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## **Diagnostic services in Australia: service rates and characteristics of patients**

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**Abstract**

*Background:* Diagnostic services are the most common area of dental service in Australia. The objective was to investigate differences in services per visit for examinations and radiographs in relation to the characteristics of patients receiving these services in terms of age and sex, aspects of visiting such as dental insurance and reasons for visit, and oral health such as number of teeth and presence of decay.

*Methods:* A random sample of Australian dentists was surveyed in 2009-10. Data on diagnostic services and patient characteristics were collected from a service log.

*Results:* A total of 1,148 dentists responded (response rate=67%). Models adjusted for age and gender of patients showed that rates [Rate Ratio, 95% CI] of examinations were higher for insured patients [1.13; 1.06-1.21], while rates of radiographs were higher for emergency visits [1.25; 1.11-1.48]. Patients with 20 or more teeth had higher rates for examinations [1.15; 1.01-

1.32] and radiographs [1.28; 1.02-1.60]. Decayed teeth were associated with lower examination rates [0.70; 0.65-0.76] but higher rates of radiographs [1.34; 1.16-1.55].

*Conclusions:* The finding that number of teeth was associated with higher rates of examinations and radiographs suggests that retention of teeth could be influencing the increasing rates of diagnostic services in Australia.

**Keywords:** dental services; private general practice; diagnostic services; examinations; radiographs

## **Introduction**

The number and type of dental services provided in dental practice has changed over time in a number of areas of service around the world.<sup>1-5</sup> For example, the dental service mix in terms of the frequency and type of service provided has been predicted to shift towards diagnostic and preventive procedures for the US population.<sup>1</sup> Services provided by Australian dentists changed over the period 1983-84 to 2009-10 to include less emphasis on replacement of teeth and more on diagnosis, prevention and retention of natural dentitions.<sup>2</sup> In the USA, diagnostic and preventive services made up the majority of all dental procedures in 1996.<sup>3</sup> Further, the proportion of diagnostic and preventive procedures increased between 1999 and 2009 for working age adults in the USA.<sup>4</sup> In the UK the largest increase per capita between 1999/2000 and 2004/05 for older adults was in dental examinations, while there was a marked decrease in dentures.<sup>5</sup>

The change in the use of dental services by age of patients has been linked to improvements in oral health in the population.<sup>6</sup> Retention of teeth has increased in Australian adults with a marked decline in edentulism.<sup>7-9</sup> However, untreated caries has persisted as a dental public health issue affecting approximately a quarter of adults.<sup>10</sup> Patterns of oral health care are also expected to undergo major changes in response to the scientific advances in dental treatment and patient populations that are living longer.<sup>11</sup>

In Australia, dental service patterns have been associated with the main diagnosis of the patient.<sup>12</sup> For example, patients attending for recall tend to have high rates of diagnostic and preventive services, while diagnoses of caries are associated with higher rates of restorative services, and diagnoses of pulpal infection are associated with higher rates of extraction and endodontic services. Diagnostic service rates have increased over time and are the most common area of dental service.<sup>2</sup> Trends in service rates in Australia have seen consistent increases over time in diagnostic services from 1983-84 to 2009-10, by which time they were the highest ranked area of service ahead of restorative and preventive services. Growth in diagnostic services had occurred for both examinations and for dental radiographs.<sup>13</sup> The high and increasing rate of diagnostic services in Australia warrants research into establishing a profile of diagnostic services (i.e., different types of examination and radiographic services) to better understand the characteristics associated with variation in these services, and likely influences on future rates of provision of diagnostic services. The objective of this study was to investigate differences in diagnostic service rates in relation to the demographic characteristics of patients such as age and sex, visit factors such as dental insurance and reason for visit, and oral health status such as number of teeth and presence of decayed teeth. The focus of the study is on identifying the characteristics of those who receive these services.

## Methods

A sample of 10% of male dentists and 40% of female dentists was randomly drawn from the dental registers for each State or Territory in Australia in 1983-84, then comprising a total of 7,427 dentists. The higher sampling rate for female dentists was designed to include sufficient numbers for comparisons by gender of dentist, as females comprise a lower percentage of registered dentists than males. Sample supplementation at each successive wave of the study based on 10% of male and 40% of female dentists who were newly registered since the previous wave ensured representative cross-sectional estimates. In 1983-84, 1988-89, 1993-94, 1998-99, 2003-04 and 2009-10 these samples were surveyed by mailed questionnaire.<sup>14-16</sup> This analysis presents data from the most recent survey in 2009-10 in order to establish the most current profile of characteristics of patients receiving diagnostic services. These data were weighted using the dental board registration statistics from 2009.<sup>17</sup> Therefore the estimates of practice activity are representative of the age and gender distribution of Australian private practice dentists around the time of the survey.

Practitioners recorded the types of services provided over one self-selected typical day of practice. The number of patients sampled by each dentist varied according to their typical level of activity. Dentists were free to choose which day to include in their service log. Only sampled dentists within any group practice provided data. Dentists were instructed to record the services provided for each patient treated on their selected typical day regardless of whether or how they were charged to the patient. A patient may have received a number of services per visit across the range of 10 main areas of service, based on the Australian Dental Association's (ADA) *Schedule of Dental Services*. The Australian Glossary of Dental Terms was first published in 1986, and expanded to the Australian Schedule of Dental Services and

Glossary in 1996.<sup>18</sup> A number of editions have been published since then, and are generally adopted as the definitive coding system for dental treatment in Australia. Diagnostic services were coded for analysis into groupings of examinations (comprising services such as comprehensive and periodic oral examinations, consultations and written reports), radiographs (such as periapical or bitewing radiographs, and panoramic radiographs) and other diagnostic services (such as pulp testing, photographic records and diagnostic models) based on the classification used in the Australian Dental Association schedule.<sup>18</sup> For this paper, the analysis excluded other diagnostic services which comprised a small component of diagnostic services.

Patient details were also collected in the log including age, gender, insurance cover and the reason for visit (with emergency visits defined as those involving relief of pain). The number of teeth and number of decayed teeth that were present was also recorded by the dentist for each patient. For analysis, the number of teeth was classified into those with 20 or more teeth and less than 20 teeth.<sup>19, 20</sup> Patients were classified into those with one or more decayed teeth and those with no decayed teeth.

Tests of statistical significance used in this analysis were based on the weighted sample data described earlier. Analyses were performed adjusting for the design effect of clustering of patients within sampled dentists. Statistical comparisons were performed using Poisson regression for service rates per visit with  $P < 0.05$  as the significance level. Adjusted models of service provision were constructed using indicator variables for the independent variables coded as 1 or 0, with a reference category not entered in the models.

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The research was conducted with ethical clearance from the Ethics Committee of the Australian Institute of Health and Welfare and conforms to the Declaration of Helsinki. The study was conducted as a mailed self-complete survey with consent implied through the return of completed surveys.

## **Results**

The response rate to the survey was 67% in 2009-10, which comprised responses from 1,148 dentists. The highest percentage of patients was found in the 45-64 years age group (36.0%) and there were similar percentages of male and female patients (Table 1). The majority of patients were insured (62.0%) and had non-emergency visits (78.3%). Most patients had 20 or more teeth (88.1%) and nearly half had one or more decayed teeth (48.3%).

Investigation of the rate per visit for the most common diagnostic procedures found that intraoral radiographs and periodic oral examinations were provided at the highest rates, followed by comprehensive oral examinations, limited oral examinations, and consultations. Other diagnostic procedures such as panoramic radiographs, diagnostic models, and pulp testing were provided at relatively lower rates. When diagnostic items were grouped into categories, examinations had the highest rate per visit (mean=0.50, 95% CI: 0.48-0.52), followed by radiographs (0.34, 0.31-0.37). Note that other diagnostic services comprised a low rate per visit (0.02, 0.016-0.027), and are not reported further in this paper.

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Examination rates per visit varied by age of the patient, with the highest rates observed in the younger age groups and lower rates in older age groups of patients (Table 1). Rates of examinations per visit did not vary by gender of patient but were higher for insured patients, those attending for non-emergency visits, for patients with more teeth and patients with no decayed teeth.

Radiograph rates per visit were highest for patients aged 18-24 and 25-44 years (Table 1), but did not vary by gender of patient or insurance status. Patients attending for emergency visits had higher rates of radiographs than non-emergency visits. Those patients with more teeth had higher rates of radiographs per visit, as did patients with one or more decayed teeth.

Models of diagnostic service rates presented in Table 2 showed that rates [Rate Ratio, 95% CI] of examinations were lower for patients aged 18-24 [0.85; 0.74-0.97] to 65 or more years [0.63; 0.54-0.74] compared to those aged 5-11 years. Radiograph rates were higher for patients aged 18-24 [2.57; 1.69-3.91] to 45-64 years [1.82; 1.24-2.69]. Diagnostic service rates did not vary by gender of patient. Rates of examinations were higher for insured patients [1.13; 1.06-1.21], while rates of radiographs were higher for emergency visits [1.25; 1.11-1.48]. Patients with 20 or more teeth had higher rates for both examinations [1.15; 1.01-1.32] and radiographs [1.28; 1.02-1.60]. Decayed teeth were associated with lower rates of examinations [0.70; 0.65-0.76] but higher rates of radiographs [1.34; 1.16-1.55].

## Discussion

This study showed that rates of diagnostic services varied by a range of patient demographic, visit and oral health characteristics. There were contrasting age-related patterns for examinations and radiographs, with examination rates higher for younger patients and radiograph rates higher for older patients. While insurance was associated with higher examination rates, the rates of radiographs did not vary by insurance status. Emergency visits exhibited the opposite pattern, with no difference in examination rates but higher rates of radiographs. There were consistent effects for number of teeth, with more teeth associated with higher rates of both examinations and radiographs. Patients with one or more decayed teeth had lower examination rates but in contrast their radiograph rates were higher.

The findings are based on national survey data of a random sample from a comprehensive sampling frame with an adequate response rate, and are restricted to private general practitioners. Data were weighted to reflect the age and gender distribution of private general practitioners in Australia, hence it is likely that the results can be generalised to represent the majority of Australian dental service providers where over 80% work in the private sector.<sup>17</sup> The majority of patients, around 66%, were from capital city locations.<sup>21</sup> Dental service rates can vary by sector,<sup>22</sup> and by geographic location.<sup>21,23</sup> Hence further research could investigate patterns of diagnostic services in public sector and rural locations. The use of service data from a self-selected typical day could potentially introduce bias. Nevertheless, it has been shown there was no significant difference in service rates in all 10 main areas of service between data collected over a 10-day sampling period compared with estimates based on one typical day.<sup>24</sup>

In Australia, an ageing population is an important demographic trend that is common to many developed countries. As a result of low birth rates and increasing life expectancy the number and proportion of older people is increasing in the Australian population.<sup>25</sup> Findings for older adults in the US show that diagnostic and preventive services accounted for the majority of dental services.<sup>26</sup> In Finland treatment rates per patient were highest for examinations overall, and examinations along with restorative treatment were provided at high rates among older adults.<sup>27</sup> The current study observed higher rates of radiographs for adults aged from 18 to 64 years. If these higher diagnostic rates are maintained in these cohorts as they age they could continue the trend towards increases in diagnostic service rates. However, they could potentially be counterbalanced by lower examination rates. The observed age-associated patterns with diagnostic services were independent of the adjustment for visit and oral health characteristics that could indicate there are other reasons for age patterns, such as routines in clinical decisions.<sup>28</sup> While the focus of the study was on identifying the characteristics of patients who receive diagnostic services there is scope for further research into characteristics of service providers who are more likely to deliver these services at higher rates. Improved patient knowledge on available dental services could also influence treatment provision.<sup>29</sup> Receipt of diagnostic radiographs has also been related to a range of practice characteristics independently of patient disease levels and sociodemographics.<sup>30</sup> These findings were interpreted as an indication that providers can exert an influence on diagnostic service rates consistent with their acting in response to a consideration of interests of the patient, economic self-interest and their own preferences for treatment.

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Insurance effects were only observed for examinations not radiographs. This could reflect the provision of diagnostic and preventive services as part of routine recall visits associated with insurance.<sup>12</sup> Dental insurance in Australia tends to be strongly associated with dental service use and is often seen as an enabling factor in terms of access to care,<sup>31</sup> with insurance associated with more recent dental visits but lower levels of relief of pain visits.<sup>32</sup> Patients with dental insurance have been reported to be more likely to receive preventive, crown and bridge and endodontic services, but less likely to receive extractions and with no differences in receipt of diagnostic, restorative or prosthodontic services.<sup>33</sup> For low socioeconomic groups having dental insurance was associated with better self-rated dental health.<sup>34</sup>

Emergency visits were associated with higher rates of radiographs, which could indicate their application in the confirmation of oral problems rather than early detection.<sup>35</sup> Among the oral health factors associated with diagnostic services, the number of teeth was associated with higher rates of both examinations and radiographs. This suggests that retention of teeth could be a driving factor in the increasing rates of diagnostic services in Australia. Reductions in the levels of tooth loss have been linked with increased treatment needs, especially in the elderly.<sup>36</sup> A study of older adults found that those who retained higher numbers of teeth had more periodontal disease and dental caries experience, and reported a past pattern of visiting the dentist more frequently.<sup>37</sup>

Decayed teeth were associated with lower rates examinations but higher rates of radiographs. This could reflect visit patterns, with those without decay being more likely to be in routine recall/check-up patterns of care while those with decayed teeth could be in problem-based visit patterns associated with higher radiograph rates. However, the analysis was adjusted for

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reason for visit, so other factors not in the statistical models could also be operating in relation to decayed teeth such as socioeconomic status,<sup>38</sup> or interactions of socioeconomic status with dental behaviours such as tooth brushing and dental visiting.<sup>39</sup> Collection of patient information in the service log focused on observed demographic, dental visit and oral health characteristics rather than socioeconomic status. Hence further research could extend the investigation to include associations with socioeconomic status.

## Conclusions

Diagnostic services varied by patient age, visit characteristics and oral health status. The number of teeth was associated with higher rates of both examinations and radiographs. This suggests that retention of teeth could be a driving factor in the relatively higher rates of diagnostic services compared with other main areas of dental service.

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**Table 1. Distributions of explanatory variables and mean rates per visit of examination and radiograph services by explanatory variables**

	Distribution	Examinations		Radiographs	
	Percent	Mean	(SE)	Mean	(SE)
<b>Patient age</b>		**		**	
5-11 years	5.1	0.7	(0.03)	0.2	(0.03)
12-17 years	7.7	0.7	(0.04)	0.3	(0.04)
18-24 years	7.4	0.6	(0.03)	0.5	(0.05)
25-44 years	27.9	0.5	(0.02)	0.4	(0.02)
45-64 years	36.0	0.5	(0.01)	0.3	(0.02)
65+ years	15.8	0.4	(0.02)	0.3	(0.03)
<b>Gender of patient</b>					
Male	55.7	0.5	(0.01)	0.3	(0.02)
Female	44.4	0.5	(0.01)	0.3	(0.02)
<b>Insurance status</b>		**			
Insured	62.0	0.5	(0.02)	0.3	(0.02)
Uninsured	38.0	0.5	(0.01)	0.4	(0.02)
<b>Reason for visit</b>		**		**	
Emergency	21.7	0.5	(0.02)	0.4	(0.02)
Non-emergency	78.3	0.5	(0.01)	0.3	(0.02)
<b>Number of teeth</b>		**		**	
< 20 teeth	11.9	0.4	(0.02)	0.2	(0.02)
20+ teeth	88.1	0.5	(0.01)	0.4	(0.02)
<b>Decayed teeth</b>		**		**	
No decayed teeth	51.7	0.6	(0.02)	0.3	(0.02)
1+ decayed teeth	48.3	0.4	(0.01)	0.4	(0.02)

\*\*p<0.01 (Poisson regression)

Table 2. Adjusted models of diagnostic service rates

	Examinations		Radiographs	
	RR	(95% CI)	RR	(95% CI)
<b>Patient age</b>				
5-11 years	Ref.		Ref.	
12-17 years	0.91	(0.80, 1.03)	1.53	(0.98, 2.39)
18-24 years	*0.85	(0.74, 0.97)	**2.57	(1.69, 3.91)
25-44 years	**0.75	(0.67, 0.84)	**1.97	(1.32, 2.92)
45-64 years	**0.68	(0.60, 0.76)	**1.82	(1.24, 2.69)
65+ years	**0.63	(0.54, 0.74)	1.47	(0.94, 2.30)
<b>Gender of patient</b>				
Male	1.03	(0.97, 1.10)	0.97	(0.85, 1.11)
Female	Ref.		Ref.	
<b>Insurance status</b>				
Insured	*1.13	(1.06, 1.21)	0.95	(0.83, 1.10)
Uninsured	Ref.		Ref.	
<b>Reason for visit</b>				
Emergency	1.00	(0.92, 1.10)	**1.28	(1.11, 1.48)
Non-emergency	Ref.		Ref.	
<b>Number of teeth</b>				
< 20 teeth	Ref.		Ref.	
20+ teeth	*1.15	(1.01, 1.32)	*1.28	(1.02, 1.60)
<b>Decayed teeth</b>				
No decayed teeth	Ref.		Ref.	
1+ decayed teeth	**0.70	(0.65, 0.76)	**1.34	(1.16, 1.55)

RR: rate ratio

\* $p < 0.05$ ; \*\* $p < 0.01$  (Poisson regression)