

**Dental insurance, dental service use  
and health outcomes:  
Effectiveness and cost-effectiveness  
among Australian adults**

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# List of Abbreviations

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory, Australia
AIHW	Australian Institute of Health and Welfare
APRA	Australian Prudential Regulation Authority
ARCPOH	Australian Research Centre for Population Oral Health
BLQ	Baseline Questionnaire
CAL	Clinical Attachment Loss
CDHP	Commonwealth Dental Health Program
CEA	Cost-Effectiveness Analysis
CEAC	Cost Effectiveness Acceptability Curve
CI	Confidence Intervals
CUA	Cost Utility Analysis
DALYS	Disability Adjusted Life years
DMFS	Decayed, Missing and Filled Surfaces
DMFT	Decayed, Missing and Filled Teeth
EuroQoL or EQ-5D	European Quality of Life Scale
GP	General Practitioner
HHI	Household Income
HICAPS	Health Industry Claims and Payments Service
HIE	Health Insurance Experiment
HLL	Healthy Life-years Lost
HRQoL	Health Related Quality of Life
ICER	Incremental Cost-Effectiveness Ratio
LHC	Lifetime Health Cover
LSDPA	Longitudinal Study of Dentists Practice Activity
MEPS	Medical Expenditure Panel Survey
MID	Minimal Important Difference
MLS	Medicare Levy Surcharge
NDTIS	National Dental Telephone Interview Survey
NHHRC	National Health and Hospital Reforms Commission
NHMRC	National Health and Medical Research Council
NHS	National Health Survey
NMB	Net Monetary benefit
NSAOH	National Survey of Adult Oral Health
NSW	New South Wales, Australia
OECD	Organisation for Economic Cooperation and Development
OHIP	Oral Health Impact Profile
OOP	Out of Pocket (Expenditure)

OR	Odds Ratio
PBS	Pharmaceutical Benefits Scheme
PD	Pocket Depth
PHI	Private Health Insurance
PHIAC	Private Health Insurance Administrative Council
PHIO	Private Health Insurance Ombudsman
PICO	Population Intervention Comparator Outcome
PR	Prevalence Ratio
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QALYS	Quality Adjusted Life Years
RAND	Research and Development Corporation
ROP	Relief of Pain
RTS	Returned To Sender
SDS	School Dental Service
SES	Socio-Economic Status
SG	Standard Gamble
SIS	Standard Information Sheets
SRGH	Self-Rated General Health
SROH/SRDH	Self-Rated Oral/Dental Health
TTO	Time Trade Off
VAS	Visual Analogue Scale

# Abstract

## ***Aim***

The aim of this research thesis is to examine the relationship between dental insurance status and dental service use and health outcomes, to ascertain the out of pocket dental expenditure from a consumer perspective and examine the cost-effectiveness of being dentally insured.

## ***Methods***

The thesis presents a summary of existing literature and examined the relationship between dental insurance status and dental service use and oral health outcomes in working age adults in Australia using a two-year prospective cohort study. Out of pocket dental expenditure was calculated for the 2 year cohort and cost-effectiveness was examined. Baseline data was collected in 2009-10 with two follow ups in 2010-11 and 2011-12, through questionnaires, service use log books and receipts. Dental insurance premium costs were imputed from a database of private health insurance funds, plans and policies.

## ***Results***

The literature review showed a positive relationship between dental insurance status and favourable dental visiting pattern (regular dental visiting, visiting for check-up and visiting the same dentist). Mixed evidence on a positive relationship with oral health outcomes was reported.

The cohort study had a 37% response rate and a 40% retention rate (from baseline) by the end of the two years. 67% of the participants were dentally insured, 73% visited a dental professional, 15% and 23% reported negative change in self-rated oral and general health respectively and mean out of pocket expenditure was \$788 during the study period.

Dental visiting among the insured was significantly higher than the uninsured. Among those who visited, there were no significant associations with dental insurance for number of visits, services or services per visit. None of the main areas of services were significantly associated with dental insurance status either. However, the insured received significantly higher rates of diagnostic and preventive services per visit. Dental insurance was positively associated with OHIP severity change and negative change in self-rated oral health but not with general health outcomes. Mean net expenditure was marginally higher among the dentally insured participants but not significantly. Dental insurance was cost effective with 95% certainty if an individual consumer was willing to pay \$4300 over two years to maintain or improve their self-reported oral health.

***Conclusion***

The systematic analysis of literature and comprehensive analysis of cohort data found that dental insurance is effective in increasing dental visiting. It is also effective in improving oral health outcomes but not general health outcomes. The out of pocket dental expenditure is large but not substantially larger than other common household expenditures. Being dentally insured is more expensive but also provides better maintenance or improvement of oral health among adults. What these results mean for subgroups based on visiting frequency, type of visiting, longer term outcomes and reduction of future expenditure needs to be further examined in larger and longer duration studies.

# Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree. I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968. I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

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Emmanuel Sumithran Gnanamanickam

Date: 10<sup>th</sup> May 2016

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# **Chapter 1**

## **Introduction and background**

## **Structure of Thesis**

This research thesis examines dental insurance in Australia and its relationship to dental service use, oral health outcomes and dental expenditure. This first chapter provides a background on the key concepts that are critical to this research, namely dental insurance, dental service use, oral health outcomes and dental expenditure and provides the rationale and objectives for this study. It also provides a summary of the literature examining the associations between dental insurance and dental service use and oral health outcomes. The second chapter details the methods that were used to analyse the relationship between dental insurance and the outcomes of interest. Chapters three to six present the results of the analysis of data, divided by outcomes and finally chapter seven summarises the results, discusses it in light of the existing research and policy milieu and the conclusions that can be drawn from this body of research.

## **Background**

Globally, oral disorders as defined by the global burden of disease study account for about 15 million Disability Adjusted Life Years (DALYs) (0.6% of all DALYs) in 2010 (Murray et al., 2012) with caries being the most prevalent condition of the 291 diseases examined in the study (Marcenes et al., 2013).

Since the turn of the 21<sup>st</sup> century oral health problems continue to affect the Australian population as well. In 2000 dental caries was the most prevalent condition affecting health reported in the Australian population. With just over 19 million decayed teeth, dental caries was the second most commonly occurring condition after upper respiratory tract infections (Australian Institute of Health and Welfare, 2000). In 2005-06 the national survey on adult oral health reported that: 6.4% of Australian aged 15 years or over did not have any natural teeth (edentulous). Among dentate Australians, an average of 4.5 teeth had been extracted due to decay or gum disease, and about 11% had inadequate dentition (less than 21 natural teeth). More than one fourth (25.5%) of Australians had at least one untreated decayed tooth. About 20% had destructive periodontal disease, 3.3% had severe tooth wear and 25% moderate tooth wear that included complete loss of enamel (Slade et al., 2007). Comparatively Australia ranks 18 out of 21 among OECD countries for adult (35-44 year) oral health status (Spencer, 2001).

Consistent with the widespread nature of dental problems, health expenditure on dental services in Australia is large, accounting for \$8.7 billion in 2012-13 (Australian Institute of Health and Welfare, 2014c). Most dental services are paid for either directly out-of-pocket, or indirectly through insurance since the vast majority of Australian dentists are in the private sector (Teusner et al., 2007). About 58% of the \$8.7 billion spent on dental services was spent by individuals and 25.4% by the

government (Federal and State and local government) (Australian Institute of Health and Welfare, 2014c). In 2010-11, of all Australians 15 years and older, 49% had seen a dental health professional at least once. However, one in 4 Australians delayed seeing a dental health professional because of cost (Australian Bureau of Statistics, 2011b). The national dental telephone interview survey of 2010 (Chrisopoulos et al., 2011) estimated that more than 30% of working age adults avoided or delayed visiting a dentist due to cost. The National Survey of Adult Oral Health 2004-06 (Spencer and Harford, 2007a) also estimated that about 33% of those aged 15-54 years avoided or delayed visiting a dentist due to cost and the proportions were significantly higher among the uninsured.

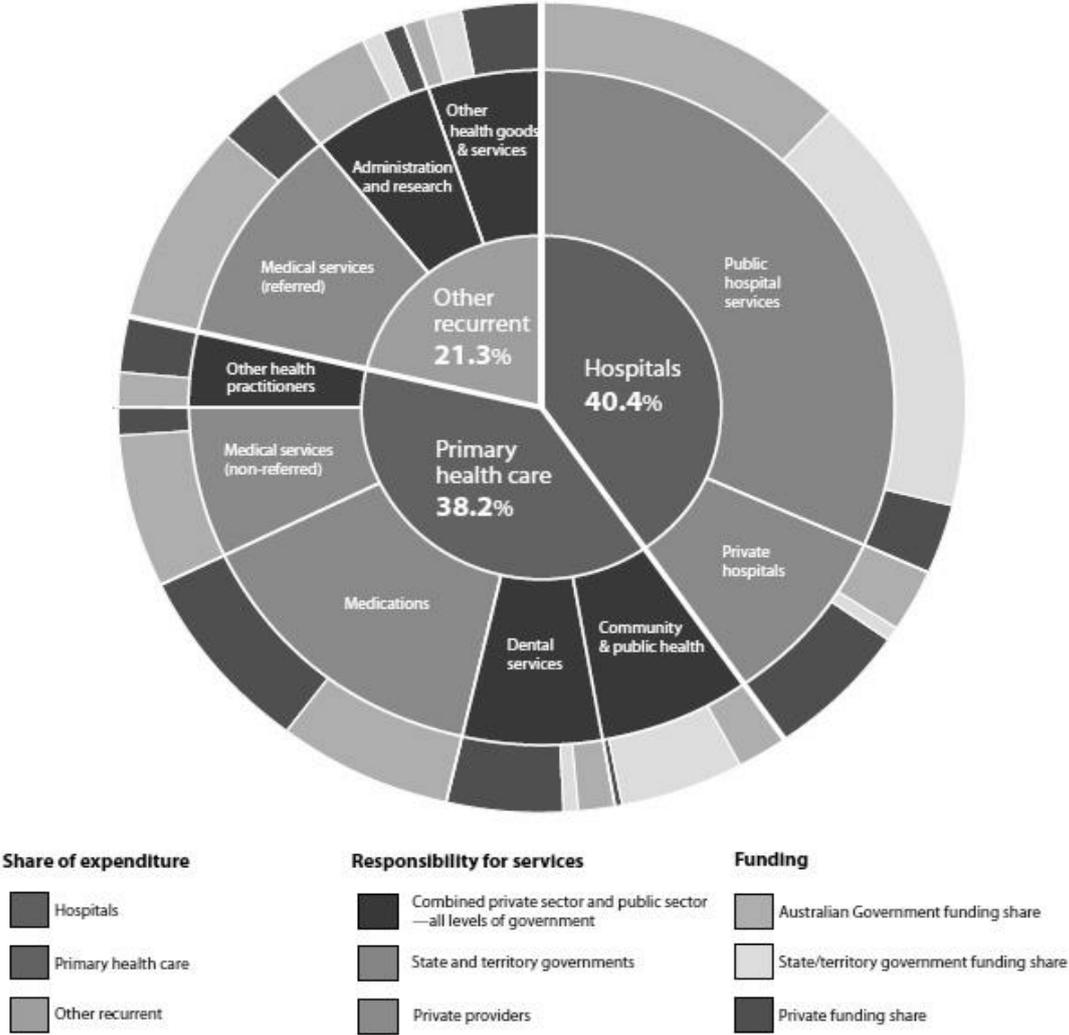
### **Health system in Australia**

The health system in Australia is multifaceted with a mixture of public and private providers and funding mechanisms as demonstrated in Figure 1.1 (Australian Institute of Health and Welfare, 2014a). The inner most level of the pie chart divides the health system based on the sector of service delivery or expenditure, the middle one on the service areas under each sector and the outermost based on the funding distribution for each area of service.

As the greyscale codes of the outer most level of the pie chart indicate, funding for all areas of services broadly fall under three areas – Australian federal government, the state or territory government and private funding. The Australian government funding is provided mainly through the universal health system called Medicare. Medicare provides access to free or subsidised hospital and medical services treatment to all Australian residents (Department of Human Services, 2015). Medicare also provides a safety net by providing an additional benefit for those who reach a relevant threshold of service use. Similarly, through the Pharmaceutical Benefits Scheme (PBS) and the PBS safety net, the cost of medicines are also subsidised. Medicare covers all or most of the services provided by doctors, specialists, optometrists and in relevant cases dentists and other health professionals, treatment and accommodation as a public patient in public hospitals and 75% of the scheduled fees for private treatment in a public or private hospitals (Department of Human Services, 2015).

Dental services on the other hand are largely not covered under Medicare. Dental services are mainly provided through private practitioners (Teusner et al., 2007) who charge fees directly to the patients. Some of these fees are subsidised by the insurance fund if the patient has dental cover under their private health insurance but is subject to limits based on the level of cover.

**Figure 1.1 Health services-funding and responsibility**



Source: AIHW 2014a.

Note: The inner segments indicate the relative size of expenditure in each of the 3 main sectors of the health system ('hospitals', 'primary health care', and 'other recurrent'). The middle ring indicates the relative expenditure on each service in the sector (shown by the size of each segment) and who is responsible for delivering the service (shown by the greyscale code). The outer ring indicates the relative size of the funding (shown by the size of each segment) and the funding source for the difference services (shown by the greyscale code).

**Dental health expenditure**

In 2008-09 dental expenditure in Australia was \$7.2 billion, second only to cardiovascular diseases in terms of expenditure (Australian Institute of Health and Welfare, 2014a) and accounting for nearly 10% of all health expenditure. In Australia, currently, dental health services are paid directly out of pocket, through insurance and government rebates and through subsidisation for concession card holders.

The total expenditure on dental services in Australia was \$8.7 billion in 2011-12 and can be broadly categorised as being sourced from the federal government direct outlay, the state and local governments, the federal government premium rebates, health insurance funds, individuals and other (Australian Institute of Health and

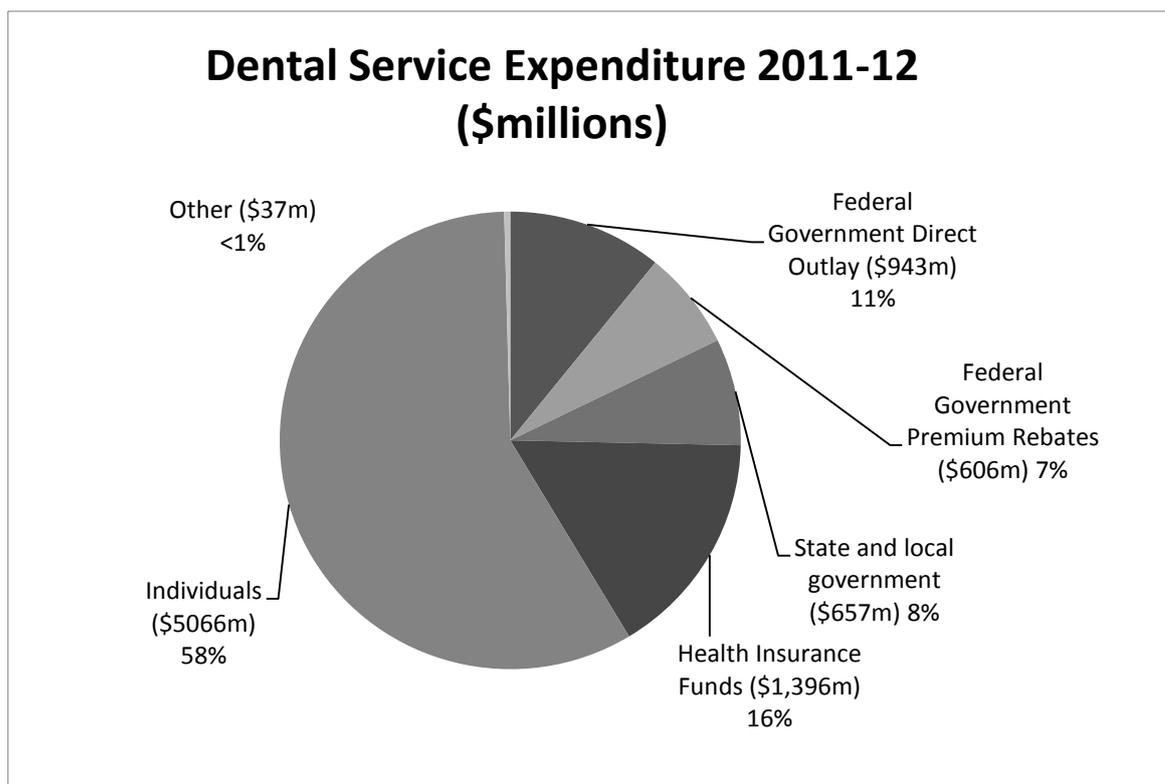
Welfare, 2014d). Figure 1.2 provides a snapshot of total expenditure on dental services and their sources in 2011-12 in \$millions.

**Government**

Federal government funding for dental care consists of funding for the school dental services which is part of general health funding and a 30% rebate on private health insurance, a portion of which is the dental component. Some funding from the commonwealth government is also spent for in-hospital services and radiological services that are used for dental examinations under Medicare and by the Department of Defence and Veteran Affairs (Harford and Spencer, 2004).

Most states and territories cover some of the direct costs of dental services for those who hold a concession health card. However there still remains some associated out-of-pocket expenses. In 2012-13 state and territory governments spent \$657 million on dental services (Australian Institute of Health and Welfare, 2014c). Birch and Anderson (2005) estimated that about 12 cents per dollar of all public sector health funds is spent on dental care as opposed to 70 cents per dollar for medical care.

**Figure 1.2: Sources of total dental service expenditure in \$millions (constant prices) 2011-12**



Source: (Australian Institute of Health and Welfare, 2014d)

**Individual**

About 58% of all expenditure on dental services in Australia in 2012-13 was spent out of pocket by individuals. The latest household expenditure survey of the ABS (Australian Bureau of Statistics) estimates weekly household expenditure on all health

practitioners' fees to be \$19 (2009-10). Of this about 38% was estimated to be spent for dental fees (Australian Bureau of Statistics, 2008, Australian Bureau of Statistics, 2011a). In 2012-13 out of an estimated \$18.5 billion that individuals spent on healthcare 27.4% was spent on dental services, second only to medications (40%) (Australian Institute of Health and Welfare, 2012).

### ***Private Health Insurance in Australia***

Private Health Insurance (PHI) is available in Australia as an option to cover all or some of the health care costs that are not covered under Medicare (Department of Health, 2015c). PHI cover can be used for both hospital and out of hospital services including ambulance services depending on the type of policy and level of cover that is purchased. In Australia there are mainly two types of private health insurance policies – hospital cover and general treatment cover. Hospital cover assists in the costs associated with being treated as a private patient in a public or private hospital. General treatment cover, which is also known as ancillary or extras cover provides assistance in costs associated with allied health and medical services such as physiotherapy, dental and optometry services. A combined policy with both types of cover can be purchased with most health insurance funds. In 2013/14, about 55.3% of the population had some form of PHI (hospital only, general only or hospital and general).

In 2013/14, about 55.2% of the population had general treatment cover (Private Health Insurance Administration Council, 2014). It is estimated that the vast majority of those with general treatment cover have dental cover as there are only a small number of policies available that exclude and/or allow policy holders to opt out of dental cover (Teusner et al., 2014a).

The Australian PHI industry is highly regulated and is directly subsidised by government via a means-tested 30% premium tax rebate. Key regulations include community rated premiums, control on premium increases and limits on the types of services that can be insured. Community rated premiums support non-discriminatory access to PHI by ensuring that premiums are the same regardless of the health or demographic characteristics of the individual. The Private Health Insurance Administrative Council (PHIAC) (whose regulatory role now sits under the Australian Prudential Regulation Authority (APRA)) was a statutory body corporate established under law that reports to the Federal Minister of Health. Its main role was monitoring and regulation of the private health insurance industry and improving the consumer experience.

Historically there have been a few policy measures that have resulted in the PHI industry in its current form. In 1983, following the establishment of Medicare the decline of PHI membership was viewed as a concern. There was a perception that the sustainability of the public system required substantial private funding provided by PHI (Hall et al., 1999). This led to a series of government interventions in the late 1990's to

create a system of incentives and disincentives to increase uptake of PHI. Subsequently the proportion of the population with PHI increased to 47% and has continued to incrementally increase in the last ten years.

Currently, there are three mechanisms that are in place to encourage uptake and maintenance of private health insurance. They are the private health insurance rebate, Medicare Levy Surcharge (MLS) and the Lifetime Health Cover (Private Health Insurance Ombudsman, 2015).

The Australian Government Private Health Insurance Rebate is an income tested rebate provided to Australian with private health insurance to cover the cost of health insurance premiums. This rebate is applied to all types of health insurance and can range from 0% to 37% based on income and type of household (single or family).

The Medical Levy Surcharge (MLS) applies to those who do not have hospital cover on their health insurance or do not have any health insurance and whose income is above a certain threshold. This surcharge is over and above the 2% Medicare levy paid by all Australian tax payers and ranges from 1% to 1.5% of income of eligible persons or families. The MLS is designed to encourage private health insurance hospital cover uptake and thereby reduce the burden on the public hospital system.

Similar to the MLS, Lifetime Health Cover (LHC) applies only to hospital health cover. It is a government mechanism to encourage earlier uptake and maintenance of hospital cover over the lifetime. Failure to purchase hospital cover by the 1<sup>st</sup> of July following one's 31st birthday makes one liable to an annual 2% loading over the yearly insurance premium. In other words a person is liable to pay a cumulative loading of 2% on their insurance premiums per year until the year of purchase of hospital cover starting from the age of 30. This loading applies to insurance premiums for the first 10 continuous years after the cover is purchased.

### ***Dental Insurance***

As described earlier, dental insurance in Australia, like PHI is optional and is covered under the general treatment policies of PHI. In 2013-14, the private health insurance industry contributed \$12.9 billion to the entire health system in Australia, accounting for 8.3% of total health funding. This excludes the \$5.5 billion private health insurance rebates of the Australian government (Australian Institute of Health and Welfare, 2015). Of the \$12.9 Billion, 12% (1.6 billion) was used in dental services.

The Australian PHI industry is highly regulated and is directly subsidised by government via a means-tested 30% premium tax rebate. Key regulations include community rated premiums, control on premium increases and limits on the types of services that can be insured. Community rated premiums support non-discriminatory access to PHI by ensuring that premiums are the same regardless of the health or demographic characteristics of the individual.

The decline of PHI membership following the establishment of Medicare in 1983 was viewed as a concern, as there was a perception that the sustainability of the public system required substantial private funding provided by PHI (Hall et al., 1999). This led to a series of government interventions in the late 1990's to create a system of incentives and disincentives to increase uptake of PHI. Subsequently the proportion of the population with PHI increased to 47% and has continued to increase incrementally in the last ten years.

In 2013/14, 55.3% of the population had some form of PHI (hospital only, general only or hospital and general). Cover for dental services are typically provided under general treatment cover which can be purchased separately or as part of a combined policy. In 2013/14, about 55% of the population had general treatment cover (Australian Prudential Regulation Authority, 2015). It is estimated that the vast majority of those with a general treatment policy have dental cover as there are only a small number of policies available that exclude and/or allow policy holders to opt out of dental cover (Teusner et al., 2014a). Dentate adults who lived in major cities were more likely to be dentally insured compared to those living in regional areas and dental insurance prevalence was higher among those whose household income was over \$100,000 a year. For majority of the dentally insured adults, more than 80% of dental costs were paid for by private health insurance.

Despite government measures to improve the affordability of PHI (i.e. 30% premium tax rebate), insurance status has remained strongly positively associated with household income and socio-economic status (Australian Bureau of Statistics, 2006). Consequently, government subsidies are inequitably distributed within the community and, as health service use by the insured has increased, there has been wide debate regarding the impact of increased PHI coverage on equity of access to health services. (Harford and Spencer, 2004, Hindle and McAuley, 2004). These concerns have been echoed in research specifically exploring access to dental services. Fitzgerald et al (2011) demonstrated that since the late 1990s income-related inequality in access to dental services has increased, i.e., those with higher incomes and better oral health also had better access to dental care while those with lower incomes had lower access to dental care. This inequality was observed to be increasing. A decomposition analysis of trends observed in time series data concluded that increased PHI coverage associated with PHI incentives played a contributory role in increasing inequity (Fitzgerald et al., 2011).

In 2009 the National Health and Hospital Reforms Commission (NHHRC) through its report to the federal government recommended a universal dental insurance scheme for preventive and restorative services and provision of dentures (National Health and Hospitals Reform Commission, 2009). The proposed funding was through an increase in the Medicare levy by 0.75%. Under this proposal those with private insurance could

continue to be insured privately. The benefit to those with private insurance would be that 'Denticare' (as this proposed policy was called) would pay that proportion of the premiums that cover preventive and restorative services and provision of dentures, and costs for additional coverage will be paid by the insured individual.

To cater for the expected increase in demand for services especially within the public sector the policy recommended internships for graduating dentists and oral health professionals. Public dental services were also encouraged to partner with the private dental services to meet demand for services. An expansion of pre-school and school dental programs were also proposed. However Denticare did not eventuate.

Currently, general treatment insurance policies that cover dental insurance generally cover four main areas of dental services, namely, general dental, major dental, endodontic and orthodontic. Policies have combined annual limits for all general service or just dental services or for each of the individual areas of dental services. The bulk of the claims (over 50%) made under general treatment policies and about 11-13% of all claims made under combined (hospital and general treatment) policies (Private Health Insurance Administration Council, 2015) were for dental services.

#### **Dental insurance, dental service use and health outcomes**

Across developed countries having PHI has been associated with; higher levels of access to dental care (dental visiting), visiting for a check-up and receiving a more comprehensive pattern of services as opposed to visiting for a problem and receiving care only to provide relief for the immediate problem. Related to these visiting patterns, associations between PHI and better oral health have also been observed. Additionally though, regular access to dental care is not necessarily associated with lower disease experience (Sheiham et al., 1985), regular care and usually visiting for a check-up have been associated with less untreated decay (Brennan et al., 2007) and fewer social impacts of oral disease (Harford and Spencer, 2007, Crocombe et al., 2012b). These associations are mainly due to early intervention resulting in better management of disease and thereby better outcomes.

While there have been numerous studies investigating the relationships between dental insurance, service use and health outcomes, only one review was identified. Bendall and Asubonteng (1995) reviewed ten American publications; four publications reported on the RAND (Research and Development Corporation) HIE (Health Insurance Experiment) and the remaining were based on population surveys. A synthesis of Australian research is required to understand the potential of cost sharing to improve dental visiting and thereby improve population oral health. A systematic literature review (Appendix 1) was conducted to systematically review and collate all empirical evidence in Australia, which investigated the association between dental insurance and dental service use and, or oral health outcomes. A summary of this literature review is presented below.

## **Summary of literature**

This literature review examined evidence from 36 publications that reported on the association between dental insurance and dental service use and, or oral health outcomes. The outcome variables for both outcome groups (i.e., service use and oral health outcomes) were heterogeneous, with proportions and means being the two main measures that were reported. Most outcome variables were reported in only a single or few publications while only three variables were reported in five or more publications. All papers reported on observational studies. While observational studies are not the highest level of research evidence, overall the quality of the publications in the review was considered high.

The consolidated evidence points towards a positive association between dental insurance and dental visiting. Literature on dental visiting considers, visiting a dentist in the last two years, visiting the same dental professional regularly and visiting for a check-up as favourable or beneficial patterns of dental visiting (Crocombe et al., 2012b). This literature demonstrates positive associations between all these three outcomes and being dentally insured. Service level outcomes on the other hand suggested a positive association for diagnostic, preventive (including only scale and cleans), dentures and crown and bridge services and a negative association for extraction services, once again suggesting a favourable service pattern for those with dental insurance.

Bivariate association between dental insurance and oral health outcomes suggests dental insurance has some favourable associations with both clinical and self-reported oral health outcomes. Global self-reported oral health was consistently positively associated with being insured and untreated decay was consistently negatively associated with having dental insurance in unadjusted results. Several other self-reported outcomes were significant but were reported only in one publication. While periodontal pocket depth and toothache experience were reported in more than one publication, they did not vary by insurance status. Individual components of DMFT and other caries measures were associated with dental insurance.

About two-thirds of the reviewed literature reported adjusted analyses, adjusting most commonly for socio-economic variables. When compared to the reported bivariate results for dental visiting and service level variables the insurance effects observed were largely unaltered in adjusted analysis. However, for health outcomes the adjusted results were mixed. Adjusted associations between insurance and global self-rated oral health remained significant, but were not significant for untreated decay and other caries measures. Two OHIP measures reported from adjusted analysis were significant. With the exception of dentate status, adjusted estimates for other self-reported measures were either not reported or not significant. These findings broadly reflect the associations found between regular visiting and health. However, the

adjusted results for oral health outcomes were drawn from a small number (n=6) of publications but most significant results for oral health outcomes were reported from larger studies based on nationally representative samples. Hence, the available evidence for oral health outcomes and insurance is mixed and limited.

The conclusions drawn from a review of existing evidence are only as valid as the evidence it summarises. All limitations that affect the studies that were reported in these publications remain. Additionally, the collated results are further limited by the variability in the data. The data in these publications are drawn from samples that differ in age, gender, geographical area and also drawn from different sampling frames.

Overall the evidence from the literature suggests that the dentally insured are more likely to have more regular access to dental care and a more comprehensive pattern of service use. Conclusions regarding the association between dental insurance and oral health are less clear. While results were mixed and there was paucity of studies reporting multiple variable analysis, the studies reviewed broadly reflected the associations usually found between regular care and oral health, that is, dental insurance was not associated with less disease experience but was associated with better managed disease (less untreated decay and more filled teeth).

### **Scope of problem**

Drawing on the introduction and background presented so far, in Australia, oral ill-health virtually affects the entire population at some point in their lives, and dental decay affects at least 90% of all adults (Slade et al., 2007). Access to regular dental care has benefits that include prevention, maintenance and timely diagnosis of oral health problems (Committee on Oral Health Access to Services, 2011). Access to dental healthcare, unlike general health is not universally available to all Australians. The majority of dental health providers work in private practice and users either pay for services out of pocket, through private health insurance or subsidised by states and territories as health care card-holders. Total expenditure on oral health was \$7.1 billion (10% of all health spending) second only to cardiovascular diseases in 2009-10 (Australian Institute of Health and Welfare, 2012). In light of the call for a universal government funded dental insurance system, this thesis aims to ascertain the effectiveness of dental insurance and consequently the cost-effectiveness of dental health insurance as provided through private health insurance in Australia.

### **Gaps and significance**

As summarised from the literature, dental service use variables were more commonly reported than oral health outcomes in the literature. Even among the reported health outcomes, very few were reported more than once and all of them reported from

cross-sectional data. Notably there were no publications examining associations between insurance status and treatment decisions and follow-up by patients, and few publications on chronic oral health conditions, perceived need for care and quality of life outcomes.

Study designs in reviewed literature were predominantly cross-sectional and three publications reported on short duration cohort studies. Experimental study designs can be best used to ascertain effectiveness of dental insurance but so far there has been only one experimental insurance study, which was conducted in the US in the 1980s. The RAND (HIE) was a large randomised controlled trial that examined the influence of insurance on health service use (including dental services) and health outcomes. The study found that the generosity of cover (level of co-payments) was positively associated with the probability of dental visiting. There were also associations with variations in services received. Prosthodontic treatment use was 62% higher among those with the most generous plan (0% co-payment) compared to those who had the least generous plan (95% co-payment) while the probability of endodontic and periodontal treatment was 50% higher (Manning et al., 1985).

The RAND HIE also investigated the relationship between dental insurance and oral health outcomes (Bailit et al., 1985). Those with the most generous plan compared to those with less generous levels of cover had less untreated decay, more filled teeth and lower periodontal index scores. The differences were greater for children and young adults (less than 35 years of age) than for older adults (Bailit et al., 1985).

The findings of the RAND HIE, however, are limited in its relevance to the current Australian policy context. The plans assessed in the HIE were markedly different from the structure of the plans available in Australia. The HIE plans provided protection from catastrophic costs via caps on total co-payments. Conversely, in Australia, the insurance plans typically have caps on benefits. In addition, Australian plans typically provide lower levels of cover (approximately 50% of dental claims), than the more generous plans in the HIE that were associated with increased probability of visiting.

Assessing the degree to which dental insurance improves access to dental care may indicate the potential for oral health improvements through public health policies that extend dental insurance coverage in the community. Alternatively, improvements in population oral health associated with PHI may also indicate the potential effectiveness of policies that aim to reduce out-of-pocket costs of dental services and, or provide public subsidisation of dental care.

As mentioned above the cost of dental care falls largely on the individual. Dental care imposes a large cost on individuals, and dental fees have risen over time with the relative costs of dentistry which increased at a faster rate than other health expenditures (Barnard, 2007). In light of this the question posed is whether dental

expenditure provides value for money for the Australian consumer. This could mean that dental care is effective in containing the burden of oral disease (Begg et al., 2007), or it may be that some expenditure is not impacting on the oral disease burden, or there could be inefficiencies in the delivery of dental services.

As summarised from the literature, having dental insurance has been linked to more favourable dental service profiles and dental visit patterns, and to better oral health (Bailit et al., 1985, Brennan et al., 1997, Slade et al., 2007). Patients with dental insurance have been shown to have service profiles which emphasises prevention and maintenance care, with less emphasis on tooth loss through extraction services (Brennan et al., 1997). Having dental insurance was associated with a higher percentage of persons making dental visits within the last year, and usually attending for a check-up rather than a problem (Slade et al., 2007). The dental component of the Rand Health Insurance Experiment concluded that significant gains in oral health could be expected if insurance coverage was extended (Bailit et al., 1985). However, the direct impact of insurance on oral health outcomes and the effect of variations in individual expenditure are not known.

Additionally an estimate of dental service use expenditure in Australia is not currently available. The available data is derived from an insured population (Australian Institute of Health and Welfare, 2011, Sivaneswaran et al., 2000) or estimated from a household expenditure survey that collects information with a two week recall period (Australian Bureau of Statistics, 2011a). There is also no study that examines the effectiveness of dental insurance from an economic perspective. This study is important to understand whether dental insurance has benefits for the oral health of Australians, and whether dental expenditure is cost-effective.

## **Research Questions and Objectives**

- What is the effectiveness of dental insurance in relation to dental service use and health outcomes?
- What is the cost-effectiveness of individual dental expenditure of the insured compared to the uninsured?

It is hypothesised that dental insurance will be cost-effective from a consumer perspective.

### **Objectives**

1. To ascertain the relationship between dental insurance and dental service use
2. To ascertain if dental insurance coverage under existing plans is positively related to oral health and Quality of Life (QoL) outcomes
3. To ascertain the relationship between individual dental service expenditure and dental insurance
4. To calculate the cost-effectiveness and/or cost-utility of dental insurance

The rest of the thesis seeks to answer these questions and discuss the results using data from a cohort study. The next chapter (Methods) describes the data from the cohort study as well as additional data sources that have been used for the study.

# **Chapter 2**

## **Methods**

## **Data**

Data for this thesis were from a few different data sets and sources. The main data and variables were from an NHMRC funded prospective cohort study with baseline data collection and follow-up at one and two years. The other sources of data for this study were mainly used to estimate insurance premium costs and are detailed in the estimation of costs section of this chapter.

### **Main dataset**

Baseline data for the main data set were collected from a random sample of adults drawn from the electoral roll using mailed self-complete questionnaires. The sample and follow up data collection is presented in Figure 2.1. Follow-up was conducted at one-and two-years after baseline to collect oral health status, Quality of Life (QoL), insurance status, and use of dental services, visiting patterns, expenditures and rebates received. These data were collected through questionnaires (Appendices 4), log books (Appendix 5) or provision of invoices and Health Industry Claims and Payments Service (HICAPS) receipts. HICAPS receipts provide detailed information on the services received and the total cost and insurance rebate for each service.

### ***Data collection tools***

#### ***Questionnaire***

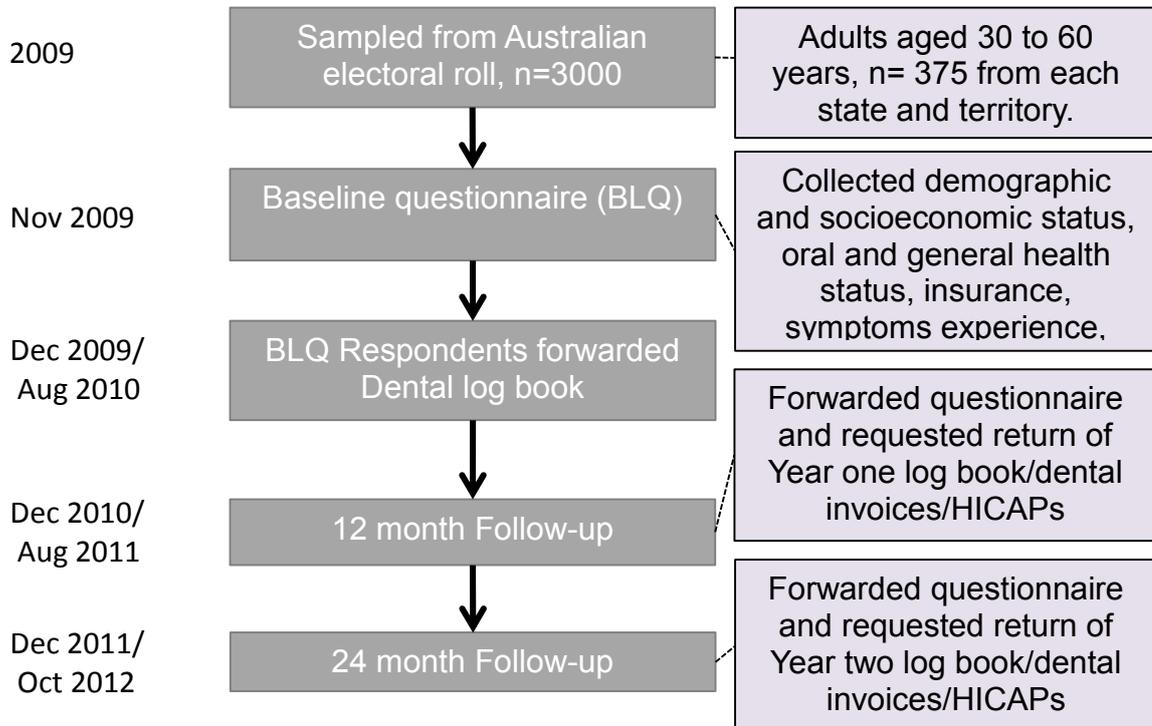
The baseline questionnaire (Appendix 4a) collected information on health and dental insurance, dental visiting practices, oral and general health status and practices, and demographic information. The baseline questionnaire also collected oral and general health quality of life through two standardised tools – the European Quality of Life Scale (EuroQoL or EQ-5D) and the Oral Health Impact Profile (OHIP). Following the baseline survey a brief form was sent out requesting specific information on the private health insurance fund and policy of the participants.

The first year follow-up questionnaire (Appendix 4b) collected information on oral and general health, EuroQoL, insurance status and dental visit and service use information for the first 12 months of the study. The second year follow up questionnaire (Appendix 4c) collected information on oral and general health, EuroQoL, insurance status, dental visiting, service use and cost from the previous 12 months, OHIP and change in oral and general health (transition judgements) across the two years.

Quality of Life (QoL) was measured by the EuroQoL and the Oral Health Impact Profile (OHIP) in this study. The EuroQoL is an instrument developed by a group of researchers in Europe, to measure and describe quality of life (The EuroQoL Group, 1990) while the OHIP measures the impact of oral ill-health on the functional, physical and social aspects of individuals (Slade and Spencer, 1994). Both these instruments are described in more detail later in this chapter. The dental insurance status, dental visiting, service use and cost information from the questionnaires was used to complement the

information collected in the log book where returned and as a substitute for non-return of log book.

**Figure 2.1: Main data set - Sample and data collection stages**



**Dental service use log book**

The dental service use log books (Appendix 5) collected detailed information on dental service use for each visit to a dental practice. The identical log book was used for both years of data collection. The information included date of visit, type of dental practice and practitioner visited, reason for visit, insurance status at time of visit, eligibility for insurance cover for services received at visit, if any services received were covered by government schemes and the list of services received and their respective item codes, costs and insurance rebates. Participants were given the option to provide a copy of their receipts along with their log of visits in lieu of entering detailed service use and cost information.

**Insurance fund data**

The second dataset used for this PhD was an insurance funds, plans and policies dataset that was collected in 2008-09. The data were drawn from the Standard Information Statements (SISs) available online from the Private Health Insurance Ombudsman (PHIO). The Standard Information Statements provide a basic overview of every health insurance policy that is available through any health fund in Australia for all three types of policies: hospital, general and combined. These sheets were used to create a database of all health funds and their policies based on the policy type and recorded information on insurance premiums per adult per month in NSW/ACT and the inclusions, exclusion and limits for the dental component of the policies. NSW and

ACT populations are often used as the reference population for Australia as together they are largest populated jurisdiction in Australia. Additionally, private health insurance is regulated to the extent that insurance funds cannot vary their policies or prescribed premiums by demographic status.

Other sources of data used in the analysis for this PhD includes health expenditure data cubes from the Australian Institute of Health and Welfare (AIHW), Australian Bureau of Statistics (ABS) publications and the National Dental Telephone Interview Survey (NDTIS) 2010 was used for comparing demographic and baseline characteristics of participants in the main dataset. Private Health Insurance Administrative Council's (PHIAC) (whose regulatory role now sits under the Australian Prudential Regulation Authority (APRA)) quarterly and annual reports were also used to ascertain dental components of health insurance policies.

### **Data preparation**

The main data set used for this thesis consisted of three sets of questionnaire data and two sets of log book data as described above. Data from returned questionnaires and log books were entered into a Microsoft Access database as raw data. Data entry integrity was checked by replication of data entry for a small subset of data items for each tool and round of data collection. Missing values were populated with codes based on their missingness; Missing but applicable, missing not applicable, data inconsistent or do not know as reported by the participant. Missing but applicable referred to data that was applicable but missing, e.g. age. An example of missing not applicable was when the participant indicated that they were not insured and hence did not answer the question on type of insurance policy. Data was deemed inconsistent when mutually exclusive variables were both answered. A few participants explicitly answered 'Don't Know' to some questions and this was treated as missing as well.

Log book data was recorded in three levels; individual level, visit level and services level. The visits were recorded as a single entry or line item and each service received in a visit was recorded in a separate table linked to the visit IDs in the visits table. The services tables recorded the service item received, the expenditure and rebate received with an automatic calculation of out of pocket expenses for each service. Visit entries were checked to delete entries that belonged outside of the study period and all entries were checked to fall within the correct year of the study.

The service expenditure information (service expenditure, insurance rebate and out of pocket expenditure) was then aggregated to populate the expenditure variables for each visit and the visits information was aggregated to populate the individual level expenditure variables. This process was followed for preparation of both first and second year follow up data separately. Expenditures that were not paid by the individual, or were directly subsidised by government programs or hospital were

excluded from the expenditure variable because the focus was on consumer service use costs only. Since the accuracy of the expenditure data was critical to the economic analysis in the study, missing cost information for individual services where services received were explicitly reported were imputed with a mean value of the specific service from the remaining sample for that year. There were only 11 participants for whom data was missing for service level expenditure and hence imputed.

Individual variables from the log books were aggregated and merged with the questionnaire data for the respective year, thus creating three data tables, one for each round of data collection. The three rounds of data were then merged into a single table by participant ID.

Several data integrity checks were conducted at each step to make sure data aggregation was accurate. One example of a data check was to check if dental insurance status for a visit was consistent with the aggregate insurance rebate variable that was calculated from the service level table. Similarly the individual level insurance status information reported through the questionnaires was checked for consistency with the information reported through the log books and insurance rebate information that was reported. Where there were discrepancies, the log book data were regarded as the gold standard as these were maintained through the year (unlike the questionnaire that was answered at the end of the year) and majority of the log books were completed by the dental practitioner or were supplemented by detailed receipts, bills or quotes. For both years where log books were not returned or were returned without information, the data collected through the questionnaires were used.

## **Analytical plan and variables**

Analyses to answer the research questions were broadly in the following 5 areas;

1. Response and bias analysis;
2. Effect of dental insurance on dental service use or access to service use;
3. Effect of dental insurance on oral health outcomes;
4. Analysis of total expenditure by insurance status and finally;
5. Economic evaluations.

Table 2.1 provides a snapshot of the 5 areas of analysis and the variables used for each area of analysis. The rest of the thesis is broadly divided into sections based on these analysis areas.

<b>Table 2.1: Analytical plan and variables</b>				
<b>Areas of Analysis</b>	<b>Outcome Variables</b>	<b>Key Explanatory variables</b>	<b>Other Explanatory variables</b>	<b>Co-Variates</b>
Response Bias	-	-	Dental insurance status, dentate status, self-reported oral health, toothache, tooth brushing and average visiting	Age, Sex, HHI, Education, Region
Access to Dental Care	% visiting No. of visits Total services Total services/visit Types of services	Dental Insurance status	OHIP, oral health behaviour(tooth brushing), oral health experience(Toothache), No. of teeth, Baseline SROH, Baseline SRGH	Age, Sex, HHI, Education, Region
Health Outcomes	No. of teeth QoL – OHIP QoL – EuroQol SROH Change SRGH Change	Dental Insurance status	HHI, oral health behaviour(tooth brushing), oral health experience(Toothache) % visiting and No. of visits visiting variables	Age, Sex, HHI, Education, Region
Cost/Expenditure Analysis	OOP expenditure	Dental Insurance Status	OOP expenditure at point of care, Rebates received	Age, Sex, HHI, Education, Region
Economic Evaluation	QoL – OHIP* SROH Change*	Dental Insurance status	OOP expenditure at point of care, Rebates received	Age, Sex, HHI, Education, Region

HHI= Household Income, SROH= Self Rated Oral Health, SRGH=Self Rated General Health, OOP=Out of pocket, \*= Significant variables from health outcome analysis

### **Main Explanatory Variable**

The main variable of interest or explanatory variable was dental insurance status. This was defined dichotomously as being insured or uninsured for dental services for the two-year study period. Operationally, any participant who was insured for at least one of the two years of the study period was considered insured. This insurance status was ascertained using the information collected through the follow up questionnaires and was complemented with information from the log books and receipts based on the rebates received during service use. Dental insurance status at baseline is also reported in some tables and comparisons, but is clearly indicated as baseline status.

### **Outcome variables by area of analysis**

#### ***Response Bias***

Baseline general demographic variables such as age, sex, household income, education and region of residence and baseline oral health variables such as dental insurance status, dentate status, self-reported oral health, toothache frequency, tooth brushing frequency and average visiting pattern, of the study respondents were compared with both non-respondents and with the matched age respondents from a population study, the National Dental Telephone Interview Survey (NDTIS) 2010, to ascertain representativeness in response and follow up. These variables are defined later in this chapter.

#### ***Access to dental care or dental service use***

<b>Variable</b>	<b>Definition</b>
Dental visiting	Proportion of participants who made one or more dental visits during the two-year period
No. of visits	Mean number of visits among those participants who made at least one visit (visited) during the two-year period which includes single or multiple visits for a course of care and multiple courses of care
Total services	Mean number of services among those participants who visited
Total services/visit	Mean number of services per visit among those participants who visited
Main types of services	Mean number of diagnostic services, preventive services, oral surgery services, restorative services and prosthodontic services among those participants who visited
Main types of services/visit	Mean number of diagnostic services, preventive services, oral surgery services, restorative services and prosthodontic services per visit among those participants who visited

Dental service use outcome variables can be divided into dental visiting variables and service area variables. Dental visiting variables included, dental visiting, mean number of visits, mean number of services and mean number of services per visit. Service area

variables included all the main types of services. The definitions of each variable is presented in Table 2.2

**Health outcomes**

The third area of analysis for this PhD project is health outcomes. This included oral health, general health and quality of life outcomes. The oral health variables were tooth loss, Oral Health Impact Profile (OHIP), and Self-Rated Oral Health (SROH) variables. The general health variable was Self-Rated General Health (SRGH) and the Quality of Life variables were different EuroQol measures. All of these were measured as change scores i.e., the change in these measures from baseline to the end of the two-year study period.

**Table 2.3a: Outcome variables and definitions – Oral Health outcomes**

Variable	Definition
Any Tooth Loss	Proportion of participants who lost at least one tooth during the two-year period – this variable was calculated using the self-reported number of teeth at baseline and end of second year
Mean Tooth Loss	Mean number of teeth lost during the two-year period.
Mean OHIP Severity Change	Oral Health Impact Profile (OHIP) severity was calculated from the OHIP-14 that was collected both at baseline and end of the second year by summing up the values for the 14 items. The items were coded on a scale of 0-4 with 0 indicating highest impact and 4 indicating lowest impact. The severity scores were calculated inversely. Hence the severity scores ranged from 0-56 with the higher score indicating higher oral health impact. The change in OHIP severity was calculated by subtracting the second year OHIP severity score from the baseline score. Hence a negative value indicated that the oral health impact has increased or there was higher impact. The mean of these change scores were used as an outcome variable
% OHIP Negative Change	The change in OHIP severity score variable as calculated above was dichotomised into participants who had no or positive change values and those who had negative change values. The proportion with only a negative change was used as an outcome variable
Negative Self-Rated Oral Health (SROH) Change	Change in self-rated oral health was captures using a global transition statement of change in self-rated oral health over the 2 years collected at the end of the second year. This was collected using a 5 level Likert scale ranging from ‘worsened a lot’ to ‘improved a lot’ with a middle value being ‘stayed the same’. This was coded on a scale from 1 to 5 and was dichotomised into those who stayed the same or improved and those who worsened. Participants who worsened were classified as those who had negative change in SROH and was used as an outcome variable.

Locker (Locker, 1998) elaborates on four different types of change measures used in oral health research. They are, before after comparisons, change scores, global transition judgements and global transition scales. In this study change scores for the above mentioned variables and global transitions judgements for both oral and general health have been used. The definitions of these variables are presented in Tables 2.3a and 2.3b, while a broader description of Health Related Quality of Life (HRQoL) measures and OHIP and EuroQol is found in the following section.

### *Health Related Quality of Life*

Health Related Quality of Life (HRQoL) is a measurement of the impact health or ill-health has on the lives of individuals (Drummond and McGuire, 2001). While life expectancy has been used to measure the impact of health on individuals, health related quality of life captures the impact beyond just an impact of mortality.

<b>Table 2.3b: Outcome variables and definitions – General Health outcomes</b>	
<b>Variable</b>	<b>Definition</b>
EuroQoL Health Utility Change	Health Utility scores were calculated using the EuroQol and the weights produced by Viney et al (2011). The EuroQol health utility score was calculated for both baseline and end of two years. The scores range from 0 to 1 where 0 indicated death or a state worse than death and 1 indicated perfect health. The change in EuroQoL health utility was calculated by subtracting the second year utility from the baseline utility. Hence a negative change value indicated that the health utility increased and a positive value indicated decrease in health utility. The mean of these change scores were used as an outcome variable
EuroQoL Health Utility Negative Change	The change in EuroQoL health utility variable as calculated above was dichotomised into participants who had no or positive change values and those who had negative change values. The proportion with only a negative change was used as an outcome variable.
Negative Self-Rated General Health (SRGH) Change	Change in self rated general health was captures using a global transition statement of change in self rated oral health over the 2 years collected at the end of the second year. This was collected using a 5 level Likert scale ranging from ‘worsened a lot’ to ‘improved a lot’ with a middle value being ‘stayed the same’. This was coded on a scale from 1 to 5 and was dichotomised into those who stayed the same or improved and those who worsened. Participants who worsened were classified as those who had negative change in SRGH and was used as an outcome variable.

There are several tools that have been developed to measure HRQoL over the years. Some of them have been developed as generic measures while others are disease specific. This study has used both a generic measure in the use of the European

Quality of Life (EuroQol) scale and a measure specific to oral health – the Oral Health Impact Profile (OHIP). Similarly there are several approaches that have been developed over the years to capture both these impacts of health - Quality Adjusted Life Years (QALYs), Disability Adjusted Life Years (DALYs), Healthy Life Years Lost (HLL) etc.

### *OHIP*

The Oral Health Impact Profile (OHIP) was developed in 1994 to measure the impact of oral ill-health on the functional, physical and social aspects of individuals (Slade and Spencer, 1994). Based on the theoretical model developed by Locker empirical methods were used to elicit statements, and judgements on the importance of those statements from patients and a judging panel. The final result was a battery of 49 questions measured using a 5 point Likert scale that yielded good levels of reliability and validity. It consists of 7 subscales of functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap.

In response to difficulties using the OHIP-49 in some research settings, especially health services research and as a self-complete questionnaire, an OHIP with 14 questions was developed a few years later (Slade, 1997). The OHIP-14 was demonstrated to have good reliability, validity and precision and has been promoted as a good substitute for the OHIP-49 in situations that warrant the use of a shorter tool to assess the social impact of oral ill-health

The OHIP can be used to calculate severity scores, prevalence and summary scores. Severity scores were used in this study and was calculated from the OHIP-14 by summing up the values for the 14 items. The items were coded on a scale of 0-4 with 0 indicating lowest impact and 4 indicating highest impact. The severity scores were calculated as impact measures. Hence the severity scores ranged from 0-56 with the higher score indicating higher oral health impact. These severity scores were then dichotomised to indicate high or low impact (Brennan et al., 2013) using a threshold of 8 or more equating to a very-often rating on two or more items.

### *EuroQol*

The EuroQol or the EQ-5D is an instrument developed by a group of researchers in Europe, to measure and describe quality of life (The EuroQol Group, 1990). They sought to develop an instrument that complemented other quality of life measures and one that could be used trans-nationally hence standardising the measurement of quality of life. It was developed based on the need for it to be easily administered and also one that produces a cardinal health utility index score along with a quality of life profile.

The initial instrument had 6 dimensions. In its current form the EuroQoL has 5 dimensions measured on a three level Likert scale, generating 245 possible health states in all (Williams, 1995) including two additional health states of death and unconsciousness.

Initial valuation studies of EuroQoL health states used the Visual Analogue Scale (VAS), however other valuation methods such as the Standard Gamble(SG) and the Time Trade Off (TTO) have been used as more and more funding has been available for health valuation research (Williams, 1995).

The EuroQoL has been used for different purposes which include population studies, RCTs, measuring QALYs and clinical decision making. QALYs can be calculated using the descriptive profile of the respondents and applying it to an appropriate tariff of health state valuations. Several such tariffs have been developed using the general public in different populations using the VAS, SG and the TTO. Its value in the measurement of QALYS is because of its ease in collection as a self-rated QoL and a tariff of health state values.

### *Comparison*

In a study by Brennan and Spencer (2005a) the EuroQol as a generic quality of life measure was compared with the OHIP as a measure specific to oral problems. Simple counts, additive scores and scale scores were compared between the two tools to establish the discriminant validity. Both the EuroQol and the OHIP had good discriminant validity though there were differences in patterns of association. OHIP was better associated with most oral health factors while the EuroQol performed better in respect to respondent characteristics, visiting, dental condition and number of decayed teeth.

### ***Cost and cost effectiveness analysis***

The final two areas of analysis in this PhD project are cost and cost effectiveness analysis. Health care interventions around the world are constantly competing with other efforts to improve human life and development such as education, environment, housing, defence etc. Within the health sector there are competing priorities for resource utilisation. It is in this context that money that buys all resources has to be optimally used in order to maximise benefits. This gains more importance when the expenditure is by the tax payer funded (government) resources and the concern around the world is if public spending is benefiting all sections of society and underpinned by values of equality and social justice. On the other side of the coin, when expenditure is a significant burden on individual and household budgets, its effectiveness is of critical importance as well.

Economic evaluations are organised methods to understand the factors involved in use of resources. They compare costs with consequences for effective decision-making.

However, in order for economic evaluations to be useful the intervention that is being studied needs to be efficacious, effective and available (Drummond et al., 2005). Some of the literature discussed above support the efficacy and effectiveness of dental insurance albeit in different populations and there are mixed outcomes.

#### *Cost-Effectiveness Analysis and Cost-Utility Analysis*

Cost-Effectiveness Analysis (CEA) is a form of economic evaluation where cost is compared to the health effect of the intervention. The outcome that is measured is usually specific to the health condition that is being studied. In this study cost is directly compared to the oral health outcomes.

Cost-Utility Analysis (CUA) on the other hand compares cost of an intervention to the utility derived from the outcomes, effects or the resultant health states. Utility is the preference people have for a health state or outcome. This utility is measured through Health related Quality of Life (HRQoL) measures.

In this study cost utility analysis was not conducted as the utility outcome measures were not found to be effective by insurance status. For cost effectiveness analysis, ICERs with bootstrapped confidence intervals, Cost Effectiveness plane, Net Monetary Benefit (NMB) and the Cost Effectiveness Acceptability Curve (CEAC) have been presented. Commonly, a CEA involves the presentation of an Incremental Cost Effectiveness Ratio (ICER) and the cost-effectiveness plane. However, this study is interested in the individual consumer perspective and the ICERs for these outcomes are not readily interpretable for an individual consumer. Normally an ICER value of 'x' means that 'x' is the cost difference in relation to one unit change in outcome between the comparison groups. Hence, the interpretation is that every unit change in the outcome requires 'x' amount of monetary outlay for the whole population. However this cannot be said for every single individual within a population. So, the ICER and its associated precision estimates are presented in this chapter followed by the cost effectiveness acceptability curve (CEAC) and net monetary benefit (NMB). The CEAC and the NMB provide a more interpretable measure from an individual consumer perspective.

ICER was calculated by the formula:

$$\text{ICER} = \Delta \text{ costs} \div \Delta \text{ effect or outcome}$$

Where,

$$\Delta \text{ Cost} = \text{Mean cost of being insured} - \text{mean cost of being uninsured}$$

$$\Delta \text{ Outcome} = \text{Outcome among the insured minus the outcome among the uninsured};$$

Probabilistic sensitivity analysis was conducted by generating a bootstrapped sample from the original sample with 10,000 replications and the Cost-Effectiveness plane of this bootstrapped sample is presented.

Net monetary benefit is being increasingly used as a summary measure in health economic evaluations because of the statistical difficulties in testing the differences in ratios such as the ICER. In this study, where the cost perspective is that of the consumer it is all the more useful because it presents the outcome as a function of the individual's willingness to pay.

NMB is the monetary benefit that an intervention will have given the willingness to pay a certain amount of money for the benefit. It is the difference in effect multiplied by the amount one is willing to pay, less the difference in cost. If the NMB is more than zero then the intervention is considered to be cost-effective. The NMB can be defined with the following expression

$$\text{NMB} = ((\text{Willingness to pay} * \text{Difference in effect}) - \text{difference in cost}) > 0$$

In a deterministic approach, i.e., one where the costs and benefits and the willingness to pay is known with certainty it is possible to produce a single net monetary benefit. However, in most cases the willingness to pay is not known and, hence, it is common to present the NMB as a function of varying values of willingness to pay.

The Cost Effectiveness Acceptability Curve (CEAC) is the probability that an intervention is cost effective when compared to another intervention or no intervention given the observed data. Similar to NMB the CEAC is represented as a function of willingness to pay thresholds. The CEAC has been plotted using the original sample and also with bootstrapped data.

#### *Determination of cost perspective and cost estimations*

Drummond et al (2005) list's four considerations in determining the costs that need to be considered for a cost analysis. The first, is the question around the perspective of the study. In this study the impact of dental insurance is examined from a consumer perspective. Hence we are employing an individual consumer perspective wherein the costs of obtaining preventive and curative dental care are the key components. Other components include those of the government providing services to those with lower income, health promotion costs and costs of other public health programs such as water fluoridation.

The second consideration in estimating costs is the nature of costs between the groups of comparison. In this study the comparison is between those who have and do not have dental insurance. The costs associated between these two groups are largely similar. Reports in the literature and findings from the study sample indicate that dental visiting is higher among the insured and so it is expected that the costs of

accessing dental care will be higher among the insured. Similarly the cost of dental insurance premiums is different between the two groups. Other costs such as public health and health promotion expenditure are expected to be similar between the two groups in this study. Government service delivery expenditure however is expected to be different between the two groups with those eligible to access government dental services likely to be uninsured.

Consequently, the third consideration in estimating costs is the inclusion or exclusion of cost categories that are likely not to change the outcome of the analysis but whose estimation is complicated and time consuming. The final consideration is the exclusion of costs that are too small in magnitude to change the outcome of analysis. Taking the dental care perspective as mentioned above, costs were largely similar between the insured and uninsured except for insurance premiums and potentially service use expenditure. Government dental service expenditure excluded as we were interested in the financial burden from a consumer perspective.

#### *Calculations of costs*

The main cost centres from a health consumer perspective were identified as:

1. Dental insurance premium costs
2. Service use costs

In this study the costs incurred are over a period of two years. While this duration is not significant for large differences in cost of insurance premiums or dental service use costs, time preference in costing needs to be considered for various reasons. For instance, benefits received today or cost incurred later is more advantageous than the opposite. Hence the costs have been adjusted to reflect the two-year period as described below.

#### *Dental insurance premium costs*

Calculation of costs requires two elements, the cost per unit and the number of units that the cost needs to be applied to in the study. For dental insurance premiums the cost per adult person (unit) was estimated from the 2008/09 insurance fund and plan Standard Information Sheets (SIS) from PHIAC based on an adult in NSW/ACT per month.

Dental services benefits paid by insurance funds as a percentage of total ancillary (general treatment) policies and combined (hospital and general) was calculated from the PHIAC quarterly databases for the Sept and Dec 2008 and Mar and June 2009 as shown in Table 2.4.

These proportions were then applied to the monthly insurance premiums depending on type of policy and multiplied into 12 months for annual premiums based on

insurance status for each year. The two premiums for each year were summed and applied as the dental insurance premium cost for the entire study period.

**Table 2.4: Proportions of dental components of insurance policies**

	2008		2009		2008/09
	September	December	March	June	Total
Dental component of ancillary only rebates	52.30 %	51.51 %	50.59 %	51.45 %	<b>51.46 %</b>
Dental component of combined rebates	13.18 %	13.02 %	13.27 %	13.31 %	<b>13.20 %*</b>

\*Insurance premium rebates paid by the commonwealth government for dental services as a proportion of total premium rebates was 11.69 % in 2008-09 (Australian Institute of Health and Welfare, 2011)

However, since the premium cost estimate was based on SISs from 2008-09 and the costs were actually incurred during the subsequent two years, the dental insurance premium costs have been adjusted to reflect the two critical factors. First, the actual rate of increase in insurance premiums that comes into effect every year on the 1<sup>st</sup> of April. The insurance premiums for each year was increased based on the premium increase rates obtained from the PHIAC databases as reported by the Department of Health website (2015a). Information on the rate of increase in insurance premium by insurance fund was available and applied to the 2008-09 insurance premiums per adult per month before the aforementioned annual dental insurance premium calculations.

The second is the decrease in dollar values of the premiums due to inflation and time preference. For this purpose the insurance premium costs have been adjusted to 2009-10 and 2010-11 prices by applying a rate of 5% (Pharmaceutical Benefits Advisory Committee, 2013) to the 2010-11 dental insurance premiums.

While the insurance premiums and the rate of increase are close to being the real rates paid by the study participants the estimation of the dental component of these insurance premiums have their limitations. There exist difficulties in obtaining information on health insurance premiums (Srivastava et al., 2014) and there is no published information on how insurance funds apportion their premiums to specific health services covered by ancillary health insurance. The use of the rebate components was the best estimate available on the dental component of insurance premiums.

#### *Service use costs*

Service use costs were from the main study collected through the log books and supplemented by the questionnaire information as described above.

#### *Total cost of dental service use*

Cost of dental service use from a consumer perspective or out of pocket expenditure for an adult consumer was estimated as the cost of dental insurance premiums plus

the total out of pocket service costs – i.e., total service costs minus the private health insurance rebates.

Total costs were calculated based on the service use and dental insurance information that was reported through the data collection tools and, as such, total costs may be under estimated for two reasons. Firstly, those who were insured and visited but did not provide visit costs were assigned only the insurance premium cost for total costs. Second, those who did not provide insurance plan information had their service use cost assigned to total cost.

### **Other Explanatory variables and co-variables**

Other explanatory variables used in the analysis include, baseline dental insurance status, dentate status, toothache frequency, tooth brushing, average visiting pattern, usual reason for visiting, number of teeth, baseline SROH and baseline SRGH. All these variables were collected at baseline through the questionnaire. Almost all variables were dichotomised into two categories to prevent effects from being constrained to any specific patterns (Rothman et al., 2008). Dichotomisation was based on external information from previous research. Dichotomisation also prevented loss of power due to low number of counts in individual cells of multiple categories.

As with 2-year dental insurance status, dental insurance status at baseline was dichotomised into insured and uninsured. Dentate status is also a binary variable with each participant who had at least one natural tooth considered dentate and others considered edentulous. Toothache frequency was collected on a 5 level Likert scale ranging from very often to never. This variable was dichotomised into two groups; one with toothache frequency of very often or often and the other with a frequency of sometimes, hardly ever or never. Tooth brushing behaviour was collected as number of times the participant brushed their teeth in the last week. This was converted into two categories; one of participants who brushed their tooth less than 2 times per day and the other of participants who brushed their teeth 2 or more times per day. Average dental visiting was collected as a variable with 5 categories but collapsed down to three categories for analysis; Average visiting of more than once a year, once a year and less than once a year. Usual reason for visiting was collected and used as three mutually exclusive categories; visiting for an exam or check-up, visiting for treatment but not relief of pain and visiting for emergency or relief of pain.

Number of teeth was collected as total number of teeth in the upper and lower jaw and was summed for total number of teeth. This variable was then dichotomised into two categories: <21 natural teeth and 21 or more natural teeth. This is a standard categorisation of number of teeth to reflect the functional dentition (Nuttall, 2001). Self-rated oral (SROH) and general health (SRGH) were both collected as a 5 level Likert scale ranging from poor to excellent. These were then dichotomised into

participants who rated their health as poor or fair and those that rated their health as good, very good or excellent.

Other co-variates that were used in the analysis were age, sex, household income (HHI), education and region. All the variables were collected at baseline. Age was mostly reported as a binary variable grouped into two, one aged before 50 years of age and the second those aged 50 or more. Occasionally age was presented in three groups of about 10 years bands each: 30-39 years, 40-49 years and 50-61 years. Sex was always reported as male or female while education was always reported in two groups: those who had no tertiary education and those that had some level of tertiary education. Household Income (HHI) was grouped into two as those with annual HHI of \$80,000 or more and those less than \$80,000. The binary categorisation was based on the distribution of income within the sample. About 50% of the sample had an income of \$80,000 or less.

### **Statistical analysis**

Statistical analysis of the data as described above generally followed a three-step process. The initial step was to investigate the distributions of all the explanatory and outcome variables. In the second step bivariate associations of all outcome variables with the main and other explanatory variables were tested. Mean (and medians where applicable) or proportions along with their 95% confidence limits were reported for each outcome variable against all explanatory variables. Bivariate associations were also tested using the appropriate regression models based on the type and distribution of the outcome variables and statistical significance was determined by a p-value of less than 0.05. Finally, multiple variable regressions models were used to test adjusted associations between two-year dental insurance status and other confounding variables. Only outcome variables that were significantly associated with dental insurance status in bivariate analysis were tested in multivariable analysis. A p value of less than 0.2 in bivariate associations was used to select variables as potential confounders for inclusion in the multivariable or adjusted model. Age and sex were used as standard confounding variables irrespective of their bivariate associations with the outcome variables.

Table 2.5 presents the outcome variables, their type and distribution and the respective kind of regression model used to test unadjusted and adjusted associations with the explanatory variables. Three main statistical models were employed in the analysis of outcome variables in this thesis: the log-binomial, modified Poisson (with robust error variances) and linear regression models. A brief description of the three regression models are provided below. Adjusted estimates generated from the regression models are reported with their confidence intervals and p-values.

Log binomial regression model as first named by Skove et al (1998) belong to the generalised linear models (GLiMs) and is the preferred modelling method to estimate prevalence ratio for outcomes that have a high prevalence (Deddens and Petersen, 2008, Skove et al., 1998). The log-binomial model assumes that the explanatory variable is binomially distributed for each category of the outcome variable and that its log is linearly related to the explanatory variables. In this thesis all outcome variables had a high prevalence and were binary in nature and hence the log-binomial regression models were used to model the effect of dental insurance status on the outcomes and adjusted prevalence ratios were generated and reported.

Poisson regression models also belong to the family of generalised linear models (GLiMs) and are based on the Poisson distribution of the error terms. They are typically used to model outcomes that are counts and whose probability is rare (Selvin, 2004). In this thesis, all outcomes with counts have been assumed to be of Poisson distribution and hence modelled using Poisson regression producing adjusted rate ratios. However, in order to overcome convergence issues and counter over dispersion a modified Poisson regression model (Zou, 2004) with robust error variances was used. Moreover, the Poisson models have been used previously in modelling service use rates in preference to other models as they have performed better in models with larger number of parameters (Brennan et al., 1997).

Linear regression was used in this thesis to model continuous outcome variables producing estimates of model coefficients. A linear regression model (Chatterjee and Hadi, 2006) essentially fits a straight line to represent the relationship between the explanatory variable(s) and the continuous outcome variable, examining the prediction of the outcome variable by the explanatory variable(s) using a least squares method. Linear regression assumes that the relationship between the variables of interest is indeed linear. This and other assumptions such as independence of observations, constant variance of errors and the normality assumption were tested before the application of the linear regression models to these outcome variables.

**Table 2.5: Outcome variables, types, distribution and regression model used**

Outcome variable	Variable Type	Measure	Distribution	Regression model used
<b>Dental Service use/ Access to dental care variables</b>				
Dental visiting	Binary	Proportion	Binomial	Log-Binomial
No. of visits	Count	Mean	Positively skewed	Modified Poisson
No. total services	Count	Mean	Positively skewed	Modified Poisson
No. total services/visit	Count	Mean	Positively skewed	Modified Poisson
Main services	Count	Mean	Positively skewed	Modified Poisson
Main services/visit	Count	Mean	Positively skewed	Modified Poisson
Main areas of services	Count	Mean	Positively skewed	Modified Poisson
Main areas of services/visit	Count	Mean	Positively skewed	Modified Poisson
<b>Oral and general health outcome variables</b>				
Any tooth loss	Binary	Proportion	Binomial	Log-Binomial
Tooth loss	Continuous	Mean	Positively skewed	Linear
OHIP severity change	Continuous	Mean	Positively skewed	Linear
OHIP severity negative change	Binary	Proportion	Binomial	Log-Binomial
EuroQoI summary change	Continuous	Mean	Positively skewed	Linear
EuroQoL negative change	Binary	Proportion	Binomial	Log-Binomial
EuroQoL Health Utility change	Continuous	Mean	Positively skewed	Linear
EuroQoL Health Utility negative change	Binary	Proportion	Binomial	Log-Binomial
Negative Self-Rated Oral Health (SROH) change	Binary	Proportion	Binomial	Log-Binomial
Negative Self-Rated General Health (SRGH) change	Binary	Proportion	Binomial	Log-Binomial
<b>Cost variables</b>				
Out of pocket dental service use cost	Continuous	Proportion	Positively skewed	Linear

## **Power and Sample Size**

The sample sizes for the original study from which the data for this study originates was determined based on the main outcome variables for each of the original aims and hypotheses. Estimates of the proportion of patients making a dental visit in the last year (Slade et al., 2007), percentage of patients receiving extractions (Brennan et al., 1997), person rating their oral health as fair or poor (Slade et al., 2007) and mean health state values (Brennan and Spencer, 2005a) were used to determine the sample size using an alpha level of 0.05 and a beta of 0.80. The effect sizes were determined from observed differences in previous studies as referenced above for each of the outcomes. The original study was designed to compare three levels of dental insurance cover. Based on these assumptions the sample size required for each comparison group ranged from 92 per group for mean health state value to 336 per group for proportion receiving an extraction.

Based on these requirements, and an expected response rate of 60% and a 65% two-year follow up rate an initial sample of 3000 adults were drawn from the electoral roll, from across Australia. A total of 1096 individuals responded at baseline and the sample reduced to 513 participants at the two-year follow-up. Of these, full two-year data were available for 438 adults. Full details of response rates are described in the next chapter. This study only compared the insured and the uninsured. Hence, the study was sufficiently powered to detect statistically significant differences between the insured and the uninsured for all the outcomes except proportion receiving an extraction. This outcome variable was not used in this PhD.

In summary, three data sources were used to examine the relationship of dental insurance with the two sets of outcome variables including an economic evaluation. They were a cohort study of Australian adults, a database of private health insurance, funds, plans, policies and premiums and secondary data from private health insurance regulatory bodies. The next chapter provides a description of the data.

## **Chapter 3**

### **Results: Response and description of Data**

This chapter provides a descriptive summary of the response rates, the baseline demographic and health characteristics of the participants and makes comparisons within and outside of the sample, that is, comparison of demographic and health variables of the two-year respondents with both non-respondents and with a population based survey. It also provides a descriptive summary of the main explanatory variable, two-year dental insurance status and all the outcome variables.

## Response rates

### Response rates by rounds of data collection

The original number of adults aged 30-61 years that was sampled from the electoral roll was 3000; 375 from each state and territory in Australia. Of these 1096 adults, agreed to participate in the study and responded to the baseline questionnaire at a response rate of 36.5%. After excluding those who were excluded due to ineligibility and those mailed questionnaires that were returned to sender (RTS) the response rate was 39.4%. At the 12-month follow up, 554 participants responded to the questionnaire and, or log book and after adjusting for RTS a response rate of 53.1% compared to the baseline response was achieved. Similarly the response rate to the 2<sup>nd</sup> year follow up was 46.8% compared to the baseline. Complete data was available for the entire two-year period for 438 participants whose responses formed the final data used for analysis in this thesis accounting for a final response rate of 40%.

At each round of data collection, a letter of introduction and up to 4 reminders to respond, were sent to each adult that had not responded. These response details are presented as a flow chart in Figure 2.1 in Chapter 2 (Methods). Table 3.1 details the various N's by data collection tool and rounds.

**Table 3.1 Crude response rates by data collection tools and rounds**

Sample (3000)	BLQ	Y1Quest	Y1Log	Y2Quest	Y2Log	N	Response Rate (%)
BLQ	x					1096	36.5
BLQ+Y1Quest	x	X				528	48.2
BLQ+Y1Log	x		x			330	30.1
BLQ+Y2Quest	x			x		499	45.5
BLQ+Y2Log	x				x	255	23.3
BLQ+1Y1	x	x				553	50.5
BLQ+1Y2	x			x		513	46.8

BLQ=Baseline questionnaire, Y1= Year one, Y2=Year two, Quest=Questionnaire, Log=Log book, 1(Y1/Y2)=One of questionnaire or log book for the year

### Response rates by completeness of data

Table 3.2 provides the sample and the response rates at different rounds of data collection by completion of data. The first row shaded in dark grey (BLQ+1Y1+1Y2) represents the data used in this thesis. This consisted of individuals who responded to the baseline questionnaire, one or both of the questionnaire and log book for the first year and one or both of the questionnaires and log book for the second year. Data were available from both the tools and in all three time-points for 208 adults. The last three rows show the retention rates from year one to year two for each combination of data collection tools. Retention rates were higher than response rates with the retention of sample for the analysis in this thesis being almost 80%.

**Table 3.2 Crude response rates by completeness of data**

Sample (3000)	BLQ	Y1Quest	Y1Log	Y2Quest	Y2Log	N	Response Rate (%)
BLQ+1Y1+1Y2	x	x		x		438	<b>40.0</b>
BLQ+Y1Quest+Y1Log	x	x	x			305	<b>27.83</b>
BLQ+Y2Quest+Y2Log	x			x	x	241	<b>22.0</b>
BLQ+BothY1+BothY2	x	x	x	x	x	208	<b>19.0</b>
BLQ+1Y1+BothY2	x	x		x	x	233	<b>21.3</b>
BLQ+1Y1+Y2Quest	x	x		x		425	<b>38.8</b>
BLQ+Y1Quest+Y2Quest	x	x		x		410	<b>37.4</b>
<b>Retention rates</b>							
1Y1+1Y2	-	x		x		438	<b>79.2</b>
Y1Quest+Y2Quest	-	x		x		410	<b>77.7</b>
1Y1+Y2Quest	-	x		x		425	<b>76.9</b>

BLQ=Baseline questionnaire, Y1= Year one, Y2=Year two, Quest=Questionnaire, Log=Log book, 1(Y1/Y2)=One of questionnaire or log book for the year, Both(Y1/Y2)=Both log book and questionnaire for the year

## **Baseline characteristics**

The baseline demographic, oral and general health characteristics of the study participants are presented in the second set of columns of Table 3.3. There were more females amongst the study participants. About half the participants belonged to the oldest age group and just under half of the participants reported an annual household income of more than \$80,000. The majority of the study participants had some level of tertiary education and had private dental insurance at baseline.

As regards oral and general health characteristics and behaviours, less than 35% of the sample were edentulous, about a quarter self-rated their oral health as fair or poor, about one fifth reported having toothache very often, often or sometimes, almost 60% brushed their teeth at least 2 times a day and less than one third usually visited a dental professional more than once a year.

## **Comparison of demographic and health variables**

### ***Comparison within sample***

The last two columns in table 3.3 present the baseline demographic and health variables, of participants from the original respondents who did not respond to the follow-up data collections. This is presented in contrast to the participants who remained in the study at the end of two years. There were about 5% more females in this study, the two older age groups were slightly over represented and there were higher proportions of insured in this study. Income and education were about the same in this study compared to the non-respondents. Dentate status among the two-year respondents was the same as the non-respondents. The study respondents had marginally higher self-reported oral health and tooth brushing frequency, and fared slightly better on toothache experience. Their usual visiting pattern was also a little better off compared to their counterparts who did not respond. Overall, there were not any major differences from the study respondents and non-respondents.

**Table 3.3: Respondent characteristics at baseline by response at 24-month follow-up and non-respondents**

Baseline characteristics	2 year respondents		Non-respondents	
	N*	Per cent (95%CI)	N*	Per cent (95%CI)
Sex	438		658	
Male		38.4 (33.8, 43.9)		44.5 (40.7, 48.3)
Female		61.6 (57.1, 66.2)		55.5 (51.7, 59.3)
Age group (years)	433		651	
30 – 39		19.4 (15.7, 23.1)		26.8 (23.5, 30.3)
40 – 49		30.5 (26.1, 34.8)		33.5 (29.9, 37.1)
50 – 61		50.1 (45.4, 54.8)		39.6 (35.9, 43.4)
Household income group	420		612	
<\$80,000		51.7 (46.9, 56.5)		53.9 (50.0, 57.8)
\$80,000+		48.3 (43.5, 53.1)		46.1 (42.1,50.0)
Post-secondary education	434		646	
None		17.5 (13.9, 21.1)		19.8 (16.7,22.9)
Tertiary education		82.5 (78.9, 86.1)		80.2 (77.1,8 3.3)
Dental insurance status (at baseline)	429		630	
Uninsured		28.4 (24.2, 32.7)		38.6 (34.8, 42.4)
Insured		71.6 (67.3, 75.8)		61.4 (57.6, 65.2)
Dentate status	435		648	
Edentulous		2.8 (1.2, 4.3)		2.9 (1.6, 4.2)
Dentate		97.2 (95.7, 98.8)		97.1 (95.8, 98.4)
Self-reported dental health	435		648	
Poor/Fair		25.7 (21.6, 29.9)		28.7 (25.2, 32.2)
Good/Very good/Excellent		74.3 (70.1, 78.3)		71.3 (67.8, 74.8)
Toothache experience	429		647	
Very often/Often/Sometimes		19.6 (15.8, 23.4)		21.9 (18.7, 25.1)
Hardly ever/Never		80.4 (76.6, 84.2)		78.1 (74.9, 81.3)
Tooth brushing	435		642	
<2 times per day		40.7 (36.1, 45.3)		44.9 (41.0, 48.7)
2 or more times per day		59.3 (54.7, 63.9)		55.1 (51.3,59.0)
Average visiting	435		639	
More than once a year		30.3 (26.0, 34.7)		24.3 (20.9, 27.6)
Once a year		28.5 (24.2, 32.8)		25.5 (22.1, 28.9)
Less than once a year		41.1 (36.5, 45.8)		50.2 (46.3, 54.1)

\* N not the same for all variables because of missing values

### **Comparison with population survey**

Table 3.4 presents the baseline demographic and health variables of the 2-year follow-up respondents and their corresponding age counterparts from the National Telephone Interview Survey (NDTIS) 2010. The NDTIS is a nationally representative dental survey that is conducted every three years and serves as the primary oral health survey in Australia. The NDTIS data is weighted to represent the geographic, age and sex distribution of the population.

The study respondents had a higher proportion of females and their age was skewed to the higher age groups compared to the population survey respondents. Household

income was about the same but the study respondents had a marginally higher proportion that had some level of tertiary education. At baseline, our study respondents had higher proportions who were dentally insured compared to the population survey.

Dentate status and usual visiting patterns were about the same for our sample when compared to the population survey, while the study respondents had slightly poorer self-rated oral health and marginally more frequent toothache experience. Overall, when compared to the population survey respondents, the study participants had a higher representation of females and dentally insured. All other characteristics were similar or marginally different between the two respondent groups.

**Table 3.4: Respondent characteristics by response at 2-year follow-up and population estimates**

Baseline characteristics	2 year respondents		Population survey (NDTIS) n=4,010	
	N*	Per cent (95%CI)	Per cent (95%CI)	
Sex	438			
Male		38.4 (33.8, 43.9)	49.8	(47.6, 52.0)
Female		61.6 (57.1, 66.2)	50.2	(48.0, 52.4)
Age group (years)	433			
30 – 39		19.4 (15.7, 23.1)	34.2	(32.0, 36.6)
40 – 49		30.5 (26.1, 34.8)	32.7	(30.7, 34.8)
50 – 61		50.1 (45.4, 54.8)	33.0	(31.2, 35.0)
Household income group	420			
<\$80,000		51.7 (46.9, 56.5)	48.6	(46.4, 50.8)
\$80,000+		48.3 (43.5, 53.1)	51.4	(49.2, 53.6)
Post-secondary education	434			
None		17.5 (13.9, 21.1)	25.7	(23.9, 27.5)
Tertiary education		82.5 (78.9, 86.1)	74.4	(72.5, 76.2)
Dental insurance status (at baseline)	429			
Uninsured		28.4 (24.2, 32.7)	40.9	(38.8, 43.1)
Insured		71.6 (67.3, 75.8)	59.1	(56.9, 61.2)
Dentate status	435			
Edentulous		2.8 (1.2, 4.3)	2.4	(1.9, 3.1)
Dentate		97.2 (95.7, 98.8)	97.6	(96.9, 98.1)
Self-reported dental health	435			
Poor/Fair		25.7 (21.6, 29.9)	19.8	(18.0, 21.8)
Good/Very good/Excellent		74.3 (70.1, 78.3)	80.2	(78.2, 82.0)
Toothache experience	429			
Very often/Often/Sometimes		19.6 (15.8, 23.4)	15.1	(13.6, 16.8)
Hardly ever/Never		80.4 (76.6, 84.2)	84.9	(83.2, 86.4)
Tooth brushing	435			
<2 times per day		40.7 (36.1, 45.3)	n.a.	n.a.
2 or more times per day		59.3 (54.7, 63.9)	n.a.	n.a.
Average visiting	435			
More than once a year		30.3 (26.0, 34.7)	25.6	(23.7, 27.5)
Once a year		28.5 (24.2, 32.8)	31.0	(28.9, 33.0)
Less than once a year		41.1 (36.5, 45.8)	43.5	(41.3, 45.7)

\* N not the same for all variables because of missing values, NDTIS – National Dental Telephone Interview Survey, n.a. – not available

## Descriptive Summary of explanatory and outcome variables

### Dental insurance status by baseline characteristics

Table 3.5 presents the descriptive summary of the two-year dental insurance status, the main explanatory variable by the baseline demographic and health characteristics of the participants. Overall, about 67% of the participants in the study were insured for dental services during the two-year study period, a higher proportion compared to the population sample as shown earlier. A higher proportion of males, those aged 40-49 years of age, those with household income over \$80,000, those with good self-rated oral health and those who usually visited once or more per year were insured for dental services during the study period.

**Table 3.5: Dental Insurance status by baseline characteristics**

Baseline Characteristics		Dental Insurance Status			
		Insured		Uninsured	
		N	% (CI)	N	%(CI)
Sex	Male	121	72.0 (65.2, 78.9)	47	28.0 (21.1, 34.8)
	Female	171	63.3 (57.5, 69.1)	99	36.7 (30.9, 42.5)
Age	30-39 years	53	63.1 (52.6, 73.6)	31	36.9 (26.4, 47.4)
	40-49 years	102	78.5 (71.3, 85.6)	28	21.5 (14.4, 28.7)
	50-61 years	133	60.5 (53.9, 67.0)	87	39.4 (33.0, 46.1)
Household income group	<\$80,000	117	53.9 (47.2, 60.6)	100	46.1 (39.4, 52.8)
	\$80,000+	167	82.3 (77.0, 87.6)	36	17.7 (12.4, 23.0)
Post-secondary education	None	44	57.9 (46.5, 69.3)	32	42.1 (30.7, 53.5)
	Tertiary education	247	69.0 (64.2, 73.8)	111	31.0 (26.2, 35.8)
Dentate status	Edentulous	6	50.0 (16.8, 83.2)	6	50.0 (16.8, 83.2)
	Dentate	284	67.1 (62.6, 71.6)	139	32.9 (28.4, 37.4)
Self-reported oral health	Poor/Fair	57	50.9 (41.5, 60.3)	55	49.1 (39.7, 58.5)
	Good/Very good/Excellent	234	72.4 (67.5, 77.3)	89	27.6 (22.7, 32.5)
	Poor/Fair	25	51.0 (36.5, 65.5)	24	49.0 (34.5, 63.5)
Self-reported general health	Good/Very good/Excellent	267	68.6 (64.0, 73.3)	122	31.4 (26.7, 36.0)
	<21	24	44.4 (30.8, 58.1)	30	55.6 (41.9, 69.2)
No. of teeth	21 or more	268	69.8 (65.2, 74.4)	116	30.2 (25.6, 34.8)
	Very often/Often/Sometimes	48	57.1 (46.3, 67.9)	36	42.9 (32.1, 53.7)
Toothache experience	Hardly ever/Never	239	69.3 (64.4, 74.2)	106	30.7 (25.8, 35.6)
	<2 times per day	112	63.3 (56.1, 70.4)	65	36.7 (29.6, 43.9)
Tooth brushing	2 or more times per day	179	69.4 (63.7, 75.0)	79	30.6 (25.0, 36.3)
	More than once a year	107	81.1 (74.3, 87.8)	25	18.9 (12.2, 25.7)
Average visiting	Once a year	94	75.8 (68.2, 83.5)	30	24.2 (16.6, 31.8)
	Less than once a year	89	49.7 (42.3, 57.1)	90	50.3 (42.9, 57.7)
Region	Major Cities	164	67.5 (61.6, 73.4)	79	32.5 (26.6, 38.4)
	Regional and Remote	128	65.6 (58.9, 72.4)	67	34.4 (27.6, 41.1)
<b>Total</b>		<b>292</b>	<b>66.7 (62.2, 71.1)</b>	<b>146</b>	<b>33.3 (28.9, 37.8)</b>

### **Descriptive summary of all outcome variables**

Table 3.6 presents the descriptive summary of all outcome variables grouped by the area of analysis. The measures reported are either means or proportions depending on the type of the outcome variable. The variables are defined in the previous (Methods) chapter.

The first section of the table presents the dental service use or access to dental service variables. About 73 % of all participants visited a dental professional at least once during the two-year period. A little over a quarter did not visit a dental professional at all. Among those participants who visited a dental professional the average number of visits were about 4 during the two-year period, receiving about 9 services in total and about 2.4 services at each visit. Of the 9 services, about 3.5 were diagnostic, 2.2 preventive, less than 0.5 oral surgery services, about 1.7 restorative services and 0.4 prosthodontic services. Of the 2.4 services received per visit, the most common were diagnostic (0.98), preventive (0.67) and restorative (0.41) services per visit. Oral surgery (0.11) and prosthodontic services (0.07) were uncommon.

The latter half of Table 3.6 presents the health outcome and cost variables. About 77% of the participants did not experience any tooth loss. The OHIP severity score of more than 50% of the participants, the health utility score generated from EuroQoL of about 82%, the self-rated oral health of almost 85% and the self-rated general health of about 77% of the participants either remained the same or improved during the two-year study period. Mean tooth loss during the study period was 0.63, change in OHIP severity score was about -1.60 units and change in health utility as measured by EuroQoL was about 1%. All three measures indicated that, on average, oral health of the entire sample worsened during the two-year period. The average out of pocket expenditure on oral health service use during the corresponding period was almost \$800. This included dental insurance premiums and excluded point of service private health insurance rebates received for those who were insured.

**Table 3.6: Descriptive summary of all outcome variables**

<b>Dental Service Use/ Access variables</b>				
<b>Variable</b>	<b>Categories</b>	<b>N</b>		<b>% (CIs)</b>
Dental Visiting	No Visits	114	-	26.7 (22.5, 30.9)
	One or more visits	313		73.3 (69.1, 77.5)
<b>Variable</b>		<b>N</b>	<b>Median</b>	<b>Mean (CIs)</b>
No. of Visits		303	3.00	3.98 (3.64, 4.32)
No. of Services		289	7.00	9.07 (8.19, 9.94)
No. of Services per visit		288	2.00	2.39 (2.26, 2.52)
No. of diagnostic services		289	3.00	3.47 (3.11, 3.83)
No. of preventive services		289	2.00	2.24 (2.00, 2.47)
No. of oral surgery services		289	0	0.34 (0.22, 0.45)
No. of restorative services		289	1.00	1.67 (1.38, 1.96)
No. of prosthodontic services		289	0	0.40 (0.27, 0.52)
No. of diagnostic services/visit		288	1.00	0.98 (0.90, 1.06)
No. of preventive services/visit		288	0.60	0.67 (0.60, 0.74)
No. of oral surgery services/visit		288	0	0.11 (0.06, 0.16)
No. of restorative services/visit		288	0.25	0.41 (0.34, 0.48)
No. of prosthodontic services/visit		288	0	0.07 (0.05, 0.09)
<b>Health outcome variables</b>				
<b>Variable</b>	<b>Categories</b>	<b>N</b>		<b>% (CIs)</b>
Tooth Loss	Any Tooth loss	95	-	22.6 (18.6, 26.6)
	No tooth Loss	325	-	77.4 (73.4, 81.4)
OHIP severity Negative Change	Some Negative Change	198	-	47.4 (42.6, 52.2)
	No Negative Change	220	-	52.6 (47.8, 57.4)
EuroQol Negative Health utility Change	Some Negative Change	76	-	18.5 (14.8, 22.3)
	No Negative Change	334	-	81.5 (77.7, 85.2)
Negative Change in SROH	Some Negative Change	64	-	15.1 (11.7, 18.6)
	No Negative Change	359	-	84.9 (81.4, 88.3)
Negative Change in SRGH	Some Negative Change	96	-	22.7 (18.7, 26.7)
	No Negative Change	327		77.3 (73.3, 81.3)
<b>Variable</b>		<b>N</b>	<b>Median</b>	<b>Mean (CIs)</b>
Tooth loss		420	0	0.63 (0.48, 0.78)
OHIP Severity Change		418	0	-1.60 (-2.22, -0.98)
EuroQol health utility change		410	0	0.009 (-0.004, 0.021)
Out of pocket expenditure		364	515.10	787.91 (676.22, 899.60)

### Summary – Response and description of data

In summary, the response rate for the cohort study was 40%. The sample's baseline characteristics were largely similar to the non-respondents and differed marginally from the estimates based on a larger population sample. About 67% of the sample was privately insured for dental services during the two-year period of the study. The next three chapters present the results of the study beginning with the relationship between dental insurance status and dental service use outcomes.

## **Chapter 4**

### **Results: Access to Dental Care / Dental Service Use**

As described in the chapter 2 (Methods) the second area of analysis in this thesis was the relationship between dental insurance status and dental service use or access to dental care and directly pertains to the first objective of the thesis: To ascertain the relationship between dental insurance and dental service use. This chapter examines the bivariate (unadjusted) and multivariable (adjusted) associations of the dental service use outcome variables with dental insurance status and other explanatory variables.

The main outcome variables for this area of analysis includes, dental visiting and among those who visited, number of visits, number of services, number of services per visit, numbers of main services, numbers of main services per visit, numbers of main areas of services and numbers of main areas of services per visit. All of these variables were defined in detail in Chapter 2 (Methods – Table 2.2)

## **Bivariate associations with insurance status and other explanatory variables**

### **Dental visiting and number of visits**

The third and fourth columns in Table 4.1 present the proportion of study participants who visited a dental professional at least once in the two-year period by insurance status and other demographic, oral and general health variables. Confidence limits for the proportions and p-values from bivariate log binomial regression models are also presented for each variable. For all outcome variables p-values that were significant (<0.05) and those under 0.20 were included in the models for multivariable analysis.

Overall, 73.3% of the sample made at least one dental visit. Dental visiting was significantly associated with dental insurance status, number of teeth, sex, household income, tertiary education and region. A higher proportion of the insured, those with 21 or more teeth, females, adults aged 50 years and over, those with income of \$80,000 or over, those with some form of tertiary education and those living in major cities visited in the two-year period.

The last two columns in Table 4.1 present the mean number of visits among those who visited, by insurance status and other health and demographic variables. Confidence intervals for the means and significance based on p-values generated from bivariate Poisson regression models are also presented. The Poisson regression modelled the actual counts of visits. Overall, the mean number of visits among those who visited was almost 4, i.e., 2 visits per year.

Two-year dental insurance status was not significantly associated with number of visits. OHIP severity, oral and general health at baseline and toothache frequency was significantly associated with number of visits. Adults with low oral health impact, poor

self-rated oral health and general health, and higher frequency of toothache visited at a higher rate. Number of visits was not significantly associated with any of the demographic variables.

**Table 4.1: Dental visiting and number of visits by Insurance status and oral and general health and demographic variables**

Variable	Categories	N	% visited (CI) <sup>^</sup>	N	Mean no. of Visits (CI) <sup>^^</sup>
<b>Main Explanatory variable</b>					
Dental Insurance Status	Insured	289	78.5 (73.8, 83.3) <sup>***</sup>	225	3.86 (3.50, 4.22)
	Uninsured	138	62.3 (54.1, 70.5)	78	4.31 (3.49, 5.12)
<b>Health variables</b>					
OHIP Severity	Low impact	318	73.6 (68.7, 78.5)	250	3.81 (3.46, 4.15) <sup>**</sup>
	High Impact	78	71.8 (61.6, 82.0)	53	4.77 (3.72, 5.82)
Dental Health at Baseline	Poor or Fair	106	72.6 (64.0, 81.3)	73	4.58 (3.72, 5.43) <sup>**</sup>
	Good, very good or Excellent	318	73.6 (68.7, 78.5)	228	3.79 (3.43, 4.14)
Toothache	Very Often/Often/ Sometimes	79	74.7 (64.9, 84.5)	56	4.63 (3.65, 5.60) <sup>**</sup>
	Hardly Ever/ Never	339	72.6 (67.8, 77.3)	239	3.81 (3.45, 4.17)
Number of teeth	Less than 21	52	53.8 (39.8, 67.8) <sup>**</sup>	25	4.16 (2.86, 5.46)
	21 or more	375	76.0 (71.7, 80.3)	278	3.96 (3.61, 4.31)
General Health at Baseline	Poor or Fair	47	76.6 (64.0, 89.2)	35	5.06 (3.72, 6.39) <sup>**</sup>
	Good, very good or Excellent	380	72.9 (68.4, 77.4)	268	3.84 (3.49, 4.18)
<b>Demographic variables</b>					
Sex	Male	162	64.8 (57.4, 72.2) <sup>***</sup>	101	3.59 (3.13, 4.06) <sup>*</sup>
	Female	265	78.5 (73.5, 83.5)	202	4.17 (3.72, 4.62)
Age	<50	211	69.2 (62.9, 75.5) <sup>*</sup>	140	3.88 (3.34, 4.42)
	50 +	213	77.5 (71.8, 83.1)	161	4.07 (3.63, 4.51)
Household Income	<\$80,000	209	66.9 (60.6, 73.4) <sup>**</sup>	132	4.09 (3.56, 4.62)
	\$80,000+	201	78.6 (72.9, 84.3)	156	3.83 (3.39, 4.28)
Tertiary Education	None	75	58.7 (47.3, 70.1) <sup>**</sup>	41	3.66 (2.91, 4.40)
	Yes	349	76.2 (71.7, 80.7)	260	4.04 (3.66, 4.42)
Region	Major Cities	238	78.2 (72.9, 83.4) <sup>**</sup>	182	4.18 (3.73, 4.62) <sup>*</sup>
	Regional and remote	189	67.2 (60.4, 74.0)	121	3.68 (3.15, 4.20)
<b>Total</b>		<b>427</b>	<b>73.3 (69.1, 77.5)</b>	<b>303</b>	<b>3.98 (3.64, 4.32)</b>

\* p<0.20, \*\* p<0.05, \*\*\* p<0.01, <sup>^</sup>Log binomial regression, <sup>^^</sup>Poisson Regression

### Number of services and services per visit

Table 4.2 presents the results for number of services and number of service per visit by insurance status and other health and demographic variables. Overall, the mean number of services was just over nine and the mean number of services per visit was 2.4 for the two-year period among those who made at least one visit.

The third and fourth columns present the mean number of services and the statistical significance (denoted by ‘\*\*’) from the Poisson regression that modelled the counts of services. The self-reported health variables and region of residence were significantly associated with number of services received. Those with poorer oral and general health and those residing in major cities received more services.

The final two columns in Table 4.2 present the results for number of services per visit and their corresponding statistical significance. The service per visit variable provides a comparative measure of service use among those who visited. It provides a different perspective from mean number of services by adjusting the services to a rate per visit. Though there were differences by almost all variables only the difference by dental insurance status was statistically significant ( $p < 0.05$ ). The insured had higher mean number of services per visit (2.5) compared to the uninsured (2.1).

**Table 4.2: Number of services and services per visit by insurance status and oral and general health and demographic variables**

Variable	Categories	N	Mean no. of services (CI) <sup>^</sup>	N	Mean no. of Services/Visit (CI) <sup>^</sup>
<b>Main Explanatory variable</b>					
Dental Insurance Status	Insured	215	9.13 (8.19, 10.06)	215	2.48 (2.34, 2.63)**
	Uninsured	74	8.89 (6.77, 11.02)	73	2.10 (1.84, 2.37)
<b>Health variables</b>					
OHIP Severity	High Impact	51	9.94 (7.52, 12.36)	51	2.18 (1.85, 2.51)*
	Low impact	229	8.85 (7.89, 9.82)	228	2.45 (2.31, 2.60)
Dental Health at Baseline	Poor or Fair	70	10.49 (8.33, 12.65)*	69	2.48 (2.18, 2.78)
	Good, very good or Excellent	218	8.63 (7.70, 9.57)	218	2.36 (2.22, 2.51)
Toothache	Very Often/Often/ Sometimes	53	10.45 (8.37, 12.54)	53	2.53 (2.20, 2.85)
	Hardly Ever/ Never	229	8.73 (7.74, 9.72)	228	2.37 (2.23, 2.52)
Number of teeth	Less than 21	24	8.33 (4.82, 11.85)	23	2.28 (1.69, 2.88)
	21 or more	265	9.13 (8.22, 10.04)	265	2.40 (2.26, 2.53)
General Health at Baseline	Poor or Fair	32	11.75 (8.27, 15.23)**	32	2.33 (2.01, 2.66)
	Good, very good or Excellent	257	8.73 (7.84, 9.62)	256	2.39 (2.25, 2.54)
<b>Demographic variables</b>					
Sex	Male	98	8.60 (7.14, 10.07)	97	2.39 (2.16, 2.62)
	Female	191	9.30 (8.20, 10.41)	191	2.39 (2.23, 2.55)
Age	<50	134	8.90 (7.66, 10.14)	134	2.47 (2.27, 2.67)
	50 +	153	9.26 (8.00, 10.53)	152	2.33 (2.15, 2.50)
Household Income	<\$80,000	127	8.91 (7.57, 10.26)	126	2.25 (2.06, 2.43)*
	\$80,000+	148	9.05 (7.86, 10.25)	148	2.51 (2.32, 2.70)
Tertiary Education	None	40	8.35 (6.50, 10.20)	39	2.59 (2.08, 3.09)
	Yes	247	9.23 (8.25, 10.21)	247	2.37 (2.24, 2.50)
Region	Major Cities	175	9.75 (8.58, 10.93)**	175	2.43 (2.27, 2.60)
	Regional and remote	114	8.01 (6.70, 9.31)	113	2.32 (2.11, 2.53)
<b>Total</b>		<b>289</b>	<b>9.07 (8.19, 9.94)</b>	<b>288</b>	<b>2.39 (2.26, 2.52)</b>

\*  $p < 0.20$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ , <sup>^</sup>Poisson Regression

### **Main areas of dental services**

Dental services are divided into ten main areas of services based on the types of service as defined in the schedule of dental services that is published by the Australian Dental Association (Australian Dental Association, 2002). The bivariate relationship of dental insurance status with the diagnostic services, preventive services, oral surgery services, restorative services and prosthodontic services are presented in this section. These services together account for about 86% (7.8 of the total 9.1) mean number of services received by the adults in the study. The other 4 services were not analysed in relationship to dental insurance as they number of services reported were very few. Diagnostic and preventive services are presented in Table 4.3 and the rest are presented in Table 4.4.

#### ***Diagnostic services***

Diagnostic services include examinations, radiological examinations and other diagnostic tests such as caries susceptibility tests. Diagnostic services are presented in the third and fourth columns in Table 4.3. Overall about one third (3.2) of all services received were diagnostic services. There were differences between the insured and uninsured but the differences were not statistically significant.

Region of residence was the only variable that was significantly different with those residing in major cities receiving significantly higher number of diagnostic services compared to those living in regional or remote areas. There were marginal differences in receipt of diagnostic service by self-rated oral health, toothache frequency, sex and household income but none were statistically significant.

#### ***Preventive Services***

Preventive services include dental prophylaxis services such as removal of plaque, fluoride applications and other preventive service such as oral hygiene instruction. Routine scale and clean services are also categorised under preventive services. The mean number of preventive services received by participants during the two-year period is presented in the last two columns of Table 4.3. Overall, the average number of preventive services was 2.24, but this was significantly higher for the insured (2.1) compared to the uninsured (1.7). The mean number of preventive services was also significantly higher for those with high OHIP severity scores, those with good self-rated oral health, participants who rarely or never experienced toothache and those who lived in major cities. Adults with higher income and 21 or more teeth also tended to receive a higher number of preventive services though these differences were not statistically significant.

<b>Table 4.3: Number of diagnostic and preventive services by Insurance status and oral and general health and demographic variables</b>					
<b>Variables</b>	<b>Categories</b>	<b>N</b>	<b>Mean no. Diagnostic services (CI)^</b>	<b>N</b>	<b>Mean no. Preventive services (CI)^</b>
<b>Main Explanatory variable</b>					
Dental Insurance Status	Insured	215	3.61 (3.23, 4.00)*	215	2.43 (2.14, 2.73)***
	Uninsured	73	3.08 (2.22, 3.95)	73	1.68 (1.33, 2.04)
<b>Health variables</b>					
OHIP Severity	High Impact	51	3.47 (2.62, 4.32)	51	1.53 (1.01, 2.05)***
	Low impact	228	3.48 (3.07, 3.89)	228	2.41 (2.14, 2.68)
Dental Health at Baseline	Poor or Fair	69	3.90 (2.98, 4.81)*	69	1.67 (1.28, 2.05)***
	Good, very good or Excellent	218	3.35 (2.97, 3.73)	218	2.43 (2.14, 2.72)
Toothache	Very Often/Often/ Sometimes	53	4.02 (3.23, 4.80)*	53	1.70 (1.26, 2.14)**
	Hardly Ever/ Never	228	3.37 (2.96, 3.78)	228	2.34 (2.07, 2.62)
Number of teeth	Less than 21	23	2.78 (1.27, 4.30)	23	1.43 (0.64, 2.23)*
	21 or more	265	3.54 (3.17, 3.91)	265	2.31 (2.06, 2.56)
General Health at Baseline	Poor or Fair	32	3.66 (2.42, 4.89)	32	2.22 (1.50, 2.94)
	Good, very good or Excellent	256	3.46 (3.08, 3.83)	256	2.25 (1.99, 2.50)
<b>Demographic variables</b>					
Sex	Male	97	3.14 (2.58, 3.70)*	97	2.26 (1.84, 2.68)
	Female	191	3.65 (3.19, 4.11)	191	2.24 (1.94, 2.53)
Age	<50	134	3.70 (3.17, 4.23)	134	2.35 (1.99, 2.71)
	50 +	152	3.31 (2.38, 3.80)	152	2.16 (1.83, 2.49)
Household Income	<\$80,000	126	3.11 (2.62, 3.60)*	126	2.11 (1.74, 2.49)*
	\$80,000+	148	3.69 (3.20, 4.18)	148	2.45 (2.11, 2.78)
Tertiary Education	None	39	3.38 (2.44, 4.33)	39	2.05 (1.42, 2.69)
	Yes	247	3.51 (3.12, 3.91)	247	2.29 (2.03, 2.55)
Region	Major Cities	175	3.76 (3.29, 4.23)**	175	2.50 (2.19, 2.82)***
	Regional and remote	113	3.04 (2.50, 3.59)	113	1.84 (1.47, 2.21)
<b>Total</b>		<b>288</b>	<b>3.16 (2.79, 3.53)</b>	<b>288</b>	<b>2.24 (2.00, 2.48)</b>

\* p<0.20, \*\* p<0.05, \*\*\* p<0.01, ^Poisson Regression

### **Oral surgery services**

Oral surgery services primarily consist of various kinds of basic and surgical extractions. The third and fourth columns of Table 4.4 present the mean number of oral surgery services and their respective n, 95% confidence intervals and statistical significance by dental insurance status and other health and demographic variables.

On average, adults in the study received 0.34 oral surgery services during the two-year period. There were no statistically significant differences by dental insurance status. However, there were statistically significant differences by all the health variables and by sex, income and tertiary education status. Oral surgery services were higher among

those who had higher OHIP scores, poorer self-rated oral health, more frequent toothache, less than 21 teeth, and poorer self-rated general health. Males, those with income below \$80,000 and those adults who did not have any tertiary education also received significantly higher oral surgery services.

### ***Restorative services***

Restorative services include different kinds of restorations such as amalgam, glass ionomer and resin restorations. Overall, the participants in the study received about 1.7 restorative services during the two-year study period. Dental insurance was significantly associated with receiving restorative services with the insured receiving a lower mean number (1.5) of restorative services compared to the uninsured (2.2). Self-rated oral and general health and age and household income were the other factors that were significantly associated with receiving restorative services. On average, those participants with poor self-rated general health received almost double the number of restorative services than their counterparts with good self-rated general health.

### ***Prosthodontic services***

Prosthodontic services chiefly comprise the provision of dentures and their components. The mean number of prosthodontic services and their respective n, confidence intervals and statistical significance are presented in the last two columns of Table 4.4. Overall, during the two-year period the study participants received about 0.4 prosthodontic services on average. Dental insurance status was not significantly associated with receiving prosthodontic services though the uninsured received marginally higher number of services. Age, as expected was a significant factor in the receipt of prosthodontic services with those over 50 years of age receiving almost double the number of prosthodontic services compared to those less than 50 years of age. Those with higher OHIP severity scores, poorer self-rated oral and general health and more frequent toothache were the other groups of participants who received significantly higher mean number of prosthodontic services.

**Table 4.4: Number of oral surgery, restorative and prosthodontic services by Insurance status and oral and general health and demographic variables**

Variables	Categories	N	Mean no. Oral surgery services (CI) <sup>^</sup>	N	Mean no. Restorative services (CI) <sup>^</sup>	N	Mean no. Prosthodontic services (CI) <sup>^</sup>
<b>Main Explanatory variable</b>							
Dental Insurance Status	Insured	215	0.32 (0.18, 0.45)	215	1.50 (1.18, 1.82)**	215	0.34 (0.21, 0.48)*
	Uninsured	73	0.39 (0.20, 0.59)	73	2.19 (1.54, 2.84)	73	0.52 (0.23, 0.81)
<b>Health variables</b>							
OHIP Severity	High Impact	51	0.90 (0.42, 1.38)***	51	2.04 (1.14, 2.94)*	51	0.59 (0.23, 0.95)**
	Low impact	228	0.20 (0.12, 0.29)	228	1.60 (1.29, 1.90)	228	0.33 (0.20, 0.46)
Dental Health at Baseline	Poor or Fair	69	0.81 (0.43, 1.19)***	69	2.29 (1.49, 3.09)***	69	0.61 (0.26, 0.96)***
	Good, very good or Excellent	218	0.19 (0.11, 0.27)	218	1.49 (1.20, 1.77)	218	0.32 (0.20, 0.45)
Toothache	Very Often/Often/Sometimes	53	0.87 (0.41, 1.33)***	53	1.85 (1.25, 2.45)	53	0.62 (0.24, 1.01)***
	Hardly Ever/Never	228	0.21 (0.13, 0.30)	228	1.64 (1.31, 1.98)	228	0.32 (0.19, 0.45)
Number of teeth	Less than 21	23	0.96 (0.07, 1.85)***	23	1.48 (0.41, 2.54)	23	0.52 (0.13, 0.91)
	21 or more	265	0.28 (0.19, 0.38)	265	1.69 (1.39, 1.99)	265	0.38 (0.24, 0.51)
General Health at Baseline	Poor or Fair	32	0.66 (0.18, 1.13)***	32	3.00 (1.80, 4.20)***	32	0.81 (0.22, 1.41)***
	Good, very good or Excellent	256	0.30 (0.18, 0.41)	256	1.51 (1.22, 1.79)	256	0.34 (0.22, 0.46)
<b>Demographic variables</b>							
Sex	Male	97	0.51 (0.23, 0.78)***	97	1.52 (1.07, 1.96)	97	0.46 (0.23, 0.70)
	Female	191	0.25 (0.16, 0.35)	191	1.75 (1.38, 2.13)	191	0.35 (0.20, 0.50)
Age	<50	134	0.37 (0.20, 0.53)	134	1.25 (0.93, 1.58)***	134	0.26 (0.13, 0.39)***
	50 +	152	0.32 (0.16, 0.48)	152	2.06 (1.59, 2.52)	152	0.51 (0.30, 0.71)
Household Income	<\$80,000	126	0.42 (0.22, 0.62)**	126	2.06 (1.55, 2.57)***	126	0.42 (0.21, 0.63)
	\$80,000+	148	0.24 (0.12, 0.37)	148	1.32 (0.99, 1.65)	148	0.35 (0.20, 0.51)
Tertiary Education	None	39	0.56 (0.07, 1.06)**	39	1.49 (0.80, 2.18)	39	0.31 (0.01, 0.61)
	Yes	247	0.30 (0.20, 0.41)	247	1.70 (1.38, 2.03)	247	0.40 (0.26, 0.54)
Region	Major Cities	175	0.30 (0.16, 0.43)	175	1.57 (1.23, 1.91)	175	0.44 (0.27, 0.61)*
	Regional and	113	0.40 (0.20, 0.60)	113	1.83 (1.31, 2.35)	113	0.31 (0.14, 0.48)
<b>Total</b>		<b>288</b>	<b>0.34 (0.22, 0.45)</b>	<b>288</b>	<b>1.67 (1.38, 1.96)</b>	<b>288</b>	<b>0.39 (0.26, 0.51)</b>

\* p<0.20, \*\* p<0.05, \*\*\* p<0.01, ^Poisson Regression

### **Main areas of dental services per visit**

This section presents the mean number of the main areas of services presented above in relation to the number of visits, i.e., it is the mean number of each area of services received per visit. Similar to the previous section the diagnostic and preventive services per visit are presented first in Table 4.5 and then the oral surgery, restorative and prosthodontic services per visit are presented in Table 4.6.

#### ***Diagnostic services per visit***

On average, there was one diagnostic service received at every dental visit. This was significantly higher among the insured. Adults whose household income was over \$80,000 and those who had higher oral health impacts (OHIP severity) had significantly higher rates of diagnostic services per visit.

#### ***Preventive services per visit***

Preventive services per visit (0.67) were a little lower compared to diagnostic services for all participants in the study. Dental insurance status was significantly associated with preventive services per visit; the insured received higher preventive services per visit compared to the uninsured. OHIP severity, dental health at baseline, and toothache frequency were the other factors that were significantly associated with preventive services per visit. Those with lower oral health impact, good self-rated oral health and hardly ever or never had toothache had higher preventive services per visit.

**Table 4.5: Number of diagnostic and preventive services per visit by Insurance status and oral and general health and demographic variables**

Variables	Categories	N	Mean no. Diagnostic services/visit (CI) <sup>^</sup>	N	Mean no. Preventive services/visit (CI) <sup>^</sup>
<b>Main Explanatory variable</b>					
Dental Insurance Status	Insured	215	1.06 (0.97, 1.15) <sup>***</sup>	215	0.73 (0.65, 0.81) <sup>***</sup>
	Uninsured	73	0.75 (0.57, 0.92)	73	0.48 (0.37, 0.59)
<b>Health variables</b>					
OHIP Severity	High Impact	51	0.79 (0.58, 1.00) <sup>**</sup>	51	0.38 (0.34, 0.53) <sup>***</sup>
	Low impact	228	1.03 (0.94, 1.12)	228	0.74 (0.66, 0.82)
Dental Health at Baseline	Poor or Fair	69	0.93 (0.76, 1.11)	69	0.45 (0.34, 0.56) <sup>***</sup>
	Good, very good or Excellent	218	0.99 (0.90, 1.09)	218	0.74 (0.65, 0.82)
Toothache	Very Often/Often/ Sometimes	53	1.07 (0.85, 1.28)	53	0.52 (0.38, 0.66) <sup>***</sup>
	Hardly Ever/ Never	228	0.97 (0.88, 1.07)	228	0.71 (0.63, 0.79)
Number of teeth	Less than 21	23	0.65 (0.39, 0.91) <sup>*</sup>	23	0.35 (0.16, 0.54) <sup>*</sup>
	21 or more	265	1.01 (0.92, 1.09)	265	0.70 (0.62, 0.77)
General Health at Baseline	Poor or Fair	32	0.74 (0.57, 0.92) <sup>*</sup>	32	0.51 (0.33, 0.70) <sup>*</sup>
	Good, very good or Excellent	256	1.01 (0.92, 1.10)	256	0.69 (0.61, 0.76)
<b>Demographic variables</b>					
Sex	Male	97	0.92 (0.78, 1.06)	97	0.65 (0.55, 0.76)
	Female	191	1.01 (0.90, 1.11)	191	0.68 (0.59, 0.77)
Age	<50	134	1.09 (0.97, 1.21) <sup>*</sup>	134	0.76 (0.65, 0.86)
	50 +	152	0.89 (0.78, 1.00)	152	0.59 (0.51, 0.68)
Household Income	<\$80,000	126	0.84 (0.74, 0.95) <sup>***</sup>	126	0.58 (0.48, 0.68) <sup>*</sup>
	\$80,000+	148	1.11 (0.98, 1.05)	148	0.76 (0.66, 0.87)
Tertiary Education	None	39	1.08 (0.77, 1.39)	39	0.66 (0.43, 0.90)
	Yes	247	0.97 (0.89, 1.05)	247	0.67 (0.60, 0.75)
Region	Major Cities	175	1.01 (0.90, 1.11)	175	0.74 (0.65, 0.84) <sup>*</sup>
	Regional and remote	113	0.94 (0.81, 1.07)	113	0.55 (0.45, 0.65)
<b>Total</b>		<b>288</b>	<b>0.98 (0.90, 1.06)</b>	<b>288</b>	<b>0.67 (0.60, 0.74)</b>

\* p<0.20, \*\* p<0.05, \*\*\* p<0.01, ^Poisson Regression

### **Oral surgery services per visit**

The third and fourth columns in Table 4.6 present the mean number of oral surgery services per visit, their confidence intervals and significance by insurance status and other explanatory variables. Overall, 0.11 services per visit were oral surgery services. The mean number of oral surgery services per visit did not vary significantly by dental insurance status.

OHIP severity, self-rated oral health, toothache frequency, number of teeth, sex, household income and tertiary education status were significantly associated with oral

surgery services. Adults with higher oral health impact as measured by OHIP, poorer self-rated oral health those with more frequent toothache, less than 21 teeth, males, those with household income below \$80,000 and those without any tertiary education had significantly higher mean number of oral surgery services.

***Restorative services per visit***

The fifth and sixth columns in Table 4.6 present the distribution of restorative services per visit by dental insurance status and health and demographic variables. Overall the mean number of restorative services per visit was 0.41. This was marginally lower for the dentally insured (0.37) compared to the uninsured (0.53), however was not statistically significant. Self-rated general health, age, household income and region of residence were significantly associated with restorative services per visit; participants who reported poorer general health, those aged 50 years and over, those with household income below \$80,000, and those living in regional and remote areas had higher restorative services per visit.

***Prosthodontic services per visit***

The last two columns in Table 4.6 present the number of prosthodontic services per visit. Overall 0.7 services per visit were prosthodontic services. There were no differences by dental insurance status. Those participants with less than 21 teeth, males and those aged more than 50 years had higher mean number of prosthodontic services per visit.

**Table 4.6: Number of oral surgery, restorative and prosthodontic services per visit by Insurance status and oral and general health and demographic variables**

Variables	Categories	N	Mean no. Oral surgery services/visit (CI) <sup>^</sup>	N	Mean no. Restorative services/visit (CI) <sup>^</sup>	N	Mean no. Prosthodontic services/visit (CI) <sup>^</sup>
<b>Main Explanatory variable</b>							
Dental Insurance Status	Insured	215	0.10 (0.04, 0.15)	215	0.37 (0.28, 0.44)*	215	0.07 (0.04, 0.09)
	Uninsured	73	0.14 (0.05, 0.24)	73	0.53 (0.38, 0.69)	73	0.07 (0.03, 0.11)
<b>Health variables</b>							
OHIP Severity	High Impact	51	0.29 (0.08, 0.51)***	51	0.41 (0.29, 0.54)	51	0.10 (0.04, 0.16)
	Low impact	228	0.06 (0.03, 0.09)	228	0.42 (0.34, 0.50)	228	0.06 (0.04, 0.08)
Dental Health at Baseline	Poor or Fair	69	0.32 (0.14, 0.50)***	69	0.50 (0.34, 0.67)*	69	0.09 (0.04, 0.15)
	Good, very good or Excellent	218	0.04 (0.02, 0.06)	218	0.38 (0.31, 0.46)	218	0.06 (0.04, 0.08)
Toothache	Very Often/Often/Sometimes	53	0.27 (0.08, 0.46)***	53	0.40 (0.27, 0.53)	53	0.10 (0.04, 0.17)*
	Hardly Ever/ Never	228	0.07 (0.03, 0.11)	228	0.42 (0.34, 0.50)	228	0.06 (0.03, 0.08)
Number of teeth	Less than 21	23	0.55 (0.06, 1.05)***	23	0.32 (0.12, 0.52)	23	0.16 (0.02, 0.29)***
	21 or more	265	0.07 (0.04, 0.10)	265	0.42 (0.35, 0.49)	265	0.06 (0.04, 0.08)
General Health at Baseline	Poor or Fair	32	0.21 (0.01, 0.42)*	32	0.55 (0.34, 0.75)**	32	0.12 (0.03, 0.22)*
	Good, very good or Excellent	256	0.10 (0.05, 0.14)	256	0.39 (0.32, 0.47)	256	0.06 (0.04, 0.08)
<b>Demographic variables</b>							
Sex	Male	97	0.17 (0.05, 0.29)***	97	0.39 (0.28, 0.51)	97	0.09 (0.05, 0.14)***
	Female	191	0.08 (0.04, 0.11)	191	0.42 (0.34, 0.50)	191	0.05 (0.03, 0.08)
Age	<50	134	0.10 (0.05, 0.16)	134	0.34 (0.25, 0.43)***	134	0.04 (0.02, 0.06)***
	50 +	152	0.11 (0.04, 0.19)	152	0.48 (0.38, 0.58)	152	0.09 (0.05, 0.13)
Household Income	<\$80,000	126	0.14 (0.06, 0.23)**	126	0.47 (0.37, 0.57)***	126	0.07 (0.03, 0.10)
	\$80,000+	148	0.06 (0.03, 0.09)	148	0.35 (0.26, 0.43)	148	0.07 (0.04, 0.10)
Tertiary Education	None	39	0.22 (-0.02, 0.46)***	39	0.39 (0.18, 0.60)	39	0.09 (0.01, 0.18)*
	Yes	247	0.09 (0.05, 0.13)	247	0.41 (0.34, 0.48)	247	0.06 (0.04, 0.08)
Region	Major Cities	175	0.07 (0.03, 0.12)*	175	0.35 (0.28, 0.42)**	175	0.07 (0.03, 0.10)
	Regional and	113	0.16 (0.06, 0.26)	113	0.50 (0.37, 0.66)	113	0.06 (0.03, 0.10)
<b>Total</b>		<b>288</b>	<b>0.11 (0.06, 0.16)</b>	<b>288</b>	<b>0.41 (0.34, 0.48)</b>	<b>288</b>	<b>0.07 (0.05, 0.09)</b>

\* p<0.20, \*\* p<0.05, \*\*\* p<0.01, ^Poisson Regression

## **Multivariable associations with dental insurance status and other explanatory variables**

This section presents the multivariable relationships between the dental service use outcome variables and dental insurance using regression models. Only outcome variables that were significantly ( $p < 0.05$ ) associated with dental insurance in bivariate models (as presented above) or whose statistical significance was below 0.20 were examined in multivariable models. The same cut off of  $p < 0.20$  was used to decide inclusion of other explanatory variables in the models. Age and sex were included in the models regardless of the p-value.

### **Dental visiting and number of services per visit**

Table 4.7 presents the estimates from the multivariable models for dental visiting and number of visits. Prevalence ratios, their CI's and statistical significance for dental visiting are presented in the second column. Dental insurance status was statistically significant in relation to dental visiting; the dentally insured has a higher prevalence (1.24) of visiting a dentist during the two-year study period, i.e., prevalence of dental visiting was 24% higher among the insured. Sex, age and number of teeth were the other significant variables; Adults with less than 21 teeth (0.69), males (0.82) and those less than 50 years of age (0.86) had lower prevalence of visiting a dental professional.

Rate ratios, their confidence intervals and statistical significance for number of services/visit are presented in the last column of Table 4.7. After adjusting for sex, age and other significant factors, dental insurance status was not significantly associated with number of visits among those participants who made at least one dental visit. Other factors were also not significant in their association with number of dental visits.

<b>Table 4.7: Ratios of dental visiting and number of services per visit adjusted for other significant variables</b>			
<b>Explanatory Variables</b>	<b>Dental Visiting</b>		<b>Number of services/visit</b>
		<b>Prevalence Ratio (CI)<sup>^</sup></b>	<b>Rate Ratio (CI)<sup>^^</sup></b>
<b>Dental insurance status</b>			
	Insured	1.24 (1.05, 1.45)*	1.13 (1.00-1.27)
	Uninsured	1	1
<b>OHIP severity</b>			
	Low impact	-	1.09 (0.96-1.23)
	High Impact		1
<b>Number of teeth</b>			
	<21	0.69 (0.53, 0.92)*	-
	21 or more	1	
<b>Sex</b>			
	Male	0.82 (0.72, 0.93)**	1.06 (0.95-1.17)
	Female	1	1
<b>Age</b>			
	<50	0.86 (0.78, 0.96)*	0.99 (0.90-1.10)
	>50	1	1
<b>Household Income</b>			
	<\$80,000	1.01 (0.89, 1.15)	0.97 (0.87-1.07)
	\$80,000+	1	1
<b>Region</b>			
	Major Cities	1.12 (0.99, 1.25)	-
	Regional and remote Areas	1	

\*(p<0.20), \*\*(p<0.05), ^ Log Binomial regression, ^^ Poisson Regression

### **Main Areas of Services**

In bivariate associations with dental insurance, only numbers of preventive and restorative services were statistically significant among the main areas of services that were examined.

#### **Preventive services**

Table 4.8 presents the adjusted rate ratios for number of preventive services received by the adult participants in the study. After adjusting for age, sex, OHIP severity, self-rated oral health, toothache frequency, number of teeth, household income and region of residence dental insurance was not significantly associated with number of preventive services. No other variable was significantly associated with the number preventive services either.

#### **Restorative Services**

The last column of Table 4.8 presents the rate ratios for the number of restorative services received by the study participants. Dental insurance status was not significantly associated with number of restorative services after adjusting for other significant variables in a Poisson regression model. The rate ratios for self-rated general health and age were statistically significant (p<0.05); participants with poorer general health received restorative services at a 60% higher rate compared to those

with good self-rated general health and those aged less than 50 years received restorative services at 31% lower rate compared to those 50 years or over.

**Table 4.8: Ratios of number of preventive and restorative services adjusted for other significant variables**

Explanatory Variables	Number of preventive services	Number of restorative services
	Rate Ratio (CI)^	Rate Ratio (CI)^
<b>Dental insurance status</b>		
Insured	1.29 (0.95, 1.75)	0.85 (0.59, 1.21)
Uninsured	1	1
<b>OHIP severity</b>		
Low impact	1.33 (0.91, 1.93)	1.06 (0.71, 1.60)
High Impact	1	1
<b>Self-rated Oral health (SROH)</b>		
Poor or Fair	0.94 (0.67, 1.32)	1.20 (0.81, 1.76)
Good, very good or Excellent	1	1
<b>Toothache</b>		
Very Often/Often/ Sometimes Hardly Ever/ Never	0.84 (0.60, 1.19)	-
<b>Number of teeth</b>		
<21	0.82 (0.44, 1.55)	-
21 or more	1	
<b>Self-rated General Health (SRGH)</b>		
Poor or Fair	-	1.60 (1.04, 2.46)*
Good, very good or Excellent		1
<b>Sex</b>		
Male	0.99 (0.78, 1.26)	0.97 (0.69, 1.36)
Female	1	1
<b>Age</b>		
<50	1.07 (0.85, 1.35)	0.69 (0.49, 0.96)*
>50	1	1
<b>Household Income</b>		
<\$80,000	0.99 (0.78, 1.25)	1.26 (0.90, 1.77)
\$80,000+	1	1
<b>Region</b>		
Major Cities	1.32 (1.04, 1.67)*	-
Regional and remote Areas	1	

\*(p<0.20), \*\*(p<0.05), ^ Poisson regression

### Main areas of services per visit

In bivariate associations with dental insurance, numbers of diagnostic, preventive and restorative services per visit were statistically significant. The adjusted rate ratios are presented in Table 4.9.

### Diagnostic services per visit

After adjusting for age, sex and other significant factors, dental insurance was significantly associated with number of diagnostic services per visit; the insured had a 22% higher rate of receiving diagnostic services per visit compared to the uninsured.

Conversely, participants with household income less than \$80,000 received diagnostic service at 15% lesser rate than those with household income of \$80,000 and over.

<b>Table 4.9: Ratios of number of diagnostic, preventive and restorative services per visit adjusted for other significant variables</b>				
<b>Explanatory Variables</b>	<b>Number of diagnostic services/visit</b>	<b>Number of preventive services/visit</b>	<b>Number of restorative services/visit</b>	
	<b>Rate Ratio (CI)^</b>	<b>Rate Ratio (CI)^</b>	<b>Rate Ratio (CI)^</b>	
<b>Dental insurance status</b>				
Insured	1.22 (1.01-1.47)*	1.50 (1.12-2.00)*	0.94 (0.70-1.25)	
Uninsured	1	1	1	
<b>OHIP severity</b>				
Low impact	1.17 (0.95-1.43)	1.48 (1.00-2.18)*		
High Impact	1	1		
<b>Self-rated Oral health (SROH)</b>				
Poor or Fair	-	0.81(0.58-1.15)	1.12 (0.83-1.51)	
Good, very good or Excellent		1	1	
<b>Toothache</b>				
Very Often/Often/ Sometimes	-	1.21 (0.85-1.70)	-	
Hardly Ever/ Never		1		
<b>Number of teeth</b>				
<21	1.00 (0.71-1.41)	1.00 (0.54-1.85)	-	
21 or more	1	1		
<b>Self-rated General Health (SRGH)</b>				
Poor or Fair	0.97 (0.75-1.25)	1.00 (0.66-1.50)	1.23 (0.86-1.76)1	
Good, very good or Excellent	1	1		
<b>Sex</b>				
Male	1.00 (0.85-1.18)	1.05 (0.84-1.32)	1.01 (0.76-1.35)	
Female	1	1	1	
<b>Age</b>				
<50	1.16 (0.99-1.35)	1.09 (0.87-1.36)	0.68 (0.52-0.90)*	
>50	1	1	1	
<b>Household Income</b>				
<\$80,000	0.85 (0.73-1.00)*	1.00 (0.80-1.25)	1.30 (0.98-1.73)	
\$80,000+	1	1	1	
<b>Region</b>				
Major Cities	-	1.15 (0.92-1.44)	0.83 (0.64-1.08)	
Regional and remote Areas		1	1	

\*(p<0.20), \*\*(p<0.05), ^ Poisson regression

### **Preventive services per visit**

Dental insurance status was significantly associated with number of preventive services per visit in adjusted analysis using a Poisson regression model. Participants with dental insurance received preventive services per visit at 50% higher rate compared to the uninsured. Similarly, those with low oral impact as measured by OHIP also had almost 50% higher rate of receiving preventive service at every visit.

### ***Restorative service per visit***

Dental insurance status was not significantly associated with number of restorative services per visit after adjusting for age, sex and other significant factors. Age was the only factor associated with restorative services per visit; participants aged less than 50 years of age received restorative services at about 32% lesser rate compared to the older participants.

### **Summary – Dental service use/access to dental care**

Participants with dental insurance visited a dental professional at a higher rate after adjusting for other factors. Among those who visited, there were no significant associations with dental insurance for number of visits, services or services per visit after adjusting for other significant factors. None of the main areas of services were significantly associated with dental insurance status either. However, dental insurance status was associated with both diagnostic and preventive services per visit. The insured received significantly higher rates of both services per visit.

The next chapter examines the relationship between dental insurance status and oral and general health outcomes.

# **Chapter 5**

## **Results: Health Outcomes**

This chapter presents the results from the third area of analysis for this PhD; the relationship between dental insurance status and health outcomes. This relates directly to the second objective of this study; to ascertain if dental insurance is positively associated with health outcomes. This chapter along with the previous chapter also answers the research question on the overall effectiveness of dental insurance.

The bivariate and multivariable associations of five oral health outcomes and three general health outcome variables were examined in this chapter. All outcomes were self-reported and were change variables, i.e., they measured change from baseline to the end of the two-year study period. The oral health variables examined any tooth loss and mean tooth loss, OHIP severity negative change and mean OHIP severity change and negative change in Self-Rated Oral Health (SROH). The General health variables included negative change in EuroQoL derived health utility value, mean EuroQoL derived health utility value change and Negative change in Self-Rated General Health (SRGH).

## **Bivariate associations between health outcomes and dental insurance**

### **Oral health outcomes**

The bivariate associations between oral health outcomes and dental insurance status are presented in Tables 5.1 and 5.2. Proportion or means and their respective confidence intervals and statistical significance tested through log binomial or Poisson regression models respectively are presented.

#### ***Tooth Loss***

Table 5.1 presents the results for both measures of tooth loss. The second and third columns present the proportions for any tooth loss. Overall, just under a quarter of the adults in the study experienced any tooth loss during the two-year period. It was not significantly associated with dental insurance status or any of the other health and demographic variables. There was a small difference in proportion of any tooth loss with regards to toothache frequency but was not statistically significant.

The last two columns in Table 5.1 present the mean tooth loss by dental insurance status and other variables. Overall the mean tooth loss was less than one (0.63) for the two-year period and there were no significant differences by dental insurance status and most other variables. Toothache frequency was significantly associated with mean tooth loss with those experiencing toothache more frequently losing about one tooth during the two years.

**Table 5.1: Tooth loss by Insurance status and oral and general health, visiting and demographic variables**

Variables	Categories	N	Any tooth loss (%) (CI) <sup>^</sup>	N	Mean tooth loss (CI) <sup>^^</sup>
<b>Main Explanatory variable</b>					
Dental Insurance Status	Insured	281	23.5 (18.5, 28.5)	281	0.60 (0.44, 0.77)
	Uninsured	139	20.9 (14.0, 27.7)	139	0.69 (0.38, 1.00)
<b>Health and visiting variables</b>					
2 year Dental visiting	No visit	112	19.6 (12.2, 27.1)	112	0.46 (0.24, 0.67)*
	One or more visits	298	24.2 (19.3, 29.0)	298	0.71 (0.52, 0.91)
Dental Health at Baseline	Poor or Fair	102	25.5 (16.9, 34.1)	102	0.79 (0.41, 1.17)
	Good, very good or Excellent	315	21.6 (17.0, 26.2)	315	0.58 (0.42, 0.74)
Toothache	Very Often/Often/ Sometimes	77	28.6 (18.3, 38.9)*	77	0.99 (0.51, 1.46)***
	Hardly Ever/ Never	335	20.9 (16.5, 25.3)	335	0.54 (0.39, 0.69)
Number of teeth	Less than 21	48	25.0 (12.3, 37.7)	48	0.94 (0.27, 1.60)
	21 or more	372	22.3 (18.1, 26.6)	372	0.59 (0.44, 0.74)
General Health at Baseline	Poor or Fair	46	23.9 (11.1, 36.7)	46	0.78 (0.26, 1.31)
	Good, very good or Excellent	374	22.5 (18.2, 26.7)	374	0.61 (0.46, 0.77)
<b>Demographic variables</b>					
Sex	Male	159	25.2 (18.3, 32.0)	159	0.74 (0.47, 1.03)
	Female	261	21.1 (16.1, 26.1)	261	0.56 (0.39, 0.73)
Age	<50	208	24.5 (18.6, 30.4)	208	0.59 (0.39, 0.79)
	50 +	205	24.4 (18.5, 30.3)	205	0.68 (0.45, 0.91)
Household Income	<\$80,000	207	23.7 (17.8, 29.5)	207	0.73 (0.48, 0.99)
	\$80,000+	196	21.9 (16.1, 27.8)	196	0.55 (0.37, 0.73)
Tertiary Education	None	71	21.1 (11.4, 30.9)	71	0.54 (0.20, 0.87)
	Yes	345	23.2 (18.7, 27.7)	345	0.66 (0.49, 0.83)
Region	Major Cities	236	22.9 (17.5, 28.3)	236	0.60 (0.42, 0.79)
	Regional and remote	184	22.3 (16.2, 28.4)	184	0.67 (0.42, 0.92)
<b>Total</b>		<b>420</b>	<b>22.6 (18.6, 26.6)</b>	<b>420</b>	<b>0.63 (0.48, 0.78)</b>

\* p<0.20, \*\*\* p<0.01, ^Log binomial Regression, ^^ Poisson regression

### **OHIP severity**

Table 5.2 presents the results for both measures of OHIP severity and negative change in Self-Rated Oral Health (SROH). The third and fourth columns present the proportion of participants who reported negative change in OHIP severity scores. A little under 50% of the participants had some level of negative change in OHIP severity and this was significantly different between the insured and uninsured; the uninsured had higher proportions experiencing negative change in OHIP severity. Those participants who reported good, very good or excellent oral health at baseline had a significantly lesser proportion reporting negative change in OHIP severity. Any differences by other variables were not statistically significant.

Mean OHIP severity change and the associated n, confidence intervals and statistical significance is reported in the 5<sup>th</sup> and 6<sup>th</sup> columns of Table 5.2. Negative values refer to worsening of OHIP scores and consequently increase of oral health impacts. On average the oral health as measured by the OHIP worsened for the study population by 1.60 severity points. This worsening was almost three times higher for the uninsured (2.85) compared to the insured (0.97). Participants who reported poorer SRGH and those with household income below \$80,000 also reported significantly higher worsening of OHIP scores. While adults with poorer SROH at the start of the study, those with more frequent toothache and those living in regional and remote areas had higher worsening, the differences were not statistically significant.

### ***Self-Rated Oral Health (SROH)***

The last two columns in Table 5.2 report the proportion of participants who self-rated their oral health as worsening over the two-year study period. About 15% of the entire study participants reported negative change in SROH. This was significantly higher among the uninsured (23%) compared to the insured (11%). Participants who started the study with poorer SROH reported a significantly higher proportion (26%) of negative change in SROH. Almost 30% of participants who started the study with poorer SRGH reported worsening in SROH. Household income also was a factor in worsening of SROH as those with an income of less than \$80,000 reported a significantly higher proportion (20%) that had negative change in SROH.

**Table 5.2: OHIP severity and SROH change variables by Insurance status and oral and general health, visiting and demographic variables**

Variables	Categories	N	OHIP Severity Negative Change (%) (CI)^	N	Mean OHIP severity change (CI)^^	N	Negative change in SROH (%) (CI)^
<b>Main Explanatory variable</b>							
Dental Insurance Status	Insured	278	43.2 (37.3, 49.0)**	278	-0.97 (-1.59, -	281	11.0 (7.3, 14.7)***
	Uninsured	140	55.7 (47.4, 64.0)	140	-2.85 (-4.22, -1.48)	142	23.2 (16.2, 30.3)
<b>Health and visiting variables</b>							
2 year Dental visiting	No visit	112	43.8 (34.4, 53.1)	112	-1.01 (-2.09, 0.07)	112	17.9 (10.6, 25.1)
	One or more visits	296	48.6 (42.9, 54.4)	296	-1.88 (-2.63, -1.12)	301	14.0 (10.0, 17.9)
SROH at Baseline	Poor or Fair	104	54.8 (45.1, 64.5)*	104	-2.39 (-4.25, -0.54)*	106	25.5 (17.0, 33.9)***
	Good, very good or Excellent	311	44.7 (39.1, 50.3)	318	-1.30 (-1.86, -0.75)	314	11.1 (7.6, 14.6)
Toothache	Very Often/Often/Sometimes	78	47.4 (36.1, 58.8)	78	-0.29 (-1.95, 1.36)*	80	25.0 (15.3, 34.7)**
	Hardly Ever/Never	331	46.8 (41.4, 52.2)	331	-1.78 (-2.37, -1.18)	334	12.6 (9.0, 16.1)
Number of teeth	Less than 21	51	58.8 (44.8, 72.8)	51	-2.82 (-5.89, 0.24)*	52	25.0 (12.8, 37.2)*
	21 or more	367	45.8 (40.7, 50.9)	367	-1.43 (-2.00, -0.86)	371	13.7 (10.2, 17.3)
SRGH at Baseline	Poor or Fair	45	64.4 (49.9, 79.0)**	45	-4.22 (-7.19, -	46	30.4 (16.6, 44.3)**
	Good, very good or Excellent	373	45.3 (40.2, 50.4)	373	-1.28 (-1.88, -0.69)	377	13.3 (9.8, 16.7)
<b>Demographic variables</b>							
Sex	Male	164	48.2 (40.4, 55.9)	164	-1.37 (-2.24, -0.49)	165	14.5 (9.1, 20.0)
	Female	254	46.9 (40.7, 53.0)	254	-1.75 (-2.60, -0.90)	258	15.5 (11.1, 19.9)
Age	<50	206	46.1 (39.3, 53.0)	206	-1.51 (-2.36, -0.66)	207	13.0 (8.4, 17.7)
	50 +	209	48.8 (42.0, 55.6)	209	-1.71 (-2.63, -0.79)	213	17.4 (12.2, 22.5)
Household Income	<\$80,000	209	51.2 (44.4, 58.0)*	209	-2.34 (-3.33, -1.36)**	211	20.4 (14.9, 25.9)***
	\$80,000+	194	43.8 (36.8, 50.9)	194	-0.81 (-1.58, -0.04)	196	10.2 (5.9, 14.5)
Tertiary Education	None	69	47.8 (35.7, 59.9)	69	-2.10 (-3.82, -0.38)	69	21.7 (11.8, 31.7)
	Yes	346	47.1 (41.8, 52.4)	346	-1.49 (-2.16, -0.82)	351	13.7 (10.1, 17.3)
Region	Major Cities	232	44.4 (38.0, 50.8)	232	-1.19 (-2.03, -0.35)*	237	13.1 (8.8, 17.4)*
	Regional and	186	51.1 (43.8, 58.3)	186	-2.11 (-3.04, -1.19)	186	17.7 (12.2, 23.3)
<b>Total</b>		<b>418</b>	<b>47.4 (42.6, 52.2)</b>	<b>418</b>	<b>-1.60 (-2.22, -0.98)</b>	<b>423</b>	<b>15.1 (11.7, 18.6)</b>

\* p<0.20, \*\* p<0.05 \*\*\* p<0.01, ^Log binomial Regression, ^^ Poisson regression

## **General health outcomes**

### ***EuroQoL health utility values***

Table 5.3 presents the results for both measures of health utility values derived from EuroQoL, proportion of negative change in health utility and mean health utility change. The third and fourth columns in the Table present the proportions of participants who reported negative change in health utility values. Overall, about 18% of adults reported negative change in health utility. Dental insurance status was significantly associated with proportion who reported negative change in health utility value as measure through EuroQoL; 24% of the uninsured and 16% of the insured. As would be expected both SROH and SRGH at the start of the study were also associated with negative change in health utility values.

The 5<sup>th</sup> and 6<sup>th</sup> columns of Table 5.3 present the mean change in health utility values as measured by EuroQoL. Health utility values range from 0 to 1 with a value of 1 normally indicating perfect health and 0 indicating death or a health state worse than death. Here the positive values indicate a reduction in the health state value and the negative values indicate an increase in health utility. Among all participants, health utility values reduced by 1%. There were no differences in mean change in health utility values by dental insurance and other variables except SRGH. Participants who started the study with a poor rating of SRGH had a 5% reduction in health utility value over the two-year period, a significantly higher reduction than those who started the study with good SRGH.

### ***Self-Rated General Health (SRGH)***

The last two columns in Table 5.3 present the proportion of participants who reported any worsening of general health along with their n, 95% confidence intervals and statistical significance. About 23% of the entire study participants reported worsening of SRGH over the two-year study period. This was marginally higher among the uninsured though not statistically significant. As with the other health outcomes, both baseline SROH and SRGH were significantly associated with reporting of worsening in general health at the end of the two-year study period. There were no statistically significant differences in proportions reporting negative change in SRGH by all other variables.

**Table 5.3: EuroQoL health utility and SRGH change variables by Insurance status and oral and general health, visiting and demographic variables**

Characteristics		N	EuroQoL health utility negative change (%) (CI) <sup>^</sup>	N	Mean EuroQoL health utility change (CI) <sup>^^</sup>	N	Negative change in SRGH (%) (CI) <sup>^</sup>
<b>Main Explanatory variable</b>							
Dental Insurance Status	Insured	277	15.9 (11.6, 20.2)**	277	0.004 (-0.011, 0.019)	281	20.3 (15.6, 25.0)*
	Uninsured	133	24.1 (16.7, 31.4)	133	0.019 (-0.006, 0.044)	142	27.5 (20.0, 34.9)
<b>Health and visiting variables</b>							
2 year Dental visiting	No visit	108	21.3 (13.5, 29.1)	108	0.015 (-0.009, 0.040)	112	17.0 (9.9, 24.0)*
	One or more visits	294	17.7 (13.3, 22.1)	294	0.008 (-0.008, 0.023)	301	25.2 (20.3, 30.2)
SROH at Baseline	Poor or Fair	101	27.7 (18.8, 36.6)***	101	0.015 (-0.024, 0.054)	106	38.7 (29.3, 48.1)***
	Good, very good or Excellent	306	15.4 (11.3, 19.4)	306	0.006 (-0.005, 0.018)	314	17.5 (13.3, 21.7)
Toothache	Very Often/Often / Sometimes	76	23.7 (13.9, 33.5)	76	0.009 (-0.032, 0.050)	80	33.8 (23.2, 44.3)*
	Hardly Ever/ Never	329	17.0 (12.9, 21.1)	329	0.008 (-0.005, 0.021)	334	20.1 (15.7, 24.4)
Number of teeth	Less than 21	46	21.7 (9.4, 34.1)	46	-0.002 (-0.066, 0.063)	52	34.6 (21.2, 48.0)*
	21 or more	364	18.1 (14.2, 22.1)	364	0.010 (-0.002, 0.022)	371	21.0 (16.9, 25.2)
SRGH at Baseline	Poor or Fair	43	46.5 (31.0, 62.0)***	43	0.050 (-0.028, 0.128)**	46	50.0 (35.0, 65.0)***
	Good, very good or Excellent	367	15.3 (11.6, 19.0)	367	0.004 (-0.007, 0.015)	377	19.4 (15.4, 23.4)
<b>Demographic variables</b>							
Sex	Male	158	13.9 (8.5, 19.4)*	158	-0.003 (-0.022, 0.015)*	165	23.6 (17.1, 30.2)
	Female	252	21.4 (16.3, 26.5)	252	0.016 (-0.001, 0.033)	258	22.1 (17.0, 27.2)
Age	<50	204	18.1 (12.8, 23.5)	204	0.009 (-0.008, 0.025)	207	18.4 (13.0, 23.7)*
	50 +	203	19.2 (13.7, 24.7)	203	0.009 (-0.010, 0.029)	213	27.2 (21.2, 33.3)
Household Income	<\$80,000	200	22.0 (16.2, 27.8)*	200	0.008 (-0.012, 0.029)	211	26.1 (20.1, 32.0)*
	\$80,000+	193	16.1 (10.8, 21.3)	193	0.008 (-0.008, 0.025)	196	19.4 (13.8, 25.0)
Tertiary Education	None	64	25.0 (14.1, 35.9)*	64	0.015 (-0.019, 0.050)	69	20.3 (10.6, 30.0)
	Yes	343	17.2 (13.2, 21.2)	343	0.007 (-0.007, 0.021)	351	23.1 (18.6, 27.5)
Region	Major Cities	231	16.9 (12.0, 21.7)	231	0.013 (-0.004, 0.029)	237	21.5 (16.2, 26.8)
	Regional and	179	20.7 (14.7, 26.7)	179	0.004 (-0.017, 0.024)	186	24.2 (18.0, 30.4)
<b>Total</b>		<b>410</b>	<b>17.8 (14.1, 21.5)</b>	<b>410</b>	<b>0.008 (-0.004, 0.021)</b>	<b>423</b>	<b>22.7 (18.7, 26.7)</b>

\* p<0.20, \*\* p<0.05, \*\*\*p<0.01, ^Log binomial Regression, ^^ Poisson regression

## **Multivariable associations between dental insurance and health outcomes**

This second section of chapter 5 presents the results of multivariable associations between dental insurance and health outcomes. Outcome variables which were significantly associated with dental insurance in bivariate associations or where significance levels were  $p < 0.20$  were tested for associations with dental insurance status in regression models adjusting for age, sex and other significant ( $p < 0.20$ ) variables.

### **Oral health outcomes**

The oral health outcome variables whose association with dental insurance was tested in multivariable models were both OHIP severity measures (negative change and mean change) and negative change in SROH.

#### ***OHIP severity***

Table 5.4 presents the prevalence and beta estimates from the multivariable adjusted models. The estimates and their confidence intervals and statistical significance for proportion of negative OHIP change and OHIP severity change scores were generated using log binomial and multiple linear regression models respectively. Negative change in OHIP severity was not associated with dental insurance after adjusting for age, sex and other significant variables. No other variable was significantly associated with negative change in OHIP severity. Reporting good, very good or excellent SRGH at baseline had a 34% lower prevalence of reporting negative change in OHIP severity and was just outside of statistical significance ( $p = 0.05$ ).

OHIP severity change scores were modelled in a multiple linear regression model with dental insurance status and other significant variables. Dental insurance status was significantly associated with OHIP severity change; the benefit from being insured was about 1.5 OHIP severity units more than the uninsured over the two-year period after adjusting for age, sex, SRGH, household income and region of residence. SRGH was also significantly associated with OHIP severity change; participants rating their general health as fair or poor at baseline were worse off by close to three OHIP severity units compared to those who reported good general health at baseline.

#### ***Self-Rated Oral Health (SROH)***

Adjusted prevalence ratios and their associated confidence intervals and statistical significance for negative change in SROH are presented in the last column of Table 5.4. After adjusting for sex, age and other significant factors, dental insurance status was significantly associated with negative change in SROH. The uninsured had a 14% higher prevalence of negative change in SROH or reporting worsening of oral health over the two-year study period. As expected those who reported poor or fair general health have significantly higher prevalence of negative change in SROH.

**Table 5.4: Ratios and estimates of negative OHIP change, OHIP severity change scores and negative change in SROH adjusted for other significant variables**

Explanatory Variables	OHIP Negative change	OHIP change scores	SROH negative change
	Prevalence Ratio (CI) <sup>^</sup>	Beta Coefficients (CI) <sup>^^</sup>	Prevalence Ratio (CI) <sup>^</sup>
<b>Dental insurance status</b>			
Insured	0.84 (0.67, 1.06)	-1.464 (-2.882, -0.046)**	0.58 (0.36, 0.93)**
Uninsured	1	0	1
<b>Number of teeth</b>			
<21	1.10 (0.83, 1.46)	-	-
21 or more	1		
<b>Self-rated General Health (SRGH)</b>			
Poor or Fair	1.40 (1.07, 1.78)**	2.971 (0.890, 5.053)**	1.84 (1.10, 3.09)**
Good, very good or Excellent	1	0	1
<b>Sex</b>			
Male	1.04 (0.85, 1.27)	-0.006 (-1.315, 1.302)	1.13 (0.71, 1.80)
Female	1	0	1
<b>Age</b>			
<50	1.01 (0.82, 1.25)	0.218 (-1.064, 1.500)	0.86 (0.54, 1.36)
>50	1	0	1
<b>Household Income</b>			
<\$80,000	1.08 (0.87, 1.34)	0.687 (-0.668, 2.042)	1.48 (0.88, 2.49)
\$80,000+	1	0	1
<b>Region</b>			
Major Cities	-	-0.729 (-2.007, 0.549)	0.79 (0.51, 1.24)
Regional and remote Areas		0	1

\* p=0.05, \*\* p<0.05, ^ Log Binomial regression, ^^ Multiple Linear Regression

### General health outcomes

The general health outcome variables whose multivariable relationship with dental insurance status were tested in regressions models were negative change in EuroQoL health utility values and negative change in Self-Rated General Health (SRGH). The adjusted prevalence ratios for these outcomes are presented in Table 5.5.

### EuroQoL health utility values

Adjusted prevalence ratios for negative change in EuroQoL derived health utility values are presented in the second column of Table 5.5. The prevalence was lower among the dentally insured but was not statistically significant after adjusting for age, sex and other significant factors. The prevalence of negative change in health utility values was 62% higher among participants whose SRGH at the start of the study was fair or poor. Male participants also have a lower prevalence but it was just outside of statistical significance.

### Self-Rated General Health (SRGH)

The last column in Table 5.5 presents the adjusted prevalence ratio for negative change in SRGH by dental insurance status and other variables. The uninsured had a

7% higher prevalence of negative change in SRGH or self-reported worsening of general health over the two-year period but it was not statistically significant. Similar to health utility negative change, SROH at the start of the study was significantly associated with negative change on SRGH; participants who started the study with better self-reported oral health had a 22% lower prevalence of worsening in general health as compared to those who started the study reporting their oral health as fair or poor.

**Table 5.5: Prevalence ratio of negative change in EuroQoL health utility values and negative change in SRGH adjusted for other significant variables**

Explanatory Variables	Negative change in EuroQoL health utility	SRGH negative change
	Prevalence Ratio (CI) <sup>^</sup>	Prevalence Ratio (CI) <sup>^</sup>
<b>Dental insurance status</b>		
Insured	0.76 (0.48, 1.19)	0.87 (0.60, 1.28)
Uninsured	1	1
<b>2 year Dental visiting</b>		
No visit	-	0.61 (0.39, 0.95)**
One or more visits		1
<b>Self-rated Oral health (SROH)</b>		
Poor or Fair	1.62 (1.04, 2.5)**	1.79 (1.20, 2.66)***
Good, very good or Excellent	1	1
<b>Toothache</b>		
Hardly Ever/ Never	-	0.78 (0.53, 1.15)
Very Often/Often/ Sometimes		1
<b>Number of teeth</b>		
<21	-	1.20 (0.77, 1.88)
21 or more		1
<b>Sex</b>		
Male	0.63 (0.39, 1.00)*	1.18 (0.84, 1.66)
Female	1	1
<b>Age</b>		
<50	1.00 (0.66, 1.52)	0.77 (0.53, 1.13)
>50	1	1
<b>Household Income</b>		
<\$80,000	1.06 (0.68, 1.67)	1.19 (0.80, 1.76)
\$80,000+	1	1
<b>Region</b>		
Major Cities	0.88 (0.59, 1.33)	-
Regional and remote Areas	1	

\* p=0.05, \*\*p<0.05, \*\*\*p<0.01 <sup>^</sup> Log Binomial regression

## Summary – Health outcomes

Dental insurance status was significantly associated with OHIP severity change and negative change in self-rated oral health but not with health utility change or self-rated general health change over the two-year study period. In a two-year period the effect of dental insurance on oral health appears to be positive among working age adults. The next chapter evaluates the cost-effectiveness of dental insurance.

# **Chapter 6**

## **Results: Economic Evaluation**

This chapter presents the results of the economic evaluation, i.e., the cost analysis and cost-effectiveness analysis.

## Cost Analysis

The cost analysis is an important step in achieving the final objective of this research thesis, i.e., assessing the cost effectiveness of dental insurance. Firstly, a brief descriptive analysis of the cost components is presented. Then, as with the previous two results chapters, bivariate and multivariable associations of cost with dental insurance and other health and demographic variables are presented. The primary and only outcome variable in the cost analysis is the net individual (out of pocket (OOP)) dental expenditure using a consumer perspective as detailed in chapter 2 (Methods). All cost estimates presented in this thesis are in Australian dollars as denoted by '\$' and calculated as 2009/10 current prices with second year (2010/11) costs discounted to 2009/10 prices.

## Dental expenditure and its components

As detailed in Chapter 2 there were two main components of individual dental expenditure. The first was the dental insurance premiums and the second the dental service use cost.

### Dental insurance premiums

Dental insurance premiums were the insurance premiums paid by individuals to private health insurance funds to obtain insurance cover for dental services under the extras or combined (hospital and extras) policy. Table 6.1 presents the means, range, median and confidence intervals for the dental insurance premium estimates for the insured per adult per year by year of study and by type of policy. Dental insurance premiums estimates were about \$200 per year per adult amounting to a total of \$402.4 for the entire study period.

**Table 6.1 – Dental insurance premium estimates by policy type and year (2009-10 \$s)**

Period	Policy types	N	Mean (CI)	Range	Median
Dental Premium Year 1 (2009-10)	All policies	232	201.01(191.42, 210.59)	431.06	195.18
	Ancillary	111	224.40 (208.47, 240.33)	431.06	195.18
	Combined	121	179.55 (169.65, 189.45)	245.88	189.21
Dental Premium Year 2 (2010-11)	All policies	231	202.24 (192.60, 211.89)	414.32	197.74
	Ancillary	110	226.35 (210.35, 242.35)	414.32	198.47
	Combined	121	180.32 (170.33, 190.31)	248.67	192.71
Dental premium Both years (2009-11)	All policies	232	402.38 (383.06, 421.69)	866.62	391.89
	Ancillary	111	448.71 (416.49, 480.93)	866.62	391.89
	Combined	121	359.87 (339.99, 379.76)	494.55	381.92

### Dental Service use costs

Dental service use costs were those paid by the participants in the study during their dental visits. Any private insurance rebates received by those participants who were insured were not included in the dental service use cost as it was indirectly paid for through the insurance premiums. Costs that were covered by government schemes or through public sector service use were also excluded. Table 6.2 presents the mean total and yearly dental service use costs among those who visited. Mean dentals service use cost was about \$760 for the entire period and around \$450 for the first year and \$430 for the second year.

**Table 6.2 – Dental service use costs by year (2009-10 \$s)**

Period	N	Mean (CI)	Range	Median
Dental service use costs - Year 1 (2009-10)	263	452.78 (341.55, 564.00)	9627.00	200.00
Dental service use costs - Year 2 (2010-11)	248	428.93 (329.42, 528.44)	6838.24	198.38
Dental service use costs - Both years (2009-11)	286	759.24 (609.09, 909.40)	9912.71	347.67

### Total net consumer expenditure

The total net expenditure or out of pocket consumer expenditure comprised of both the dental insurance premium costs and the dental service use costs. Table 6.3 presents the mean net expenditure for the entire study period and the individual years.

The number of participants (N) is higher than for the individual components since some insured participants did not incur any service use costs and some participants who did incur service use costs were not insured and hence did not incur dental insurance premium costs. Additionally the N for the net expenditure variable also includes those adults who were both not insured and did not visit during the two years. These participants' expenditure was zero and was included in the analysis as they were true zero consumer expenditures. Mean net dental expenditure was almost \$800 for the two years and ranged between \$460 and \$493 in the two years.

**Table 6.3 – Total net expenditure by year (2009-10 \$s)**

Period	N	Mean (CI)	Range	Median
Net expenditure - Year 1 (2009-10)	336	493.20 (405.35, 581.04)	9627.00	277.48
Net expenditure - Year 2 (2010-11)	333	459.74 (383.84, 535.64)	7030.95	271.77
Net Expenditure - Both years (2009-11)	364	787.91 (676.22, 899.60)	9912.71	515.10

### **Bivariate associations with insurance status and other variables**

This section reports on the bivariate associations between net consumer (out of pocket) dental expenditure and dental insurance status and health and demographic variables. The N, means and their associated 95% confidence intervals, range, median and statistical significance are presented in Table 6.4. Dental insurance status was significantly associated with net expenditure; the insured had a higher average net expenditure of \$879 compared to the uninsured (\$628). As expected participants who visited a dental professional in the two-year period had significantly higher expenditure. Participants who had higher frequency of toothache experience, those who usually visit more than once a year, those with at least one tooth loss, those with some level of tertiary education and those who lived in the major cities had significantly higher average net expenditure.

**Table 6.4: Net dental expenditure by Insurance status and oral and general health and demographic variables**

Characteristics		N	Mean (CI)	Median	Statistical significance <sup>^</sup>
<b>Main Explanatory variable</b>					
Dental Insurance Status	Insured	232	879 (753, 1005)	591	**
	Uninsured	132	628 (414, 842)	268	
<b>Health variables</b>					
2 year Dental visiting	No visit	101	207 (160, 254)	0	***
	One or more visits	262	1014 (868, 1159)	632	
Dental Health at Baseline	Poor or Fair	82	889 (571, 1208)	548	NS
	Good, very good or Excellent	280	751 (640, 862)	510	
Toothache	Very Often/Often/ Sometimes	69	1060 (686, 1435)	487	**
	Hardly Ever/ Never	287	720 (611, 829)	583	
Number of teeth	Less than 21	44	609 (348, 870)	335	NS
	21 or more	320	813 (690, 935)	523	
General Health at Baseline	Poor or Fair	34	833 (492, 1173)	527	
	Good, very good or Excellent	330	783 (665, 902)	515	
Average visiting pattern	More than once a year	110	1125 (913, 1337)	711	Ref
	Once a year	107	810 (597, 1024)	511	**
	Less than once a year	145	517 (359, 676)	366	***
Any Tooth Loss	No	275	716 (608, 824)	494	**
	At least one	73	1049 (677, 1420)	616	
Usual Reason for visiting	Exam or Check-up	197	725 (623, 827)	537	Ref
	Treatment Not ROP	119	828 (613, 1044)	515	NS
	Emergency or ROP	45	814 (303, 1325)	290	NS
Tooth brushing	<2 times per day	144	719 (530, 908)	436	
	2 or more times per day	218	825 (688, 963)	550	NS
<b>Demographic variables</b>					
Sex	Male	131	716 (499, 934)	446	NS
	Female	233	828 (703, 954)	559	
Age	<50	77	651 (588, 839)	473	NS
	50 +	106	759 (581, 938)	542	
Household Income	<\$80,000	176	705 (543, 867)	449	NS
	\$80,000+	173	816 (668, 964)	543	
Tertiary Education	None	63	506 (365, 647)	440	**
	Yes	298	846 (714, 978)	531	
Region	Major Cities	204	882 (712, 1051)	537	*
	Regional and remote	160	668 (535, 802)	494	
<b>Total</b>		<b>364</b>	<b>788 (676, 900)</b>	<b>515</b>	

NS=Not Significant, Ref=Reference group, \*p<0.20, \*\* p<0.05, \*\*\*p<0.01, ^Linear Regression

### **Multivariable association with dental insurance and other variables**

As with the other areas of analysis, multivariable analysis was conducted to ascertain the adjusted effect of dental insurance on net expenditure. Multiple linear regression modelling was used to generate beta coefficients after adjusting for age, sex and other significant variables. A significance cut off of  $p < 0.20$  was used to select variables into the linear model.

Table 6.5 presents the beta estimates, their 95% confidence intervals and statistical significance for net expenditure by dental insurance status and other significant variables. No significant association between average net expenditure and dental insurance status was detected when all other significant variables are kept constant. Dental visiting as expected was associated with net expenditure and so was toothache experience at baseline. When all other variables are held constant the average net expenditure for those who made at least one dental visit was \$636 and for participants who experienced more frequent toothache was \$339. Those who experienced any tooth loss during the study period also had a higher expenditure and this was just outside of statistical significance ( $P=0.05$ ).

<b>Table 6.5: Beta estimates of net expenditure adjusted for other significant variables</b>			
<b>Explanatory Variables</b>	<b>Net Expenditure</b>		<b>Statistical significance</b>
		<b>Beta Estimates (CI)</b>	<b>^</b>
<b>Dental insurance status</b>			
	Insured	0	
	Uninsured	-114.37 (-364.89, 136.15)	NS
<b>Average visiting pattern</b>			
	More than once a year	0	
	Once a year	-253.53 (-544.33, 37.27)	NS
	Less than once a year	-261.18 (-570.32, 47.95)	NS
<b>Dental visiting</b>			
	No visit	0	
	One or more visits	635.84 (146.23, 348.15)	***
<b>Toothache</b>			
	Very Often/Often/ Sometimes	338.60 (50.05, 627.14)	
	Hardly Ever/ Never	0	**
<b>Any tooth loss</b>			
	No	0	
	At least one	270.87 (-5.97, 547.71)	*
<b>Sex</b>			
	Male	0	
	Female	11.24 (-227.85, 250.33)	NS
<b>Age</b>			
	<50	0	
	>50	134.14 (-95.80, 364.09)	NS
<b>Household Income</b>			
	<\$80,000	0	
	\$80,000+	207.08 (-99.58, 513.74)	NS
<b>Region</b>			
	Major Cities	0	
	Regional and remote Areas	-83.15 (-313.26, 146.96)	NS

\*p=0.05, \*\*p<0.05, \*\*\*p<0.01, ^ Multiple linear regression

## Cost Effectiveness Analysis

The second section of this chapter presents the results for the Cost-Effectiveness Analysis (CEA) and directly answers the questions pertaining to the fourth objective of the study, i.e., the cost-effectiveness of dental insurance. Two outcomes – OHIP Severity change and negative change in SROH were found to be effective by insurance status in the analysis of oral and general health outcomes in Chapter 5. These two outcomes are tested for cost-effectiveness in this chapter from a consumer perspective as in the cost-analysis. Commonly, a CEA involves the presentation of an Incremental Cost Effectiveness Ratio (ICER) and the cost-effectiveness plane. However, since this study is interested in the individual consumer perspective and the ICERs for these outcomes are not readily interpretable for an individual consumer, the ICER and its associated precision estimates are presented in this chapter followed by the cost effectiveness acceptability curve (CEAC) and net monetary benefit (NMB). The CEAC and the NMB provide a more interpretable measure from an individual consumer perspective.

## Costs and outcomes

Table 6.6 provides a summary of the net (out of pocket) expenditure and the two outcome variables, OHIP severity change and Negative Change in Self-Rated Oral Health (SROH) by the main explanatory variable, dental insurance status. The costs were higher among the insured while the worsening of both the outcomes was higher among the uninsured.

**Table 6.6: Summary Statistics of costs and outcomes**

Dental insurance status	N	Mean	Median	Lower 95% CL for Mean	Upper 95% CL for Mean	Standard Deviation	Standard Error
<b>Net out of pocket expenditure</b>							
Insured	232	878.72	591.42	752.90	1004.55	972.70	63.86
Uninsured	132	628.31	268.33	414.28	842.34	1243.03	108.19
<b>OHIP Severity change</b>							
Insured	220	-0.91	0.00	-1.58	-0.24	5.06	0.34
Uninsured	126	-2.98	-2.00	-4.39	-1.58	7.95	0.71
<b>Negative change in SROH</b>							
Insured	223	0.10	0.00	0.06	0.14	0.30	0.02
Uninsured	128	0.24	0.00	0.17	0.32	0.43	0.04

### Cost effectiveness analysis - OHIP severity change

Table 6.7 provides the ICER calculations and mean costs, outcomes and differences for OHIP severity change. The different in cost between the insured and the uninsured was just over \$250 while the different in OHIP severity change was 2.08 OHIP severity points. Based on these differences the ICER was \$121 for every unit change in OHIP. However this ICER is not interpretable from a consumer perspective as it is a population measure, as explained earlier. The Cost effectiveness plane, the net monetary benefit and the cost-effectiveness acceptability curve therefore are presented below in order to interpret the result from a consumer perspective.

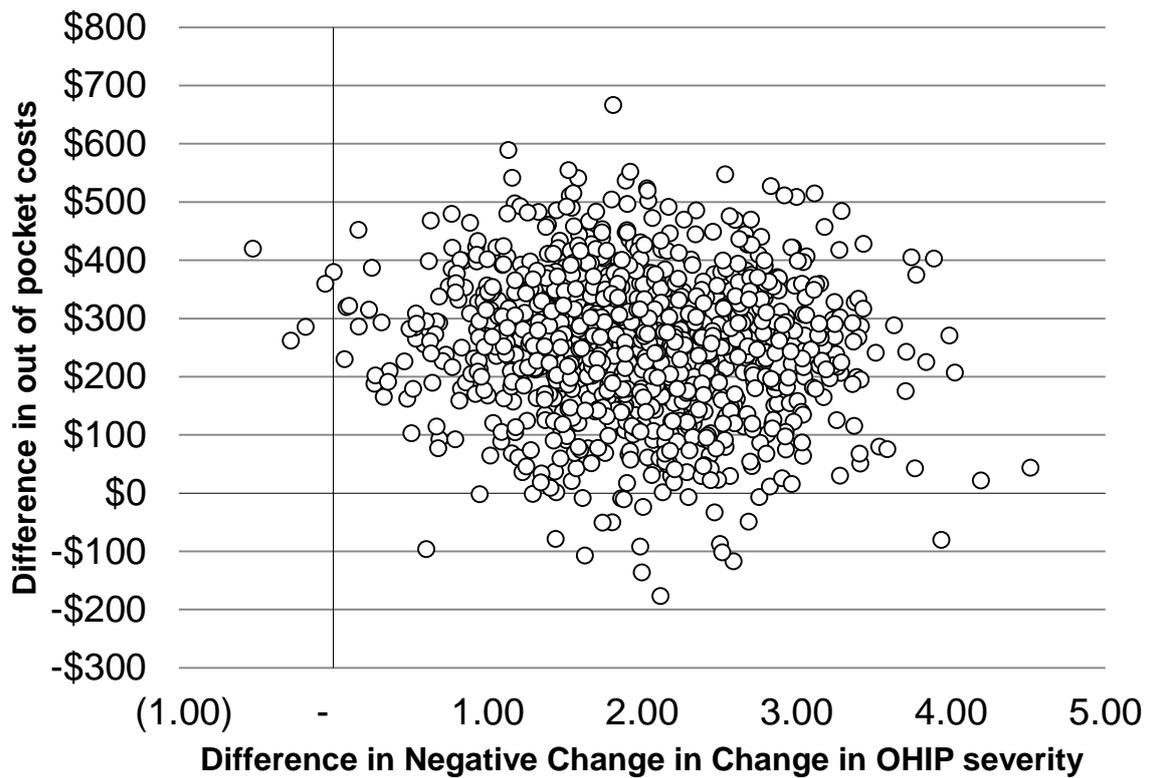
**Table 6.7: Incremental Cost Effectiveness Ratio (ICER) – OHIP severity Change**

Outcomes	Cost (\$)		Outcome		Difference		ICER (CI)
	Insured	Uninsured	Insured	Uninsured	Cost (CI)	Outcome (CI)	
OHIP severity Change	878.72	628.31	-0.91	-2.98	\$250.42 (\$4-\$497)	2.08 (0.57 – 3.58)	\$120.68 (-\$3 – \$495)

Probabilistic sensitivity analysis was conducted by generating a bootstrapped sample from the original sample with 10,000 replications. The 95% confidence intervals for the ICER ranging from -\$3 to \$495, was generated using the bootstrapped sample. In other words we can be 95% sure that the mean cost to gain an average reduction of 1 unit in OHIP severity ranges between -\$3 and \$495 for an insured adult.

The replicated ICERs from the bootstrapped sample are presented in Figure 6.1. The figure is essentially the north-east quadrant of the cost effectiveness plane where both the cost and the effect are higher for being insured. While a handful of differences in outcome fell below 0, a few more of the replicated differences in cost fell below zero.

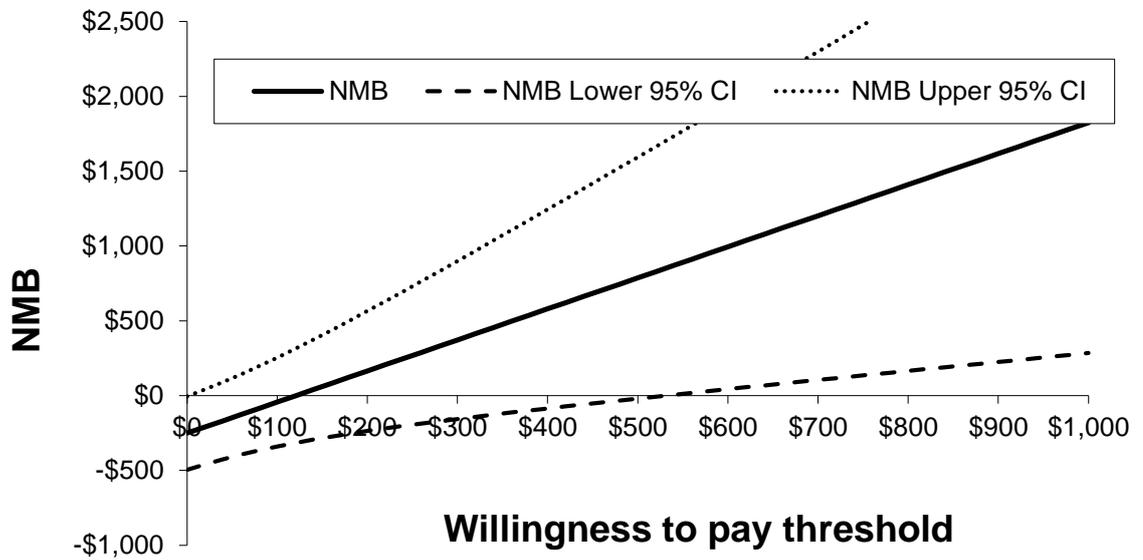
Figure 6.1: Bootstrapped ICER replications for Change in OHIP severity



**Net monetary benefit (NMB)**

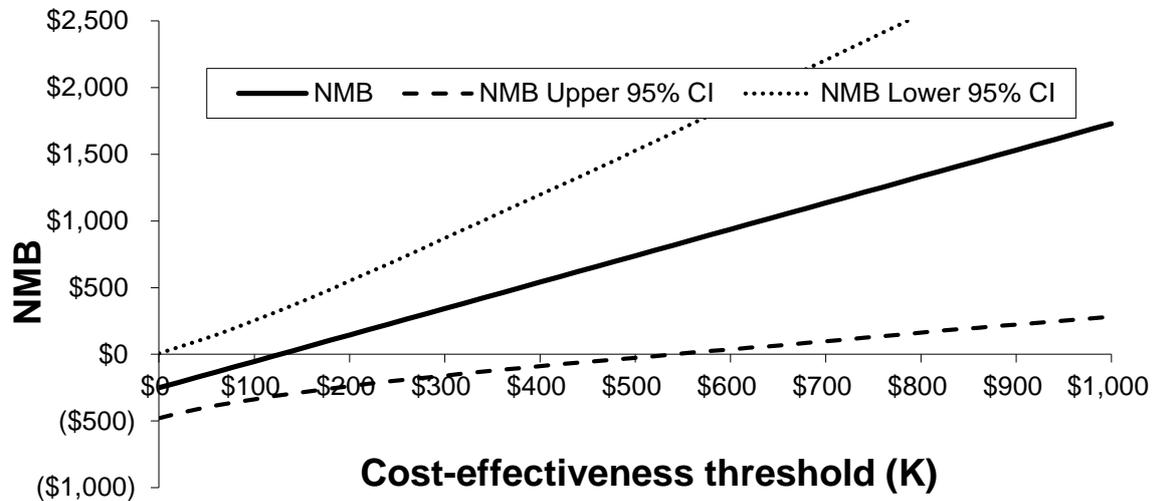
Figure 6.2 plots the Net Monetary Benefit (NMB) of change in OHIP severity at varying levels of willingness to pay. Willingness to pay thresholds was varied from \$0 to \$1000 based on the distribution of the ICER. The thick black line represents the mean NMB while the dotted and dashed lines represent the upper and lower limits of the 95% confidence intervals (CIs) of the NMB, respectively. The NMB is zero at \$121 which is the ICER. The upper and lower CIs of the NMB become positive at about \$3 and \$530, respectively, indicating that the we can be 95% sure that the net monetary benefit from being insured can be achieved from as low as \$3 but more certainly from \$530.

**Figure 6.2: Net Monetary Benefit for insured vs uninsured: change in OHIP severity**



Figures 6.3 present the net monetary benefit calculated using the bootstrapped sample. The bootstrapped sample provides a similar set of estimates to the original sample.

**Figure 6.3: Net Monetary Benefit for insured vs uninsured (Using Bootstrap): change in OHIP severity**



**Cost Effectiveness Acceptability Curve (CEAC)**

The Cost Effectiveness Acceptability Curve (CEAC) was plotted using the original data and also with bootstrapped data. Figure 6.4 shows the CEAC for the original data. The CEAC shows the probability of dental insurance being effective for each value of willingness to pay. The willingness to pay per unit of OHIP severity change is plotted on the horizontal axis and the probability of dental insurance being cost effective is plotted on the vertical axis (y-axis). As the willingness to pay threshold increases, the probability of dental insurance being cost effective (y axis) also increases. From the Figure we can deduce that the probability of the dental insurance being cost effective rises sharply for lower cost and slows down to negligible increase in the probability of being cost-effective at about \$500. Dental insurance becomes more probable (probability >50%) of being cost-effective at the value of \$121.

**Figure 6.4: CEAC for Insured vs uninsured (original sample): change in OHIP severity**

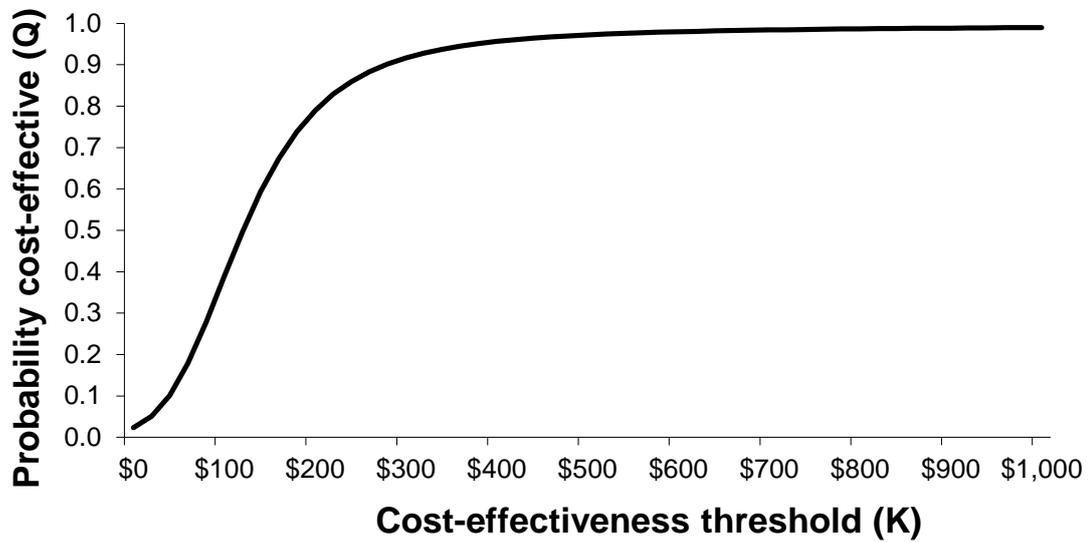
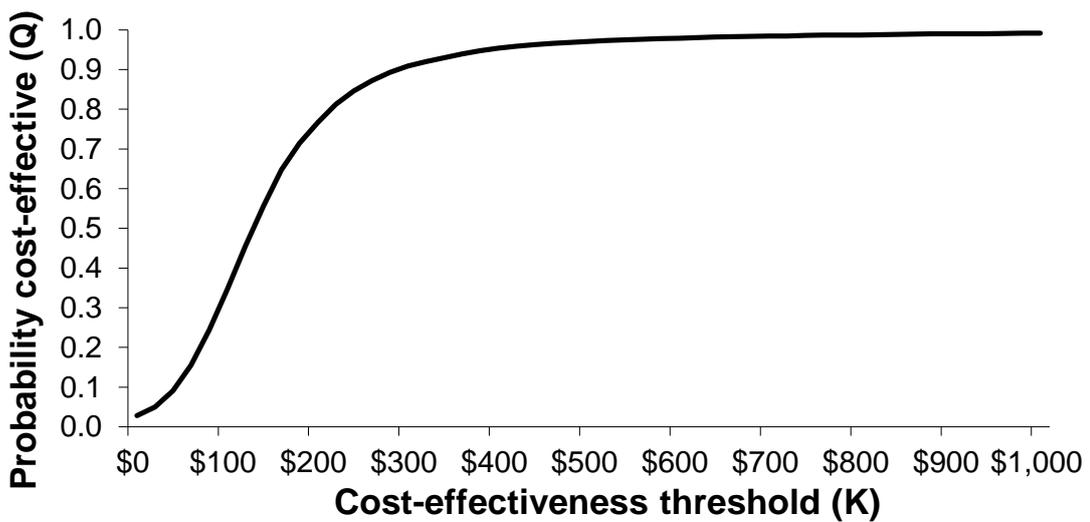


Figure 6.5 shows the CEACs produced from the bootstrapped sample. The increase in probability of being cost-effective becomes negligible at about \$250 for the bootstrapped CEAC

**Figure 6.5: CEAC for Insured vs Uninsured (bootstrapped sample): change in OHIP severity**



## Cost Effectiveness Analysis – Negative change in SROH

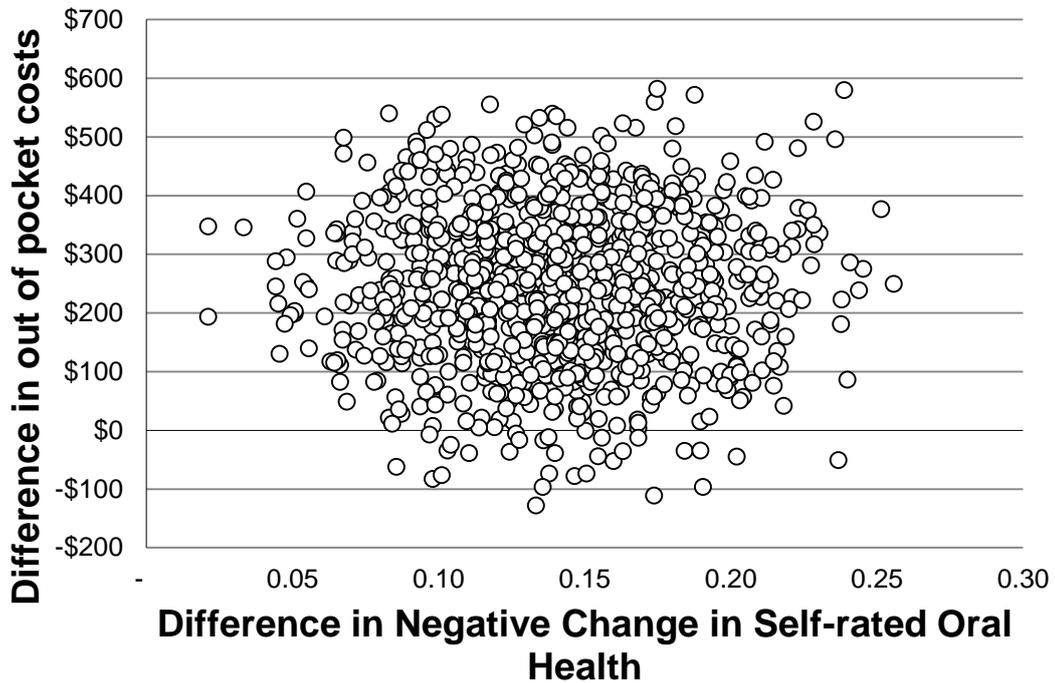
Table 6.8 presents the estimates for the costs and negative change in Self-Rated Oral Health (SROH) for the two groups insured and uninsured, and the differences in costs and negative change in SROH and the corresponding ICER. The Confidence limits of the differences in costs and negative change in SROH and the ICER is also presented. The costs for the insured and uninsured are \$879 and \$628 respectively and the difference in costs between the two groups is \$250. As described in the methods Chapter (2) negative change in SROH is a binary variable and the means reported are of the proportion of adults who had a negative change in SROH. Ten percent of the insured has negative change in SROH while almost a quarter of the uninsured has negative change in SROH with a difference of 14% and an ICER of \$1745. Confidence intervals were generated from a bootstrapped sample. As with OHIP severity change the perspective of interest is the individual consumer. Hence, the ICER is not readily interpretable from an individual consumer perspective and hence it is necessary to use the other measures to present the cost-effectiveness analysis as presented and discussed below.

**Table 6.8: Incremental Cost Effectiveness Ratio (ICER) – Negative Change in SROH**

Outcomes	Cost (\$)		Outcome		Difference		ICER (CI)
	Insured	Uninsured	Insured	Uninsured	Cost (CI)	Outcome (CI)	
Negative Change in Self Rated Oral Health	878.72	628.31	0.10	0.24	\$250.42 (\$4- \$497)	0.14 (0.06- 0.23)	\$1744.66 (-\$76 - \$5199)

The replicated ICERs from the bootstrapped sample are presented in Figure 6.6. This Figure essentially represents the north-east quadrant of a cost-effectiveness plane where both the costs and the effects of the intervention are higher compared to the existing or no intervention (in this case being uninsured). The replicated plots in the Figure show that the difference in effects are all positive for being insured while majority of the replicated plots for the differences in out of pocket costs are >\$0. This indicates that being dentally insured is both more expensive than being uninsured and also more effective when examining negative change self-rated oral health as the outcome.

**Figure 6.6: Bootstrapped ICER replications for Negative Change in Self-Rated Oral Health**



**Net monetary benefit (NMB)**

Figure 6.7 presents the NMB of being insured against varying levels of willingness to pay based on the original sample. Here the willingness to pay thresholds has been varied from \$0 to \$10,000 based on the ICER of \$2062. The NMB is \$0 at the ICER. The lower and higher 95% confidence lines intersect the x axis at about \$25 and \$5,250 indicating that we can be 95% sure that the benefit of SROH remaining the same or improving can be achieved from as low as \$25 but almost certainly at \$5,250 over a two-year period.

**Figure 6.7: Net Monetary Benefit for insured vs uninsured (original data): Negative Change in SROH**

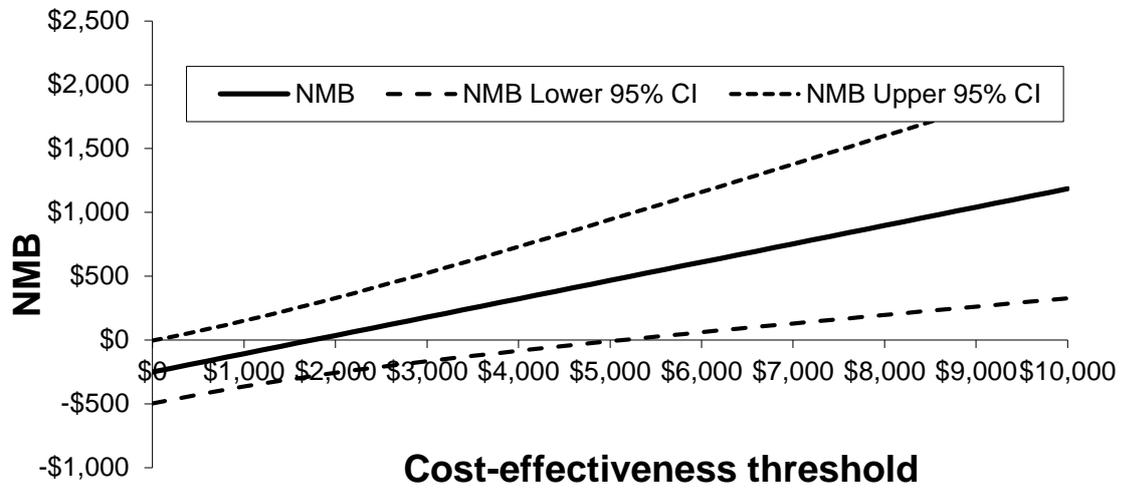
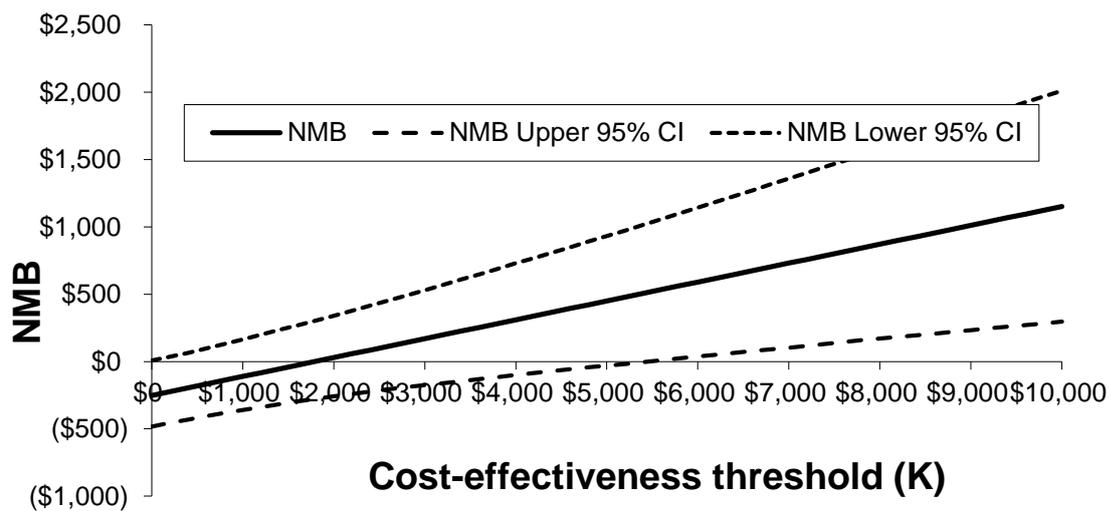


Figure 6.8 present the net monetary benefit and their respective 95% confidence limit lines that were generated using the bootstrapped sample. The NMB slope and its 95% confidence slopes generated from the bootstrapped sample are very similar to the one generated from the original ranging from about \$8 to \$5450.

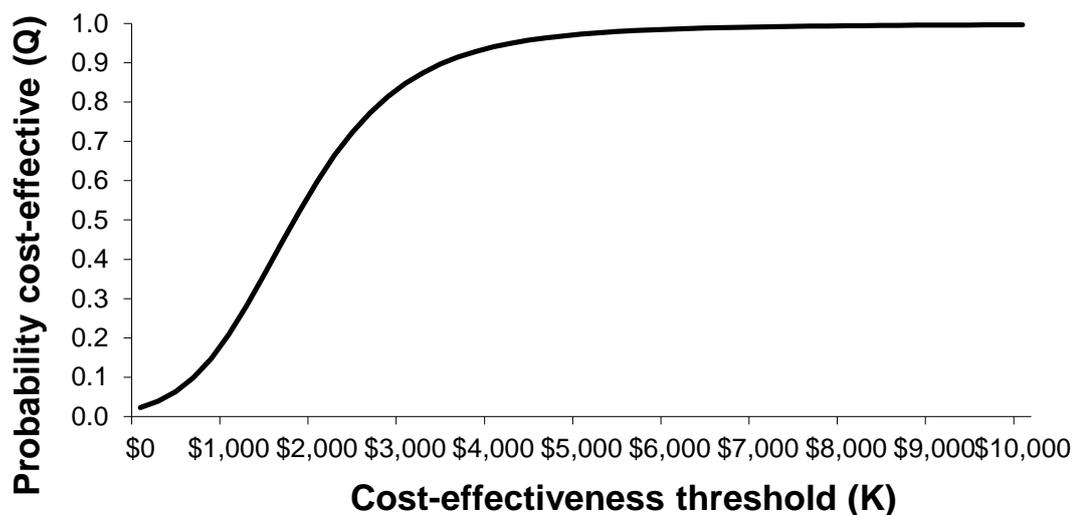
**Figure 6.8: Incremental Net Benefit for insured vs uninsured (Using Bootstrap): Negative change in SROH**



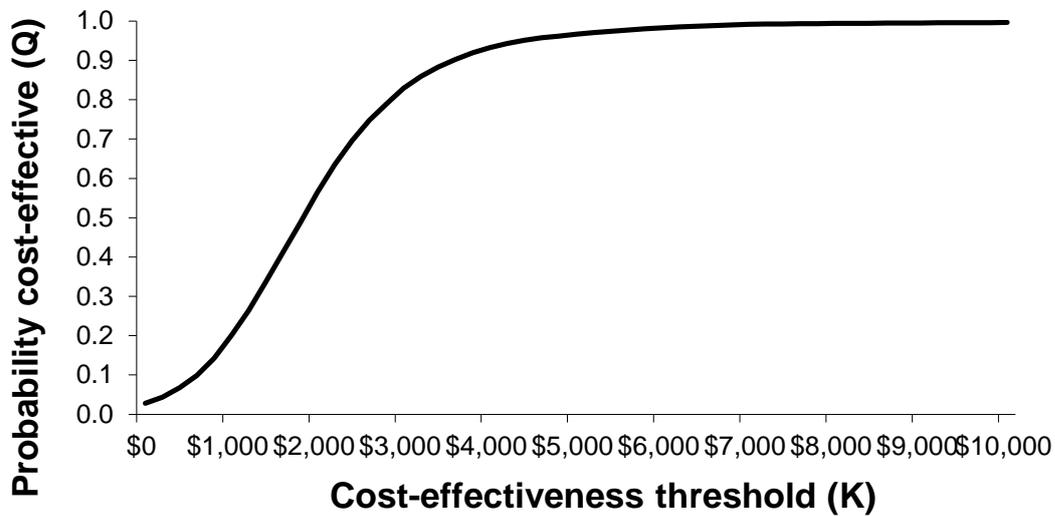
### Cost Effectiveness Acceptability Curve (CEAC)

The CEAC is the probability that the NMB is greater than zero for varying cost effectiveness or willingness to pay thresholds. Figures 6.9 and 6.10 plot the CEACs for negative change in self rated oral health (SROH) using each of the original sample and the bootstrapped sample. Both curves flatten out as the probability increases. The CEAC for the original sample shows that dental insurance being cost effective becomes more probable (> 50% probability) at the ICER. The increase in probability (95%) of being cost effective becomes negligible at about \$4200. The CEAC for the bootstrapped sample does so at a threshold value of about \$4300. This indicates that on average, cost effectiveness of being insured in relation to SROH improving or remaining the same can be achieved at a willingness to pay of \$4300 over a two-year period.

**Figure 6.9: CEAC for Insured vs Uninsured: Negative change in SROH**



**Figure 6.10: CEAC for Insured vs Uninsured (bootstrapped sample): Negative change in SROH**



## Summary

### Cost analysis

Total out of pocket expenditure was just under \$800 for the two-year period, and this was marginally higher (\$879) among the insured with about 41% of this being insurance premium expenditure. Though, mean net expenditure was higher among the dentally insured participants, it was not statistically significant when all other significant factors were held constant.

### Cost effectiveness analysis

Dental insurance is cost effective with 95% certainty if an individual consumer is willing to pay \$4300 over two years to maintain or improve their self-reported oral health.

The next and final chapter of this thesis discusses the results that were presented in this and the preceding three chapters (Chapters 3-6) in light of the literature summarised in Chapter 1 and additional relevant literature.

# **Chapter 7**

## **Discussion and Conclusion**

This thesis comprehensively examines the relationship between dental insurance status and dental service use and oral health outcomes through a systematic literature review and a prospective cohort study of Australian adults. An examination of the expenditure involved in dental service use among working age adults and a cost-effectiveness analysis of dental insurance was also conducted. The driving force behind such an examination is the assessment of the role of dental insurance in improving oral health and reducing the financial burden of oral disease and associated health care costs. This chapter discusses the findings of each of the four objectives of the study in light of the reviewed literature in Australia and other global research, lists the limitations and strengths, discusses some implications and finally provides a summary of conclusions that can be drawn from this study. Some aspects of the study are discussed in more than one section of this chapter as they are critical findings but their implications need to be assessed in light of the study limitations.

## **Findings from the study**

### **Dental service use**

The systematic literature review as summarised in Chapter one showed that a consistent significant association between dental insurance and dental visiting was observed in Australian research. Dental visiting provides a simple indication of current access to dental care, but more critically, routine visiting has been suggested as improving oral health (Crocombe et al., 2012b, Thomson et al., 2010) especially in the long term. In the seminal RAND health insurance experiment that examined the effectiveness of dental insurance on dental service use in an RCT (Manning et al., 1985), dental visiting was found to increase with the level of co-payments; the lower the co-payment, the higher the dental visiting. In other studies in the US, it has been consistently reported that dental insurance was associated with an increased probability of dental visiting (Mueller and Monheit, 1988, Manski et al., 2002). Even having general health insurance coverage is shown to have a positive influence on the probability of having a dental visit during the year (Manski and Cooper, 2007).

In this thesis, visiting a dental professional by working age adults, during the two-year study period was examined and having dental insurance was found to be positively associated with dental visiting. Over a two-year period being insured significantly increased the prevalence of dental visiting by 24%.

However, other research has shown a distinction between routine dental visiting and problem visiting and its relationship with oral health (Thomson et al., 2000). While dental visiting in this study was not categorised by reason for visiting, the mean number of visits among those who visited did not vary by insurance status. Similarly, there were no significant differences by insurance status for both the mean number of total services and the total services per visit. This points toward a positive effect of

dental insurance in promoting access to dental care but once accessed, dental insurance does not appear to affect quantity of visits or services.

In examining the relationship between dental insurance and dental visiting an area of concern is the effect of selection bias. Selection bias is the bias associated with self-selection into insurance, which may result in disproportionate uptake of insurance as summarised from the literature review in Chapter 1. In Australia, Srivastava and colleagues (2014) in a non-peer reviewed working paper controlled for selection bias and found that selection bias existed but the effect of dental insurance remained. Overseas, Cooper et al (2012) used three different analytical approaches on the Medical Expenditure Panel Survey (MEPS) data to control for selection bias and concluded that it was not of concern as it did not alter the effect of dental insurance. Two other analyses (Meyerhoefer et al., 2014, Munkin M, 2008) that controlled for selection bias concluded that dental insurance coverage increases dental service use. Because selection bias has not appeared to affect the effect of dental insurance in these studies, selection bias per se was not assessed in this study. However, the effect of dental insurance on dental visiting was examined in models adjusting for other variables that are likely confounders in the relationship. In this study, a fairly large adjusted effect size of 24% higher prevalence of dental visiting among the dentally insured was detected

The examination of the different types of services by dental insurance status provides a perspective on the kind of visiting among the study participants. Relationships between dental insurance status and the rate of receiving diagnostic, preventive, restorative, oral surgery and prosthodontic services and services per visit were examined. Only the rate of receiving diagnostic and preventive services per visit were significantly associated with dental insurance status after adjusting for age, sex and other significant factors; the insured received higher rates of these two types of services per visit.

Diagnostic services primarily consist of examinations, radiographs, laboratory tests, biopsies, and initial consultations with a general dentist. Preventive services as the name suggests consists of scale and cleans, fluoride treatments, oral hygiene instruction and health promotion, plaque removal, fissure sealants and other such services that support maintenance of oral health and prevention of disease.

In this study diagnostic and preventive services together accounted for about 60% of all services received by working age adults. In a study in the US, using the Medical Expenditure Panel Survey (MEPS) among a similarly aged group as this study (21-64 years) of working adults, diagnostic and preventive services accounted for 75% of all services (Manski et al., 2014). It was found that the privately insured adults were more likely to receive diagnostic and preventive services at any given dental visit. In the RAND RCT (Manning et al., 1985), diagnostic and preventive, restorative,

prosthodontic, endodontic and periodontic services were significantly higher among those on the insurance plan with no co-payments compared with those on a plan with 95% co-payments. The preventive and diagnostic services were three times higher among the group with zero co-payments compared with the group with 95% co-payments.

Preventive dental visits have been shown to predict lower non-preventive (restorative, endodontic, periodontic and other non-preventive service types) dental visits and lower non-preventive dental expenditure in a population of children in the US (Sen et al., 2013). In an adult population using a more liberal definition (any visit that included a scale and clean service) of preventive visits Moeller et al (2010) found that participants with preventive dental visits had more overall visits but were less likely to have visits for expensive non-preventive dental services and lower expenses than those participants who visited a dental professional only for problems. If being insured increases the rate of receiving preventive services then its impact on dental visiting in the future is likely to be cost saving. The association between preventive visiting and being insured also has implications for equity in access to service with those with lower socio-economic status, more likely to be dentally uninsured (Brennan et al., 1997).

Additionally, in this study only diagnostic and preventive services per visit were associated with dental insurance status. This may suggest that dental insurance does not drive intervention based service use and aids a reduction in over provision of restorative treatment. If dental insurance does play this function, the role of insurance in dentistry becomes wider than just financing of dental care. From a workforce perspective, some of the diagnostic and preventive services associated with dental insurance could be provided by oral health professionals other than dentists.

The reviewed literature showed associations between insurance status and oral surgery services with the insured receiving lesser extraction services based on three cross-sectional analyses (Brennan and Spencer, 2002, Brennan et al., 1997, Brennan et al., 2000). However, in a more recent cross-sectional analysis (Brennan and Spencer, 2007) did not find any significant association in adjusted analysis. All these studies were based on a patient sample while in a population sample in this thesis, the association between insurance status and receiving extraction services was not statistically significant, though on average the insured received a lower number of extraction services. While both the previous studies and the current study adjusted for demographic and oral health variables there were differences in some factors that were adjusted for.

Access to dental care as opposed to dental service use provides a different perspective on health care utilisation. Spencer (2004) lists a set of variables that provide an indication of access to dental care which include dental visiting, visiting for a problem

and receiving extractions and, or fillings in the last 12 months. Another publication (Roberts-Thomson and Stewart, 2003) uses time since last visit and reason for visit as indicators of access to dental care. In this study, dental visiting has been shown to be higher among the insured, but other indicators were not examined individually. Hence it is not possible to comment on the effectiveness of dental insurance to improve access to dental care but certainly dental insurance appears to increase prevalence of dental visiting.

### **Health outcomes**

Health outcomes examined in this thesis included both oral and general health outcomes and also global measures and disease specific and generic Health Related Quality of Life (HRQoL) measures. All outcomes examined were self-reported outcomes. The disease specific outcomes that were significantly associated with dental insurance status were, change in OHIP severity and negative change in self-rated oral health.

The Oral Health Impact Profile (OHIP -14), a 14-item instrument used in this study is a derivative of the OHIP – 49 and has good reliability, validity and precision (Slade, 1997). It provides a measure of the functional, physical and social functioning impact of oral ill-health on individuals. In this study the two-year change in OHIP severity was significantly associated with dental insurance status. The insured worsened at a lower rate compared to the uninsured.

The RAND health insurance experiment collected data in the late 70's and early 80's of the 20<sup>th</sup> century and the outcome measures were DMFT and periodontal index. The study found that lower or no co-payments for services resulted in better oral health outcomes in regards to decayed and filled teeth and periodontal disease (Bailit et al., 1985). However this effect was most pronounced for those under 35 years of age and especially those with the poorest health in the age group. However, this study did not report on self-reported measures that are more commonly used in the recent years.

In the review of Australian research (Appendix 1) two publications (Brennan and Spencer, 2005a, Sanders et al., 2009) reported OHIP in relation to dental insurance status. No adjustments were made for other factors in one paper (Sanders et al., 2009). The uninsured had a significantly higher mean severity score compared to the insured. The same publication reported on data from the US adult population where the effects were significant. These examinations were of cross sectional data. The other publication that also analysed cross-sectional data of a patient based sample reported significant positive associations (insured had lower (better) OHIP scores) in unadjusted analysis and significant positive associations for two of three OHIP measures in adjusted analysis. In this study for the first time this relationship has been demonstrated in a prospective population cohort sample of adults.

Tsakos et al (2012) have pointed out that mean change scores do not take into consideration which aspects of impact has changed and to what extent. Significant differences in mean scores do not provide an answer to the question on the meaningfulness or significance from an individual perspective. The use of a minimal important difference (MID) hence is needed in interpreting meaningfulness of the observed change of OHIP severity scores. MIDs ranging from 5 to 10 scale points have been reported in the literature for different populations and oral health conditions employing different versions of the OHIP instrument (Brennan, 2013, Tsakos et al., 2012). However, detecting a MID of 5 requires large sample sizes (Locker et al., 2004). The change in OHIP in this study is about 1.6 severity points in the two-year period ranging from one for the insured to almost three for the uninsured. This is less than a minimal important difference reported in the published literature and could be evidence of the ineffectiveness of dental insurance. Another plausible explanation maybe that this difference between the insured and uninsured will widen over a longer duration of time than that observed over the two-year period and the effect estimates may have been more precise with a larger sample size. Additionally, minor interventions such as a single extraction across a two-year period is unlikely to result in a noticeable change in OHIP or other QoL outcomes.

An alternative measure of OHIP that was used in this study was a binary measure of OHIP change; OHIP negative change. This variable differentiated the participants who had some level of negative change in their OHIP severity scores from those that did not have any change or whose change was positive. Though dental insurance status was significantly associated with negative change at a bivariate level it was not statistically associated with dental insurance status after adjusting for health and demographic factors. The prevalence of negative change was 22% higher for the uninsured but was not statistically significant. This varying unadjusted and adjusted relationship of negative change in OHIP severity with dental insurance status adds to the plausible conclusion that the two-year duration for change in OHIP severity may not have been sufficient to detect significant adjusted differences between the insured and uninsured, if any, even though the study retrospectively collected information on period of having dental insurance before the start of the study. It was not possible however to ascertain the OHIP severity ratings previous to the start of the study. Conversely measurement of change in outcomes over a long duration may be susceptible to a response shift phenomenon which could lead to no change in outcome.

As mentioned earlier, OHIP measures in relation to dental insurance status have been previously reported only in cross-sectional analysis. In Canada, Locker et al (2011) reported a significant association between dental insurance status and OHIP-prevalence scores among adults. Another report (Johansson et al., 2010) comparing OHIP severity between adults with public dental insurance and fees for service care in

Sweden found those opting for fees for service care had significantly higher OHIP severity scores. With no previous literature examining OHIP severity in relation to dental insurance status in longitudinal data it is not possible to comment on the potential duration by which a significant difference (if any) that is relevant can be observed.

Global transition judgements have been used to capture changes in subjective health to ameliorate the above identified issues with change scores from multi-item quality of life scales (Allen, 2003). Global transition judgements capture the overall judgment of an individual's change in the specific area of health over a defined reference period (Locker, 1998). The other advantage of using transition judgments is that it removes the influence of the baseline score since, theoretically, a study participant is probably using the baseline status as a reference point for their judgement. In this study the global transition judgement statement with a reference period of two years was used to capture self-reported change in health. The prevalence of negative change in self-rated oral health over the two-year study period was significantly associated with dental insurance status in adjusted analysis. The uninsured adults had a 14% higher prevalence of worsening of oral health compared to the insured.

Global transition judgements have been shown to be consistent with other self-reported oral health symptoms and experiences and clinically measured tooth loss (Locker, 1997). Hence the 14% difference by dental insurance status observed in this study is both meaningful and relevant. This is a critical finding of this study.

The general health outcomes that were examined in this study were health state utility values derived from EuroQoL (negative and mean change) and the global transition judgement statement of self-rated general health (SRGH)(similar to the oral health specific transition judgement statement). Negative change in health utility values and the SRGH, i.e., proportion of participants with any negative change in the two variables from baseline to end of the two-year study period were significantly associated with dental insurance in bivariate analysis; the insured had significantly lesser negative change, but this was not significantly associated after adjusting for other factors.

The primary goal of assessing the effectiveness of oral health in relation to dental insurance is to be able to extend the assessment to an economic analysis which then can be used for comparing dental insurance as an intervention with other competing health interventions and technologies. This extension was not possible as effectiveness was not established among adults during a two-year period. Because of the way the private insurance system functions in Australia it is certain that adults who have dental insurance also have private health insurance. However, the mechanism by which private health insurance is expected to influence general health is quite different to the effect dental insurance will have on oral health because of the structure of the two

healthcare delivery systems. General healthcare is provided mainly through the government funded public health care system while more than 90% of dental health care is provided privately and funded directly or indirectly by the patients. Hence, it was not appropriate to compare the effect of dental insurance on general health with the effect of private health insurance on general health.

To the best knowledge of the author, there is only one reported study (Brennan and Spencer, 2005a) that examined the relationship between dental insurance status and general health outcomes. In a cross-sectional analysis of patient data, three measures of the EuroQoL were positively associated with being insured in unadjusted analysis and the significant relationship remained for two measures in adjusted analysis. In this thesis there were significant bivariate associations between dental insurance status and negative change in health utility, but not after adjusting for other factors in multiple variable analyses.

### **Cost**

For the first time, this thesis has sought to estimate the cost (out of pocket expenditure) of dental service use from a consumer perspective in Australia. The estimates were a sum of dental insurance premium costs and the dental service use out of pocket costs. Participants who did not have dental insurance did not incur any insurance premium costs. Similarly, participants who did not visit a dental professional did not incur any service use costs. This estimation is critical in light of total dental expenditure in Australia being \$8.7 billion in 2011-12 of which 57% was estimated to be out of pocket expenditure by individuals (Australian Institute of Health and Welfare, 2014d).

Previously only one study has estimated household dental premium costs and a few studies have estimated individual, per capita or household out of pocket dental service-use costs in Australia. Spencer (2001) estimated dental insurance premiums and a dental health component of private health insurance rebate in 2000 using a similar approach to this study. Dental insurance premium in 2000 for a family living in the Australian state of New South Wales (NSW) was estimated to be \$322.58. This was based on the standard premium for a family based in NSW subscribing to a standard policy of one specific insurance fund. The estimates in this thesis are for a single adult based in NSW or the Australian Capital Territory (ACT) but are more thorough given that it is based on a range of varying insurance funds, policies and plans of the participants. However the estimate of mean dental insurance premium of about \$180 per adult per year for 2009-10 is similar to the estimate by Spencer in 2001 when taking into consideration the ten year time difference and the differences in insurance premium costs for a family (as in Spencer (2001)) compared to a single adult.

On the other hand dental service use cost estimates were previously reported in a few publications (Table 7.1). The Australian Bureau of Statistics (ABS) (2011a) collected

expenditure information using a two-week recall period from the household expenditure survey. A weekly mean household expenditure of \$7.23 (ranging from \$5.23 to \$9.86 for working age adults) on dental fees was reported for 2009-10. This is about 38% of all dental practitioner fees and 11% of all weekly household medical care and health expenses. Annually this equates to a household expenditure of about \$376 for dental fees. Average dental visiting is about 1-2 visits per year; hence a two-week recall period is likely to under report visiting and consequently expenditure.

A conference abstract (Barnard, 2007) on trends in costs of dentistry reported \$340 per patient per year for dental service use in 2004. This was estimated from a survey of registered dental practitioners but detailed information on the study was not available. Sivaneswaran and colleagues (2000) examined dental insurance claims data for adults 18 years and over from one insurance fund in NSW, Australia from 1991-95 to estimate cost of dental services. The mean cost per patient year was \$385 in 1995 dollars ranging from \$336 for the 25-34 year olds and increasing to \$450 among the 55-64 year olds.

Another publication (Teusner et al., 2013a) reporting on dental service use expenditure from the first year follow up of this thesis reported a mean out of pocket expenditure of \$489 for one year. However that estimate was based on only those participants who incurred at least a dollar of service-use expenditure. Per capita expenditure of \$288 per adults per year was also reported. The AIHW in its health expenditure publication also reports individual out-of-pocket dental expenditures, and in 2009-10 (Australian Institute of Health and Welfare, 2011) this was estimated at \$212 for dental services for all age groups equating to about 22% of all out of pocket recurrent health expenditure. Table 7.1 provides a comparison of all these different estimates of individual dental service expenditure along with the estimates from this study.

**Table 7.1: Estimates of Individual dental service expenditure by sources**

Publication	Data source	Population	Year	Estimate/ year
Australian Bureau of Statistics (2011a)	Health Expenditure survey based on two week recall	All adults (18+)	2009-10	\$376 (7.23/week)
Barnard (2007)	Dental practitioner survey	All	2004	\$340
Sivaneswaran et al. (2000)	5 year Insurance claims data from a single insurance fund	NSW insured adults (18+)	1995	\$385
Teusner et al. (2013a)	One-year data from Australian electoral roll sample	Adults 31-61 years	2009-10	\$489 (\$288 per capita)
Australian Institute of Health and Welfare (2011)	Projected from private health insurance data provided from PHIAC	All	2009-10	\$212
Current study	Two-year data from Australian electoral roll sample	Adults 31-61 years	2009-10	\$380

The service-use expenditure estimates in this study are likely to be more reliable than the estimates so far reported in the literature. In this study, dental service use expenditure was estimated from a national sample of adults consisting of a mix of insured and uninsured participants. The data were from service use log books, questionnaires and or receipts and provide a holistic perspective of dental service use. Additionally participants who did not visit a dentist were included in the estimate calculations to account for nil service expenditures in the final estimates. The mean dental service use expenditure for the two years was estimated to be \$759 and the median was \$348 per adult. This equated to a mean expenditure of just under \$400 per year.

As for total out of pocket (net) dental expenditure from a consumer perspective, no previous estimate has been reported in Australia. There have been a few estimates reported overseas. In 1998, data from the survey of household spending in Canada (Chaplin and Earl, 2000) estimated household per capita expenditure on dental care at CAN\$231 (19% of total average household health expenditure) and the average household expenditure among those who incurred any expense was CAN\$476 (48.5% of total). The Medical Expenditure Panel Survey (MEPS) of 1996 and 2006 estimated mean out of pocket expenditure in the USA at US\$254 and US\$299 respectively (Christian and Chattopadhyay, 2014). Examining data from the 2006 health and retirement study in the US (Manski et al., 2010) out of pocket expenditure among adults 51 years and over was \$951 during a 2 year period.

These estimates cannot be directly compared to the Australian estimates reported from the analysis in this study because of the differences in mechanisms that control

and regulate dental health services and private health insurance in the different countries. However they provide an indication of the level of out of pocket financial burden of Australian adults in comparison to Canada and the USA. However, as detailed in the introduction (Chapter 1) out of pocket expenditure is a significant proportion (58%) of total expenditure on dental health in Australia (Australian Institute of Health and Welfare, 2014d).

Dental insurance status and its association with out of pocket (net) expenditure from a consumer perspective was also examined in this study. There are a few studies that have examined this association and were mainly conducted in the US. Data from 1990 among older adults (Kington et al., 1995), showed that having a separate dental insurance policy was not associated with dental expenditures among those who used dental services. Analysing data from the 1996 MEPS, Manski et al (2002) found a significant association between having dental insurance and dental expenditure. However this was total expenditure and not only out of pocket expenditure.

This study shows that the insured incur more out of pocket spending, than the uninsured but no association was found between dental insurance status and out of pocket consumer expenditure in adjusted analysis. Dental visiting and toothache experience though were significantly associated with expenditure. As expected those visiting more often and those with more frequent toothache experience reported higher expenditure. This points to a confounding influence that dental visiting and/or oral ill health has on the relationship between dental insurance status and out of pocket expenditure. As reported earlier there is a significant relationship between dental insurance status and visiting, with the insured visiting more often which is expected to automatically translate to more spending. An additional explanation for this result could be that the higher out of pocket expenditure resulting from insurance premium costs to the insured may be offset by the higher service use costs to the uninsured because of the more expensive and elaborate curative services received.

### **Cost Effectiveness**

Literature on health economics in dental research is quite sparse with a few studies examining effectiveness of periodontal programmes, fluoridation programmes and health education programmes (Sintonen and Linnosmaa, 2000). To the best knowledge of the author there is no report on the cost-effectiveness of dental insurance globally and this is reflective of the underlying question of the effectiveness of dental insurance. Firstly, as discussed in the preceding pages most of the studies examining the effectiveness of dental insurance have been cross-sectional in nature which cannot take into consideration temporality and hence expenditure over time. Secondly, there is mixed evidence on the relationship between dental insurance and health outcomes and even in this study the interpretability and meaningfulness of one of the two effective outcomes (OHIP severity change) is potentially limited by the 2 year duration

and relatively small sample as discussed earlier. Hence, the cost-effectiveness results here have to be discussed in view of these issues. The estimation of dental insurance premiums and computation of total out of pocket expenditure for dental service use including premiums expenditure has also not been reported before.

Cost-effectiveness of two oral health outcomes were assessed in this thesis work; OHIP severity change and negative change in Self-Rated Oral Health (SROH). For both of these outcomes the insured had higher out of pocket expenditure and while change in both the outcomes was negative, i.e., health worsened for all participants, the change was lower for the insured compared to the uninsured. This means that the Incremental Cost Effectiveness Ratio (ICER) sits on the north east quadrant of a cost effectiveness plane. However, the ICER is not the appropriate measure for the consumer perspective that has been adopted in this study because it is a population measure, which is not interpretable for an individual consumer. An ICER which is applicable to a population is not applicable to every individual in the population at the same level. Similarly, a unit change in outcome is unlikely to cost the same for every unit change even for the same individual. Hence the net monetary benefit is more meaningful and relevant to discuss.

Dental insurance was found to provide a net monetary benefit from as low as \$3 and up to \$530 for OHIP severity change as the outcome and from as low as \$25 and up to \$5250 for no negative change in SROH. A simple conclusion of this analysis, from a consumer perspective is that being dentally insured is more effective but also more costly. The average cost to remain the same or improve in oral health is higher than \$2000 over a two-year period.

### **Limitations and strengths of the study**

There were a few limitations to the main data set used in this study. The response rates were quite low (36% to begin with) and even lower for the follow ups. This is lower than normal for mail and telephone surveys (Dillman, 1978) but appears to be the part of a declining trend in response rates to mail surveys in the recent years (Aday and Cornelius, 2011). The lower response rates is not unusual (Aday and Cornelius, 2011) given the population (working adults) and the duration of the study combined with the requirement to maintain log book with service use records for two years. However there was sufficient sample for the analysis in this study. Hence a comparison of respondents with non-respondents and populations estimates was critical in observing any response bias.

The study participants differed from the non-respondents in sex, age and insurance status. More females, more of the older age groups and more insured persons participated in the full study. When compared with population estimates as well, the major differences were in sex, age and dental insurance status. The focus of the study

being on dental insurance could explain some of these differences; the uninsured may not have seen value in participating in a study on insurance and the younger age groups are less likely to be insured. Additionally the uninsured, the younger age group and those with lower educations have been identified as groups that respond to questionnaire surveys at lower levels compared to their counterparts (Aday and Cornelius, 2011). Hence the generalisability of this study is limited to this extent.

Dental service-use costs in this study was collected through dental service use log books and receipts and were supplemented by aggregate service use and cost information collected through the questionnaires. However, there were no significant differences in expenditure and visit information by the source of data collection (Teusner et al., 2013a). The different options of data collection may have improved the response rate. The dental insurance premiums data were based on an adult in a single jurisdiction in Australia. The variations in insurance premium rates, especially among funds that operate only in specific states, may not be adequately captured, although insurance funds are not permitted to vary premiums by regional locations.

The reporting of dental insurance status can be subject to misreporting by some respondents (Kreider et al., 2015). It is critical to this study that such error is minimised because misclassification of dental insurance can affect the reliability of the findings of the study. Dental insurance status was collected at baseline, and at both follow ups. This was also collected at the time of each visit and was verified through report of rebates and receipts where available. Additionally, information collected on the insurance fund and policy enabled the detection of misclassification of general health insurance as dental insurance. Multiple reporting and verification through other proxy variables in the data minimised the measurement error as regards dental insurance status.

The cost-effectiveness analysis and interpretation does not take into consideration the costs or cost saving to a consumer before the period of study and also the costs or costs saving in the future. Similarly the potential worsening or improvement of oral health was not considered. Additionally, the opportunity cost of seeking dental treatment, especially curative treatment that requires long rehabilitation or reduced productivity has not been considered in the costing of dental service use. The service use and dental insurance premium costs also had the potential to be under reported and hence the estimates maybe conservative.

Apart from the limitations on generalisability due to the data characteristics, the interpretation of the findings of this study for other populations needs to take into consideration the context of the health and insurance systems and associated policies within Australia. The policy issues that need to be taken into consideration include the regulation of the private health industry, the means tested tax incentives and

subsidies, and the age-based incentives for uptake of private health insurance as elaborated in detail in the first chapter of this thesis.

In terms of strengths, there were a few firsts in this study. This is the first study that comprehensively examined the effects of dental insurance, robustly estimates cost of dental insurance premiums and dental service use together, and examines the cost-effectiveness of dental insurance. Potential recall bias was minimised through the detailed capture of service use information and costs at the time of visiting. Other strengths have been discussed in specific, across different chapters of this thesis.

## **Implications of the study**

### **Health and policy implications**

The literature review (Appendix 1) identified limited research examining the effect of dental insurance status on oral health outcomes as a gap in the current literature. Specifically, only one cross sectional analysis of the baseline data of this study found an association with global Self-Rated Oral Health (SROH). This prospective cohort analysis confirmed the association of dental insurance status with prevalence of negative change (any deterioration) in self-rated oral health. The critical implication here is that being dentally insured has the effect of preventing worsening of oral health within a two-year period.

This study examined out of pocket dental expenditure. The 30% insurance rebate provided by the Commonwealth Government to all insured and its effect on dental service use and health outcomes has not been examined. The 30% rebate forms the bulk of Commonwealth Government expenditure on dental services though it is not possible to ascertain clearly what percentage of it is used exclusively for dental services (Harford and Spencer, 2004).

Previously the Commonwealth Dental Health Program (CDHP) focused on those with the highest expected need for dental health care services. However the 30% rebate has shifted the focus of expenditure towards those with moderate or low need who are mostly middle or high-income earners. Hence commonwealth expenditure on dental services seems to benefit the economically and orally healthier at the expense of those who need it the most (Harford and Spencer, 2004). The most recent policy change in this regard has been the means-tested nature of the provision of this rebate that varies based on income and type of household. This policy change was introduced after the conduct of this study. Hence, this study cannot be used to debate the policy around health insurance tax rebates but provides valuable evidence on dental expenditure.

It has been argued, using different data, that cost is a significant barrier for accessing dental services in Australia (Australian Bureau of Statistics, 2011a, Chrisopoulos et al., 2011, Spencer and Harford, 2007a). This study has for the first time quantified the cost involved in accessing dental care among working age adults. Working age adults on average can expect to spend about \$380 per year (2009-10 prices) on dental services.

Average weekly household spend on various expenditure items has been collected and reported by the ABS using the Household Expenditure Survey (Australian Bureau of Statistics, 2011a). Though the estimates are for a household and based on a recall period of two weeks they provide a good benchmark to compare the dental service use expenditure estimated in this study with other household expenditure. A single person household for instance was estimated to spend about \$94 per week for food and non-alcoholic beverages, \$18 for clothing and footwear, \$89 for transport, and \$80 for recreation. The lowest amount spent was for tobacco products (\$8) and the highest was for housing costs (\$153). The dental service-use expenditure per week for an adult estimated in this study was about \$7.30, lower than any single broad goods and service expenditure groups reported by the ABS.

In spite of this comparatively lower cost of dental service use, cost has been reported as a barrier for accessing dental services and a financial burden as reported by survey respondents (Australian Bureau of Statistics, 2011a, Chrisopoulos et al., 2011, Spencer and Harford, 2007a). This could be because of the perception and expectation that dental health services should be provided by the state in some form or the other in a welfare oriented economy such as Australia. Additionally this perception could be relative in comparison to the limited out of pocket general health expenditure. Additionally, the out of pocket contribution to total dental expenditure continues to be high (57%). Hence the financial burden needs to be considered in light of the relative proportion of dental expenditure in the entire health or even wider societal expenditure.

One of the rationales for this study was the suggestion that dental insurance may reduce financial burden of oral disease and ill-health. While it is not possible to comment on the long term plausible effect of dental insurance from this study, it appears that the financial burden of accessing dental services is not alleviated largely because of one's insurance status, during this two-year study period. Most of the insured participants in this study were insured for a long period of time prior to enrolling in this study. More than a third of them were insured for more than 20 years while only 12% were insured for less than 5 years. It appears that previous dental insurance status does not reduce current dental expenditure, contrary to what has been shown in the literature as described earlier in this chapter. This study does not show that dental insurance alleviates dental financial burden, though the sample did

not allow further stratified analysis based on period of dentally insured status. The policy question remains.

### **Implications for future research and analysis**

In today's society and research environment it is almost impossible to answer the question on the effect of dental insurance through a randomised control trial (RCT). Ethical considerations of such a trial coupled with tight funding budgets make such RCTs unlikely. This study has sought to answer it through a short duration cohort study but suffers from lower responses, hence affecting generalisability and application in different populations. However, this study has set in place for the first time in Australia in a prospective analysis the effect of dental insurance on both dental service use and outcomes and expenditure. Expanding this study to other populations, older and younger age groups and replicating it in a larger sample will be necessary to confirm and, or extend the evidence.

One of the avenues for future research that was identified by the review of literature was the need for cohort design studies to examine the relationship between dental insurance and dental service use and outcomes. Though this original study has addressed that research gap, future studies examining this association will have to be of longer duration, ideally embedded in a life course cohort. Certainly a large study with more participants and of longer duration will afford the opportunity to analyse the effect of dental insurance in sub-groups of age, visiting patterns and duration of being insured and examine closely the influence of selection bias over a longer period.

This study has found that dental insurance status has a significant effect (24% higher among the insured) on dental visiting. However future studies have to differentiate between routine visiting and problem visiting by stratifying by reason for visiting and type of services received to ascertain the translational effect of insurance on oral health through visiting.

While there have been studies examining the translation of benefit from routine service use to health outcomes (Crocombe et al., 2012a, Thomson et al., 2010) the specific effect of dental insurance status on the translation of benefit from dental service use to health outcomes has not been and will need to be studied in the future. Ultimately any health intervention whether structural as in the case of insurance or otherwise needs to be effective in terms of the final outcome of better health and quality of life.

Working adults on average can expect to spend just under \$400 per year (2009-10 prices) on dental services. It is significantly higher than the estimate of \$212 per person (2009-10) (Australian Institute of Health and Welfare, 2011) for individual expenditure on dental services by the AIHW from PHIAC data. Even though this estimate is conservative and limited by the data and other issues discussed in the

previous section, it does force a rethink on the use of the estimates from PHIA data to inform decision making and policy. The estimates from this study may not be generalizable but warrants further study in this area to determine the true or closest to true out of pocket or individual expenditure on dental services for all Australians.

The final report of the National Advisory Council on Dental Health (Australian Government, 2012) identified the need for research to quantify the costs of dental ill-health on the government and society. While this research is a step in the process of filling that research gap, by quantifying out of pocket expenditure from a consumer perspective, a wider health provision and societal perspective on quantifying cost of dental disease is needed.

As identified in the review of literature a wide range of dental service use outcomes have been examined in relation to dental insurance but there is paucity of evidence as regards oral health outcomes. This study has addressed that gap but not in the area of clinical outcomes. Although this study does not examine clinical outcomes, self-reported health outcomes provide a measure of the value attached to good health and can also provide a meaningful evaluation of health (Allen, 2003).

While there is the paucity of literature examining relationship between dental insurance and general health outcomes, this study did not find any associations. If dental insurance as a policy or structural intervention needs to be assessed for cost-effectiveness against other competing investments in health, effectiveness as regards general health quality of life measures need to be assessed. Alternatively ineffectiveness needs to be established to eliminate dental insurance as an intervention to improve health. Both of these need to be established in future research.

## **Conclusion**

Dental insurance is effective in increasing dental visiting. It is also effective in improving oral health outcomes but not general health outcomes. Being dentally insured has the effect of preventing worsening of oral health within a two-year period. The differences in oral health outcomes between the dentally insured and uninsured, are both meaningful and relevant. The out of pocket dental expenditure is large but not substantially larger than other common household expenditures. Being dentally insured is more expensive but also provides better maintenance or improvement of oral health among adults. What these results mean for subgroups based on visiting frequency, type of visiting, longer term outcomes and reduction of future expenditure needs to be further examined in larger and longer duration studies.

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# Appendices

## Appendix 1 - Systematic Literature Review

### Introduction

Similar to other OECD and developed countries, Private Health Insurance (PHI) plays a key role in the financing of dental care in the Australian health system (Paris et al., 2010). In 2012-13, PHI contributed \$11.8 billion to the Australian health system, accounting for 8% of total health funding (after accounting for government subsidies). Of this total, 11.8% (\$1.4 billion) was for dental services (Australian Institute of Health and Welfare, 2014c). In Australia, PHI coexists with a tax funded universal coverage health system (Medicare). However this system only provides limited coverage of dental services. Over the last decade there have been several highly targeted Medicare dental schemes (e.g. Teen Dental Plan, Chronic Diseases and Disability Scheme). Currently the funding of dental services by the federal government via Medicare is limited to some in-hospital services and funding of services for eligible school-aged children (<18 years of age, means tested); the range of services is restricted and the amount claimable is capped over a two-year period (Department of Health).

In addition to limited direct commonwealth government funding, the state and territory governments also provide public dental services. During the 1970s and 1980s a universal public child dental service (school dental service (SDS)) which was funded by the Commonwealth government existed. But the Commonwealth's involvement in community dental services (including school dental services) was subsequently withdrawn in 1997, leaving States and Territories to maintain the SDS. Subsequently since the 1990s differences between jurisdictions in terms of organisation and eligibility criteria for the SDS have emerged and the coverage of the SDS has markedly declined (Australian Government, 2012). Adult public dental services also vary across jurisdictions, nearly all jurisdictions have introduced co-payments, eligibility to access services is means tested, (i.e. concession Health Care Card holders) and access is effectively rationed via triaging systems and long waiting lists (Australian Government, 2012). Consequently, public dental service provision has been typically orientated towards emergency care, eligible to few, and accessed by only a small minority of the population (Brennan et al., 2008). The majority of dental services are provided in the private sector employing 80% of all practising dentists (Australian Institute of Health and Welfare, 2014b). More than half of the 8.7 billion spent on dental services (58%) in 2012-13 was funded directly by individuals, and a further 12% funded indirectly by individuals via PHI (Australian Institute of Health and Welfare, 2014c).

The Australian PHI industry is highly regulated and is directly subsidised by government via a means-tested 30% premium tax rebate. Key regulations include community rated premiums, control on premium increases and limits on the types of

services that can be insured. Community rated premiums support non-discriminatory access to PHI by ensuring that premiums are the same regardless of the health or demographic characteristics of the individual.

The decline of PHI membership following the establishment of Medicare in 1983 was viewed as a concern, as there was a perception that the sustainability of the public system required substantial private funding provided by PHI (Hall et al., 1999). This led to a series of government interventions in the late 1990's to create a system of incentives and disincentives to increase uptake of PHI. Subsequently the proportion of the population with PHI increased to 47% and has continued to increase incrementally in the last ten years.

In 2013/14, 55.3% of the population had some form of PHI (hospital only, general only or hospital and general). Cover for dental services are typically provided under general treatment cover which can be purchased separately or as part of a combined policy. In 2013/14, about 55% of the population had general treatment cover. It is estimated that the vast majority of those with a general treatment policy have dental cover as there are only a small number of policies available that exclude and/or allow policy holders to opt out of dental cover (Teusner et al., 2014a).

Despite government measures to improve the affordability of PHI (i.e. 30% premium tax rebate), insurance status has remained strongly positively associated with household income and socio-economic status (Australian Bureau of Statistics, 2006). Consequently, government subsidies are inequitably distributed within the community and, as health service use by the insured has increased, there has been wide debate regarding the impact of increased PHI coverage on equity of access to health services. (Harford and Spencer, 2004, Hindle and McAuley, 2004). These concerns have been echoed in research specifically exploring access to dental services. Fitzgerald et al (2011) demonstrated that since the late 1990s income-related inequality in access to dental services has increased, i.e., those with higher incomes and better oral health also had better access to dental care while those with lower incomes had lower access to dental care. This inequality was observed to be increasing. A decomposition analysis of trends observed in time series data concluded that increased PHI coverage associated with PHI incentives played a contributory role in increasing inequity (Fitzgerald et al., 2011).

Across developed countries having PHI has been associated with; higher levels of access to dental care (dental visiting), visiting for a check-up and receiving a more comprehensive pattern of services as opposed to visiting for a problem and receiving care only to provide relief for the immediate problem. Related to these visiting patterns, associations between PHI and better oral health have also been observed. Additionally though, regular access to dental care is not necessarily associated with lower disease experience (Sheiham et al., 1985), regular care and usually visiting for a

check-up have been associated with less untreated decay (Brennan et al., 2007) and fewer social impacts of oral disease (Harford and Spencer, 2007, Crocombe et al., 2012b). These associations are mainly due to early intervention resulting in better management of disease and thereby better outcomes.

Dental insurance influences dental visiting patterns by lowering the cost at the time of accessing care, and while this has been associated with better oral health, PHI has been argued to induce additional use of services (moral hazard) that are of marginal or no benefit (Grytten, 2005). Higher levels of service use by insured may also be explained by self-selection of those who have greater need for care or have a predisposition to regularly seek care (adverse self-selection and advantageous selection). Self-selection into dental insurance based on oral health status, risk or care seeking attitudes is obscured in the Australian context given the system of incentives and disincentives and the bundling of dental insurance with cover for other services. However there is potential for bias associated with self-selection in observational studies of insurance and service use (Hopkins et al., 2013).

This type of bias can be reduced by experimental study designs, but so far there has been only one experimental insurance study, which was conducted in the US in the 1980s. The RAND Health Insurance Experiment (HIE) was a large randomised controlled trial that examined the influence of insurance on health service use (including dental services) and health outcomes. The study found that the generosity of cover (level of co-payments) was positively associated with the probability of dental visiting. There were also associations with variations in services received.

Prosthetic treatment use was 62% higher among those with the most generous plan (0% co-payment) compared to those who had the least generous plan (95% co-payment) while the probability of endodontic and periodontal treatment was 50% higher (Manning et al., 1985).

More importantly the RAND HIE also investigated the relationship between dental insurance and oral health outcomes (Bailit et al., 1985). Those with the most generous plan compared to those with less generous levels of cover had less untreated decay, more filled teeth and lower periodontal index scores. The differences were greater for children and young adults (less than 35 years of age) than for older adults (Bailit et al., 1985).

The findings of the RAND HIE, however, are limited in its relevance to the current Australian policy context. The plans assessed in the HIE were markedly different from the structure of the plans available in Australia. The HIE plans provided protection from catastrophic costs via caps on total co-payments. Conversely, in Australia, the insurance plans typically have caps on benefits. In addition, Australian plans typically provide lower levels of cover (approximately 50% of dental claims), than the more generous plans in the HIE that were associated with increased probability of visiting.

Assessing the degree to which dental insurance improves access to dental care may indicate the potential for oral health improvements through public health policies that extend dental insurance coverage in the community. Alternatively, improvements in population oral health associated with PHI may also indicate the potential effectiveness of policies that aim to reduce out-of-pocket costs of dental services and, or provide public subsidisation of dental care.

While there have been numerous studies investigating the relationships between dental insurance, service use and health outcomes, only one review was identified. Bendall and Asubonteng (1995) reviewed ten American publications; four publications reported on the RAND HIE and the remaining were based on population surveys. A synthesis of Australian research is required to understand the potential of cost sharing to improve dental visiting and thereby improve population oral health. The aim of this section of the thesis is to systematically review and collate all empirical evidence in Australia, which investigated the association between dental insurance and dental service use and, or oral health outcomes.

## Review methods

The research question was investigated through a systematic search of all available published research in Australia that reports on the relationship between dental insurance and the two outcome categories – dental service use and oral health outcomes. A search strategy which could be employed across different databases and literature search engines was developed in consultation with a research librarian. The PICO (Population Intervention Comparator Outcome) model as shown in Box 1 was used to define the search terms. Both outcomes were included in the same search strategy combined with an 'OR' boolean, since it was possible that there were papers that reported on both outcomes. The search strategy was piloted in two large literature databases and subsequently refined.

### Box 1: PICO Model

Population	Adults in Australia
Intervention	Private dental insurance
Comparator	Those not insured
Outcome	Dental service use/oral health outcomes

## Literature search

Using the search strategy shown in Box 2 a comprehensive literature search was conducted in the latter half of 2014. The search terms were altered to suit the search conditions of the various databases. The Cochrane library, Dental and Oral Sciences

Source , Embase, Medline, PubMed, Scopus and Web of Science were searched and results with abstracts were imported into an EndNote database for perusal.

### **Inclusion and Exclusion criteria**

Inclusion and exclusion criteria were applied to the search results for empirical and practical reasons. Only publications reporting data on human adults (18 years and older) and whose full text were accessible in the English language were included. Those publications that reported on children and adults together were included. Other criteria pertinent to the study questions were articles published since 1986, reporting on reviews and observational data from Australia, reporting private dental health insurance, and one or both of dental service use or oral health outcomes and their association with private dental insurance. The cut off year of 1986 was chosen based on the publication year of the RAND HIE which is the seminal study investigating this research question.

#### **Box 2: Search strategy and search terms**

OHIP OR "Self-rated oral health" OR "Self-rated dental health" OR OHRQoL OR "oral health related quality of life" OR "adequate dentition" OR dentate OR "number of teeth" OR "dental caries" OR Perio\* OR CAL OR DMF

OR

"oral health services" OR "dental service use" OR "dental service utilisation" OR "dental access" OR "dentists visit\*" OR "Oral Health Care"

AND

Insurance OR \*insured

AND

Adult\*

AND

Australia\*

The EndNote database was used to peruse the publications and as a platform to carry out the steps in the review process. Initially, any citations prior to the cut off year of 1986 were removed. Next, duplicate citations were identified and removed. A three stage sifting process (Appendix 2) was then conducted to identify citations that were both relevant to the research question and met the inclusion and exclusion criteria.

In the first stage, the publication titles were examined and all citations whose titles did not match the inclusion criteria were eliminated. Citations whose titles were not clear on the meeting of criteria were carried forward to the next stage. The abstracts of the remaining citations were examined in the next stage.

The list of citations after this stage was subjected to a search of references cited in the papers and citation tracking through Google scholar and the Scopus database to identify additional publications and grey literature. Additionally, two experts were identified, based on number of publications in the final list of papers, and contacted to identify any additional papers or grey literature. The total numbers of papers identified, retained or eliminated at each stage of the review process are shown in Fig A1.1.

Data were extracted into a table that defined the sample, variables of interest and the key findings from each publication (Appendix 3). A descriptive synthesis (Centre for Reviews and Dissemination, 2009) identified all relevant outcomes and their respective measures. A narrative synthesis (Centre for Reviews and Dissemination, 2009) collated results of each outcome and all measures (means, percentages and odds ratios (OR) and prevalence ratios (PR)) of the outcome variables were included. Where relevant the measures were combined or reported as a range. The uninsured were the reference group for all comparisons and ratios unless stated otherwise.

### Full paper quality assessment

<i>Table A1.1 – Domains and elements assessed to determine study quality</i>		
Domains	Elements	Essential (Yes/No)
Publication	Peer reviewed journal article	No
Study Question	Clearly stated and appropriate	Yes
Study Population	Description of study population	Yes
	Sample size justification	No
	Sample sufficient size for analysis	No
	Inclusion/exclusion criteria stated	No
	Sample representativeness assessed	No
Outcome measurement	Primary outcomes clearly defined	Yes
	Outcome assessment standard, valid and reliable	No
Statistical analysis	Statistical tests appropriate	Yes
	Modelling and multiple variable analysis conducted	No
	Controlled for potential confounders (in relation to insurance status)	No
	Potential for selection bias assessed (i.e. associated with self-selection into insurance)	No
Discussion	Conclusions, relating to insurance associations, supported by results	Yes
	Biases and limitations taken into consideration	No

Adapted from the Agency for Healthcare Research and Quality (AHRQ)(West et al., 2002)

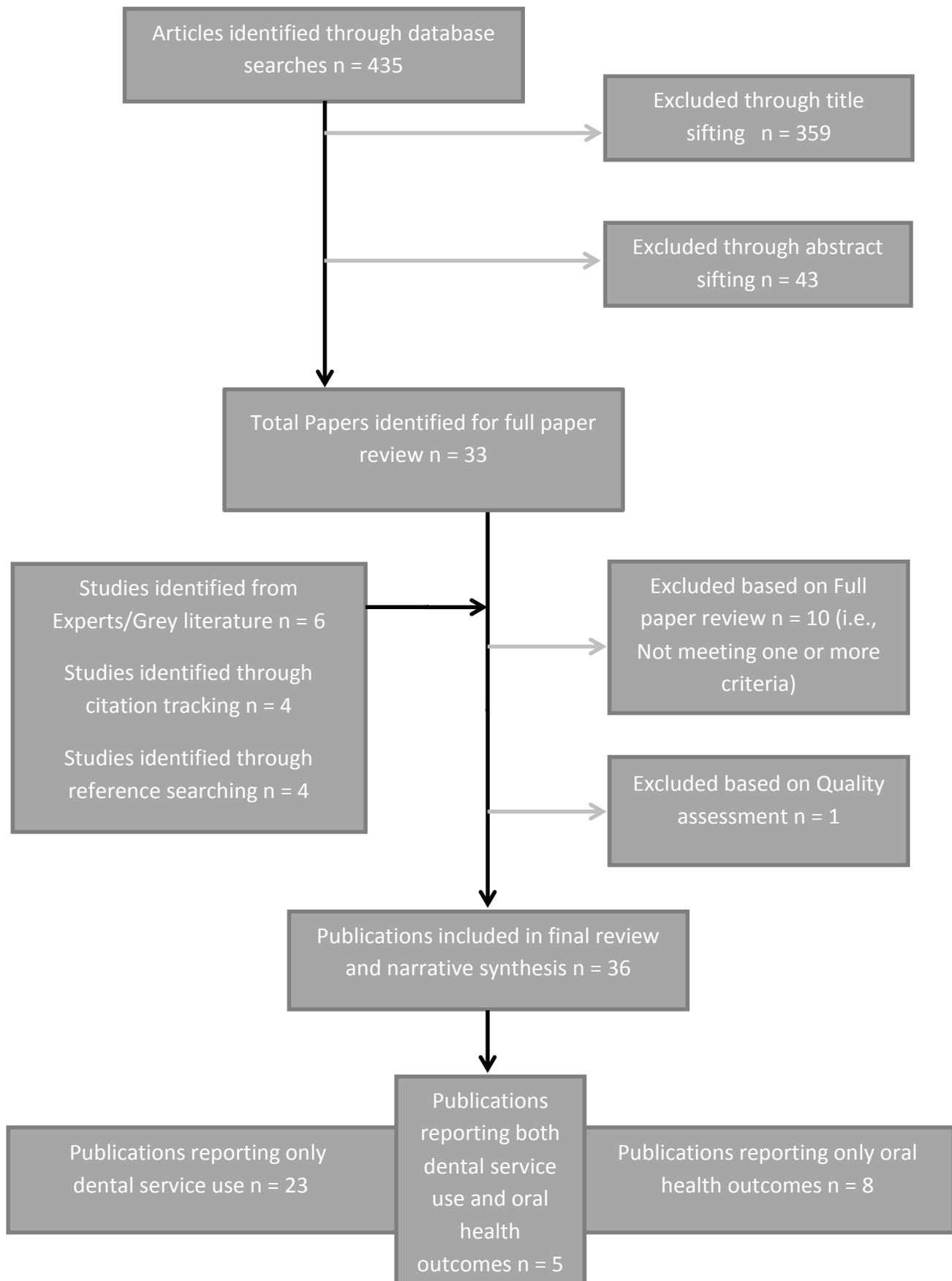
Several research quality assessment systems (Armijo-Olivo et al., 2012, Centre for Reviews and Dissemination, 2009, Jackson and Waters, 2005, Sanderson et al., 2007, West et al., 2002) were identified to assess the quality of the literature identified. As many assessment systems were focused on specific study designs, none of these

existing systems was considered appropriate for the current review. Hence, the quality assessment system employed in this review was adapted from the Agency for Healthcare Research and Quality (AHRQ) at the US Dept. of Health and Human Services (West et al., 2002) (Table A1.1). In their report of systems to assess quality and strength of evidence, they developed a set of 9 domains elements that were appropriate in assessing strength of evidence. An adapted version of that grid consisting of 5 domains and their elements were used in the current study. The domains and elements broadly covered type of publication, clear study question, well described study population, clearly defined, valid and reliable outcome measurement, appropriate use of statistical methods and a discussion and conclusion that was supported by the results and took into consideration potential biases and limitations

### **Results of the review**

All citations that were identified through the electronic searches were imported into an EndNote database. The review filtering steps and the resulting number of citations included in the review are shown in Fig A1.1. After removing duplicates and filtering out publications prior to 1986, a total of 435 citations were available for the review process. Three hundred and fifty nine citations were excluded after title sifting and a further 43 were excluded after abstract sifting. After the second stage of abstract sifting eight more publications were added from tracking of references and citations and 6 papers were identified from grey literature and through experts, resulting in 47 papers in total. Full paper review eliminated 10 papers resulting in 37 papers that were assessed for quality. The final data for the review was made up of 36 publications after one publication was eliminated based on quality.

**Figure A1.1: Flowchart of literature review process**



**Table A1.2: Quality Assessment matrix of final review papers**

Paper	Peer review	Question		Study population			
		Clearly stated	Described	Sample justified	Sufficient size	Criteria	Representativeness
Teusner et al. (2014b)	Yes	✓	✓	✓	Limited	✓	✓
Srivastava et al. (2014)	No	✓	✓	PE	✓	Limited	✗
Teusner et al. (2014a)	Yes	✓	✓	✓	✓	✓	✓
Anikeeva et al. (2013)	Yes	✓	✓	✓	✓	✓	✓
Brennan et al. (2013)	Yes	✓	✓	✗	✓	✓	✓
Hopkins et al. (2013)	Yes	✓	✓	PE	✓	✓	Limited
Teusner et al. (2013a)	Yes	✓	✓	✗	Limited	✓	✓
Teusner et al. (2013b)	Yes	✓	✓	✗	Limited	✓	✓
Australian Research Centre for Population Oral Health (2012)	No	✓	✓	✓	✓	✓	✓
Roberts-Thomson et al. (2011)	Yes	✓	✓	✗	✓	✓	✓
Chrisopoulos et al. (2011)	No	N/A	N/A	PE	✓	✓	PE
Australian Research Centre for Population Oral Health (2010)	No	✓	✓	PE	✓	✓	✓
Jamieson et al. (2010)	Yes	✓	✓	PE	✓	✓	✓
Mejia (2010)	No	✓	✓	PE	✓	✓	✗
Armfield et al. (2009)	Yes	✓	✓	PE	✓	✓	✓
Jamieson et al. (2009)	Yes	✓	✓	PE	✓	✓	✓
Sivaneswaran (2009)	Yes	✓	✓	✗	✓	✓	PE
Sanders et al. (2009)	Yes	✓	✓	PE	✓	✓	✓
Australian Research Centre for Population Oral Health (2008a)	No	✓	✓	PE	✓	PE	PE
Australian Research Centre for Population Oral Health (2008b)	No	✓	✓	PE	✓	✓	PE
Vecchio (2008)	Yes	✓	✓	PE	✓	✓	PE
Roberts-Thomson and Stewart (2008)	Yes	✓	✓	✗	✓	✓	✓
Spencer and Harford (2007b)	No	✓	✓	PE	✓	✓	PE
Spencer and Harford (2007a)	No	✓	✓	✓	✓	✓	✓
Slack-Smith et al. (2007)	Yes	✓	✓	PE	✓	✓	✓
Brennan and Spencer (2007)	Yes	✓	✓	✗	Limited	✓	✓
Sibbritt et al. (2007)	Yes	✓	Limited	✗	✓	✓	✓
Gablinger et al. (2006)	No	✓	PE	PE	✓	✓	PE
Brennan and Spencer (2005b)	Yes	✓	✓	✗	✓	✓	✗
Slack-Smith and Hyndman (2004)	Yes	Limited	Limited	PE	✓	✓	PE
Ringland et al. (2004)	Yes	✓	✓	PE	✓	✓	✗
Roberts-Thomson and Stewart (2003)	Yes	✓	✓	✗	✓	Limited	✓
Australian Institute of Health and Welfare (2002)	No	✓	✓	✗	✓	✓	PE
Brennan and Spencer (2002)	Yes	✓	✓	✗	✓	✓	✓
Brennan and Spencer (2006)	Yes	✓	✓	✗	✓	✓	✓
Brennan et al. (2000)	Yes	✓	✓	✗	✓	✓	✓
Brennan et al. (1997)	Yes	✓	✓	✗	✓	✓	✓

✓ = Met criteria, ✗ = Did not meet criteria

- Notes:
1. PE= published elsewhere. Refers to studies based on data sets collected by another organisation and the study details (sample size justification, study population description etc.) is available from other publication associated with the collection of the respective data.
  2. Srivastava et al (2014) stated that only complete cases were included in analysis. this resulted in the exclusion of proxy respondents and edentulous due to a selection of variables included in the analysis that were only asked of these participants, sample justification was described elsewhere for data source, representativeness of analysis sample not assessed, not stated whether weighting was applied to reflect Australian population.
  3. Brennan & spencer 2007 – some clinically significant effects in relation to insurance status, were observed but were not statistically significant, hence while the ‘n’ was sufficient for the key aim of the paper, it was possibly insufficient for the statistical analysis of insurance effects.
  4. Gablinger et al (2006) – grey literature - this paper appeared to be a draft paper, some sections appeared incomplete/insufficient for a journal submission

**Table A1.2: Quality Assessment matrix of final review papers (continued)**

Paper	Outcome			Analysis			Discussion	
	Defined	Valid/ reliable	Appropriateness	Modelling	Confounding controlled	Selection bias assessed	Conclusion supported	Limitations
Teusner et al. (2014b)	✓	✓	✓	✓	Limited	✗	✓	✓
Srivastava et al. (2014)	✓	✓	✓	✓	✓	✓	✓	<
Teusner et al. (2014a)	✓	✓	✓	✓	Limited	✗	✓	✓
Anikeeva et al. (2013)	✓	✓	✓	✓	Limited	✗	✓	✓
Brennan et al. (2013)	✓	✓	✓	✓	Limited	✗	✓	✓
Hopkins et al. (2013)	✓	✓	✓	✓	✓	✓	✓	Limited
Teusner et al. (2013a)	✓	✓	✓	✓	✓	✗	✓	✓
Teusner et al. (2013b)	✓	✓	✓	✓	✓	Limited	✓	✓
Australian Research Centre for Population Oral Health (2012)	✓	✓	✓	✗	✗	✗	✓	✓
Roberts-Thomson et al. (2011)	✓	✓	✓	✓	✓	✗	✓	✓
Chrisopoulos et al. (2011)	✓	✓	✓	✗	✗	✗	✓	✗
Australian Research Centre for Population Oral Health (2010)	✓	✓	✓	✗	✗	✗	✓	PE
Jamieson et al. (2010)	✓	✓	✓	✓	✓	✗	✓	Limited
Mejia (2010)	✓	✓	✓	✗	✗	✗	✓	Limited
Armfield et al. (2009)	✓	✓	Limited	✓	✓	✗	✓	✓
Jamieson et al. (2009)	✓	✓	✓	✓	✓	✗	✓	✗
Sivaneswaran (2009)	✓	✓	✓	✗	✗	✗	✓	✗
Sanders et al. (2009)	✓	✓	✓	✓	✓	✗	✓	✓
Australian Research Centre for Population Oral Health (2008a)	✓	✓	✓	✗	✗	✗	✓	✗
Australian Research Centre for Population Oral Health (2008b)	✓	✓	✓	✓	✓	✗	✓	Limited/PE
Vecchio (2008)	✓	✓	✓	✓	✓	✗	✓	✓
Roberts-Thomson and Stewart (2008)	✓	✓	Limited	✓	✓	✗	✓	✓
Spencer and Harford (2007b)	✓	✓	✓	✗	✗	✗	✓	PE
Spencer and Harford (2007a)	✓	✓	✓	✗	✗	✗	✓	✓
Slack-Smith et al. (2007)	✓	✓	✓	✓	✓	✗	✓	✓
Brennan and Spencer (2007)	✓	✓	✓	✓	✓	✗	✓	✓
Sibbritt et al. (2007)	✓	✓	✓	✓	✓	✗	✓	Limited
Gablinger et al. (2006)	✓	✓	✓	✓	✓	✗	✗	✗
Brennan and Spencer (2005b)	✓	✓	✓	✓	✓	✗	✓	✗
Slack-Smith and Hyndman (2004)	✓	✓	✓	✗	✗	✗	✓	Limited
Ringland et al. (2004)	✓	✓	✓	✓	✓	✗	✓	Limited
Roberts-Thomson and Stewart (2003)	✓	✓	✓	✓	✓	✗	✓	Limited
Australian Institute of Health and Welfare (2002)	✓	✓	✓	✗	✗	✗	✓	✗
Brennan and Spencer (2002)	✓	✓	✓	✓	✓	✗	✓	✓
Brennan and Spencer (2006)	✓	✓	✓	✓	✓	✗	✓	✓
Brennan et al. (2000)	✓	✓	✓	✓	Limited	✗	✓	✓
Brennan et al. (1997)	✓	✓	✓	✓	Limited	✗	✓	✓

✓ = Met criteria, ✗ = Did not meet criteria

## Quality Assessment

A quality assessment was applied to 37 papers, only one paper was excluded from the review based on failure to meet one of the essential quality criteria of conclusion relation to dental insurance associations supported by the results (Gablinger et al., 2006) (Table A1.2). The majority of the papers (72%, n=26) were published in peer reviewed journals, mostly meeting the non-essential criteria except for sample size justification, controlling for confounding and accounting for bias associated with self-selection into insurance (i.e., endogeneity of insurance).

Of the non-reviewed papers (grey literature), one paper (Srivastava et al., 2014) was accessed from a research centre website and the rest were reports published by the Australian Institute of Health and Welfare (Dental Statistics and Research Unit (DSRU) or Australian Research Centre for Population Oral Health (ARCPOH) reports, n= 4) or non-peer-reviewed short reports published in the Australian Dental Journal (Data Watch articles prepared by ARCPOH).

All in-scope articles adequately described their study questions and study populations. Nearly all papers (n=35) assessed representativeness, but the large majority (84%, n=31) of papers did not justify their study sample size or report the estimated power of their analysis sample. Of these, 14 papers sourced data from large nationally representative data sets for which representativeness and sample size information was published elsewhere. All articles had a sufficient number of observations to conduct analysis related to the stated study aims, however a small number of studies (n=4) appeared to have limited power for testing insurance associations (which were not the primary aim of these publications).

All papers clearly defined their respective outcome variables, and all outcome variables were common in the literature. With the exception of two Data Watch articles, all the non-peer-reviewed reports (n=7) presented descriptive analysis or unadjusted estimates only, and did not conduct modelling (multiple variable analyses). However two reports provided some adjustment by conducting stratified analyses. Among the peer-reviewed papers, nearly all conducted modelling, applied accepted modelling techniques and included relevant controls.

Only two papers (Srivastava et al., 2014, Hopkins et al., 2013) explicitly estimated the effect of selection bias (associated with self-selection into insurance). Several other papers attempted to reduce selection bias by including independent variables in models that were associated with both insurance and the outcome variable. Only a few papers (n=7) failed to acknowledge study limitations, however all but two of these papers was based on a large representative data set where collection and methodological issues were reported elsewhere.

### **Descriptive synthesis**

The final data for the review consisted of 36 publications (Appendix 3), of which 33 were cross sectional analyses and three cohort analyses. These publications reported from a total of 11 studies. Some studies were reported in multiple publications. Different time points of the same studies were also reported in separate publications. Table A1.3 provides a descriptive summary of all the studies.

The participants in the various studies ranged from young adults in South Australia and older women in New South Wales to population-based studies of nationally representative samples. The main variable of interest, dental insurance was reported as having (insured) or not having dental insurance (uninsured) in all publications. Two publications that did not report outcomes directly comparing the insured and uninsured were eliminated from the review at the full paper sifting stage.

Dental service outcomes were more commonly reported (n= 28) than oral health outcomes (n=13) and five publications reported both service use and oral health outcomes. Time since last visit, often dichotomised as dental visit in the last 12 months was the most common outcome measure reported in 10 of the 28 publications on dental service use. Among the publications reporting on oral health outcomes global self-rated oral health and DMFT (Decayed, Missing and Filled Teeth) were the most commonly reported health outcomes, followed by different measures of tooth decay. Only one study reported periodontal disease, pocket depth (PD) and clinical attachment loss (CAL).

**Table A1.3 – Year of study, authors, year of publication, samples and outcome measures of reviewed publications**

Study Year	Publication	Participants (Years)	Service Use outcomes	Oral health outcomes
<b>Cost Effectiveness of Insurance</b>				
2009/10	Teusner et al. (2014b)	Adults (30-61)	-	Self-Rated Oral Health (SROH)
	Brennan et al. (2013)	Adults (30-61)	Visited in last 12 months, reason for visit	-
	Brennan et al. (2013)	Adults (30-61)	Regular dental visiting (on average visit at least once every 2 years), last visit for Check up	-
2010/11	Teusner et al. (2013a)†	Adults (30-61)	Visited in last 12 months, number of dental visits	-
<b>National Survey of Adult Oral Health (NSAOH)</b>				
2004-06	Srivastava et al. (2014)	Adults (15+)	Visited in last 12 months	
	Chrisopoulos et al. (2011)	Adults (15+)	-	Caries in Adults (D,M,F & DMFT), untreated decay, periodontal disease, Pocket Depth (PD) & Clinical Attachment Loss (CAL)
	Jamieson et al. (2010)	Adults (18-34)	-	Oral Impairment (Combined Self Rated measure of toothache, food avoidance and discomfort due to mouth appearance)
	Sivaneswaran (2009)	NSW adults (15+)	Visited in last 12 months, last visit at private practice, average visiting pattern, regular dentist, usual visiting for check-up	Tooth loss, Adequate dentition, untreated coronal decay, DMFT, missing teeth due to pathology, PD, SRDH, Toothache/facial pain, need for extractions/fillings, perceived urgency for treatment
	Jamieson et al. (2009)	Adults (15-34)	-	Untreated dental decay
	Armfield et al. (2009)	Adults (18+)	-	DMFT and components
	Australian Research Centre for Population Oral Health (2008a)	Dentate adults (18+)	Average visiting pattern, usual reason for visit, fillings received, extractions received	SRDH, toothache frequency
	Australian Research Centre for Population Oral Health (2008b)	Dentate adults (15+)	Infrequent dental visiting (no visit in last 5 years or more)	-
	Spencer and Harford (2007b)	Dentate adults (15+)	Time since last visit, no visit in last 5 years	-
	Spencer and Harford (2007a)	Adults (15+)	Time since last visit(Visit in the last 12 months and no visits in last 5 years), sector of attendance, average visiting pattern, regular dentist, usual reason for visit	-

**Notes:**

1. Cohort study designs are indicated (†), all other studies were cross sectional studies.
2. Favourable visiting pattern is a composite variable comprised from average visiting pattern, attending a regular dentist (provider continuity), usually attending for a check-up.
3. Two publications reported on two studies each and appear twice in this table (Chrisopoulos, Beckwith and Harford 2011 and Hopkins, Kidd and Ulker 2013).

**Table A1.3 – Year of study, authors, year of publication, samples and outcome measures of reviewed publications (continued)**

Study Year	Publication	Participants (Years)	Service Use outcomes	Oral health outcomes
<b>Study of Dental Service Use</b>				
2004/05	Teusner et al. (2013b)†	South Australian adults (45-54)	Regular visiting: usually visit once or more a year, Recent visit: One or more visits during the 2 year study period	-
<b>Australian Bureau of Statistics (ABS) National Health Survey (NHS)</b>				
1995	Hopkins et al. (2013)	Children and adults	Time since last dental visit (categorical)	-
	Slack-Smith and Hyndman (2004)	Adults (60+)	Visited in the last 12 months	-
2001	Hopkins et al. (2013)	Children and adults	Time since last dental visit (categorical)	-
	Slack-Smith et al. (2007)	Adults (18-24)	Visited in the last 12 months	-
2005	Vecchio (2008)	Community dwelling adults (65+)	Visited in the last 12 months	-
<b>South Australian Young Adults</b>				
1998/99	Roberts-Thomson et al. (2011)†	South Australian adults (20-24)	No dental visit since baseline (2.5yrs), usual reason for visit: Problem	-
	Roberts-Thomson and Stewart (2008)	South Australian adults (20-24)	-	Pre-cavitated lesions, decayed tooth, total caries experience
	Roberts-Thomson and Stewart (2003)	South Australian adults (20-24)	Visited in the last two years, reason for dental visit (Check-up Vs Problem)	-
<b>National Dental Telephone Interview Survey (NDTIS)</b>				
2010	Australian Research Centre for Population Oral Health (2012)	Adults (18+)	Dental visit in the last 12 months, mean number of visits, check-up visits, extractions, fillings, scale and cleans, root canal treatment, crowns and bridges, gum treatment, dentures	-
	Chrisopoulos et al. (2011)	Children and adults (5+)	Time since last visit(categorical) (18+), reasons for last dental visit, type of practice at last visit, favourable visiting pattern (18+), average number of services: No. of visits, extractions, fillings, scale and cleans.	Missing Teeth (mean)
2008	Australian Research Centre for Population Oral Health (2010)	Adults (60+)	Visited in the last 12 months, usual reason for visit, extraction in last year	-
	Teusner et al. (2014a)	Adults (18+)	Favourable visiting pattern	-
2002	Sanders et al. (2009)	Dentate adults (18+)	-	OHIP Severity, OHIP Prevalence
1999	Australian Institute of Health and Welfare (2002)	Dentate adults (15+)	Dental visit in the last 12 months, No visit in last 5 years, reason for visit, extractions, fillings	-

**Notes:**

1. Cohort study designs are indicated (†), all other studies were cross sectional studies.
2. Favourable visiting pattern is a composite variable comprised from average visiting pattern, attending a regular dentist (provider continuity), usually attending for a check-up.
3. Two publications reported on two studies each and appear twice in this table (Chrisopoulos, Beckwith and Harford 2011 and Hopkins, Kidd and Ulker 2013).

**Table A1.3 – Year of study, authors, year of publication, samples and outcome measures of reviewed publications (continued)**

Study Year	Publication	Participants (Years)	Service Use outcomes	Oral health outcomes
<b>Child Fluoride Study Follow Up</b>				
2005/06	Mejia (2010)	Adults (18-30)	–	Dental decay, untreated Coronal decay, filled permanent teeth, teeth missing due to Caries
<b>Longitudinal Study of Dental Practice Activity (LSDPA)</b>				
2003/04	Brennan and Spencer (2007)	Dental practitioners reporting on patients (5+)	Service rates per visit: restorative, examination, radiograph, prophylaxis, topical fluoride, endodontic, extraction	Caries: initial, cavitated and gross lesions
1997/98	Brennan and Spencer (2002)	Dental practitioners reporting on patients (18+)	Service rates per visit: diagnostic, preventive, restorative, endodontic, extraction, crown and bridges, prosthodontic, general/miscellaneous	–
1993/94	Brennan et al. (2001)	Dental practitioners reporting on patients (18+)	Extractions	–
	Brennan et al. (2000)	Dental practitioners reporting on patients	Provision of services: diagnostic, preventive, restorative, endodontic, extraction, crown and bridges, prosthodontic, general/miscellaneous	–
	Brennan et al. (1997)	Dental Practitioners reporting on patients (18+)	Reason for visit: check-up, emergency, other. Services per visit, provision of services: diagnostic, preventive, restorative, endodontic, extraction, crown and bridges, prosthodontic, general, periodontal, orthodontic	–
<b>Burden of Oral Disease Study</b>				
2001-02	Brennan and Spencer (2005b)	Adult (18+) patients of private dentists in South Australia	-	OHIP Counts(dichotomised items to never/hardly ever and occasionally through to very often and summing them), Additive scores (severity) and scale scores
<b>Longitudinal Study on Women’s Health</b>				
1999	Sibbritt et al. (2007)	Adult women (73-78)	Visit in the last 12 months	–
<b>New South Wales Older Peoples Health Survey</b>				
1999	Ringland et al. (2004)	Adults (65+)	–	Dentate status, toothache frequency, mouth or denture problems

**Notes:**

1. Cohort study designs are indicated (+), all other studies were cross sectional studies.
2. Favourable visiting pattern is a composite variable comprised from average visiting pattern, attending a regular dentist (provider continuity), usually attending for a check-up.
3. Two publications reported on two studies each and appear twice in this table (Chrisopoulos, Beckwith and Harford 2011 and Hopkins, Kidd and Ulker 2013).

## **Narrative synthesis**

### **Dental Service Outcomes**

#### ***Service Use outcomes***

The dental service use outcomes variables examined dental visiting and the type of services received or provided.

There were various dental visiting outcomes reported, and included, time since last visit (various categories) average visiting pattern, number of dental visits, reason for visit, sector of dental visiting, visiting a regular dentist and favourable visiting pattern (composite variable combining average visiting, usual reason and visiting a regular dentist). Tables A1.4a and A1.4b present the collated unadjusted and adjusted results from all publications for these outcome variables. The second column in these tables presented the number of studies with the asterisk (\*) after the number of studies indicating 'statistically significant bivariate differences' and the accent (^) indicating 'statistical significance not tested'. Hence some line items have two sets of numbers under number of studies, to denote one set of studies that reported statistically significant results and another not reporting anything (^) or not statistically significant.

**Table A1.4a: Collated results - Dental service use outcomes – Dental visiting**

Dental visiting outcome	Unadjusted			Adjusted		
	Number of studies (reference/s)	Insured <sup>(a)</sup> Per cent/ Mean	Uninsured <sup>(a)</sup> Per cent/ Mean	Number of studies (reference/s)	Ratios <sup>(b)</sup>	Notes
<b>Time since last visit</b>						
In the last year (%)	10*(Australian Institute of Health and Welfare, 2002, Slack-Smith and Hyndman, 2004, Slack-Smith et al., 2007, Spencer and Harford, 2007b, Vecchio, 2008, Australian Research Centre for Population Oral Health, 2010, Australian Research Centre for Population Oral Health, 2012, Brennan et al., 2013, Teusner et al., 2013a, Srivastava et al., 2014)	50.9 – 74.2	28.6 – 53.3	3*(Slack-Smith et al., 2007, Vecchio, 2008, Brennan et al., 2013)	PR 1.48 OR 1.9, 2.6	1
In last 2 years (%)	2*(Roberts-Thomson and Stewart, 2003, Teusner et al., 2013b)	81.7 – 88.0	58.1 – 72.3	2*(Roberts-Thomson and Stewart, 2003, Teusner et al., 2013b)	PR 2.19 & 1.17	2
< 12 month (%)	1*(Chrisopoulos et al., 2011)	53.6 – 71.9	35.9 – 49.6		–	3
1–2 years (%)	2^(Hopkins et al., 2013) 1*(Chrisopoulos et al., 2011)	16.3 – 17.9	15.8 – 20.6		–	3
More than 2 years (%)	2^(Hopkins et al., 2013) 1*(Chrisopoulos et al., 2011)	11.9 – 28.9	29.8 – 49.9		–	3
No visit in last 5 years (%)	2*(Spencer and Harford, 2007a, Spencer and Harford, 2007b) 1^(Australian Institute of Health and Welfare, 2002)	4.9 – 5.9	12.1 – 16.8	1*(Australian Research Centre for Population Oral Health, 2008b)	OR 2.3†	4,5
No visit in last 2.5 years (%)	1* (Roberts-Thomson et al., 2011)	16.1	26.0	1(Roberts-Thomson et al., 2011)	NS	
No. dental visits (last 12 months) (Mean)	3(Chrisopoulos et al., 2011, Australian Research Centre for Population Oral Health, 2012, Teusner et al., 2013a)	2.3 – 2.5	2.3	–	–	

(a) Percentage or mean insured or uninsured. Percentage reported as a range if outcome reported in more than one publication

(b) Ratios were either OR, odds ratios, PR, prevalence ratios, or RR rate ratios of the insured group relative to the uninsured.

\* Statistically significant difference, † Ratios where the insured group were the reference category, ^ Differences between insured and uninsured not statistically tested

Notes: 1. Sex, Age, Household Income (HHI), Oral Health Impact Profile (OHIP)

2. Model adjusted for age, sex and HHI and attitudinal factors

3. One publication (Hopkins et al., 2013) reported from two studies.

4. One publication reported adjusted analysis only. Three publications reported from National Survey of Adult Oral Health (NSAOH) using varying different samples.

5. Population attributable fraction 29% (i.e. 29% of infrequent dental visiting can be avoided if the entire population was insured)

In unadjusted analyses, visiting in the last 12 months was always higher among the insured ranging from 50.9 % to 74.2% and lower for the uninsured ranging from 28.6 % to 53.3%. After adjusting for other variables the odds ratios for visiting in the last 12 months were 1.9 and 2.6 in two publications. Another reported a prevalence ratio of 1.5.

Two publications (Hopkins et al., 2013, Chrisopoulos et al., 2011) reported on time since last visit in categories from three studies. Among the insured 53.6 % to 71.9 % visited in the last 12 months, 16.3% – 17.9% visited in the last 1 to 2 years and 11.9% to 28.9% visited 2 or more years ago. The proportion visiting among the uninsured were 35.9%– 49.6%, 15.8% – 20.6% and 29.8% – 49.9 respectively.

One publication (Srivastava et al., 2014) attempted to assess and control for the potential endogeneity of dental insurance using a simultaneous equation approach that accounted for the interrelationships between dental health, the purchase of private dental insurance and the use of dental services. The study concluded that insurance was endogenous in models of dental service use and that after accounting for interrelationships the association between having insurance and visiting in the previous 12 months persisted. The study concluded that if the uninsured were to be covered for dental care under the same circumstances as the insured then their probability of visiting the dentist would increase from 43% to 66%.

Infrequent dental visiting was reported in four publications with three studies categorising infrequent visiting as no visits in five years (Australian Institute of Health and Welfare, 2002, Spencer and Harford, 2007a, Spencer and Harford, 2007b), and one study categorising it as no visit during the cohort study period of 2.5 years. (Roberts-Thomson et al., 2011) In all four publications the insured had smaller percentages of the samples who did not visit and the differences were statistically significant. In one adjusted analysis the uninsured has higher odds (2.3) of infrequent dental visiting; accounting for a population attributable risk fraction of 29% (i.e. 29% of infrequent dental visiting can be avoided if the entire population was insured). In the cohort study (Roberts-Thomson et al., 2011) dental insurance was not significant in adjusted analysis.

The proportion who visited on average once a year or more ranged from 66.0% to 71.0 % among the insured. These proportions were lower for the uninsured ranging from 34.0% to 42.6%. Adjusted prevalence ratios for visiting were approximately 1.5 for the insured compared to the uninsured. Average visiting of once in two years was also higher among the insured, and this association persisted in the adjusted analysis: prevalence ratio of 1.2 for the insured.

**Table A1.4b: Collated results - Dental service use outcomes - Dental visiting (continued)**

Dental visiting outcome	Unadjusted			Adjusted		Notes
	Number of studies (reference/s)	Insured <sup>(a)</sup> Per cent/ Mean	Uninsured <sup>(a)</sup> Per cent/ Mean	Number of studies (reference/s)	Ratios <sup>(b)</sup>	
<b>Usual visiting pattern</b>						
Once a year (%)	4* (Spencer and Harford, 2007b, Australian Research Centre for Population Oral Health, 2008b, Sivaneswaran, 2009, Teusner et al., 2013b)	66.0 – 71.0	34.0 – 42.6	1*(Teusner et al., 2013b)	1.48	1
Once in 2 years (%)	1*(Anikeeva et al., 2013)	83.2	57.7	1*(Teusner et al., 2013b)	PR 1.18	
<b>Favourable visiting pattern (combination of visiting, check-up visit and regular dentist)</b>						
Favourable (%)	2*(Chrisopoulos et al., 2011, Teusner et al., 2014a)	55.4 - 62.8	23.5 - 31.1	1*(Teusner et al., 2014a)	PR 1.82, 1.95	2
Intermediate (%)	1*(Chrisopoulos et al., 2011)	27.9	40.3	–	–	
Unfavourable (%)	1*(Chrisopoulos et al., 2011)	9.3	28.7	–	–	
<b>Reason for visit</b>						
Relief of pain (%)	2*(Brennan et al., 1997, Brennan et al., 2013) 1^(Australian Institute of Health and Welfare, 2002)	10.5 - 28.5	25.8 – 48.5	1*(Brennan et al., 2013)	PR 0.60	
Check-up (%)	7*(Brennan et al., 1997, Australian Research Centre for Population Oral Health, 2010, Chrisopoulos et al., 2011, Spencer and Harford, 2007a, Australian Research Centre for Population Oral Health, 2008a, Sivaneswaran, 2009, Anikeeva et al., 2013) 1^(Australian Institute of Health and Welfare, 2002)	42.5 - 71.3	27.7 – 57.1	1(Anikeeva et al., 2013)	NS	
Problem (%)	4*(Australian Research Centre for Population Oral Health, 2008a, Chrisopoulos et al., 2011, Roberts-Thomson et al., 2011, Roberts-Thomson and Stewart, 2003)	27.0 – 33.0	42.9 – 67.0	2*(Roberts-Thomson et al., 2011, Roberts-Thomson and Stewart, 2003)	OR 0.65 RR 1.7†	3
<b>Sector of visiting at last visit</b>						
Private (%)	3*(Chrisopoulos et al., 2011, Sivaneswaran, 2009, Spencer and Harford, 2007a)	88.0 – 95.2	73.6 – 76.8	–	–	
Public (%)	1*(Chrisopoulos et al., 2011)	1.7	13.4	–	–	
Regular dentist (%)	2*(Spencer and Harford, 2007a, Sivaneswaran, 2009)	88.9 – 90.2	68.8 – 72.3	–	–	

(a) Percentage or mean insured or uninsured. Percentage reported as a range if outcome reported in more than one publication

(b) Ratios were either OR, odds ratios, PR, prevalence ratios, or RR rate ratios of the insured group relative to the uninsured.

\* Statistically significant difference

† Ratios where the insured group were the reference category

^ Differences between insured and uninsured not statistically tested

**Notes:** 1. First model adjusted for age, sex and HHI while the second adjusted additionally for attitudinal factors

2. Two levels of insurance cover were compared to the uninsured (reference group). Both PRs reported.

3. Population attributable fraction 23% (i.e. 23% of problem visiting can be avoided if the entire population was insured)

Mean number of visits among those who visited, were reported by three publications and were not statistically different between the insured and uninsured. Two publications (Chrisopoulos et al., 2011, Teusner et al., 2014a) created a composite variable: favourable visiting pattern. The insured had significantly higher proportions that had a favourable visiting pattern while the uninsured had a significantly higher proportion with an intermediate and unfavourable visiting pattern.

Reason for visit (usual reason and reason for last visit) was reported in 11 publications (Australian Institute of Health and Welfare, 2002, Anikeeva et al., 2013, Australian Research Centre for Population Oral Health, 2008a, Brennan et al., 2013, Brennan et al., 1997, Chrisopoulos et al., 2011, Australian Research Centre for Population Oral Health, 2010, Roberts-Thomson et al., 2011, Roberts-Thomson and Stewart, 2003, Sivaneswaran, 2009, Spencer and Harford, 2007a) with various categorisations - check-up, relief of pain/emergency, problem and others - in different studies. In all studies the differences between insured and uninsured were statistically significant. In unadjusted analyses, the proportion visiting for relief of pain/emergency ranged from 10.5% to 28.5 % for the insured and 25.8% to 48.5 for the uninsured. The proportion visiting for a check-up ranged from 42.5% to 71.3% for insured and 27.7% to 57.1% for the uninsured and the proportion visiting for a problem ranged from 31.0% to 33.0% and 42.9% to 67.0% for the insured and uninsured respectively.

The adjusted prevalence ratio for relief of pain visiting was 0.6 for the insured and check-up visiting was 1.1 (Not statistically significant (NS)). Visiting for a problem was negatively associated with dental insurance - the insured had 0.7 the odds of problem oriented visiting compared to uninsured.(Roberts-Thomson and Stewart, 2003) Another publication (Roberts-Thomson et al., 2011) reported a rate ratio of 1.7 with a population attributable fraction of 23% for the uninsured.

A few studies (Chrisopoulos et al., 2011, Sivaneswaran, 2009, Spencer and Harford, 2007a) reported on sector (public or private sector) of dental visiting and attending a regular dentist. About 90% of the insured visited the private sector and had a regular dentist. The uninsured had a significantly lower proportion for both variables.

### ***Service area outcomes***

Collated results for all service area outcome variables and their respective measures (proportions, means and ratios) are presented in Tables A1.5a and A1.5b. Two types of service level outcomes were reported; Services received or provided (data collected from consumers or practitioners) and services per visit; these were reported as proportions and mean number of services. All outcomes and their respective measures (proportions, means and ratios) are shown in the Table. All publications reported service area outcomes among only those who visited.

**Table A1.5a: Collated results - Dental service use outcomes – Services Received/Provided**

Dental service received/ Provided	Unadjusted			Adjusted		Notes
	Number of studies (reference/s)	Insured(a) Per cent/ Mean	Uninsured(a) Per cent/ Mean	Number of studies (reference/s)	Ratios (b)	
<b>Percent who received services (among those who visited in the last 12 months)</b>						
Fillings (%)	1(Australian Research Centre for Population Oral Health, 2012)* 2(Australian Institute of Health and Welfare, 2002, Australian Research Centre for Population Oral Health, 2008a)	37.2 – 48.9	42 – 50.0			
Restorative (%)	–	–	–	1(Brennan et al., 2000)	NS	
Extractions (%)	5*(Brennan et al., 1997, Australian Institute of Health and Welfare, 2002, Australian Research Centre for Population Oral Health, 2008a, Australian Research Centre for Population Oral Health, 2010, Australian Research Centre for Population Oral Health, 2012)	4.3 – 14.8	10.2 – 40.0	1*(Brennan et al., 2000)	OR 0.50	1
Scale and Cleans (%)	1*(Australian Research Centre for Population Oral Health, 2012)	83.5*	63.6			
Preventive (%)	–	–	–	1*(Brennan et al., 2000)	OR 1.42	
Diagnostic (%)	–	–	–	1(Brennan et al., 2000)	NS	
Root Canal (%)	1(Australian Research Centre for Population Oral Health, 2012)	7.0	7.2			
Endodontic (%)				1*(Brennan et al., 2000)	OR 1.52	
Crowns and Bridges (%)	1(Australian Research Centre for Population Oral Health, 2012)	11.3	9.8	1*(Brennan et al., 2000)	OR 1.94	
Gum Treatment (%)	1(Australian Research Centre for Population Oral Health, 2012)	4.5	4.5			
Dentures (%)	1*(Australian Research Centre for Population Oral Health, 2012)	3.2	6.3			
<b>Mean services received among those who visited in the last 12 months</b>						
Fillings (Mean)	1*(Chrisopoulos et al., 2011)	0.62	0.83			
Extractions (Mean)	1*(Chrisopoulos et al., 2011)	0.21	0.31			
Scale and Cleans (Mean)	1*(Chrisopoulos et al., 2011)	1.09	0.68			

(a) Percentage or mean insured or uninsured. Percentage reported as a range if outcome reported in more than one publication

(b) Ratios were either OR, odds ratios, PR, prevalence ratios, or RR rate ratios of the insured group relative to the uninsured.

\* Statistically significant difference

† Ratios where the insured group were the reference category

^ Differences between insured and uninsured not statistically tested

**Notes**

1. Results from one publication (Brennan et al., 2001) excluded as adjusted analysis used different sub categorisations of insurance status.

**Table A1.5b: Collated results - Dental service use outcomes Services Received/Provided (continued)**

Dental service received/ Provided	Unadjusted			Adjusted		Notes
	Number of studies (reference/s)	Insured <sup>(a)</sup> Per cent /Mean	Uninsured <sup>(a)</sup> Per cent /Mean	Number of studies (reference/s)	Ratios <sup>(b)</sup>	
<b>Per cent of persons receiving services per visit</b>						
Diagnostic (%)	1*(Brennan et al., 1997)	46.3	42.0	1(Brennan et al., 1997)	NS	
Preventive (%)	1*(Brennan et al., 1997)	29.4	20.0	1*(Brennan et al., 1997)	OR 1.37	
Extraction (%)	1*(Brennan et al., 1997)	4.3	10.0	1*(Brennan et al., 1997)	OR 0.52	
Restorative (%)	1 (Brennan et al., 1997)	42.0	43.0	1(Brennan et al., 1997)	NS	
Crown and Bridge (%)	1*(Brennan et al., 1997)	7.5	3.4	1*(Brennan et al., 1997)	OR 2.25	
Endodontic (%)	1(Brennan et al., 1997)	8.0	8.5	1*(Brennan et al., 1997)	OR 1.27	
Prosthodontic (%)	1(Brennan et al., 1997)	6.0	6.5	1(Brennan et al., 1997)	NS	
<b>Mean services per visit</b>						
Total (Mean)	1(Brennan et al., 1997)	2.15	1.96			
Diagnostic (Mean)	1(Brennan and Spencer, 2002)	0.66	0.65	1(Brennan and Spencer, 2002)	NS	
Examination (Mean)	1(Brennan and Spencer, 2007)	0.36	0.34	1(Brennan and Spencer, 2007)	NS	
Radiograph (Mean)	1(Brennan and Spencer, 2007)	0.32	0.37	1(Brennan and Spencer, 2007)	NS	
Preventive (Mean)	1*(Brennan and Spencer, 2002)	0.42	0.29	1*(Brennan and Spencer, 2002)	RR 1.27	1
Prophylaxis (Mean)	1(Brennan and Spencer, 2007)	0.20	0.16	1(Brennan and Spencer, 2007)	NS	
Topical fluoride (Mean)	1(Brennan and Spencer, 2007)	0.07	0.04	1(Brennan and Spencer, 2007)	NS	
Extraction (Mean)	2*(Brennan and Spencer, 2002, Brennan and Spencer, 2007)	0.06, 0.04	0.13, 0.13	1*(Brennan and Spencer, 2002)1(Brennan and Spencer, 2007)	RR 0.50 & NS	2
Restorative (Mean)	1*(Brennan and Spencer, 2007)1(Brennan and Spencer, 2002)	1.24, 0.66	1.02, 0.60	2(Brennan and Spencer, 2002, Brennan and Spencer, 2007)	NS	
Crown and Bridge (Mean)	1*(Brennan and Spencer, 2002)	0.13	0.06	1(Brennan and Spencer, 2002)	NS	
Endodontic (Mean)	2(Brennan and Spencer, 2002, Brennan and Spencer, 2007)	0.03, 0.13	0.06, 0.13	2(Brennan and Spencer, 2002, Brennan and Spencer, 2007)	NS	
Prosthodontic (Mean)	1(Brennan and Spencer, 2002)	0.09	0.11	1(Brennan and Spencer, 2002)	NS	
General (Mean)	1(Brennan and Spencer, 2002)	0.05	0.05	1(Brennan and Spencer, 2002)	NS	

(a) Percentage or mean insured or uninsured. Percentage reported as a range if outcome reported in more than one publication

(b) Ratios were either OR, odds ratios, PR, prevalence ratios, or RR rate ratios of the insured group relative to the uninsured.

\* Statistically significant difference

† Ratios where the insured group were the reference category

^ Differences between insured and uninsured not statistically tested

Notes

1. Reported as weak effect
2. Reported as a moderate effect

Extraction services were most commonly reported and in all publications (Australian Institute of Health and Welfare, 2002, Australian Research Centre for Population Oral Health, 2008a, Australian Research Centre for Population Oral Health, 2012, Brennan et al., 1997, Australian Research Centre for Population Oral Health, 2010) they were found to be significantly higher among the uninsured in unadjusted analysis and a significant adjusted rate ratio or odds ratio in multiple variable analyses. This was true for all four measures; percentage of respondents receiving extractions and extractions per visit and mean number of extractions and extractions per visit.

Preventive services were reported in all four measures and were found to be significant in all unadjusted and adjusted analysis with significant odds ratios of 1.4 for percent of preventive services and mean number of services and rate ratio of 1.37 for services per visit.

Adjusted estimates were reported for crown and bridge and endodontic services for three of the four outcomes. Both services were associated with insurance status with odds ratio ranging from 1.3 to 1.5 and 1.9 to 2.3 for endodontic and crown and bridge services respectively for the insured. One publication (Brennan and Spencer, 2002) that reported on mean number of services reported a non-significant association. Two publications (Brennan and Spencer, 2002, Brennan and Spencer, 2007) which analysed mean services per visit reported non-statistically significant estimates in adjusted analysis for both types of services.

In unadjusted analyses there were mixed results for filling and restorative services. The insured had statistically significantly higher proportion and mean number of scale and cleans. No papers reported significant results for all other service areas in adjusted analysis.

### **Oral health outcomes**

Oral health outcomes included clinical outcomes measured and collected through a clinical examination, and self-reported outcomes collected by mailed survey or telephone questionnaires directly from the respondents. Both clinical (Table A1.6a) and self-reported oral health outcomes (Table A1.6b) were reported in the 12 publications reporting oral health outcomes (Table A1.6). One publication (Chrisopoulos et al., 2011) reported from two different studies.

### ***Clinical outcomes***

The most common clinical oral health outcomes were related to caries and periodontal disease. Caries was reported in the form of Decayed Missing and Filled Teeth (DMFT) and its components (mean and percentages) and Decayed, Missing and Filled Surfaces (DMFS) and decayed surfaces.

**Table A1.6a: Collated results – Oral health outcomes – Clinically measured**

Clinically measured outcomes	Unadjusted			Adjusted		
	Number of studies (reference/s)	Insured <sup>(a)</sup> % / Mean	Uninsured <sup>(a)</sup> % / Mean	Number of studies (reference/s)	Ratios <sup>(b)</sup>	Notes
Decayed tooth (Mean)	1*(Armfield et al., 2009)	0.38	0.82	1*(Armfield et al., 2009)	S	1
Missing tooth (Mean)	1*(Armfield et al., 2009)	4.17	5.04	1*(Armfield et al., 2009)	S	
Filled tooth (Mean)	1*(Armfield et al., 2009)	8.99	6.79	1*(Armfield et al., 2009)	S	
DMFT (Mean)	1*(Armfield et al., 2009), 1(Sivaneswaran, 2009)	12.80, 14.08	13.10, 13.18	1(Armfield et al., 2009)	NS	
Missing teeth due to pathology (%)	1*(Sivaneswaran, 2009)	4.1	5.7			
Decayed teeth (%)	4*(Sivaneswaran, 2009, Jamieson et al., 2009, Mejia, 2010, Chrisopoulos et al., 2011)	19.4 – 21.9	30.4 – 43.9	1(Jamieson et al., 2009)	NS	2
No Decay (%)	1*(Mejia, 2010)	31.2	24.0	-		
One or more Filled teeth (%)	1 (Mejia, 2010)	61.1	55.2	-		
Missing tooth due to caries (%)	1*(Mejia, 2010)	2.9	8.4	-		
DMFS (Mean)	1(Roberts-Thomson and Stewart, 2008)	5.93	6.24	-		
Decayed surfaces (Mean)	1(Roberts-Thomson and Stewart, 2008)	0.65	1.05	-		
Precavitated decayed surfaces (Mean)	1*(Roberts-Thomson and Stewart, 2008)	1.71	2.91	1(Roberts-Thomson and Stewart, 2008)	NS	
<b>Cariou lesion severity among those diagnosed with caries</b>						
Initial lesions (%)	1*(Brennan and Spencer, 2007)	30.0	19.6	-		
Cavitated lesions (%)	1(Brennan and Spencer, 2007)	49.3	45.7	-		
Gross lesions (%)	1*(Brennan and Spencer, 2007)	20.7	34.7	-		
<b>Periodontal disease measures</b>						
Periodontal disease (%)	1*(Chrisopoulos et al., 2011)	19.4	27.0	-		
> 4mm periodontal Pocket Depth (%)	2(Sivaneswaran, 2009, Chrisopoulos et al., 2011)	18.3 – 21.7	21.6 – 21.7	-		
Clinical attachment loss of 4+mm (%)	1(Chrisopoulos et al., 2011)	42.1	47.1	-		

\* Statistically significant difference

† Ratios where the insured group were the reference category

(a) Percentage or mean insured or uninsured reported as a range if outcome reported in more than one publication

(b) Ratios were either OR, odds ratios, PR, prevalence ratios, or RR rate ratios of the insured group relative to the uninsured.

**Notes**

- Two publications reported from the same study with one reporting for adults 18+ and the other for 15+. Only results from the study on adults 18+ was included in table. No estimates were provided for DMFT and its components in adjusted analysis. Only p-values were reported.
- Dental insurance was not reported in the final model and was assumed to not be significant and hence removed from the final model as reported in the methods.

While DMFT counts the number of Decayed Missing and Filled Teeth in a person's mouth, DMFS counts the number of surfaces Decayed, Missing and Filled tooth Surfaces.

Unadjusted analysis of mean DMFT showed different results in two different publications. Adjusted analysis was reported in one study which did not find any significant differences between the insured and uninsured. As for the individual components mean decayed, missing and filled teeth were all significant in both unadjusted and adjusted analysis.

Significant unadjusted results for percentage of untreated decay were reported in 4 publications (Chrisopoulos et al., 2011, Jamieson et al., 2009, Mejia, 2010, Sivaneswaran, 2009). Among the insured the percentage with untreated decay ranged from 19.4% to 21.9%, and among the uninsured it ranged from 30.5% to 43.9%, and one study reported that the uninsured had 60% higher odds of having untreated decay than the insured. In one (Jamieson et al., 2009) adjusted analysis of untreated decay dental insurance was not statistically significant.

Percentage of respondents with no dental decay, one or more filled teeth and missing teeth due to caries were all reported in one publication (Mejia, 2010). The insured had significantly higher percentages of respondents with no decay and one or more filled teeth and a lower percentage with missing teeth due to caries in unadjusted analysis.

Mean DMFS, decayed surfaces and precavitated decayed surfaces in unadjusted analysis were reported by one publication each (Roberts-Thomson and Stewart, 2008). Precavitated decayed surfaces were significantly higher among the uninsured. Another publication (Brennan and Spencer, 2007) reported on the distributions of three different severity levels of carious lesions among those with caries. Among the insured about half the respondents had cavitated lesions while 30% and 20% had initial and gross lesions, respectively. Among the uninsured the distribution was reversed with 35% having gross lesions, 20% initial lesions and the rest having cavitated lesions.

For periodontal outcomes, one publication (Chrisopoulos et al., 2011) reported periodontal disease and clinical attachment loss of 4+mm and two publications (Chrisopoulos et al., 2011, Sivaneswaran, 2009) (reporting from the same study) reported on pocket depth. The unadjusted differences between the insured and uninsured were significant only for the periodontal disease measure. One publication (Sivaneswaran, 2009) reported unadjusted estimates on the mean number of missing teeth due to pathology and found the uninsured had a significantly higher mean.

**Table A1.6b: Collated results – Oral health outcomes – Self Reported**

Self-reported outcomes	Unadjusted			Adjusted		
	Number of studies (reference/s)	Insured <sup>(a)</sup> % / Mean	Uninsured <sup>(a)</sup> % / Mean	Number of studies (reference/s)	Ratio <sup>s(b)</sup>	Notes
Self-rated Oral health: Good/very good /excellent (%)	3*(Australian Research Centre for Population Oral Health, 2008a, Sivanewaran, 2009, Teusner et al., 2014b)	79.9 – 88.2	63.8 – 83.0	1*(Teusner et al., 2014b)	PR 1.20 & 1.38	1
Dentate status :< 21 natural teeth (%)	1*(Sivanewaran, 2009)	7.3	16.2	-		
Edentulism (adults) (%)	1*(Sivanewaran, 2009)	2.3	8.4	-		
Edentulism (older adults) (%)	1*(Ringland et al., 2004)	16.0	33.0	1*(Ringland et al., 2004)	OR 0.50 †	
Missing teeth (Mean)	1*(Chrisopoulos et al., 2011)	4.70	6.20	-		
<b>Oral Health Impact Profile (OHIP)</b>						
Severity (Mean)	2*(Brennan and Spencer, 2005a, Sanders et al., 2009)	6.21-7.45	8.27-11.31	1*(Brennan and Spencer, 2005a)	‡	2
Prevalence (%)	1*(Sanders et al., 2009)	13.2	20.0	-		3
Counts (Mean)	1*(Brennan and Spencer, 2005a)	2.28	3.61	1(Brennan and Spencer, 2005a)	‡	
Scale Scores (Mean)	1*(Brennan and Spencer, 2005a)	6.08	8.25	1*(Brennan and Spencer, 2005a)	‡	
<b>Perceived need for treatment:</b>						
Extractions/ fillings (%)	1*(Sivanewaran, 2009)	26.3	35.9	-		
Urgent treatment (%)	1(Sivanewaran, 2009)	73.7	69.8	-		
<b>Toothache:</b> Very Often /Often/Sometimes (%)	3(Sivanewaran, 2009, Jamieson et al., 2010, Australian Research Centre for Population Oral Health, 2008a)	12.0 – 18.0	16.0 – 23.6	1(Jamieson et al., 2010)	NS	4
Orofacial pain (%)	1(Sivanewaran, 2009)	21.8	24.9	-		
Dissatisfied appearance (%)	1(Jamieson et al., 2010)	24.0	27.1	1(Jamieson et al., 2010)	NS	4
Food avoidance (%)	1*(Jamieson et al., 2010)	13.1	22.3	1(Jamieson et al., 2010)	NS	4
<b>Combined measures of toothache and mouth and denture problems</b>						
Never/Hardly Ever (%)	1(Ringland et al., 2004)	78.7 – 80.3	78.2 – 81.1	1(Ringland et al., 2004)	Ref	
Sometimes (%)	1(Ringland et al., 2004)	12.6 – 14.9	10.9 – 15.6	1(Ringland et al., 2004)	NS	
Often/Very Often (%)	1(Ringland et al., 2004)	6.9 – 7.1	5.7 – 8.0	1(Ringland et al., 2004)	NS	
<b>Combined measure of toothache, food avoidance and discomfort due to mouth appearance</b>						
Any of the three (%)	1(Jamieson et al., 2010)	39.9	45.1	1(Jamieson et al., 2010)	NS	4
All of the three (%)	1*(Jamieson et al., 2010)	2.1	9.1	1(Jamieson et al., 2010)	NS	4

\* Statistically significant difference, † Ratios where the insured group were the reference category, ‡ Significant beta estimates

(a) Percentage or mean insured or uninsured reported as a range if outcome reported in more than one publication

(b) Ratios were either OR, odds ratios, PR, prevalence ratios, or RR rate ratios of the insured group relative to the uninsured.

Notes: 1. Interactions with household income explored. PR were significant for only the two lower income groups (up to \$80,000)

2. Effect size (Sanders et al 2009): 33% (ratio of net difference of the uninsured group divided by the insured group)

3. Effect size: 52% (ratio of net difference of the uninsured group divided by the insured group)

4. Insurance not included in the final model as it was not a significant factor

### ***Self-reported outcomes***

The self-reported outcomes were varied; only global self-reported dental health (SRDH), toothache frequency, OHIP severity and edentulism (having no teeth) were reported by more than one publication (Table A1.6b).

Global self-reported oral health was reported in three publications (Australian Research Centre for Population Oral Health, 2008a, Sivaneswaran, 2009, Teusner et al., 2014b), all of which showed a significant positive association between having insurance and reporting good to excellent oral health. One of these studies (Teusner et al., 2014b) also provided adjusted prevalence ratios and assessed the interaction between insurance and household income.

Among those in the two lower income groups (up to \$80,000 household income) the insured had higher adjusted prevalence ratios (1.4 and 1.2 respectively) for having good to excellent SRDH. However for adults in the two highest income groups, having insurance was not associated with good SRDH.

Unadjusted estimates of the association between self-reported toothache and insurance status were reported in three publications (Australian Research Centre for Population Oral Health, 2008a, Jamieson et al., 2010, Sivaneswaran, 2009). The association between insurance status and experiencing toothache very often, often or sometimes in the last 12 years was not statistically significant in any of the three publications.

Inadequate dentition (less than 21 natural teeth) proportions were significantly higher among the uninsured in unadjusted analysis. Edentulism was reported in two publications but were reported separately as respondents were from different age cohorts. One publication (Sivaneswaran, 2009) which reported on the total adult population of NSW reported a higher rate of edentulism among the insured. The other publication (Ringland et al., 2004) that also reported adjusted odds ratios had its respondents drawn from an older adult population (Adults aged 65 and over). The unadjusted odds ratio of insured being edentulous, compared to uninsured was 0.4 while the adjusted odds ratio was 0.5.

Self-reported missing teeth was reported in one publication (Chrisopoulos et al., 2011) and was found to be significantly associated with being uninsured in unadjusted analysis. Unadjusted analysis of perceived need for extractions or fillings and urgent (within 3 months) treatment was reported in another study (Sivaneswaran, 2009). The uninsured had a significantly higher need for extractions or fillings than the insured while there were no differences in the need for urgent treatment.

Two combined self-reported variables were reported in the reviewed literature. One was a combined measure of toothache and mouth or denture problems in the last year (Ringland et al., 2004). Frequency of symptoms experience was not associated with insurance status in both unadjusted and adjusted analysis.

The other combined variable was oral impairment, a composite variable based on frequency of oral symptoms experience (Jamieson et al., 2010). The uninsured had a higher percent experiencing all three symptoms than insured. However, there were no differences between insured and uninsured for those who reported at least one symptom. In this study oral health impairment was not included in the final adjusted regression model and was hence considered non-significant.

Two measures of oral health impact were reported in one publication (Sanders et al., 2009). Oral Health Impact Profile (OHIP) severity and prevalence were both significantly higher among the uninsured. Another publication (Brennan and Spencer, 2005a) reported three measures of OHIP: counts, additive scores (severity) and scale scores. All three measures were positively associated with being insured in bivariate analysis. OHIP severity and scale scores were also significantly associated with dental insurance status in adjusted analysis.

## **Discussion of review results**

This review examines evidence from 36 publications that reported on the association between dental insurance and dental service use and, or oral health outcomes. The outcome variables for both outcome groups (i.e., service use and oral health outcomes) were heterogeneous, with proportions and means being the two main measures that were reported. The evidence for most outcome variables was limited to a single or a few publications while only three variables were reported in five or more publications. There was also considerable heterogeneity in the reported categories of some outcome variables. For instance, time since last visit was categorised into last 12 months and last 2 years or into less than 12 months, 1-2 years, more than two years and so on.

The consolidated evidence points towards a positive association between dental insurance and dental visiting. Literature on dental visiting considers, visiting a dentist in the last two years, visiting the same dental professional regularly and visiting for a check-up as favourable or beneficial patterns of dental visiting (Crocombe et al., 2012b). This review demonstrates positive associations between all these three outcomes and being dentally insured. Service level outcomes on the other hand suggested a positive association for diagnostic, preventive (including only scale and cleans), dentures and crown and bridge services and a negative association for

extraction services, once again suggesting a favourable service pattern for those with dental insurance.

Consolidated unadjusted evidence for oral health outcomes suggests dental insurance has some favourable associations with both clinical and self-reported oral health outcomes. Global self-reported oral health was consistently positively associated with being insured and untreated decay was consistently negatively associated with having dental insurance in unadjusted results. Several other self-reported outcomes were significant but were reported only in one publication. While periodontal pocket depth and toothache experience were reported in more than one publication, they did not vary by insurance status. Individual components of DMFT and other caries measures were associated with dental insurance.

While unadjusted differences in outcomes between the insured and uninsured provide a descriptive understanding of the associations, they fail to take into consideration other factors that potentially attenuate or strengthen the association. The report of The National Advisory Council on Dental Health in 2012 (Australian Government, 2012) recognised the complex and varied structural, social and individual factors that affect dental service use. About two-thirds of the publications reported adjusted analyses, adjusting for several different factors, depending on the aim of the paper. The most common adjusted analysis was for the socio-economic variables.

The insurance effects observed for most of the reported dental visiting and service level variables were largely unaltered in adjusted analysis. However, for health outcomes the collated adjusted results were mixed. After adjusting for other explanatory variables associations between insurance and global self-rated oral health remained significant, but were not significant for untreated decay and other caries measures. Two of the three OHIP measures reported in adjusted analysis were significant. With the exception of dentate status, adjusted estimates for other self-reported measures were either not reported or not significant. These findings broadly reflect the associations found between regular visiting and health. It is important to note that the adjusted results for oral health outcomes were drawn from a small number (n=6) of publications but most significant results for oral health outcomes were reported from larger studies based on nationally representative samples. Hence, the available evidence for oral health outcomes and insurance is mixed and limited.

### **Quality, strength of evidence and selection bias**

All papers reported on observational studies. While observational studies are not the highest level of research evidence, overall the quality of the publications in the review was considered high. The viability of conducting experimental studies in health insurance research is very low, as evidenced by the fact that there has only been one

RCT which explored the effects of health insurance on health service use (Manning et al., 1985). The majority of the papers were published in peer-reviewed journals. Only one paper was excluded after quality assessment.

Several studies employing a range of analytical approaches have assessed the endogeneity of insurance in the context of dental service use (i.e. selection bias associated with selection into dental insurance)(Cooper et al., 2012, Hopkins et al., 2013, Munkin M, 2008, Srivastava et al., 2014). These studies all concluded that a slight to substantial bias, was present, however after accounting for selection bias the significant effects of insurance persisted. While important, explicitly accounting for endogeneity of insurance (i.e. selection bias) was not treated as an essential quality criterion for the purposes of this review. Assessment of this type of bias is relevant to papers where insurance is the main explanatory variable, which was not the case for many of the publications. One publication in the review (Srivastava et al., 2014) which explicitly controlled for endogeneity concluded that bias was present but the effect of dental insurance remained. Given the prohibitive costs of conducting experimental studies in this field of research, future studies to estimate potential selection bias are required.

### **Limitations**

While there are similarities between Australia and other countries in terms of Australian dental financing arrangements, the regulatory framework of Australian PHI market is unique. The generalisability of these findings to other countries may be limited. Similarly significant changes in future policy on health insurance and dental service delivery may also affect the application of these results in Australia.

This review, though not a systematic review contains several elements and approaches that are akin to systematic reviews: the research question was focussed and the outcomes were specific, the literature search was systematic and comprehensive with a priori criteria for inclusion and exclusion in the review, the quality of the reviewed papers was assessed and data extraction was conducted by two authors, a narrative synthesis of the data has been provided with supporting tables consolidating the results by outcome and the PRISMA statement for reporting systematic reviews was followed where applicable.

However, the literature search and sifting process was independently done by only one reviewer. This can lead to researcher bias but has been ameliorated by seeking feedback from experts in the field to identify any literature that may have been incorrectly eliminated due to any bias. A meta-analysis was not considered to add additional value to the results due to the variations in data from the different studies

and the varied number of outcome variables and measures reported for each outcome group.

The conclusions drawn from a review of existing evidence are only as valid as the evidence it summarises. All limitations that affect the studies that were reported in these publications remain. Additionally, the collated results are further limited by the variability in the data. The data in these publications is drawn from samples that differ in age, gender, geographical area and also drawn from different sampling frames.

### **Public health implications**

Oral diseases are one of the most common chronic diseases and their high prevalence makes them an important public health concern. Poor oral health has a negative impact on quality of life and remediation can impose a large financial burden on the individual (e.g. out of pocket expenses) and society (e.g. productivity costs). Difficulty in accessing timely dental care can also lead to secondary health system costs (i.e. increased GP visits, emergency and hospital admissions for preventable oral conditions) (The National Advisory Council on Dental Health, 2012). Consequently the National Oral Health Plan recognises the importance of improving access to dental health services as a population health approach to improving oral health (National Advisory Committee on Oral Health (NACOH), 2004). Dental insurance in effect provides a relatively modest cost attenuation at point of care. Ultimately understanding the impact of dental insurance assesses the effect of this cost attenuation on dental service use and oral health.

At a health system level, there is evidence that PHI policies are regressive in nature and have potentially increased inequity in access (Fitzgerald et al., 2011, Harford and Spencer, 2004). In addition, the exclusionary nature and low annual claim limits of dental plans typically offered in Australia do not protect individuals from large and potentially catastrophic dental costs associated with service use necessary for the maintenance of a functional dentition. While this review found statistically significant associations between being insured and favourable patterns of dental service use and some associations with good oral health, these findings do not necessarily support private insurance or existing policies aimed at subsidising PHI. Alternative insurance systems (e.g. public insurance, social insurance) structured to address equity issues may achieve both better access to care and equity.

### **Areas for future research**

As noted earlier, dental service use variables were more commonly reported than oral health outcomes. Even among the publications that reported health outcomes, very few outcomes were reported more than once and all of them reported from cross-sectional data. Notably there were no publications examining associations between

insurance status and treatment decisions and follow-up by patients, and few publications on chronic oral health conditions, perceived need for care and quality of life outcomes.

Study designs in this review were predominantly cross-sectional and three publications reported on short duration cohort studies. More cohort studies of longer duration would contribute to extending the evidence base. If insurance was found to be effective, the cost-effectiveness of insurance will need to be ascertained to inform future policy.

As noted earlier socioeconomic factors are key potential confounders in studies of dental service use and insurance. After sex and age, household income was the most commonly controlled variable in the reviewed publications. Higher SES is a predictor of accessing care and a predictor of having PHI (Manski et al., 2002, Locker et al., 2011). Those with higher incomes are more able to afford PHI, and incur tax surcharges if they remain uninsured (Australian Tax Office, 2014). Theoretically, accounting for SES further isolates the influence of insurance, but several studies identified an interaction between household income and insurance (Anikeeva et al., 2013, Teusner et al., 2014a, Teusner et al., 2014b) status in relation to dental visiting and SRDH. Future studies should assess the modifying effects of SES in the associations between insurance and service use and/or oral health.

### **Conclusions from the review**

The available evidence in Australia suggests that the dentally insured are more likely to have more regular access to dental care and a more comprehensive pattern of service use. Conclusions regarding the association between dental insurance and oral health are less clear. While results were mixed and there was paucity of studies reporting multiple variable analysis, the studies reviewed broadly reflected the associations usually found between regular care and oral health, that is, dental insurance was not associated with less disease experience but was associated with better managed disease (less untreated decay and more filled teeth).

Ultimately understanding the impact of dental insurance is aimed at assessing the effect of relatively modest cost attenuation (at point of care) on access to dental care and oral health. The finding that dental insurance is strongly associated with dental care is not necessarily support for private insurance or for the government's policies supporting PHI. At a health system level there is much evidence to suggest these policies are regressive in nature and have potentially increased inequity in access. However alternative insurance systems (e.g. public insurance, social insurance) structured to address equity issues may achieve both better access to care and equity.

**Authorship declaration for Appendix 1**

*The PhD student developed the search strategy and criteria with input from the supervisors and colleagues. The database searching, retrieving and sifting of titles and abstracts were independently done by the PhD student and the quality assessment was conducted by a colleague. All papers in the final list of search results were independently read by the PhD student and data was extracted into a table developed by the student and a colleague. Synthesis of results and drafting of manuscript was done by the PhD student with input from a colleague and discussion of results was done by all.*

## Appendix 2: Literature Review Sifting Table

<b>Table A2.1a: Literature search results – Publications identified in initial database searches</b>										
<b>Title Sifting</b>		<b>Inclusion and Exclusion Criteria</b>						<b>Total papers identified Country</b>		
		<b>Australia</b>	<b>Epidemiological study/ Review</b>	<b>Adults</b>	<b>Dental Insurance</b>	<b>Oral Health Outcomes/ Service Use</b>	<b>Relationship between Outcomes/Service Use and Dental Insurance</b>			
Number of papers eliminated based on title		135	17	36	327	195	344	436		
<b>Abstract Sifting</b>										
<b>Year</b>	<b>Authors</b>	<b>Australia</b>	<b>Epidemiological study/Review</b>	<b>Adults</b>	<b>Dental Insurance</b>	<b>Oral Health Outcomes</b>	<b>Oral Health Service Use</b>	<b>Relationship between Outcomes/Service Use and Dental Insurance</b>	<b>Full paper Review</b>	<b>Country</b>
1991	Mendoza, Newcomb & Nixon	AUS	Yes	Not Clear	Yes	Yes – Plaque score, periodontal disease severity	Yes	Yes	Yes	AUS
1995	Roberts-Thomson, Brennan and Spencer	Yes	Yes	Yes	No	No	Yes	Yes	No	Aus
1996	Hawthorne and Smales	Yes	Not Clear	Yes	No	No	No	No	No	Aus
	Slade et al	Yes	Yes	Yes – 65+	No	Yes	Yes	No	NO	Aus, Canada, NC US
1997	Brennan, Spencer and Szuster	Yes	Yes	Yes?	No	Yes	Yes	Yes	Yes	Aus
	Appollonio et al	No	Yes	Yes	No	Yes	No	No	No	
1998	Slade et al	Yes	No	Yes	No	Yes	No	No	NO	Global?
1999	Sivaneswaran, Taylor and Lazarus	Yes	Yes	Yes - 18+	Yes – Insured only	No	Yes	No	No	NSW, Aus

2000	Brennan, Spencer and Slade	Yes	Yes	Yes	No	Yes	No	No	No	Aus
	Brennan, Spence and Szuster	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
	Sivaneswaran, Taylor and Lazarus	Yes	Yes	Yes	Yes – Only insured through a health insurance duns	No	Yes	No	No	NSW, Aus
2001	Brennan, Spencer and Szuster	Yes	Yes	Yes	Yes	Yes	Yes – Extractions only	Not Clear	Yes	Aus
2002	Brennan and Spencer (JPHD)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Australia
	Brennan and Spencer (CDH)	Yes	Yes	Yes	Yes	No	Not Clear	Yes	Yes	Australia
	Brennan and Spencer (IJBm)	Yes	Yes	Yes	No	Yes	Yes	No	No	Australia
2003	Roberts-Thomson and Stewart	Yes	Yes	Yes – 20-24	Yes	Yes	Yes	Yes	Yes	SA, Aus
	Brennan and Spencer (ADJ)	Yes	Yes	Yes	No	No	Yes	No	NO	AUS
	Brennan and Spencer (IDJ)	Yes	Yes	Yes	No	No	Yes	No	No	
2004	Ringland et al,	Yes	Yes – NSW older people’s survey 1999	Yes – Older Adults	Yes	Yes	No	Yes	Yes	NSW,AUS
	Slack-Smith and Hyndman	Yes	Yes – NHS 1995	Yes 60+	Yes	Yes	Yes	Yes	Yes	Aus
2005	Australian Research Centre for Population Oral Health	Yes	Yes – NDTIS 2002	Yes	No	Yes	Yes	No	No	Aus
	Adegbembo et al	No	Yes	Yes	Yes	Yes	No	Yes	No	Canada
	Brennan and Spencer	Yes	Yes	Yes	Yes	No	Yes – Diagnostic, Preventive, Restorative, Extraction and Prosthodontic Services	Yes	Yes	Aus

	Godman et al	No	Yes	Yes	Yes	No	Yes	Yes	No	USA
	Persson and Persson	No	Not clear	Yes	No	Yes	No	No	No	North America?
	Smith and Shay	No	Yes	Yes	Not Clear	Yes	Yes	Not Clear	No	USA
	Sohn and Ismail	No	Yes	Yes	Yes	Yes	Yes	Yes	No	USA
2006	Australian Research Centre for Population Oral Health	Yes	Yes	Yes	No	Yes	Yes	No	No	Aus
	Brennan and Spencer	Yes	Yes	Yes	No	No	Yes	No	No	Aus
2007	Brennan and Spencer	Yes	Yes	Yes	Yes	No	Yes – Restorative and Extraction services	Yes	Yes	Aus
	Crocombe and Slade	Yes	Yes	Yes	No	Yes	No	No	No	Aus
	Curtis et al	Yes	Yes	Yes	No	No	Yes	No	No	NSW, Aus
	Doyle et al	No	Yes	Yes	No	No	Yes	No	No	USA?
	Maupome et al	No	Yes	Yes	No	No	Yes	No	No	USA
	Sibbritt, Byles and Cockrell	Yes	Yes	Yes – Aged women – 73-78 yrs.	Yes – Private ancillary insurance	No	Yes	Yes	Yes	Aus
	Slack-Smith et al	Yes	Yes – Aus Nat health Survey	Yes – 18-24	Yes	No	Yes	Yes	Yes	Aus
2008	Australian Research Centre for Population Oral Health	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
	Roberts-Thomson and Stewart	Yes	Yes	Yes – 20-25 yrs.	Not clear	Yes	Yes	Not clear	Not clear	SA, Aus
	Roberts-Thomson, Luzzi and Brennan	Yes	Yes	Yes 15+	No	Yes	Yes	No	No	AUS
	Seirawan	No	Yes	Yes	Not Clear	No	Yes	Not Clear	No	USA
2009	Armfield, Slade and Spencer	Yes	Yes	Yes	Yes	Yes	No	No	Not clear	Aus
	Australian Research Centre for Population Oral Health	Yes	Yes	Yes	No	Yes	No	No	No	AUS

	Jamieson et al	Yes	Yes – NSAOH	Yes – 15 -34	Not Clear	Yes	No	Not Clear	Yes	AUs
	Locker	No	Yes	Yes	No	Yes	No	No	No	Canada
	Sanders et al	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes?	AUS and USA
	Sivaneswaran	Yes	Yes – NSAOH	Yes	Yes	Yes	Yes	Yes	Yes	NSW, AUs
	Yuen et al	No	Yes	Yes	Yes	Yes	No	Yes	No	USA
2010	Boggess et al	No	Yes	Yes	No	Yes	Yes	No	No	USA
	Jamieson et al	Yes	Yes – NSAOH 04-06	Yes – 18-34	Not Clear	Yes	Yes	Not Clear	Yes	Aus
	Mejia	Yes	Yes	Yes – 18-30					Yes – No Abstract – Only full text	Aus
	Sibbritt, Byles and Tavener	Yes	Yes – Study on women’s health	Yes – Older women	Not Clear	No	Yes	Not Clear	Yes	AUS
	Williams, Parker and Jamieson	Yes	Yes	Yes	Not Clear	Yes	Not Clear	Not Clear	Yes	AUS
2011	Ahn et al	No	Yes	Yes	Not Clear	Yes	No	Not Clear	No	USA
	Evren et al	No	Yes	Yes	No	Yes	No	No	No	Turkey
	Janardhanan et al	No	Yes	Yes	No	No	Yes	No	No	USA
	Roberts-Thomson, Stewart and Do	Yes	Yes	Yes – young Adults	Yes	No	Yes	Yes	Yes	AUS
2012	Chaudhari et al	No	Yes	Yes	No	No	Yes	No	No	USA
	Geyer and Micheelis	No	Yes	Yes	Not Clear	Yes	No	No	No	Germany
	MacEntee et al	Yes	No	Yes	No	Yes	Yes	No	No	Aus and Canada
	Palfreeman and Zoellner	Yes	Yes	Yes	Yes – Only Medicare	No	Yes	Yes	Yes	Aus
	Rajabiun et al	No	No	Yes	No	No	Yes	No	No	USA
2013	Anikeeva, Brennan and Teusner	Yes	Yes	Yes- 30-61	Yes	No	Yes	Yes	Yes	AUS
	Bahadori et al									
	Brennan, Anikeeva and Teusner	Yes	Yes	Yes- 30-61	Yes	Yes	Yes	Yes	Yes	Aus
	George et al	Yes	Yes	Yes – Pregnant women - NSW	Not Clear	Yes	Yes	Yes	Yes	AUS

	George et al	Yes	Yes	Yes – Pregnant women - NSW	Not Clear	No	Yes	Yes	Yes	AUs
	Guiney et al	Not Clear	Yes	Yes	Not clear	No	Yes	Not Clear	Yes	??
	Laloo et al	Yes	Yes	Yes	No	Yes	No	No	No	Qld, AUS
	Ponnusamy et al	Yes	Yes	Yes	No	No	No	No	No	Tas, AUS
	Teusner, Brennan and Gnanamanickam	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	AUS
	Teusner, Brennan and Spencer	Yes	Yes	Yes – 45-54	Yes	No	Yes	Yes	Yes	AUS
2014	Jones , Parker and Jamieson	Yes	Yes	Yes	No	Yes	No	No	No	Aus
	Ju, Brennan and Spencer	Yes	Yes	Yes	No	No	Yes	No	No	AUS
	Listl, Moeller Manski	No	Yes	Yes	No	No	Yes	No	No	Europe
	Teusner, Anikeeva and Brennan	Yes	Yes – CEI Data	Yes – 30-61	Yes	Yes	No	Yes	Yes	AU
	Vujicic and Nasseh	No	Yes	Yes	Yes	No	Yes	Yes	No	USA

**Table A2.1b: Literature search results – Subsequent publications identified**

Additional Papers Identified through grey literature and experts										
Year	Authors	Established economies	Epidemiological study/ Review	Adults	Dental Insurance	Oral Health Outcomes	Oral Health Service Use	Relationship between Outcomes/Service Use and Dental Insurance	Full paper review	Country
2005	Brennan & Spencer	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Aus
2008	Vecchio	Yes	Yes	Yes – Older Australian	Not Clear	No	Yes	Not Clear	Yes	Aus
2009	Korda et al	Yes	Yes	Yes – Women 53 to 58 yrs.	Not Clear	No	Yes	Not Clear	Yes	Aus
2010	Australian Research	Yes	Yes	Yes – Older 60+	Yes	No	Yes	Yes	Yes	Aus

	Centre for Population Oral Health									
2013	Hopkins, Kidd and Ulker	Yes	Yes	Yes	Yes – Private Ancillary Health Insurance	No	Yes	Yes	Yes	Aus
2014	Teusner, Brennan & spencer	Yes	Yes	Yes	Yes – Private dental Insurance	No	Yes	Yes	Yes	Aus
<b>Additional Papers identified through Citation tracking and reference searching</b>										
<b>Year</b>	<b>Authors</b>	<b>Established economies</b>	<b>Epidemiological study/ Review</b>	<b>Adults</b>	<b>Dental Insurance</b>	<b>Oral Health Outcomes</b>	<b>Oral Health Service Use</b>	<b>Relationship between Outcomes/Service Use and Dental Insurance</b>	<b>Full paper review</b>	<b>Country</b>
2002	AIHW DRSU	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
2006	Gablinger, Savage and Hall	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
2007	Spencer and Harford in Slade et al	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
	Spencer and Harford	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
2008	AIHW DRSU	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Aus
2011	Chrisopoulos, Beckwith and Harford	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Aus
2012	Brennan and Ellershaw	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus



	Brennan and Spencer (CDH)	Yes	Yes	Yes	Yes	No	Not clear	Yes	No	Australia
2003	Roberts-Thomson and Stewart	Yes	Yes	Yes – 20-24	Yes	Yes	Yes	Yes	Yes	SA, Aus
2004	Ringland et al,	Yes	Yes – NSW older people's survey 1999	Yes – Older Adults	Yes	Yes	No	Yes	Yes	NSW,AUS
	Slack-Smith and Hyndman	Yes	Yes – NHS 1995	Yes 60+	Yes	Yes	Yes	Yes	Yes	Aus
2005	Brennan and Spencer	Yes	Yes	Yes	No - comparison was between dentists who had a higher % of insured and dentists who had a lower % of insured patients.	No	Yes – Diagnostic, Preventive, Restorative, Extraction and Prosthodontic Services	Yes	No	Aus
	Brennan and Spencer	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Aus
2006	Gablinger, Savage and Hall	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
2007	Brennan and Spencer	Yes	Yes	Yes	Yes	No	Yes – Restorative and Extraction services	Yes	Yes	Aus

	Sibbritt, Byles and Cockrell	Yes	Yes	Yes – Aged women – 73-78 yrs.	Yes – Private ancillary insurance	No	Yes	Yes	Yes	Aus
	Slack-Smith et al	Yes	Yes – Aus Nat health Survey	Yes – 18-24	Yes	No	Yes	Yes	Yes	Aus
	Spencer and Harford in Slade et al	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
	Spencer and Harford (ADJ)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
2008	AIHW DRSU	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Aus
	Australian Research Centre for Population Oral Health	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
	Roberts-Thomson and Stewart	Yes	Yes	Yes – 20-25 yrs.	Yes – Reported as private insurance	Yes	Yes	Yes	Yes	SA, Aus
	Vecchio	Yes	Yes	Yes – Older Australian 65+	Yes	No	Yes	Yes	Yes	Aus
2009	Armfield, Slade and Spencer	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Aus
	Jamieson et al	Yes	Yes – NSAOH	Yes – 15 -34	Yes	Yes	No	Yes	Yes	AUs
	Korda et al	Yes	Yes	Yes – Women 53 to 58 yrs.	No	No	Yes	No	No	Aus
	Sanders et al	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	AUS and USA
	Sivaneswaran	Yes	Yes – NSAOH	Yes	Yes	Yes	Yes	Yes	Yes	NSW, AUs
2010	Australian Research Centre for Population Oral Health	Yes	Yes	Yes – Older 60+	Yes	No	Yes	Yes	Yes	Aus
	Jamieson et al	Yes	Yes – NSAOH 04-06	Yes – 18-34	Yes	Yes	Yes	Yes	Yes	Aus

	Mejia	Yes	Yes	Yes – 18-30					Yes – No Abstract – Only full text	Aus
	Sibbritt, Byles and Tavener	Yes	Yes – Study on women’s health	Yes – Older women	No – only global private health insurance	No	Yes	No	No	AUS
	Williams, Parker and Jamieson	Yes	Yes	Yes	No	Yes	Not Clear	No	No	AUS
2011	Chrisopoulos, Beckwith and Harford	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Aus
	Roberts-Thomson, Stewart and Do	Yes	Yes	Yes – young Adults	Yes	No	Yes	Yes	Yes	AUS
2012	Brennan and Ellershaw	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Aus
	Palfreeman and Zoellner	Yes	Yes	Yes	No – Only Medicare under Chronic Disease dental Scheme	No	Yes	No	No	Aus
2013	Anikeeva, Brennan and Teusner	Yes	Yes	Yes- 30-61	Yes	No	Yes	Yes	Yes	AUS
	Brennan, Anikeeva and Teusner	Yes	Yes	Yes- 30-61	Yes	Yes	Yes	Yes	Yes	Aus
	George et al	Yes	Yes	Yes – Pregnant women	No – Only private	No	Yes	No	No	Sydney, Aus



### Appendix 3: Final Review and data extraction

Authors (year)		Outcome variables					
Data source /sampling frame	Study participants	Methods	Dental service use	Oral health	Controls/ covariates	Main findings	Comments
<b>1. Teusner et al. (2014a)</b>							
NDTIS 2008: Random sample of Australians aged 5+. Two stage stratified design - 18+ from electoral roll and matched with electronic white pages to retrieve telephone numbers. These were stratified by state and region and a systematic sample of households was drawn from each stratum. A person aged 5+ was randomly selected from contacted household.	Dentate working aged adults (18 + years) n = 1984  Data collected by telephone interview.	Cross-sectional study  Analysis was restricted to dentate persons.  Bivariate associations were reported.  Multiple variable associations were tested by estimating adjusted prevalence ratios (Poisson regression model, confidence intervals adjusted to take account of design effects)	The outcome variable was favourable dental visiting, yes / no derived from a respondent's visiting frequency, usual reason for a visit and usual provider. Those who visited on average at least once per year, usually visited for a check-up (as opposed to a problem) and usually visited the same provider, were categorised as having a favourable visiting pattern	Nil	The main explanatory variables were level of dental insurance (higher and lower). Other explanatory variables were age (categorised into four groups) sex, region, tooth brushing, (categorised into those brushing twice a day or more and those brushing less than twice a day), toothache experience, smoking status, SRDH, household income group (3 groups), difficulty paying \$150 dental bill.	38% had favourable dental visiting, 26.1% had lower cover, and 18% had higher cover, 55. (% was uninsured). Favourable visiting varied significantly by dental insurance status, lower: 55.4%* (48.7,62.0) and higher 59.4%* (49.8,68.3) Adjusted for other variables Favourable dental visiting was associated with having dental insurance but there was no variation in visiting by level of cover. Lower cover PR: 1.82* (1.46,2.27), higher cover PR:1.95* (1.55,2.46)	Models were stratified by Household income group were also assessed. The association between insurance and favourable visiting was modified by household income. Both levels of cover were associated higher prevalence of favourable visiting for those in the two lowest income groups, but not associated for those in the highest income group.

<b>2. Teusner et al. (2014b)</b>							
Cross-sectional survey data/ random sample of 3,000 adults from Australian electoral roll Data was from a prospective cohort study that drew its sample from the Australian electoral roll aged 30-61 years.	Dentate working aged adults (30 to 61 years of age) n = 1,052 Data was collected through a mail questionnaire at baseline and a follow up questionnaire at the end of one year. A log book of dental services received was maintained through the 12 months period.	Cross-sectional study Analysis was restricted to dentate persons. Bivariate associations were reported. Multiple variable associations were tested using a log binomial regression model and prevalence ratios generated. A subsequent model also included and interaction term for insurance and household income.	Nil	The outcome variable was self-rated oral health consisting of a global self-rating dichotomised into those who reported good/very good/excellent and poor/very poor.	The main explanatory variables were dental insurance and household income coded into approximate tertiles. Other explanatory variables were age (categorised into three groups) gender and tooth brushing (categorised into those brushing twice a day or more and those brushing less than twice a day.	RR – 39.1% n=1052 dentate respondents. 72.4% of the respondents rated their health as good/very good/excellent. 53.9 % were insured. SRDH varied significantly by dental insurance status (79.9:63.8). Dental insurance was significantly associated with good dental health for the two lowest income groups (<40,000 -PR: 1.38(1.07, 1.78) and 40k-80k) 1.20 (1.05, 1.37)) but not for the higher income groups. This association was similar in the model with the interaction term.	Household income modified the relationship between dental insurance and self-rated dental health with insurance status having a greater impact on visiting among lower income households.
<b>3. Srivastava et al. (2014)</b>							
NSAOH 2005/ households randomly sampled from the Australian electoral roll.	11,231 Australian dentate adults aged 15 years and over	Observational study, Analytical approach: simultaneous equation framework to investigate the interrelationships	Insurance and visit equation: visited in the last 12 months	Nil	Insurance and visit models : Dental insurance, derived premium price, age; gender; ATSI status; geographic remoteness, born in Australia;	72.3% of those who were insured visited in the last 12 months while 53.3% of the uninsured visited. There was a positive association between insurance and the probability of dental visit after controlling for observed socioeconomic, demographic	Modelling approach accounts for potential reverse causation between service use and dental health, and for potential endogeneity of

between dental health, private dental insurance and the use of dental services.

language spoken at home; education(beyond year 12); individual income, dwelling status (rented, mortgages, and rent-free); state of residence and smoking status, dental anxiety, Concession health care card (eligible to public dental care), dentist density, flossing (proxy for risk aversion)  
Health equation: flossing, recent symptoms (toothache, sore gums, bleeding gums, sensitive teeth, broken tooth, pain in jaw/face)

and risk variables, and dental health status.  
Probability of an uninsured individual visiting the dentist if they became insured would increase from 43% to 66% (average insurance effect 56%).

After correcting for the endogeneity of oral health, insurance is positively correlated with oral health, reinforcing previous evidence that there is advantageous selection and risk aversion in health insurance purchase.

private health insurance in dental service use.  
Controlling for the endogeneity of insurance reduces bias and increases the size of the estimated effect of insurance on dental service use  
The total effects= direct effect of variables on the probability of seeing a dentist and indirect effects through the influence of variables on the take-up of private insurance and oral health.  
For most variables, the direct effect on insurance dominates total effects and the indirect effect on insurance take-up through oral health is small and insignificant  
Only coefficients were reported

with their  
respective  
standard errors –  
no PRs

#### 4. Teusner et al. (2013b)

Random sample of 2248 adults from the electoral roll in South Australia of Adults aged 45-54. Survey data prospectively collected over 2-year period	45-54 yr. old South Australian adults N=529 n=452 after excluding edentulous, those with unknown insurance status and those with incomplete service use data for the two-year period.	The study was a two-year prospective cohort study supplemented by a follow up questionnaire. Data was collected at baseline through a mail questionnaire in 2004-05. An annual dental service log book was used to collect dental service use data over the two-year period. The supplementary questionnaire was sent to those who completed the 2 year dental service use component about 12 months after the 2 year period	The outcome variables were regular visits and recent visit. The regular visits variable was collected at baseline and was defined as usually period of visiting a dentist as once a year (yes/No). Recent visits were ascertained from the service use log books and were defined as making at least one dental visit during the two-year period (yes/No).	Nil	Private insurance details collected included plan type and whether it covered dental service use. Dental insurance status was determined if the respondents were insured for dental services for 12 months or more during the 2 year period. Dental care attitudes were collected using a 23 -item Likert scale developed by Gilbert et al. The six attitude components were quality of care, importance of dental visiting to prevent dental problems, eventuality of	RR-43.8% at baseline, of these 66.5% at 2 year follow up 75.25 had dental insurance, the majority (76.6%) of who were insured for more than 10 years. 63.7% had regular visits and 84.5% had visits during the 2 year period. Insured had a significantly higher proportion who made regular visits(71.0:41.5) and recent visits (88.0:72.3) After adjusting for age, sex and household income insurance was positively associated with both outcomes. PR: 1.57 (1.24, 2.00) and 1.21 (1.04, 1.40). After adjusting for additionally for the attitudinal factors as well insurance was positively associated with dental visits (PR: 1.48 (1.16-1.88) and recent visits (PR: 1.17 (1.01-1.36).	The PRs among the insured were marginally diminished when adjusting for the attitudinal factors. Dental care attitudes were collected after 2-year data collection period – potential temporality issues.
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to retrospectively collect information on dental insurance status and attitudes to dental care during the 2-year period of the service use data collection.

Dentate person whose dental insurance status was known were included in the analysis. Bivariate associations were tested using the Kruskal-Wallis test and adjusted prevalence ratios were generated using Poisson regression models for the two outcome variables.

decline of dental health, effectiveness of modern dentistry to solve dental problems, cost being a factor in dental care decisions and cynicism about the dental profession. Each attitudinal factor was dichotomised based on the sample median with the reference category being those whose mean score was less than the median. A factor analysis was done for the 6 factors. Age sex and household income were the other covariates used in the analysis.

5. Teusner et al. (2013a)							
<p>Cross-sectional survey data/ random sample of 3,000 adults from Australian electoral roll</p> <p>Data was from a prospective cohort study that drew its sample from the Australian electoral roll aged 30-61 years</p>	<p>Working aged adults (30 to 61 years of age). n= 552</p>	<p>Descriptive analysis</p> <p>Data was collected through a mail questionnaire at baseline and a follow up questionnaire at the end of one year. A log book of dental services received was maintained through the 12 months period.</p> <p>Only bivariate association were tested. Dental visiting was compared using a chi-square test and mean number of visits among those who visited were compared using ANOVA.</p>	<p>The main outcome variable of the study was expenditure though dental visiting (Yes/No) and number of dental visits among those who visited was also reported.</p>	<p>Nil</p>	<p>Dental insurance</p> <p>Other demographic and explanatory variables were reported but not adjusted for.</p> <p>Dental insurance status was for the period of the study and where there were discrepancies the status was defined by their status at the time of receiving care.</p>	<p>RR of 39.4% at baseline of which 53.1% responded at follow up. 57% had insurance for dental services. About 58.8% had made a dental visit during the two-year period.</p> <p>67.2 % of the insured visited while 45.1% of the uninsured visited, This difference was statistically significant. Among those who visited the mean number of visits was not different between the two groups. (2.3 visits uninsured, 2.5 visits insured)</p>	<p>Associations not adjusted by other factors.</p>
6. Hopkins et al. (2013)							
<p>Data was sources from the NHS 1995 and 2001. Both the studies survey</p>	<p>Households sampled 18,184 and 17,695 observations in 1995 and 2001.</p>	<p>Observational study. Compared two time points. Endogeneity (insurance status</p>	<p>The main outcome variable capturing dental care utilisation was time since the last dental visit which</p>	<p>Nil</p>	<p>PAHI</p> <p>Other explanatory variables included socio-economic (age, sex, health</p>	<p>1995: insured were 35.7 %, in 2001: 40.1 %</p> <p>Bivariate: in both years higher proportion of those with PAHI had visited a dentist at</p>	<p>Study explored the magnitude of endogeneity bias due to non-random selection</p>

households that are randomly chosen using a stratified multistage area sample, with subtle differences in how to individuals in the households were chosen. In 1995 general information on all members of the household were collected while in 2001 only information from one adult, one aged 7-17 and all children under 6 in each household was collected.	The paper reports on 18,184 (1995) and 17695(2001) respondent individuals for whom complete information on PAHI and dental care utilisation was available.	and dental service use) was accounted for by instrumental variables (wearing glasses and total number of glasses in household).  A joint maximum likelihood model that accounts for endogeneity in purchase of PAHI was used to estimate the relationship between PAHI and dental care utilisation. Two related instrumental variables - 'Glasses' - wearing glasses or not and 'total glasses' - no. of person in the household who wear glasses was used as dummy instrumental variables. The rationale was that both the variables were primary	was used as a categorical variable ranging from <3 months to 2 years or more.	care card status, income, English spoken at home, born in Australia and Education level, marital status, employment status), health risk characteristics(selected-reported health, smoking status, number of chronic health conditions, wearing glasses and number of glasses in household) and area of residence (Major city or not).	all categories of the recent visit variable except 2 or more years ago. < 3 months: Insured 20.23 – 22.08 Uninsured: 13.50- 13.06 3-6mnths: Insured 14.42 - 14.92 Uninsured: 8.94 - 8.77 6-12 months: Insured 18.99 - 19.99 Uninsured: 14.12- 15.09 1-2 yrs.: Insured 17.42 - 17.87 Uninsured:15.83 – 16.22 >2 yrs.: Insured 28.92 –25.13- Uninsured: 49.88– 47.84 < 12 months 53.64 – 56.99 35.92 – 37.56 1-2 yrs. 17.42 - 17.87 15.83 – 16.22 2 or more 25.13 – 28.92 47.84 – 49.88  In both endogenous and exogenous adjusted models individuals who had PAHI went to the dentist significantly more frequently than those who were not insured. This was the case for both samples. Average partial effects were much larger when PAHI was treated as endogenous. This effect also seems to have grown over the time period between the two surveys contributing to	into ancillary insurance, they found substantial bias. Concluded that failure to account for endogeneity can lead to underestimation of insurance effects.  Strong evidence of endogeneity of ancillary health insurance in relationship with dental care utilisation was observed. Ignoring endogeneity would result in under estimation of the effect of insurance.
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reason why individuals would purchase PAHI in addition dental care. Adjusted analysis was presented with models treating PAHI as endogenous and exogenous. Average partial effects for both models were presented to ascertain the size of the effects.

increasing inequalities in access to care.

### 7. Brennan et al. (2013)

Cross-sectional survey data/ random sample of 3,000 adults from Australian electoral roll Data was from a prospective cohort study that drew its sample from the Australian electoral roll aged 30-61 years	Dentate working aged adults (30 to 61 years of age) n = 1,052 Part of 2 year prospective study. Baseline data is reported and was collected through mailed questionnaires.	Observational study, Adjusted prevalence ratios.	Main outcome variables were time since last visit and reason for last visit coded as making visit in the last 12 months and relief of pain as reason for the last visit.	DI, Sex, age, household income, OHIP	Response rate: 39.1% 53.9 % were insured and 46.1% were uninsured. 70.9% of the uninsured visited (statistically significant). Working aged adults with dental insurance had a higher prevalence (Adj PR 1.48) of having a recent visit Oral health impact was not associated with visiting a dentist in the last 12 months. Participants with higher OHIP scores had a higher	Insured are more likely to have a regular pattern of dental care, less oriented to pain relief; accounting for oral health (OHIP) did not modify these associations.
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prevalence of visiting a dentist for relief of pain. Relief of pain visits among insured was 10.5% and among uninsured 25.8%. After adjusting for OHIP scores and other covariates insurance remained significantly associated with relief of pain being the reason for visiting a dentist (Adj PR 0.6 PR).

#### 8. Anikeeva et al. (2013)

<p>Cross-sectional survey data/ random sample of 3,000 adults from Australian electoral roll Data was from a prospective cohort study that drew its sample from the Australian electoral roll aged 30-61 years</p>	<p>Working aged adults (30 to 61 years of age). Part of 2 year prospective study. Baseline data is reported in this paper and was collected through mailed questionnaires.</p>	<p>Cross-sectional analyses. The analysis was restricted to dentate persons. Unadjusted associations were tested using a chi-square test while adjusted prevalence ratios were generated using a log-binomial model. Significance was based on non-overlapping 95% confidence intervals.</p>	<p>The outcome variables were regular dental visiting and visiting for a check-up. Those who visited at least once in two years were considered regular visitors while those whose last visit was for a check-up were considered visiting for a check-up.</p>	<p>Nil</p>	<p>The main explanatory variables were dental insurance and household income. Other explanatory variables were sex, age, and tooth brushing.</p>	<p>Response rate was 39.1% - A total of 1052 dentate individuals made up the final data for the analysis. 71.5% of the respondents made regular dental visits and 50.4% last visited for a check-up. 53.9% of the respondents were insured. Average visiting, once every two years: Insured 83.2%, uninsured 57.7% Last dental visit for check-up – Insured 60.8%, uninsured 38.3% Insurance was positively associated with both the outcomes in bivariate analysis. After adjusting for age, sex, income and tooth brushing the significant</p>	<p>Response rate was low. Household income modified the relationship between dental insurance and regular dental visiting and visiting for a check-up, with insurance status having a greater impact on visiting among lower income households.</p>
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positive association remained for regular dental visiting(once in two years) (PR=1.18 (1.01-1.36) but not for visiting for a check-up(1.13).

### 9. Australian Research Centre for Population Oral Health (2012)

<p>NDTIS 2010: Random sample of Australians aged 5+ interviewed by telephone. Two stage stratified design - 18+ from electoral roll and matched with electronic white pages to retrieve telephone numbers. These were stratified by state and region and a systematic sample of households was drawn from each stratum. A person aged 5+ was then randomly</p>	<p>The data was from NDTIS 2010, using data from 18+ yr. olds and those who were dentate. N was not reported. N=6765</p>	<p>Data weighted to reflect geographic, age and gender distribution of Australia and to account for the probability of selection. Only bivariate associations were reported. Statistical significance was determined with non-overlapping 95% confidence intervals.</p>	<p>Visiting in the last 12 months, Mean number of visits, Check-up visits, extractions, Fillings, Scale and Cleans, Root canal treatment, Crown and Bridges, Gum treatment, and Dentures.</p>	<p>Nil</p>	<p>Dental insurance</p>	<p>Dental Insurance: 55.6 % (53.8, 57.3)          Visiting in the last 12 months % : 70.9 (68.7, 73.1): 48.3 (45.6, 62.4)          Mean number of visits: 2.3 (2.2, 2.4): 2.3 (2.2, 2.5)          Check-up visits % ; 66.1 (63.6, 68.7): 50.2 (46.5, 54.0)          Extractions % : 10.4 (8.9, 11.9), 19.0 (16.1, 22.0)          Fillings % : 37.2 (34.6, 39.7): 43.9 (40.1, 47.6)          Scale and Cleans % : 83.5 (81.6, 85.4): 63.6 (59.9, 67.4)          Root canal treatment % : 7.0 (5.6, 8.4): 7.2 (5.4, 8.9)          Crown and Bridges % : 11.3 (9.6, 12.9): 9.8 (7.7, 11.8)          Gum treatment % : 4.5 (3.6, 5.5): 4.5 (3.1, 5.9)          Dentures % : 3.2 (2.4, 4.0): 6.3 (4.6, 7.9)</p>	<p>Dental insurance was related to a higher proportion of dental visiting and check-ups among those who visited. The dentally insured adults' service patterns had lower level of extractions, filling and dentures and a higher level of preventive services compared to the uninsured. Grey literature report. Associations between dental insurance and dental service use stratified by age group and by cardholder status.</p>
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selected from each household that was contacted for the study.

Generally the pattern of associations between insurance and dental service use did not vary across age groups with the exception of visiting for a check-up, where those in the 65+ years age groups there was no association between with insurance. The pattern of associations did not vary by card-holder status.

#### 10. Roberts-Thomson et al. (2011)

The data was from longitudinal cohort study of young adults in Adelaide, South Australia. The baseline sample was drawn from the electoral roll and matched	Prospective cohort study of young adults (20 to 24 years of age). The participants were those residing in Adelaide in 1998, aged 20-25 years and	Prospective cohort study with one follow up. Bivariate associations were tested using a chi-square test. Multivariate associations were modelled for the two outcome	Two main outcome variables; not making a dental visit since baseline and reporting 'a problem' as the usual reason for visiting at follow up.	Nil	Baseline Independent variables were demographics (sex, educational level and living arrangements), affordability of dental care (insurance status, government	65.65 response rate for the baseline interviews, 64.9% of whom participated in the follow up interviews. At baseline 54.8 % had not visited a dentist in the previous 12 months while this was 55.5% at follow up. 22.1% did not make a visit during the study period. 38.1% and 38.8% respectively	Young adults 20-25 yrs. at baseline only from Adelaide, Australia The highest attributable fraction was education (27%).
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with electronic white pages. Telephone numbers were identified for complete or partial matches and contacted by a primary approach letter prior to telephone interviews. A subsequent telephone interview was conducted 2.5 years later to collect follow up data.	those who completed the follow up telephone interview 2.5 years later – n=1216 adults at baseline, (65.6% response) n=891 at follow-up (64.9% response)	variables separately using logistic regression and population attributable fraction was reported for variables that were significant in the final model.	concession card status, avoidance of dental care due to cost and difficulty paying a \$100 dental bill), visiting factors (use of public care, perceived need for visit) and health behaviours (smoking and physical activity status).	said they usually visited for a problem at baseline and follow up. In total 61.9% were uninsured at baseline. Dental insurance was associated with both outcome variables in unadjusted analysis – No visit since baseline 16.1:26.0 and visit for a problem 27.3:44.8 but only associated with problem being the usual reason for visit in adjusted analysis - (Uninsured RR - 1.7, 1(3-2.5)) with an attributable fraction of 23% only second to having not tertiary education.
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### 11. Chrisopoulos et al. (2011)

NSAOH: Cross-sectional survey - Multi-stage stratified random sample of households from Aust. Electoral Roll, individuals randomly selected within households contactable by	Cross sectional surveys: NSAOH 15+ NDTIS 5+ Australian residents from the electoral roll and white pages. Different age ranges were reported for	Only bivariate associations were reported. No comment on statistical significance was made but the report provided confidence intervals for all estimates in the supplementary tables.	Use of dental services(Time since last visit (NDTIS 2010)18+, Reason for last dental visit (NDTIS 2010) 5+, Type pf practice visited at last visit(NDTIS 2010) 5+, Dental visiting patterns(NDTIS 2010)18+, Avg no. of dental services received in the last 12	Caries in Adults, periodontal disease, PD, CAL (NSAOH) 15+, Tooth retention and loss (NDTIS 2010) 15+	Dental insurance	Private dental insurance* (NDTIS 2010) 5+: Insured 53.8 (52.4, 55.3) (15+ 55.7 (54.0, 57.3)): uninsured 46.2 (44.7, 47.6) Caries in Adults (NSAOH) 15+: Insured had less decayed teeth*(0.38(0.31, 0.45):0.81(0.69, 0.93) and missing teeth*(4.17 (3.85, 4.49):5.04(4.68, 5.40)) and more filled teeth*(8.99(8.54, 9.45):6.79(6.45, 7.13)) with a	Some of the outcomes include children and some other includes 15-18s.
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<p>phone (i.e. listed in electronic white pages). Residents interviewed by phone and those aged 15+ were orally examined. Data weighted to reflect geographic, age and gender distribution of Australia for both components of the study and to account for the probability of selection.</p> <p>NDTIS 2010: Random sample of Australians aged 5+ interviewed by telephone. Two stage stratified design - 18+ from electoral roll and matched with electronic white pages to retrieve</p>	<p>different outcomes.</p>	<p>months by those aged 5+ and those who attended in the last 12 months )</p> <p>Dental visiting patterns: Favourable visiting pattern consisted of those who visited a dentist once or more a year, for a check-up and had a regular dental provider. Unfavourable visiting behaviour refers to visiting less than once in 2 years, visiting for a problem or visiting for a problem usually once in two years and hat having a regular dental provider. All other combinations of these variables were considered intermediate visiting pattern.</p>	<p>higher overall DMFT (13.54 (12.91, 14.18), 12.64 (12.08, 13.21)).</p> <p>Untreated decay*(NSAOH) 15+: Insured 19.4(16.8, 22.0):uninsured 31.1% (28.5, 33.8)</p> <p>Periodontal disease*(NSAOH) 15+: Insured 19.4% (17.2, 21.6): uninsured 27.0 % (24.6, 29.4)</p> <p>Pocket depth 4+mm(NSAOH) 15+: Insured 18.3 (15.9, 20.8): uninsured 21.7 % (19.1, 24.4)</p> <p>Attachment loss 4+mm(NSAOH) 15+: Insured 42.1 (38.7, 45.4): uninsured 44.1% (41.1, 47.1)</p> <p>Tooth retention and loss (NDTIS 2010) 15+: Average number of missing teeth*: Insured 4.7 (4.5, 4.9):uninsured 6.2 (5.8, 6.6)</p> <p>Use of dental services - Time since last visit (NDTIS 2010)18+: &lt;12 months* - Insured 71.9 (69.7, 73.9):uninsured 49.6 (47.0, 52.1), 1-&lt;2 yrs.*: Insured 16.3 (14.6, 18.1):uninsured 20.6(18.7, 22.8), 2-&lt;5yrs*: insured 7.8(6.6, 9.2):uninsured 16.6 (14.7, 18.7), 5+ years*: insured</p>
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telephone numbers. These were stratified by state and region and a systematic sample of households was drawn from each stratum. A person aged 5+ was then randomly selected from each household that was contacted for the study. Data weighted to reflect geographic, age and gender distribution of Australia for both components of the study and to account for the probability of selection.

4.1(3.2, 5.2):uninsured 13.2 (11.5, 15.1)  
Reason for last dental visit (NDTIS 2010) 5+: Check-up\*: Insured 70.3 (68.4, 72.1): uninsured 57.1 (54.5, 59.6), Problem\*: insured 29.7 (27.9, 31.6): uninsured 42.9 (40.4, 45.5)  
Type pf practice visited at last visit(NDTIS 2010) 5+: Private\*: 94.9 (94.1, 95.6): uninsured 76.8 (74.3, 79), Public\*: 1.7(1.3, 2.3):13.4 (11.6, 15.5), SDS\*: 2.8 (2.3, 3.3):8.2 (7.0, 9.7)  
Dental visiting patterns(NDTIS 2010)18+: Favourable\*: 62.8(60.5, 65.1):31.1 (28.56, 33.7), Intermediate\*: 27.9 (25.8, 30.1) :40.3 (37.5, 43.1), Unfavourable\*: 9.3 (8.0, 10.7):28.7 (26.0, 31.4)  
Avg no. of dental services received in the last 12 months by those aged 5+ and those who attended in the last 12 months:  
No. of visits: 2.37(2.29, 2.45):2.32(2.28, 2.41), Extractions\*: 0.21(0.17, 0.25):0.31(0.26, 0.37), Fillings\*: 0.62(0.56, 0.69):0.83(0.73, 0.93), Scale and Clean\*: 1.09(1.06, 1.13), 0.68 (0.59, 0.77)

### 12. Mejia (2010)

The data was a follow up study of a the Child Fluoride Study which drew its sample from the school dental service in 1991-92 when the participants were aged 4-15 in South Australia	The current follow up study targeted those aged 18-30 at the time of the study tracing a total of 7663 respondents. Of these a total of 925 participants are included in the analysis reported in this paper i.e. those who met the age criteria and completed the questionnaire and lived in the metropolitan area to have an oral examination.	Cross sectional analysis – Only Bivariate associations were tested using non-overlapping confidence intervals.	Nil - Service use variables were used as explanatory variables	The main dependent variables were dental caries, measured as DMFT and untreated coronal decay, filled permanent teeth and teeth missing due to caries.	The independent variables were socio-demographic, use of dental services and life events – none of which were used to adjust control	60.2 % of the participants had private dental insurance. 295 of the young adults did not have any caries experience. Dental decay: Insured (31.2:24.0) were more likely to be free of dental decay but the difference was not significant though generating a p-value of < 0.05. Untreated coronal decay: Uninsured had a statistically significant higher percentage of untreated coronal decay (21.5:43.9). One or more filled teeth: Insured had a marginally higher % (61.1:55.2) Teeth missing due to caries: Uninsured had a significantly higher percentage that had one or more missing teeth due to caries.(2.9:8.4)	Only bivariate un adjusted analysis. Only south Australian young adults from metro area.
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### 13. Jamieson et al. (2010)

NDTIS – Multi-stage stratified random sample of households from Aust. Electoral Roll,	Cross sectional survey - 18-34 year old participants of the NSAOH 2004-06 who	The data was weighted to represent the age, sex and geographic distribution of the	Nil – Service use variables were used as explanatory variables	The main outcome variable was a combined self-reported	Exposure variables included demographic, socioeconomic, self-perceived oral health,	984 participants aged 18-34 years were included in the analysis. Just over 40% had experiences oral health impairment that is one of toothache, impaired	This is another example of a paper where the bivariates indicate an association with dental
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<p>individuals randomly selected within households contactable by phone (i.e. listed in electronic white pages)</p>	<p>also completed a dental examination were included in the study.</p>	<p>Australian population at the time. Univariate, bivariate and multivariate estimates were generated. Factors significant in bivariate analysis were entered into an initial Poisson regression model and prevalence ratios were generated. The final regression model was constructed by removing factors one at a time according to the size of p-value until only statistically significant factors were left in the model. Statistical significance was determined by a p-value less than or equal to 0.05 and confidence intervals not including the no-</p>	<p>measure of toothache, discomfort because of mouth appearance and food avoidance termed as oral impairment. A rating of very often, often or sometimes for any one of the measures was considered oral impairment.</p>	<p>dental service utilisation and clinical oral health outcomes.</p>	<p>dentofacial appearance or food avoidance. Prevalence of all three components was just over 6%. Being uninsured was significantly associated with the composite measure (Insured vs Uninsured: 2.1:9.1) as well as food avoidance (13.1:22.3) in bivariate analysis. Prevalence of toothache (18.0:23.6), dissatisfied appearance (24.0:27.1) and prevalence of any one of the three items (39.9:45.1) were not significantly different. Dental insurance was not a factor of significance that remained in the final models.</p>	<p>insurance and health, but insurance is knocked out the final model, as it does not survive the model, possibly due to inclusion of variables such as “usual reason for visiting”, in a model where DI was the key explanatory variable this variable would not be included, as it is theoretically a collider.</p>
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difference value.  
Three models  
were constructed  
- Model A  
included non-  
clinical factors,  
Model B clinical  
factors and Model  
C - both factors.

#### 14. Australian Research Centre for Population Oral Health (2010)

<p>NDTIS is a two stage, stratified sampling design that selected Australian residents aged 5 and over. The sampling frame was the electronic white pages which was accessed through a sample from the Australian electoral roll and matched to the electronic white pages records.</p>	<p>Survey data 2008 NDTIS, older adults (60 years of age)</p>	<p>Cross-sectional study, unadjusted prevalence.  Data was weighted to reflect the age and gender distribution of the Australian resident population in 2007 to account for the different probabilities of selection due to the study design.  Bivariate association were reported as proportions for dentate adults with statistical significance determined</p>	<p>Visiting in last 12 months, usual reason for visit, received extraction in last 12 months and difficulty in paying a \$100 dental bill.</p>	<p>Nil</p>	<p>Dental Insurance Dentate status, gender, residential location, year level of schooling, eligibility for public care and dental insurance was reported for each outcome variable by three age groups and total 60+ adults.</p>	<p>2486 respondents who were 60+ were the participants in this study. Dental visit in the last 12 months: 52.1% visited - Dental visiting was significantly higher among insured - 72.6 vs 53.3% Usual reason for visit being check-up: 41.7% visited for check-up - Insured was 65.7% and uninsured was 36.1% - Significantly higher for insured. One or more extractions received in the past 12 months: Overall 17.5% received one or more extractions - Significantly higher percentage of uninsured (23.2%) received one or more extractions compared to the insured (12.8). The differences were</p>	<p>Uninsured appear to have a less favourable dental visiting pattern.  Associations not adjusted by other factors but associations were stratified by age group. Overall patterns varied for prevalence visiting in the last 12 months and receiving one or more extraction, no association between insurance and these types of service use for older adults 80+ years.</p>
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		through non-overlapping confidence intervals.				significant except for the oldest age group (80+) Difficulty paying \$100 dental bill: More than two fold relative difference between % of insured and uninsured that had difficult paying \$100 dental bill overall.	
<b>15. Sivaneswaran (2009)</b>							
NSAOH/NDTIS – Multi-stage stratified random sample of households from Aust. Electoral Roll, individuals randomly selected within households contactable by phone (i.e. listed in electronic white pages)	Cross sectional survey - Data from the NSW component of the NSAOH was used.	The data was weighted to represent the age, sex and geographic distribution of the Australian population at the time.  Bivariate analysis of a range of oral health – Clinical and self-reported and dental service variables were reported. Statistical significance was determined using non-overlapping confidence intervals.	dental service utilisation (dental visit within last 12 months, visiting private practice at last visit, usual visiting of at least once a year, regular dentist, usual visiting a dentist for check-up)	Clinical(Tooth loss, adequate dentition, untreated coronal decay, DMFT, Teeth missing due to pathology and >4mm periodontal pocket depth) and self-reported (Self rated oral health, toothache experience, or facial pain, need for extraction/fi	Dental insurance	3630 NSW adults were interviewed of which 1099 underwent a clinical examination.  Clinical Oral Health: Complete tooth loss* (2.3% insured and 8.4% uninsured), fewer than 21 natural teeth*(7.3:16.2), untreated coronal decay*(20.7:33.2) and mean tooth loss due to pathology *(4.1:5.7) was significantly higher among uninsured. DMFT - mean (12.8:13.1) and >4mm periodontal pocket depth % (21.7:21.6) was similar between the two groups.  Dental care utilisation patterns: The uninsured had significantly less favourable patterns of dental visit within last 12 months(74.2 %of insured and 48.3% of uninsured), visiting private	Only NSW adults

lling,  
perceived  
urgency of  
treatment)  
and

practice at last  
visit\*(88.0:74.4), usual  
visiting of at least once a  
year\*(69.3:41.1), having a  
regular dentist\*(90.2:72.3)  
and usual visiting a dentist for  
check-up\*(71.3:42.6)

Self-reported measures:  
Significantly higher  
percentage of adults  
reported a fair to poor rating  
on their oral health (11.8  
insured and 21.9 %  
uninsured) and perceived  
need for an extraction or  
filling (26.3:35.9). Toothache  
(14.0:18.4) and orofacial pain  
(21.8:24.9), though higher  
among uninsured was not  
statistically significant.  
Similarly perceived urgency  
for treatment within 3  
months (73.7:69.8) was not  
statistically significant.

#### 16. Sanders et al. (2009)

NDTIS 2002 - Multi-stage stratified random sample of households from Aust. Electoral Roll, individuals randomly	Cross sectional survey – 18+ year old dentate participants of the NDTIS 2002 who also completed a self-	Data weighted to reflect geographic, age and gender distribution of Australia. Wald test was used to compare means. Effect	NIL – Service utilisation variables used as explanatory variables	OHIP – 7 and OHIP 14 severity and prevalence	Private dental insurance	RR 64.8% for the telephone survey of which 65.5 % responded to the self- complete questionnaire.  OHIP Severity (mean) OHIP – 7: Insured 4.33: uninsured 5.51* Effect size 27%	Main aim of the paper was to establish the construct validity of the OHIP-7.
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selected within households contactable by phone (i.e. listed in electronic white pages)	administered questionnaire were included in the study.	sizes were calculated as a ratio of net difference of the comparison group divided by the reference group				OHIP-14: 6.21:8.27* 33%  OHIP prevalence (proportion) OHIP – 7: 12.7:18.8* 48% OHIP 14: 13.2:20.0* 52%	
<b>17. Jamieson et al. (2009)</b>							
NDTIS – Multi-stage stratified random sample of households from Aust. Electoral Roll, individuals randomly selected within households contactable by phone (i.e. listed in electronic white pages)	Cross sectional survey - 15-34 year old participants of the NSAOH 2004-06 who also completed a dental examination were included in the study.	Data weighted to reflect geographic, age and gender distribution of Australia. Univariate, bivariate and multivariate estimates were generated. Factors significant in bivariate analysis were entered into an initial logistic regression model. The final regression model was constructed by removing factors one at a time according to the size of p-value until only statistically significant factors	NIL – Service utilisation variables used as explanatory variables	The main outcome of the study was untreated dental decay.	Socio demographic (age, sex, residential location, indigenous status, education, public dental care eligibility, dental insurance status, trouble paying \$100 bill, payment for last dental visit and cost prevented dental care), dental service utilisation (Reason for usual visit, dental visit in last 12 months, last dental visit 5+ years ago, last visit to private dentist, usual visit once a year, have a regular dentist, avoid dental care	Total of 1125 participants of the age of 15-34 who participated in the telephone interview and had their dental examinations. In bivariate analysis, prevalence of untreated decay among the insured vs uninsured was 21.9 and 30.4. Dental insurance was statistically significant with an OR of 1.56 (1.34-1.78) for the uninsured (P-value was not reported). Dental insurance was not reported in the final model and was assumed to not be significant and hence removed as per the method reported.	Participants included those 15 and over.

were left in the model. Statistical significance was determined by a p-value less than or equal to 0.05 and confidence intervals not including the no-difference value.

and dental fear) and oral health perception factors (Toothache/orofacial pain/food avoidance, self-perceived need for extractions/fillings and self-rated oral health) were tested as predictors of untreated dental decay.

#### 18. Armfield et al. (2009)

NDTIS – Multi-stage stratified random sample of households from Aust. Electoral Roll, individuals randomly selected within households contactable by phone (i.e. listed in electronic white pages)	Cross sectional survey - Data was from the NSAOH 2004-06 18+ years of age  Dentate participants who completed a clinical oral examination were included in the analysis.	Data weighted to reflect geographic, age and gender distribution of Australia.  Mean DMFT and component scores for each of the covariates were calculated using logistic regression. Multivariate analysis was also done using the	NIL	The main outcome variables were DMFT and its components and Periodontitis as per the CDC and gingival index. But only DMFT and its components were	Although the main explanatory variable was dental fear, other covariates including dental insurance were examined.  Age, sex, income, education, employment, plaque index and insurance status	5364 dentate adults aged 18 and over undertook the dental examination accounting for about 43.3% of those who answered the initial interview survey. Dental insurance was statistically significant for DMFT and all its components with the insured having lesser decayed (0.38:0.82) and missing teeth (4.17:5.04) and more filled teeth (8.99:6.79) and DMFT (14.08:13.18). In adjusted analysis insurance was statistically significant	Although the main explanatory variable was dental fear, other covariates including dental insurance were examined.
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			main explanatory variable and other covariates but only p-values for the other covariates were reported.	reported by each covariate.		(P<0.05) only for the three individual components of the DMFT index, namely decayed teeth, missing teeth and filled teeth.	
<b>19. Australian Research Centre for Population Oral Health (2008b)</b>							
NDTIS/NSAOH 2004-06 – Multi-stage stratified random sample of households from Aust. Electoral Roll, individuals randomly selected within households contactable by phone (i.e. listed in electronic white pages)	Cross sectional survey - Data was from the NSAOH 2004-06 15+ years of age  Only dentate adults who had answered questions pertaining to all the 12 factors were analysed for the paper - 12609	Data weighted to reflect geographic, age and gender distribution of Australia.  Adjusted odds ratios for the 12 factors were calculated using logistic regression model. Statistical significance was reported based on non-overlapping 95% confidence intervals. Larger odds ratios were indicative of a higher ranking of factors.  Population attributable risk	Main outcome variable was Infrequent dental attendance defined as no visit to a dentist in the past 5 years or more.	Nil	12 factors - Country of birth, dental insurance, number of teeth, gender, age, highest education level, smoking status, self-rated health status, difficulty paying \$100 dental bill, dental anxiety, locality, and health care card status.	About 10% of the adults in the survey reported infrequent dental visiting. Little less than 50% had private dental insurance.  10 of the 12 factors were significantly associated with infrequent dental visiting with lack of dental insurance having the largest effect - Odds ratio of 2.3 (CI: 1.8-2.8). Being uninsured produced a large population attributable risk fraction of 29%.  When considering both individual (OR) and population impact (PAR) dental insurance was the strongest single factor influencing infrequent dental visiting. About 29% of all infrequent dental visiting can be prevented if all Australian adults had dental insurance -	PAR assumes causal relationship between the factor and outcome, that the factor can be eliminated and that it is the only risk factor that can be removed from the populations at a time.  PAF - Highest after country of birth

fraction was also calculated for each factor with a larger PAF considered a higher ranking of the factor.

## 20. Australian Research Centre for Population Oral Health (2008a)

NSAOH/NDTIS – Multi-stage stratified random sample of households from Aust. Electoral Roll, individuals randomly selected within households contactable by phone (i.e. listed in electronic white pages)	Data was from the NDTIS 2004-06. Dentate adults over 18 years of age were included in the analysis.	4 groups of adults were compared - insured card holders (965), insured non-card holders (4998), uninsured card holders (2354) and uninsured non-card holders (3996) - Data was weighted to reflect the age and sex distribution of Australian population at the time. Bivariate associations were reported by the four groups and statistical significance was indicated by non-overlapping	Usual frequency of dental visits, usual reason for visiting a dentist, affordability of care, and fillings and extractions received.	Self-reported dental health status and toothache experience	Dental insurance by card holder status	Usual Frequency of dental visits: 2/3(66 & 67%) of both the insured groups visited once or more per year, significantly higher than the other two groups: uninsured cardholder (41%) and uninsured non -cardholders (34%). 40% and 48% of the uninsured cardholder and non-cardholders respectively visited less often that every two years Visited at least once in two years: 67+14 & 66+16 insured cardholders and non-cardholders respectively visited at least once in two years and 34+17 and 41 +18 uninsured.  Usual reason for dental visit: Uninsured were significantly more likely to visit for a problem than the insured. About 2/3 of the insured	Only bivariate associations
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confidence intervals.

groups visited for a check-up while the rest visited for a problem.

Self-reported dental health: More than 85%(85 and 88) of the insured groups rated their dental health as excellent/very good or good while Uninsured card holders were significantly more likely to rate their dental health as fair or poor (70 and 83).

Self-reported toothache experience: Similar to dental health, almost 90 %( 88 and 88) of the insured groups rated their toothache experience as never/hardly ever. Uninsured card holders were significantly more different than any of the other groups (77 and 84).

Extraction in the last 12 months: The extraction rates for the insured groups were about 1 in ten<sup>10-11</sup>, significantly lower than both the uninsured groups<sup>18-28</sup>

Fillings in last 12 months: Fillings rates were very similar among all the four groups (42-45 and 42-46%)

Favourable dental attendance pattern for the insured.

### 21. Vecchio (2008)

The data was from the ABS National health survey of 2005. It was a household survey across Australia in 2004-05.	Cross-sectional study, adjusted odds ratios This paper studies a community dwelling individuals 65 years and over resulting in a sample size of 3750.	Bivariate associations were tested using a chi-square test and a logistic regression was used to test multivariate associations and produce odds ratios The sample was weighted by individual weight provided by the ABS.	Dental visit in the past 12 months was the outcome variable	NIL	Remoteness and State of residence. Other variable included were income, dental insurance, health status, age, concession card status, gender, education and country of birth. Dental insurance status was categorised as those having ancillary cover and those having no insurance.	Approximately 33% of the study participants had ancillary insurance cover with 56.3% of them visiting a dentist in the last 12 months compared to 28.6% of the uninsured. In adjusted analysis, individuals with private ancillary insurance had 1.9 (OR: 1.915 - CI: 1.896-1.934) times the odds of visiting a dentist in the last 12 months compared with those without cover. Use of dental services varied by State of residence and remoteness. Strong and positive link between dental visiting in the past 12 months and private dental insurance.	Variation in use of dental services by location was the main aim of this study. There was some variation by State, but this was possibly explained by variations in dentate status. Greater variation by remoteness/region of residence. Only included older adults aged 65 and over
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### 22. Roberts-Thomson and Stewart (2008)

Stratified random sample from the electoral roll of 2300 young adults, matched to electronic white pages	Of 1921 subjects who partial or full details were available, 1261 responded to a computer assisted	Cross Sectional survey CATI and dental examinations were conducted. Data was weighted by	Nil	Three outcome variables: mean number of precavitated lesions,	Range of socio demographic, financial and health behaviour variables including private	Precavitated surfaces*: 1.71:2.91 Decayed surface: 0.65:1.05 DMFS:5.93:6.24	Insurance reported as private insurance but previous publications on the same study indicated that the
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residing in Adelaide, Australia 20-24 yr. olds in 1999	telephone survey. 65.6 response rate for the interview of which 51 percent were examined resulting in a sample of 644 young adults.	gender, educational level, and country of birth and health card status to reflect the south Australian population aged 20-24 yrs. Bivariate and multivariate associations were examined using ANOVA and linear regression models. Significant variable from the bivariate analysis was included in the multivariate analysis	decayed tooth surfaces and total caries experience.	dental insurance were collected	Insurance was significant factor only for precavitated caries in bivariate analysis. In multivariate analysis the significant association was lost for insurance as an independent variable.	telephone interview collected dental insurance status. A model that was explicitly interested in exploring associations with insurance would no typically have recent visiting as controls; this could be potential colliders in the model. Associations examined by multiple variable linear regression models. Current research has demonstrated that this is not appropriate model.
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### 23. Brennan and Spencer (2007)

LSDPA 2003/2004 Random sample of private dental practitioners from state dental registers.	N= 511 private dental practitioners Results reported all patients over the age of 5 - total n was 953.	Cross-sectional study – self complete provider held service logs.  Data weighted to reflect the sex	Service rates per visit: restorative, examination, radiograph, prophylaxis, Topical F, endodontic, extraction. Analysis of	Dental caries was classified into initial, cavitated and gross lesions.	Dental insurance, sex, age, socio-economic status, geographic location, reason for visit	Response: 76% Among patients with caries diagnosis: Being insured was associated with higher percentage of initial lesions (30.0% vs 19.6%) and a lower percentage of gross lesions	Study reported patients 5 years and over, hence the results included children, though they accounted for
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15.5% of patients were less than 18.	and age distributions of registered practitioners. Analysis of patients with caries as main diagnosis. Unadjusted associations of patient characteristics and carious lesion severity. Adjusted rate ratios (Poisson regression) of service use	patients with caries as main diagnosis.				(20.7% vs 34.7%). Cavitated lesions were similar(49.3:45.47) The percentages were for insured group and uninsured group and hence cannot be used in comparison with other Insured patients received higher rates of restorative (1.241:1.017) services per visit but lower extraction services (0.061:0.129) per visit when compared to the uninsured. Other services were not significantly different Examination: 0.361:0.338 Radiograph: 0.318:0.365 Prophylaxis: 0.197:0.158 Topical Fluoride: 0.069:0.044 Endodontic: 0.033:0.060 Among patients with caries diagnosis, after adjusting for explanatory variables, having dental insurance was not associated with variations in rates of services.	only 15.5% of the patients No discussion why previously observed patterns of insurance and service use were not observed for those with caries diagnosis. Some associations were indicated by clinically meaningful effects but these were not statistically significant, sample size was possibly insufficient for testing these specific associations.
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#### 24. Spencer and Harford (2007b)

NDTIS – NSAOH 2004-6/Multi-stage stratified random sample of households from Aust. Electoral Roll,	12861 dentate respondents of the 14123 adults 15+ interviewed	Cross-sectional study, prevalence (unadjusted),	Time since last dental visit and no visit in the last 5 years among Australian dentate adults.	Nil	Dental insurance	62.1 % of the dentate adults visited a dentist in the previous 12 months. Among the insured this was 73.1 and 52.5 % among the uninsured*. Among those who did not visit in the last 5	Associations not adjusted by other factors. Included 15+ Bias analysis/assessment showed that
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individuals randomly selected within households contactable by phone (i.e. listed in electronic white pages)						years - 4.9% were insured and 13.7 were uninsured. The uninsured appear to have a less favourable visiting pattern when compared to the insured.	the potential for bias was low. Time trend and cohort analysis of dental visiting but this analysis did not assess associations with DI
<b>25. Spencer and Harford (2007a)</b>							
NDTIS – NSAOH 2005/Multi-stage stratified random sample of households from Aust. Electoral Roll, individuals randomly selected within households contactable by phone (i.e. listed in electronic white pages)	n=14,123 Australians aged 15 and over	Cross-sectional study, prevalence (unadjusted),	Time since last visiting a dental practitioner, sector of attendance, average visiting pattern, continuity of care (regular dentist), usual reason for visit.	Nil	Dental insurance	Visiting dentist within the last 12 months: 1.4 times difference between the insured and the uninsured - 71.6% Vs 49.4% Last dental visit 5 or more years ago*: Higher % of those uninsured than insured - 16.8 vs 5.9% Last visit at Private practice*: 95.2% of the insured and 73.6 of the uninsured Usual patterns of dental visits*: 67.4% of insured and 40.2% of uninsured usually visit a dentist at least once a year. Usual attendance at the same dentist*: 88.9% of the insured and 68.8 % of uninsured Usual attendance for check-up*: 70% for insured and 43.2% for uninsured - Greatest variation among all variables	Associations not adjusted by other factors. Included 15+ Bias analysis/assessment showed that the potential for bias was low.

### 26. Slack-Smith et al. (2007)

Data was from the 2001 population based ABS National Health survey with an overall response rate of 90% Households sampled	ABS National health survey 2001, 1628 respondents aged 18–24 years	Cross-sectional, face-to-face interviews of households. Normalised weights were applied to approximate the 2001 Australian national population. Adjusted odds ratio: Logistic regression was used to model adjusted association based on significance of individual associations. All main effects were modelled together and removed using a backward stepwise approach with a significance criteria of $p=0.05$	Visited dentist in last 12 months	Nil	Demographic (gender, Education, language, socio-economic disadvantage, city of residence, private health insurance and concession card holder status), health and lifestyle factors (general health, smoking status, physical activity and alcohol consumption) were tested.	Approximate response:90% Of the sample 35% had private health insurance. In Univariate analysis, those with private health insurance had a significantly higher percentage of visiting in the previous 12 months (51:36 %*). Of the 8 variables (gender, education, language at home, socio-economic disadvantage, area of residence, private health insurance, smoking status and alcohol consumption) found to be significantly associated with visiting only private health insurance, gender and alcohol consumption were significantly associated with dental visiting in the previous 12 months. The odds of visiting by the insured was 1.9 (CI: 1.6-2.4) compared to the uninsured.	ABS National health survey 2001, 1628 respondents aged 18–24 years Not sure if private health insurance was global health insurance or only those that had ancillary insurance also. The ratio of 35 to 65 for insured seems like it was only private ancillary insurance from the ABS data tables 15-24 year olds With private health insurance Hospital cover only: 6.0 Ancillary cover only: 3.0 Both hospital and ancillary cover: 31.1 Total(b) 41.5 Without private health insurance: 57.2 Total(c) 100.0
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### 27. Sibbritt et al. (2007)

Longitudinal study on women's health. The sample was drawn from the Medicare database with deliberate over representation of women from rural and remote areas.	1999 survey of 10433 women aged 73-78. Excluded respondents who did not provide dental service use information.	Longitudinal cross sectional survey. Adjusted odds ratios were produced from a logistic regression model using backwards stepwise approach.	The main outcome variable was dental visiting in the past 12 months.	Nil	Area of residence, demographic characteristics, smoking and medical history, physical and general health subscales of SF - 36, Australian Nutrition screening initiative and Duke social support index	9387 women answered the question on dental visiting of which 34.9% had visited in the previous 12 months. Unadjusted proportions were not reported. Women were more likely to visit a dentist if they had a private ancillary health insurance with an adjusted odds ratio of 2.59 for the insured.	Older Australian Women aged 73=78 Visiting in last 12 months was positively associated with medication use, higher education, eating fruits/vegetables most days, and with higher scores on the Physical Functioning subscale (SF-36) Having a chronic illness was associated with lower odds of visiting.
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### 28. Brennan and Spencer (2005a)

Burden of oral Disease study – 2 stage sampling of dentists from the south Australian dentist register and their	Patients of dentists in South Australia	Cross-sectional study Frist 5 patients of a sampled dentist on a randomly chosen day of practice	Nil	OHIP-14 - 3 measures; counts, additive and scale scores	The main aim of the study was to test differences between OHIP and EuroQol.- Sex, Age, type of visit, insurance status, number of teeth and main diagnosis	64.8% of the patients were insured Bivariate: OHIP simple count: 3.61:2.28* OHIP Additive score (severity): 11.31:7.45* Scale Scores: 8.25:6.08* Adjusted (beta) (uninsured as reference group): OHIP simple count: -0.67	Main aim of the study was to compare OHIP and EuroQol Effect of insurance on EuroQol scores also reported
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patients in South Australia Cross-sectional					condition were used in the adjusted model	OHIP Additive score: -2.30* Scale Scores: -1.40*
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**29. Slack-Smith and Hyndman (2004)**

ABS/National Health Survey 1995/Random sample of households	Data was from the 1995 national health survey - sample of 7544 eligible respondents 60 year or over with an initial response rate of 91.5%.	Cross-sectional study, face-to-face interviews of households. Data was weighted to reflect the Australian population. Excluded interviews not providing dental attendance data. Multiple variable logistic regression (stepwise) stratified by sex	The main outcome variable was dental visiting in the last 12 months.	Nil	Demographic variables such as age, sex, education, ethnicity, income, social disadvantage and presence of another adult in the household, health insurance variables such as private health insurance, ancillary cover of private health insurance and health care concession card ownership, health behaviour variables such as smoking status and exercise level and personal health variables such as self-reported general health and presence of arthritis were	In Univariate analysis respondents with ancillary health insurance 50.9 (50.6-56.7) had higher attendance ratios as opposed to those who did not 28.6 (27.1-35.2). However in multivariable analysis insurance status was not part of the final model for both males and females. Insurance status excluded from multiple variable models due to missing data.	Intra-household correlation was assessed to be low and therefore clustering/design effects were not accounted for in analysis.
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30. Ringland et al. (2004)							
NSW Older people's health survey 1999	Computer assisted telephone interview survey carries out in 1999. A total of 8881 interviews were completed by respondents with a response rate of 70.7%.	Cross-sectional study, interviewed through telephone	Nil	The main outcome variables were dentate status (dentate or edentulous) and frequency of toothache or mouth or denture problems in the last 12 months (Never and hardly ever or sometimes or often and very often) analysed by dentate status.	Several social, economic, and demographic variables were analysed including private dental insurance status.	Of the entire sample 25% had private health insurance. Dentate status: Those who had private health insurance were less likely to be edentulous (Insured Vs uninsured %16.0:33.0 (OR - 0.39) while in adjusted analysis as well the insured were half as likely to be edentulous as the uninsured (OR- 0.50) Problem with teeth, mouth or dentures in the last 12 months: Edentulous: Never/Hardly Ever:80.3:81.1, sometimes: 12.6:10.9 and Often/Very Often: 7.1:8.0 Dentate Never/Hardly Ever:78.7:78.2, sometimes: 14.9:15.6 and Often/Very Often: 6.9:5.7 Both among the dentate and the edentulous there were no significant differences between the insured and uninsured - neither of the groups reported having significant problems	While insurance was independently associated with being edentulous it was not associated with having problem with teeth, mouth or dentures in the past 12 months. Only older Adults 65+ from NSW were part of this study

collected and used to test the relationship with the main outcome variable.

sometimes or often and very often compared to never and hardly ever.

### 31. Roberts-Thomson and Stewart (2003)

Electoral roll sample 20-24 yr. old matched with electronic white pages and interviewed over telephone in 1999	Of 1921 subjects who partial or full details were available, 1261 responded to a computer assisted telephone survey.	Cross-sectional study, interviewed through telephone Adjusted odds ratios (logistic regression) Data was weighted by gender, educational level, country of birth and health card status to reflect the south Australian population aged 20-24 yrs.	Time since last visit (dichotomised into 2 yrs. or less and more than 2 years) and reason for dental visit (check up or problem) were the outcome variables.	Nil	Range of socio demographic, financial and health behaviour variables Private dental insurance, Sex, age, language at home, education, current student, living arrangements (independent or with parents), difficulty paying dental \$100 bill, avoid care due to cost, government health care card, smoking status, physical activity	Response rate of 65.6% was achieved. Comparisons of the sample with census data showed differences in tertiary education status and government concession card status. Dental insurance was significant in bivariate analyses with both visit in previous two years(81.7:58.1) and usual reason for visiting: for problem – 27.0:44.9) In multivariate analysis young adults who have insurance had more than twice the odds (2.19) of visiting in the last two years while the insured had 0.65 times the odds of usually visiting for a problem.	Baseline results from a longitudinal study. Young adults who were full-time students living at home with parents would have been eligible for insurance cover under a family policy. Hence selection bias is less likely with this age group. Consistent with higher likelihood of being insured, current students had significantly higher odds of having a recent visit.
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### 32. Brennan and Spencer (2002)

LSDPA 97-98 Random sample of private dental practitioners	N=345 dental practitioners with visits being	Cross-sectional study Typical day of service provision	Services/visit of 8 main areas of service diagnostic, preventive, restorative,	Nil	Dental insurance, Patient age, patient sex, visit type( emergency	Response Rate: 60.3% Insurance status was significantly associated with
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from state dental registers	the unit of analysis n=4,115 patient visits  Exclusions: public sector practitioners, those who did not provide complete service log, patient visits to children (<18 years)	was recorded by each dentist Rate ratios estimated by Poisson regression models	endodontic, extraction, crown and bridge, prosthodontic, general/misc.		vs non-emergency), Patient status (new vs previous), location (capital city vs non-capital city), dentures, number of teeth, decayed teeth, dental knowledge scale, payment scale, SEIFA index (SES)	three of the 8 service areas in bivariate analysis. Diagnostic:0.66 :0.65, preventive:*0.42:0.29, restorative: 0.66:0.60, Crown and Bridge*:0.13:0.06, Endodontic: 0.13:0.13, Extraction*: 0.04:0.13, General/Miscellaneous: 0.05:0.05 and Prosthodontic: 0.09:0.11  In multivariate models, insurance status was associated with higher preventive (RR=1.27) and lower extraction rates (RR=0.50) per visit with week and moderate effect sizes respectively. This represents a more favourable service pattern in terms of preventive orientation and retention of teeth.
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### 33. Australian Institute of Health and Welfare (2002)

NDTIS 1999	7829 Adults representative of the Australian population	Cross Sectional Study	Visiting in the last 12 months, not visiting in the last 5 or more years, Reason for visit among dentate and those who visited, Differences in fillings and extractions received, avoiding visiting due to cost, dental visiting as a	Nil	Dental insurance status by card holder status	Overall 36.2 % of dentate adults were insured. Nearly 70% of dentate adults with insurance visited a dentist in the past 12 months, while among the uninsured it was less than 50%. Over 5 % ( 5.6-5.9) insured did not visit in the last 5 years and between 12.1-14.9% uninsured did not visit in the last 5 years.	All relationships were bivariate not accounting for any variations in other relevant variables
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large financial burden  
and difficulty in  
paying a \$100 dental  
bill.

Reason for last dental visit:  
Among insured 53.7 of  
cardholders and 42.5% of  
non-cardholders visited for a  
check-up - lower among  
uninsured ranging from  
27.7% to 41.4% - The trend  
was reversed for those who  
last visited for relief of pain.  
Insured: 22.4% cardholders  
and 26.2% non-card holders ,  
Uninsured: 31.5% non-  
cardholders and 48.5%  
cardholders

Fillings: Insured (46.5 – 48.9%)  
and Uninsured (44.5 -50%)  
received similar amount of  
fillings in the last 12 months  
but insured (10.3-14.8%)  
received far less extractions  
compared to the uninsured  
(18.6 -40%)

Avoided or delayed visiting due  
to cost: Uninsured (33-43%)  
approximately twice as likely  
to avoid or delay due to cost  
compared to insured (17-  
23%)

Cost Prevented  
recommended/wanted  
treatment: Uninsured – 25-  
40%, Insured 14-16%

Dental visits in the last year  
were a large financial burden:  
Cardholders without dental  
insurance –32%

Difficulty in paying \$100 bill:  
Insured were half as likely  
than the uninsured to report  
difficulty

### 34. Brennan et al. (2001)

LSDPA 1993-94/ random sample of private dental practitioners from state dental registers	n=415 (n=216 male dentists, n=154 female dentists Exclusions: practitioners not working and those working in the public sector. n=6,614 patient visits. Exclusions: patients aged 0 to <18 years or age unknown	Observational Cross-sectional study, self- complete provider-held service logs. Adjusted Odds ratios for insured by type of visit, emergency or non-emergency were provides in adjusted analysis. Data weighted to reflect population of practitioners.	Provision of extractions (one or more)	Nil	Type of visit, insurance status and age were controlled for in the association between diagnosis and extractions Dental insurance was stratified by visit type: emergency insured (EI), emergency uninsured (EU), non-emergency uninsured(NEU) reference group was non- emergency insured(NEI) Main diagnosis (caries, pupal/periapical infection, periodontal disease) assessed in separate models	Response rate: 74% Irrespective of diagnosis the insured (4.3) had lower levels of extractions compared to the uninsured (10.2). Uninsured patients who had emergency visits had the highest odds of extraction followed by emergency visits by insured patients. Models adjusted for a caries diagnosis: for younger adults EU (6.37) had significantly higher odds of extraction than NEU (0.81) and NEI, but not higher than EI (2.88). For older adults EU (11.25) had the highest odds of receiving an extraction, significantly higher than for EI (3.37), NEU (1.10) and EI. Models adjusted for a pupal/periapical infection: for younger adults EU (5.43) had significantly higher odds of extraction than NEU (0.79) and NEI, but not higher than EI (2.31). For older adults EU (9.72) had the highest odds of receiving an extraction, significantly higher than for EI (3.03), NEU (1.09) and EI.	Insurance status was used as a controlling variable but reported for the outcome of extractions along with type of visit – emergency or non-emergency. Overall, after accounting for diagnosis (reason for extraction) amongst older adults, EU patients had higher odds of receiving an extraction in comparison to EI, NEI and NEU. Amongst younger adults EU patients had higher odds of receiving an extraction in comparison to NEI and NEU. Although not
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					Age groups (younger adults 18–44 and older adults 45+)	Models adjusted for a periodontal diagnosis: for younger adults EU (6.25) had significantly higher odds of extraction than NEU (0.78) and NEI, but not higher than EI (2.73). For older adults EU (12.68) had the highest odds of receiving an extraction, significantly higher than for EI (3.91), NEU (1.17) and EI.	significantly higher, EU had higher odds than EI.
<b>35. Brennan et al. (2000)</b>							
LSDPA 1993-94/ random sample of private dental practitioners from state dental registers	n=415 (n=216 male dentists, n=154 female dentists n=8,154 patient visits Exclusions: practitioners not working and those working in the public sector.	Cross-sectional study, self- complete service logs. Adjusted odds ratios. Data weighted to reflect population of practitioners.	Provision of dental services: diagnostic, preventive, restorative, endodontic, extraction, crown and bridge, prosthodontic, general, periodontic, orthodontic		Main diagnosis (caries, cuspal fracture, failed restoration, pupal infection, periodontal disease, recall/maintenanc e) reason for visit, insurance status, patient age and sex	Response rate: 74% Unadjusted estimates not reported by insurance status After controlling for main diagnosis, Insured patients had higher odds of receiving preventive (1.42), endodontic (1.52) and crown and bridge services (1.94), but had lower odds for extractions (0.50). Insurance was not associated with receipt of diagnostic or restorative services.	Insurance status was associated with main diagnosis, patients with main diagnoses of recall and cuspal fracture were more likely to be insured than uninsured, and those with caries and pulpal infection were more likely to be uninsured.
<b>36. Brennan et al. (1997)</b>							
LSDPA 1993-94/ random sample of private dental practitioners from state dental registers	n=415 (n=216 male dentists, n=154 female dentists n=8,154 patient visits (adults	Cross-sectional study, self-completed provider-held service logs. Adjusted odds ratios.	Reason for visit: Check- up, emergency, other Services per visit: Counts Main areas of dental services: diagnostic,	Nil	Insurance Status: Yes or no  Covariates for Main areas of services:	Response rate: 74% Insured: Higher check-ups, lesser emergency and higher number of services per visit 2.15; 1.96 Services per visit: Insured had significantly higher diagnostic	

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<p>aged 18 years or older) Exclusions: practitioners not working and those working in the public sector.</p>	<p>Data weighted to reflect population of practitioners. Bivariate association significance based on Chi-square tests</p>	<p>preventive, restorative, endodontic, extraction, crown and bridge, prosthodontic, general, periodontic, orthodontic</p>	<p>Age, sex and reason for visit</p>	<p>(46.3:42.0), preventive (29.4:20.0), crown and bridge (7.5:3.4) and lower extractions (4.3:10.0) Main Areas of services: Insured – Statistically significant higher diagnostic (46.3% vs. 42.0%), preventive (29.4% vs. 20.0%) and crown and bridge services (7.5% vs. 3.4%) and lower extraction services (4.3% vs. 10.0%). Adjusted analysis: Insured more likely to receive preventive (Adj OR=1.37), endodontic (Adj OR=1.27), crown and bridge (Adj OR= 2.25) and less likely to receive extractions (Adj OR=0.52).</p>
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## Appendix 4a: Data collection tools – Baseline Questionnaire



<h1>Use of Dental Services and Oral Health</h1>	 <p><b>ARCPOH</b> Australian Research Centre for POPULATION ORAL HEALTH</p>
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**THE UNIVERSITY  
OF ADELAIDE**  
AUSTRALIA

This research is supported by the  
Australian National Health & Medical Research Council

**HOW TO ANSWER QUESTIONS**  
Most items are answered by marking the relevant box with a cross  (Example 1)

**EXAMPLE 1**

How would you rate your <b>GENERAL</b> health?	Poor <input type="checkbox"/>	Fair <input type="checkbox"/>	Good <input type="checkbox"/>	Very good <input checked="" type="checkbox"/>	Excellent <input type="checkbox"/>
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Others are answered by writing a number in the box (Example 2)

**EXAMPLE 2**

In the last week how many times did you brush your teeth?	1	2	Times per week
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Please answer in terms of your current, actual situation.  
Good estimates are acceptable if exact answers cannot be given.

**YOUR COOPERATION IS IMPORTANT AND APPRECIATED.**

Mailing ID

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**Section 1** This section asks about your insurance status. Please mark boxes with a cross. **X**

Do you currently have private health insurance? (Includes hospital or ancillary/extras insurance and does not include cover by Medicare).

Yes

No  → Go to section 2

If yes, which best describes what your private health insurance covers (see definitions):

- Combined hospital & ancillary/extras cover
- Hospital cover only
- Ancillary/extras cover only

**Definitions**

Hospital Cover provides benefits to cover (or partially cover) fees for accommodation, operating theatre charges and other charges by private hospitals (or public hospitals for treatment as a private patient). This policy type also covers the costs of drugs and doctors/specialist fees for hospital treatment of private patients.

Ancillary cover, also known as "Extras" cover provides benefits to cover (or partially cover) a range of health related services not provided by a doctor, including services provided by dentists, optometrists and physiotherapists.

Name of health insurance fund:

- Medibank Private
- Mutual Community (BUPA)
- HBA (BUPA)
- HCF (Hospitals Contribution Fund of Australia Limited)
- MBF Australia Pty Limited
- MBF Alliances (SGIC, SGIO, NRMA)
- Health Partners
- Australian Health Management (AHM)
- NIB Health Funds Ltd
- Other (please specify) .....

Please state name of:

- Extras/general treatment policy .....
- Combined hospital & extras policy .....
- .....
- Hospital policy .....

How would you describe the level of dental cover provided by your policy?

- No cover for dental services
- Budget/low level of cover for dental services
- Medium/intermediate cover for dental services
- Top/premium level cover for dental services

How long ago did you commence your current policy?

- MORE THAN 20 years ago
- BETWEEN 10 and 20 years ago
- BETWEEN 5 and 9 years ago
- LESS THAN 5 years ago





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**Section 2** This section asks about your dental visiting. Please mark boxes with a cross. X

How recent was your last visit to a dental professional? (Includes dentist, dental specialist, dental hygienist, dental technician, dental mechanic, denturist or dental therapist).	<input type="checkbox"/> Less than 12 months ago <input type="checkbox"/> One to less than two years ago <input type="checkbox"/> Two to less than five years ago <input type="checkbox"/> Five to less than ten years ago <input type="checkbox"/> Ten years or more <input type="checkbox"/> Don't know
What was the main reason for your last dental visit?	<input type="checkbox"/> Examination or checkup <input type="checkbox"/> Treatment (not for the relief of pain) <input type="checkbox"/> Emergency/Relief of pain
Where do you usually go for dental treatment?	<input type="checkbox"/> Private dental practice <input type="checkbox"/> Public dental clinic (including, dental hospital, community clinic) <input type="checkbox"/> Other site (please specify) -----
How often on average would you seek care from a dental professional?	<input type="checkbox"/> More than two times a year <input type="checkbox"/> Two times a year <input type="checkbox"/> Once a year <input type="checkbox"/> Once in two years <input type="checkbox"/> Less often than once in two years

**Section 3** This section asks about your oral and general health

In the last week how many times did you brush your teeth?	<input type="text"/> <input type="text"/> Times per week										
Do you have any of your own natural teeth?	<input type="checkbox"/> Yes, I have some of my natural teeth <input type="checkbox"/> No, I have none of my natural teeth										
How would you rate your GENERAL health?	<table border="1"> <tr> <td>Poor</td> <td>Fair</td> <td>Good</td> <td>Very good</td> <td>Excellent</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </table>	Poor	Fair	Good	Very good	Excellent	<input type="checkbox"/>				
Poor	Fair	Good	Very good	Excellent							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>							
How would you rate your DENTAL health?	<table border="1"> <tr> <td>Poor</td> <td>Fair</td> <td>Good</td> <td>Very good</td> <td>Excellent</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </table>	Poor	Fair	Good	Very good	Excellent	<input type="checkbox"/>				
Poor	Fair	Good	Very good	Excellent							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>							





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**Section 3 Oral and general health continued. Please mark boxes with a cross. X**

There are 16 teeth, including wisdom teeth, in the UPPER jaw. How many of these 16 teeth do you have remaining in your upper jaw? Do not count false teeth. If you have no teeth in your upper jaw, write "00".

I have   (number) natural teeth in my upper jaw

There are 16 teeth, including wisdom teeth, in the LOWER jaw. How many of these 16 teeth do you have remaining in your lower jaw? Do not count false teeth. If you have no teeth in your lower jaw, write "00".

I have   (number) natural teeth in my lower jaw

Dentures (plates) are artificial teeth that can be removed. Do you wear a denture or false teeth in your UPPER jaw?

Yes  No

Do you wear a denture or false teeth in your LOWER jaw?

Yes  No

**Section 4 During the last 12 months HOW OFTEN have you had ...**

	Very Often	Often	Sometimes	Hardly Ever	Never
A Toothache...	<input type="checkbox"/>				
Gums that hurt...	<input type="checkbox"/>				
Gums that bleed...	<input type="checkbox"/>				
Sensitive teeth... (eg. due to hot or cold food or drinks)	<input type="checkbox"/>				

**Section 5 During the last 12 months have you had ...**

... a broken or chipped natural tooth?	<input type="checkbox"/> Yes <input type="checkbox"/> No
... a broken or chipped filling?	<input type="checkbox"/> Yes <input type="checkbox"/> No
... pain in the face, jaw, temple, in front of the ear or in the ear?	<input type="checkbox"/> Yes <input type="checkbox"/> No

**Section 6 This section asks you to rate your general health TODAY. Please mark A CROSS in one box only for the response that best fits your case for EACH statement.**

Mobility	I have no problems in walking about <input type="checkbox"/>	I have some problems in walking about <input type="checkbox"/>	I am confined to bed <input type="checkbox"/>
Self-care (eg. washing, dressing)	I have no problems with self-care <input type="checkbox"/>	I have some problems with washing and dressing myself <input type="checkbox"/>	I am unable to wash or dress myself <input type="checkbox"/>
Usual activities (eg. housework, family, leisure)	I have no problems performing my usual activities <input type="checkbox"/>	I have some problems performing my usual activities <input type="checkbox"/>	I am unable to perform my usual activities <input type="checkbox"/>
Pain / discomfort	I have no pain or discomfort <input type="checkbox"/>	I have moderate pain or discomfort <input type="checkbox"/>	I have extreme pain or discomfort <input type="checkbox"/>
Anxiety / depression	I am not anxious or depressed <input type="checkbox"/>	I am moderately anxious or depressed <input type="checkbox"/>	I am extremely anxious or depressed <input type="checkbox"/>





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**Section 7** The questions below ask you about troubles that you may have in daily life because of dental problems.

**HOW OFTEN** during the last year ...

Please **CROSS ONE** box that best describes your experience

1... have you had <u>trouble pronouncing any words</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
2... have you felt that your <u>sense of taste has worsened</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
3... have you had <u>painful aching</u> in your mouth?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
4... have you found it <u>uncomfortable to eat any foods</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
5... have you been <u>self conscious</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
6... have you <u>felt tense</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
7... has your <u>diet been unsatisfactory</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
8... have you had to <u>interrupt meals</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
9... have you found it <u>difficult to relax</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
10... have you been a <u>bit embarrassed</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
11... have you been a <u>bit irritable</u> with other people because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
12... have you had <u>difficulty doing your usual jobs</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
13... have you felt that <u>life in general was less satisfying</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
14... have you been <u>totally unable to function</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>





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**Section 8 Please mark with a cross the alternative that best describes you during the last week.**

Concerning my use of prescribed medicines:

- I do not or rarely use any medicines at all.  
 I use one or two medicinal drugs regularly.  
 I need to use three or four medicinal drugs regularly.  
 I use five or more medicinal drugs regularly.

To what extent do I rely on medicines or medical aid? (Not glasses or hearing aid)(eg. walking frame, wheelchair, prosthesis)

- I do not use any medicines and/or medical aids.  
 I occasionally use medicines and/or medical aids.  
 I regularly use medicines and/or medical aids.  
 I have to constantly take medicines or use a medical aid.

Do I need regular medical treatment from a doctor or other health professional?

- I do not need regular medical treatment.  
 Although I have some regular medical treatment, I am not dependent on this.  
 I am dependent on having regular medical treatment.  
 My life is dependent upon regular medical treatment.

Do I need help looking after myself?

- I need no help at all.  
 Occasionally I need some help with personal care tasks.  
 I need help with the more difficult personal care tasks.  
 I need daily help with most or all personal care tasks.

When doing household tasks: (eg. preparing food, gardening, using the video recorder, radio, telephone or washing the car).

- I need no help at all.  
 Occasionally I need some help with household tasks.  
 I need help with the more difficult household tasks.  
 I need daily help with most or all household tasks.

Thinking about how easily I can get around my home and community:

- I get around my home and community by myself without any difficulty.  
 I find it difficult to get around my home and community by myself.  
 I cannot get around the community by myself, but I can get around my home with some difficulty.  
 I cannot get around either the community or my home by myself.

Because of my health, my relationships (eg. with my friends, partner or parents) generally:

- Are very close and warm.  
 Are sometimes close and warm.  
 Are seldom close and warm.  
 I have no close and warm relationships.

Thinking about my relationship with other people:

- I have plenty of friends, and am never lonely.  
 Although I have friends, I am occasionally lonely.  
 I have some friends, but am often lonely for company.  
 I am socially isolated and feel lonely.





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**Section 8  
cont....****Please mark with a cross the alternative that best describes you during the last week.**

Thinking about my health and my relationship with my family:

- My role in the family is unaffected by my health.
- There are some parts of my family role I cannot carry out.
- There are many parts of my family role I cannot carry out.
- I cannot carry out any part of my family role.

Thinking about my vision, including when using my glasses or contact lenses if needed:

- I see normally.
- I have some difficulty focusing on things, or I do not see them sharply. (eg. small print, a newspaper, or seeing objects in the distance).
- I have a lot of difficulty seeing things. My vision is blurred. (eg. I can see just enough to get by with).
- I only see general shapes, or am blind. (eg. I need a guide to move around).

Thinking about my hearing, including using my hearing aid if needed:

- I hear normally.
- I have some difficulty hearing or I do not hear clearly. (eg. I ask people to speak up, or turn up the TV or radio volume).
- I have difficulty hearing things clearly. (eg. Often I do not understand what is said. I usually do not take part in conversations because I cannot hear what is said).
- I hear very little indeed. (eg. I cannot fully understand loud voices speaking directly to me).

When I communicate with others: (eg. by talking, listening, writing or signing)

- I have no trouble speaking to them or understanding what they are saying.
- I have some difficulty being understood by people who do not know me. I have no trouble understanding what others are saying to me.
- I am only understood by people who know me well. I have great trouble understanding what others are saying to me.
- I cannot adequately communicate with others.

If I think about how I sleep:

- I am able to sleep without difficulty most of the time.
- My sleep is interrupted some of the time, but I am usually able to go back to sleep without difficulty.
- My sleep is interrupted most nights, but I am usually able to go back to sleep without difficulty.
- I sleep in short bursts only. I am awake most of the night.

Thinking about how I generally feel:

- I do not feel anxious, worried or depressed.
- I am slightly anxious, worried or depressed.
- I feel moderately anxious, worried or depressed.
- I am extremely anxious, worried or depressed.

How much pain or discomfort do I experience?

- None at all.
- I have moderate pain.
- I suffer from severe pain.
- I suffer unbearable pain.



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**Section 9** This section helps us to ensure we have a good cross section of people in the study.

Date of birth:	<input type="text"/> / <input type="text"/> / <input type="text"/> 19 <input type="text"/>	Sex: Male <input type="checkbox"/> Female <input type="checkbox"/>
	day month year	

Place of birth:	<input type="checkbox"/> Australia <input type="checkbox"/> Other (please specify) -----
-----------------	--

Language spoken at home:	<input type="checkbox"/> English <input type="checkbox"/> Other (please specify) -----
--------------------------	--

How would you describe your current employment status?	<input type="checkbox"/> Full time (35+ hrs) <input type="checkbox"/> Part-time <input type="checkbox"/> Not employed <input type="checkbox"/> Don't know/refusal
--	--

If you are currently unemployed how would you describe your situation?	<input type="checkbox"/> Retired <input type="checkbox"/> Home duties <input type="checkbox"/> Unemployed and looking for work <input type="checkbox"/> Student <input type="checkbox"/> Not employed, and not looking for work <input type="checkbox"/> Don't know/refusal
--	--

What is the highest post-school qualification that you have completed?	Certificate <input type="checkbox"/> Diploma <input type="checkbox"/> Degree <input type="checkbox"/> Post-graduate degree <input type="checkbox"/> None <input type="checkbox"/>
--	---

Could you please indicate the category of your total household income?	<input type="checkbox"/> Up to \$20,000 per year <input type="checkbox"/> From \$20,001 to \$40,000 <input type="checkbox"/> From \$40,001 to \$60,000 <input type="checkbox"/> From \$60,001 to \$80,000 <input type="checkbox"/> From \$80,001 to \$100,000 <input type="checkbox"/> From \$100,001 to \$120,000 <input type="checkbox"/> More than \$120,000 per year
--	--

How many adults in the household (including yourself) are dependent on this income?	<input type="text"/> <input type="text"/>
---	---

How many children in the household are dependent on this income?	<input type="text"/> <input type="text"/>
--	---

Thank you for your participation.  
Please return your completed questionnaire in the reply paid envelope provided.



## Appendix 4b: Data collection tools – First year follow up questionnaire

 80150	<b>Use of Dental Services and Oral Health Study</b> <b>Year One Logbook Retrieval</b>	 Australian Research Centre for POPULATION ORAL HEALTH	 THE UNIVERSITY OF ADELAIDE AUSTRALIA		
<b>Section 1 This section asks about your oral and general health</b>					
There are 16 teeth, including wisdom teeth, in the UPPER jaw. How many of these 16 teeth do you have remaining in your upper jaw? Do not count false teeth. If you have no teeth in your upper jaw, write "00". I have <input type="text"/> <input type="text"/> (number) natural teeth in my upper jaw					
There are 16 teeth, including wisdom teeth, in the LOWER jaw. How many of these 16 teeth do you have remaining in your lower jaw? Do not count false teeth. If you have no teeth in your lower jaw, write "00". I have <input type="text"/> <input type="text"/> (number) natural teeth in my lower jaw					
How would you rate your GENERAL health?	Poor <input type="checkbox"/>	Fair <input type="checkbox"/>	Good <input type="checkbox"/>	Very good <input type="checkbox"/>	Excellent <input type="checkbox"/>
How would you rate your DENTAL health?	Poor <input type="checkbox"/>	Fair <input type="checkbox"/>	Good <input type="checkbox"/>	Very good <input type="checkbox"/>	Excellent <input type="checkbox"/>
<b>Section 2 This section asks you to rate your general health TODAY. Please mark a CROSS <input checked="" type="checkbox"/> in one box only for the response that best fits your case for EACH statement.</b>					
Mobility	I have no problems in walking about <input type="checkbox"/>	I have some problems in walking about <input type="checkbox"/>	I am confined to bed <input type="checkbox"/>		
Self-care (eg. washing, dressing)	I have no problems with self-care <input type="checkbox"/>	I have some problems with washing and dressing myself <input type="checkbox"/>	I am unable to wash or dress myself <input type="checkbox"/>		
Usual activities (eg. housework, family, leisure)	I have no problems performing my usual activities <input type="checkbox"/>	I have some problems performing my usual activities <input type="checkbox"/>	I am unable to perform my usual activities <input type="checkbox"/>		
Pain / discomfort	I have no pain or discomfort <input type="checkbox"/>	I have moderate pain or discomfort <input type="checkbox"/>	I have extreme pain or discomfort <input type="checkbox"/>		
Anxiety / depression	I am not anxious or depressed <input type="checkbox"/>	I am moderately anxious or depressed <input type="checkbox"/>	I am extremely anxious or depressed <input type="checkbox"/>		
<b>Section 3 This section asks about your insurance status. Please mark boxes with a cross. <input checked="" type="checkbox"/></b>					
Do you currently have private health insurance? (Includes hospital or ancillary/extras insurance and does not include cover by Medicare).					
Yes <input type="checkbox"/> No <input type="checkbox"/> → Go to section 4					
If yes, which best describes what your private health insurance covers (see definitions):	<input type="checkbox"/> Combined hospital & ancillary/extras cover <input type="checkbox"/> Hospital cover only <input type="checkbox"/> Ancillary/extras cover only				



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**Section 4** This section asks about your dental visiting. Please mark boxes with a cross. **X**

Over the last 12 months how many dental visits have you made?  
Write '00' if you did not make any dental visits.

<input type="text"/>	<input type="text"/>	Visits
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Over the last 12 months did you receive any of the following treatments?

Type of treatment	If Yes, how many?
Extractions (removal of teeth) <input type="checkbox"/> Yes, <input type="checkbox"/> No.	<input type="text"/> <input type="text"/> teeth
Fillings <input type="checkbox"/> Yes, <input type="checkbox"/> No.	<input type="text"/> <input type="text"/> fillings
Crowns <input type="checkbox"/> Yes, <input type="checkbox"/> No.	<input type="text"/> <input type="text"/> crowns
Bridges <input type="checkbox"/> Yes, <input type="checkbox"/> No.	<input type="text"/> <input type="text"/> bridges
Dentures (false teeth) <input type="checkbox"/> Yes, <input type="checkbox"/> No.	<input type="text"/> <input type="text"/> dentures
Root canal treatment <input type="checkbox"/> Yes, <input type="checkbox"/> No.	<input type="text"/> <input type="text"/> times
X-rays <input type="checkbox"/> Yes, <input type="checkbox"/> No.	<input type="text"/> <input type="text"/> x-rays
Scale & clean <input type="checkbox"/> Yes, <input type="checkbox"/> No.	<input type="text"/> <input type="text"/> times

Over the last 12 months what was the total cost of your dental treatment? Total cost \$.....

Over the last 12 months what was the total insurance rebate, if any, for your dental treatment? Total cost \$.....

This research is supported by the Australian National Health & Medical Research Council

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## Appendix 4c: Data collection tools – Second year follow up questionnaire



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Section 4 (cont)	This section asks about your dental visiting. Please mark boxes with a cross. <input checked="" type="checkbox"/>				
<b>Over the last 12 months did you receive any of the following treatments?</b>					
<b>Type of treatment</b>	<b>If Yes, how many?</b>				
Extractions (removal of teeth) <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text"/> <input type="text"/> teeth				
Fillings <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text"/> <input type="text"/> fillings				
Crowns <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text"/> <input type="text"/> crowns				
Bridges <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text"/> <input type="text"/> bridges				
Dentures (false teeth) <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text"/> <input type="text"/> dentures				
Root canal treatment <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text"/> <input type="text"/> times				
X-rays <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text"/> <input type="text"/> X-rays				
Scale & clean <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text"/> <input type="text"/> times				
Over the last 12 months what was the total cost of your dental treatment?	Total cost \$.....				
Over the last 12 months what was the total insurance rebate, if any, for your dental treatment?	Total rebate \$.....				
Over the last 12 months were all or any of your costs covered or reimbursed by a government scheme? (i.e. Medicare, DVA etc.)	Total amount \$.....				
<b>These statements are about your satisfaction with the dental care received at your last visit.</b>					
1. The <u>dental surgery</u> had everything needed for my dental care.	Strongly disagree <input type="checkbox"/>	Disagree <input type="checkbox"/>	Neutral <input type="checkbox"/>	Agree <input type="checkbox"/>	Strongly agree <input type="checkbox"/>
2. The way my dental care was provided could have been better.	Strongly disagree <input type="checkbox"/>	Disagree <input type="checkbox"/>	Neutral <input type="checkbox"/>	Agree <input type="checkbox"/>	Strongly agree <input type="checkbox"/>
3. The dental care I received <u>did not improve</u> my dental health.	Strongly disagree <input type="checkbox"/>	Disagree <input type="checkbox"/>	Neutral <input type="checkbox"/>	Agree <input type="checkbox"/>	Strongly agree <input type="checkbox"/>
<b>These statements relate to your beliefs about the delivery of dental care.</b>					
1. The community should be responsible for ensuring that everyone is able to receive dental care.	Strongly disagree <input type="checkbox"/>	Disagree <input type="checkbox"/>	Neutral <input type="checkbox"/>	Agree <input type="checkbox"/>	Strongly agree <input type="checkbox"/>
2. People with similar dental problems should be provided with similar dental care.	Strongly disagree <input type="checkbox"/>	Disagree <input type="checkbox"/>	Neutral <input type="checkbox"/>	Agree <input type="checkbox"/>	Strongly agree <input type="checkbox"/>



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**Section 5** The questions below ask you about troubles that you may have in daily life because of dental problems.

HOW OFTEN during the last year ... Please CROSS ONE box that best describes your experience

1... have you had <u>trouble pronouncing any words</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
2... have you felt that your <u>sense of taste has worsened</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
3... have you had <u>painful aching</u> in your mouth?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
4... have you found it <u>uncomfortable to eat any foods</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
5... have you been <u>self conscious</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
6... have you felt tense because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
7... has your <u>diet been unsatisfactory</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
8... have you had to <u>interrupt meals</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
9... have you found it <u>difficult to relax</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
10... have you been a bit <u>embarrassed</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
11... have you been a bit <u>irritable</u> with other people because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
12... have you had <u>difficulty doing your usual jobs</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
13... have you felt that <u>life in general was less satisfying</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>
14... have you been <u>totally unable to function</u> because of problems with your teeth, mouth or dentures?	Very often <input type="checkbox"/>	Fairly often <input type="checkbox"/>	Occasionally <input type="checkbox"/>	Hardly ever <input type="checkbox"/>	Never <input type="checkbox"/>

**Section 6** This section asks about your health, dental care and attitudes.

Over the past two years...

1... How much has your <u>general health</u> changed?	Worsened a lot <input type="checkbox"/>	Worsened a little <input type="checkbox"/>	Stayed the same <input type="checkbox"/>	Improved a little <input type="checkbox"/>	Improved a lot <input type="checkbox"/>
2... How much has your <u>dental health</u> changed?	Worsened a lot <input type="checkbox"/>	Worsened a little <input type="checkbox"/>	Stayed the same <input type="checkbox"/>	Improved a little <input type="checkbox"/>	Improved a lot <input type="checkbox"/>



**Section 6  
(cont.)**

**This section asks about your health, dental care and attitudes.  
Please mark boxes with a cross. X**

Do you usually...			
1...feel that the things that happen to you in your life are hard to understand?	Yes, usually <input type="checkbox"/>	Yes, sometimes <input type="checkbox"/>	No <input type="checkbox"/>
2...see a solution to problems and difficulties that other people find hopeless?	Yes, usually <input type="checkbox"/>	Yes, sometimes <input type="checkbox"/>	No <input type="checkbox"/>
3...feel that your daily life is a source of personal satisfaction?	Yes, usually <input type="checkbox"/>	Yes, sometimes <input type="checkbox"/>	No <input type="checkbox"/>

**Please indicate the extent to which you agree or disagree with each statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.**

I see myself as...	Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly
1. Extroverted, enthusiastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Critical, quarrelsome	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Dependable, self-disciplined	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Anxious, easily upset	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Open to new experiences, complex	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Reserved, quiet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Sympathetic, warm	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Disorganised, careless	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Calm, emotionally stable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Conventional, uncreative	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Please indicate the extent to which you agree or disagree with each statement.**

	Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly
1. Compared to people of my same age I rate my chances of needing future dental treatment as higher.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. You only need to visit a dentist when you have an actual problem that needs treatment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Regular checkups, even when nothing is wrong will prevent problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Regular dental visiting is important because dentists can detect problems before you experience symptoms or pain.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. I think regular visiting is important to prevent small problems from becoming large problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. If you visit a dentist regularly you will avoid large unexpected dental costs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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## Appendix 5: Data collection tools Dental log book

### Dental Visit Log

Date: \_\_\_/\_\_\_/\_\_\_

Type of practice:  Private  Public

Practitioner  Dentist  
type:  Other (specify) \_\_\_\_\_

Reason  Check-up  
for visit:  Treatment (not for relief of pain)  
 Emergency/Relief of pain

**Dental Insurance status at time of this visit:**  
 Insured  Not insured  
**If insured for dental services, was the patient**  
Eligible to claim an insurance rebate for any of  
services provided at this visit?  Yes  No

Copy of **HICAPS** or **dental provider receipt** has  
been attached  Yes  No  
**If 'no' then please complete table below.....**

Was the patient covered for any services at this visit  
by **government schemes** (e.g. DVA, Medicare  
dental services)?  Yes  No

#### Services and cost of treatment:

ADA item code (or description or service)	Total cost (\$ amt)	Insurance rebate (\$ amt)

Turn over to enter more services.



### ***Dental Visit Log Instructions***

**Services and cost of treatment:** You may attach a photocopy of your HICAPS or dental provider receipt or statement provided by either your practitioner or health insurer. **Please cover or white-out patient and provider details.**

**Alternatively,** the participant/practitioner can choose to complete the services and cost of treatment table on the dental visit log sheet as per instructions below.

**Item code:** Please record the ADA dental service item code, ONE PER LINE, until ALL of the dental procedures performed at this visit have been listed. Please record ALL services, even incomplete services or services for which the patient was not charged. Multiple services of the same type should be recorded as two separate services.

**Total cost:** Please cite total service fee charged for each item provided at this visit.

**Private Health Insurance rebate:** If you do not have insurance covering dental services, leave this column blank (Private Health insurance does not include cover provided by Medicare, DVA, or other government schemes).

If you received an insurance rebate for the service received, cite the amount received for each item as stated on your HICAPS receipt. If you did not claim a rebate at the time of your dental visit please enter details after you have processed your claim with your insurer.

If there was no rebate provided because your insurance plan did not cover a service received or because you had reached your annual cap on claimable services, please record \$0 in the rebate column.