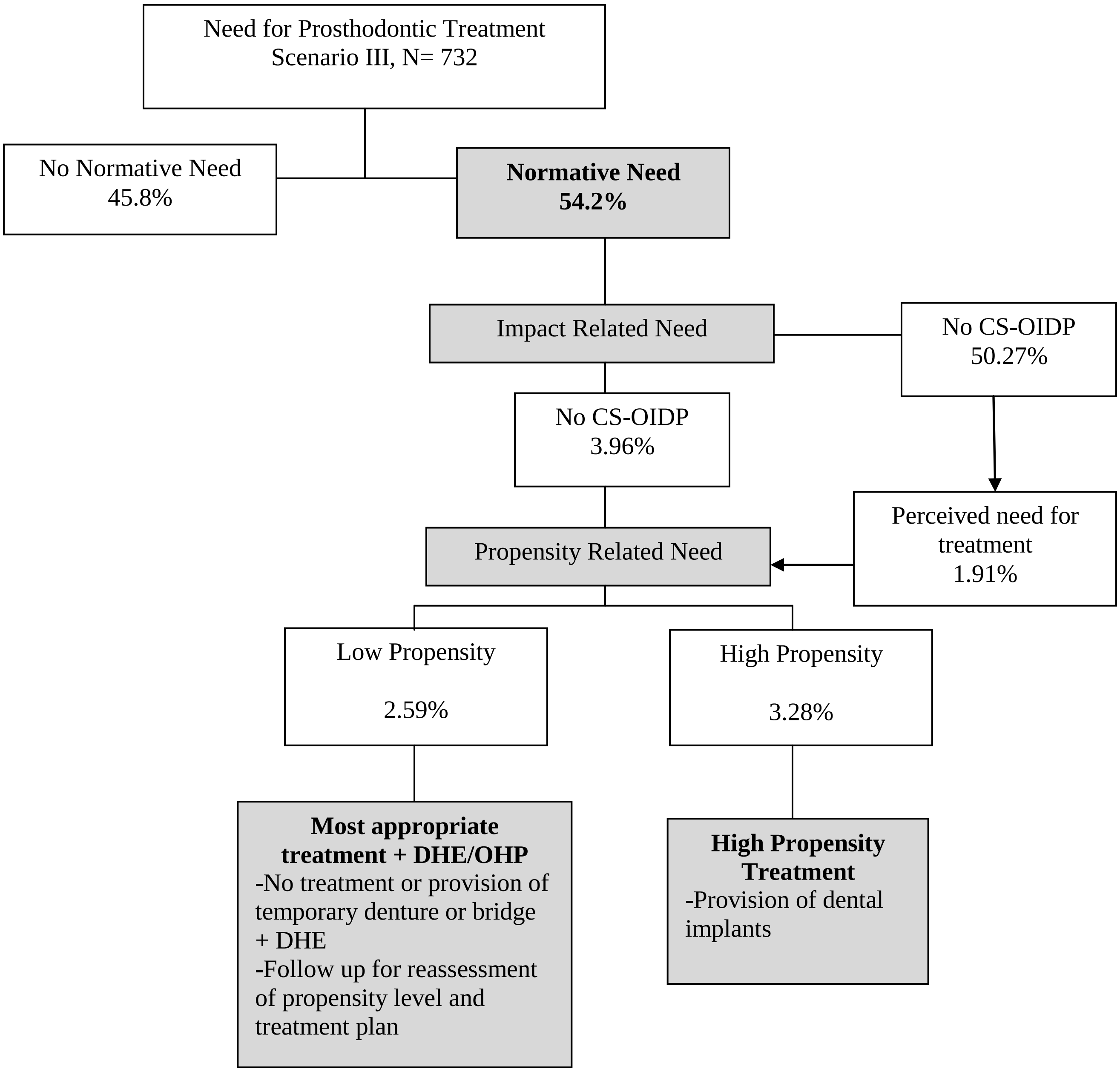
(x): Number of dentures and bridges needed per 100 adult assessed using the sociodental approach (at different level of CS-OIDP score and propensity criteria) (N=383)



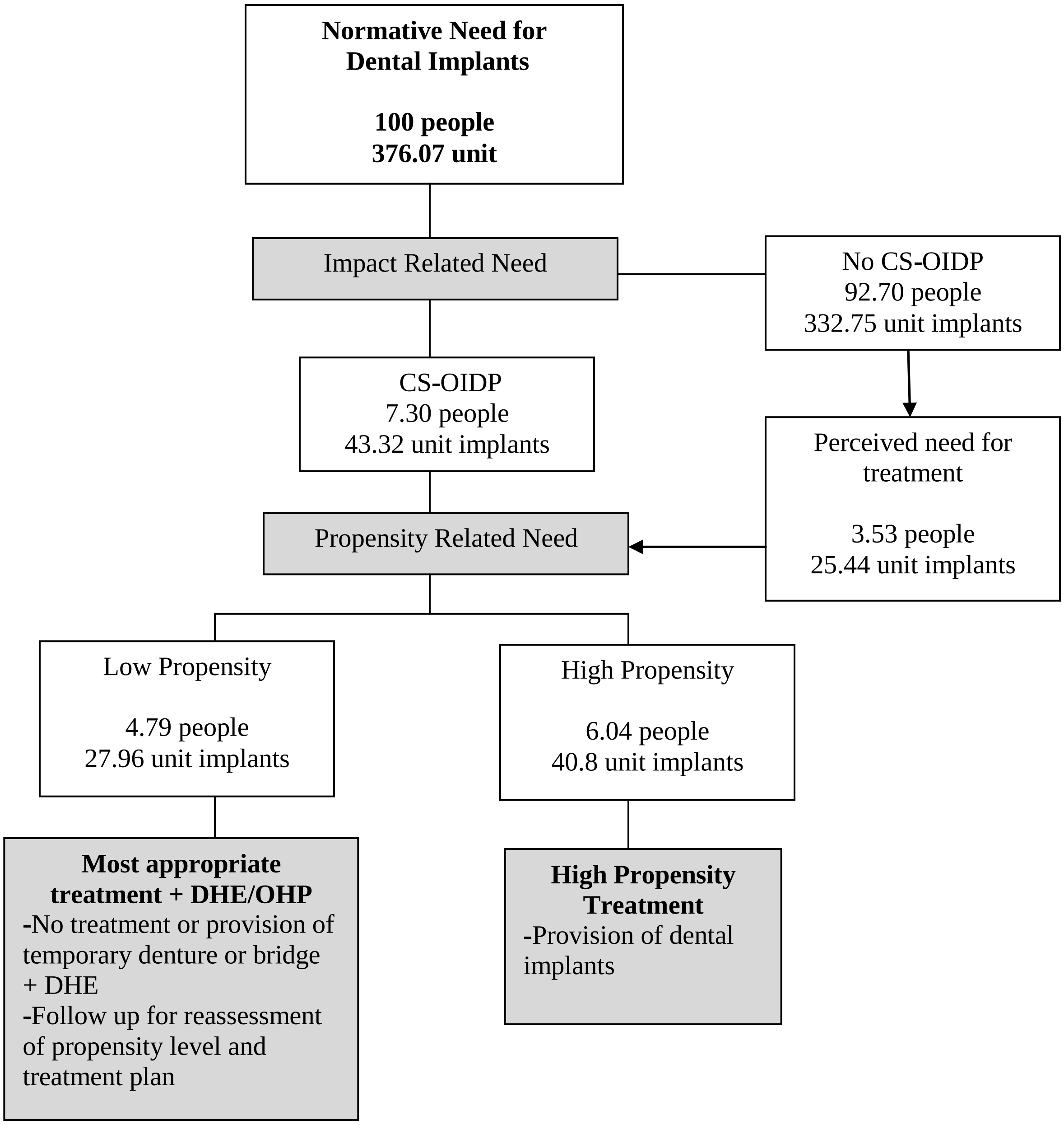
(xi): Percentages of Malaysian adults (aged 30-54) who needed dentures and/or bridges assessed using the sociodental approach (with the incorporation of perceived need for treatment) (N=732 people).



(xii): Number of dentures and bridges needed per 100 adult assessed using the sociodental approach (incorporation of perceived need for treatment) (N=383)



(xiii): Percentages of Malaysian adults (aged 30-54) who needed dental implants assessed using the sociodental approach (incorporation of perceived need for treatment) (N=732 people).



(xiv): Percentages of Malaysian adults (aged 30-54) who needed dental implants assessed using the sociodental approach (incorporation of perceived need for treatment).