

## Diagnostic and preventive service trends in private general practice: 1983-1984 to 1998-1999

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### Abstract

**Background:** Aggregate trends have indicated increases in the provision of diagnostic and preventive services but there have been few reports based on their component sub-categories. The aims of this study were to investigate time trends in the provision of sub-categories of diagnostic and preventive services across a 15-year period.

**Methods:** A random sample of Australian dentists was surveyed by mailed questionnaire in 1983-1984, 1988-1989, 1993-1994 and 1998-1999 (response rates 71-75 per cent). Data were weighted to provide representative estimates for the age by sex distribution of private general practitioners in 1983, 1988, 1993 and 1998.

**Results:** Rates per visit were higher, Poisson regression,  $P < 0.05$ , in 1998-1999 compared to baseline for examinations, radiographs, prophylaxis and topical fluoride. Diagnostic and preventive service rates varied by age of patient: compared to patients aged 65+ years, examinations were higher among children aged <5 years to adults aged 25-44 years, radiographs were lower among children <5 years and 5-11 years but higher among adults aged from 18-24 years to 45-64 years, prophylaxis services were lower among children <5 years but higher among adolescents 12-17 years to adults aged 45-64 years, while topical fluoride was higher among children 5-11 years and adolescents 12-17 years.

**Conclusions:** Examination, radiograph, prophylaxis, and topical fluoride rates increased over the study period. While examination rates increased for both children and adults, and prophylaxis rates increased for adolescents and adults, rates for radiographs and topical fluoride only increased for adults. Age-specific changes in service rates over time indicate the effect of changing oral health status and population demographics on service provision.

**Keywords:** Diagnostic, preventive, private general practice, service provision, time trends.

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### INTRODUCTION

In Australia service-mix has been dominated by restorative, diagnostic, and preventive services.<sup>1</sup> Findings from other countries such as the USA have shown that most dental treatment involved a narrow range of procedures, primarily of a reparative nature.<sup>2</sup> Variations over time in Australia have included increases between 1983-1984 and 1988-1989 for diagnostic, preventive, crown and bridge, orthodontic, and general services.<sup>3</sup> The UK has reported reductions in extractions and prosthodontics and increases in diagnostic, preventive and restorative care,<sup>4</sup> while findings from the USA have found evidence of improvements in oral health as reflected in changes in service patterns over time within a population of insured patients.<sup>5</sup>

Population surveys have shown an increase in the number of visits made by patients who attend for dental care. For example, the average number of visits has increased from 1.9 visits per year in 1979<sup>6</sup> to 2 per year in 1987-1988<sup>7</sup> and 2.4 per year in 1994.<sup>8</sup> The increased use of dental services over time has been associated with the increasing retention of teeth into adulthood and the resulting larger pool of teeth at risk of oral disease.<sup>9</sup> Trends towards improved oral health have been observed in the Australian population over recent decades. Reductions in caries experience have occurred among children,<sup>10</sup> and decreased levels of tooth loss among adults.<sup>6-8</sup> Shifts in oral health status can be considered with demographic changes. Population trends in Australia will maintain a stable pool of children and young adults, while increasing the pool of middle to older aged adults at risk of oral disease.<sup>11</sup>

Changing patient demographics and technological advances are predicted to lead to higher patient expectations and greater demands for oral health care.<sup>12</sup> The overall mix of services is expected to continue to shift toward diagnostic and preventive services.<sup>13</sup> However, most reports have focused on aggregate trends, with few investigations based on the component sub-categories of diagnostic and preventive services. This leads to the research question: do the aggregate trends observed for diagnostic and preventive services hold for sub-categories of services within these main

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areas of service? Service provision has been shown to be related to the age of patient,<sup>1</sup> hence there needs to be control for this variable in any analysis of time trends. Therefore, the aim of this study was to investigate trends in service provision for private general dental practitioners by comparing measures of services per visit at four points across a 15-year period based on a finer level of disaggregation of diagnostic and preventive services into sub-categories, and controlling for the effect of age of patient.

## MATERIALS AND METHODS

### Sample and response

A longitudinal design involving a sample of 10 per cent of male dentists and 40 per cent of female dentists was randomly drawn from the dental registers for each State or Territory in Australia in 1983. The higher sampling rates for female dentists was designed to include sufficient numbers for comparisons by sex 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 per cent of male and 40 per cent of female dentists who were newly registered since the previous wave ensured representative cross-sectional estimates. In 1983-1984, 1988-1989, 1993-1994 and 1998-1999 these samples were surveyed by mailed questionnaire, providing response rates of 73, 75, 74 and 71 per cent respectively.

The data were weighted using the estimated number of practising private general practice dentists at December 1983 and 1988,<sup>14,15</sup> with the age and sex distribution of dentists from the 1981 and 1986 population censuses of Australia,<sup>16,17</sup> and dental board registration statistics from 1992,<sup>18</sup> and 1994.<sup>19</sup> This weighted measure of practice activity was representative of the age and sex distribution of Australian private practice dentists at each time.

The data reported here are restricted to private general practitioners. The provision of oral health services was dominated by general practitioners (84.6 per cent), with a small percentage of practitioners in specialist and restricted practice (10.3 per cent), and the remainder in areas such as administration, teaching and research.<sup>19</sup> Most practitioners were in the private sector (81.4 per cent).

### Service provision data

Practitioners recorded the types of services provided over one to two self-selected typical days of practice. The number of patients sampled by each dentist varied according to their typical level of activity. Dentists were free to choose which days to include in their service log. Only sampled dentists within any group practice provided data. Dentists were instructed to record for each patient treated on their selected typical days the services provided regardless of whether or how they were charged to the patient. A patient may receive a

number of services per visit across the range of 10 main areas of service.

Services were classified following the Australian Dental Association's *Schedule of Dental Services*.<sup>20</sup> Diagnostic services were classified into the categories of examinations, radiographs, and other diagnostic services. The category of examinations comprised items of service such as oral examinations, consultations and written reports. Radiographs comprised items covering radiological examination and interpretation such as intraoral periapical or bitewing radiographs, cephalometric radiographs and panoramic radiographs. Other diagnostic services comprised items such as caries activity testing, biopsy of tissue and blood sampling. Preventive services were classified into the categories of prophylaxis, topical fluoride, oral hygiene instruction/dietary advice, provision of a mouth guard, fissure sealing, application of desensitizing agent, odontoplasty, and fluoridation application. The category of prophylaxis comprised items of service such as removal of plaque, removal of supragingival calculus and plaque, and removal of supra and subgingival calculus and plaque. Topical fluoride comprised the items of topical application of fluoride (e.g., using gel in trays) and instruction in and supervision of self-application of topical fluoride. Fluoride application involved site-specific remineralization that included arrest of caries using silver fluoride treatment per quadrant and spot application of concentrated fluoride to early enamel lesions involving isolation and control of the target area of a single tooth.

### Analysis

Tests of statistical significance used in this analysis were based on the weighted sample data described earlier, using a weighting factor that avoided inflating the sample size rather than the measures for the population of private general practitioners. Statistical comparisons were performed using Poisson regression for service rates per visit using counts of services per visits as the dependent variable with  $P < 0.05$  as the significance level (StrataCorp. Strata statistical software: 6.0 College Station TX: Strata Corporation, 1999). Indicator variables were used for each independent variable, coded as 1 with the reference category coded as 0.

Service rates were compared using rate ratios derived from the Poisson regressions. A rate ratio of 1 indicates no difference in the rate of services, a rate ratio above 1 indicates higher rates, and those below 1 lower rates, in relation to the chosen reference category. Rate ratios in the range 0-0.3 or 2.6 indicate strong effects, 0.4-0.5 or 1.7-2.5 moderate effects, and 0.6-0.8 or 1.2-1.6 weak effects, while those in the region of 0.9-1.1 are considered as indicating no effect.<sup>21</sup> The design effect of clustering of patient observations within the primary sampling unit of a dentist was controlled for in the analysis.

**Table 1. Age and sex distribution of responding private general practitioners by time of study**

	1983-1984		1988-1989		1993-1994		1998-1999	
	Male	Female	Male	Female	Male	Female	Male	Female
Age of dentist	%	%	%	%	%	%	%	%
20-29 years	13.1	37.7	13.2	37.9	12.8	27.5	10.7	28.5
30-39 years	30.9	36.5	34.5	38.4	30.3	45.5	26.1	39.9
40-49 years	22.3	14.1	25.3	12.4	28.5	18.0	31.0	25.0
50-59 years	23.1	8.2	12.8	8.5	15.3	6.0	21.5	6.1
60+ years	10.6	3.5	14.1	2.8	13.1	3.0	10.7	0.4
Total (n)	282	85	304	177	274	167	261	228

**RESULTS**

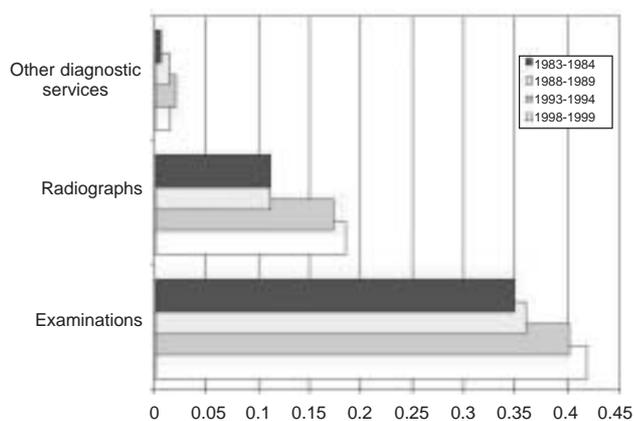
**Age and sex distribution of respondents by time of study**

The age and sex distributions of responding general practitioners from private practice are presented in Table 1. In total, there were 367 dentists from 1983-1984, 481 from 1988-1989, 441 from 1993-1994 and 489 from 1998-1999, with higher percentages of younger female compared with male dentists. The age distribution of the sample was not known, as age of dentist was not listed on the published dental registers. However, the age and sex distribution of respondents could be compared to national data reported on the population of registered dentists to assess potential bias. There was generally close agreement between the distributions of respondents compared to the population of dentists,<sup>14-19</sup> with a tendency for younger dentists to be slightly over-represented, and older dentists to be slightly under-represented among the respondents. This was adjusted for in the weighting process.

**Service provision by time of study**

Figure 1 shows the rate of diagnostic service provision per visit by time of study. Examinations comprised the bulk of diagnostic service provision, followed by radiographs, and then other diagnostic services. Rate of provision of both examinations and radiographs increased over the period of the study. Further analyses of diagnostic services are restricted to examinations and radiographs.

Figure 2 shows the rate of preventive service provision per visit by time of study. Prophylaxis



**Fig 1.** Diagnostic services per visit by time of study.

services and topical fluoride were provided at higher rates compared with the other preventive services. Prophylaxis services showed a steady increase over the study period, while both topical fluoride and fissure sealant services were higher in 1998-1999 compared with baseline in 1983-1984. Further analyses of preventive services are restricted to prophylaxis and topical fluoride services.

**Service provision by patient age and time of study**

Table 2 shows examination services by patient age and time of study. A gradient by age of patient was observed at each time of the study, with higher rates of examination services among children compared to older age groups of patients. A pattern of increase in examination rates was observed among children aged 5-11 years and adults aged 65+ years at the last point in time of the study, while adults aged 18-24 years to 45-64 years tended to show an increase between 1988-1989 and 1993-1994.

Table 3 shows radiograph services by patient age and time of study. Radiograph services were highest at baseline among patients aged 12-17 to 25-44 years, but by the later time points of the study patients aged 18-24 to 45-64 years showed higher rates. A pattern of increase in rates of radiograph services was most marked among patients aged 18-24 and 25-44 years between 1988-1989 and 1993-1994, while patients in the 45-64 year age group exhibited increases in radiographs over each point in time of the study, with patients aged 65 years or more showing a trend towards an increased rate of radiographs at the last point in time of the study.

Table 4 shows dental prophylaxis services by patient age and time of study. At each point in time of the study children aged <5 years had the lowest rate of prophylaxis, but significant variation by age of patient was only observed in 1993-1994. All age groups had a higher rate of prophylaxis services in 1998-1999 compared to baseline, but significant increases were only observed for patients in the age range 12-17 to 45-64 years.

Table 5 shows topical fluoride services by patient age and time of study. The highest rates of topical fluoride services were observed in the 5-11 and 12-17 years age groups for all four points in time of the study. All age groups had higher rates of topical fluoride services in 1998-1999 compared to the baseline rate in 1983-

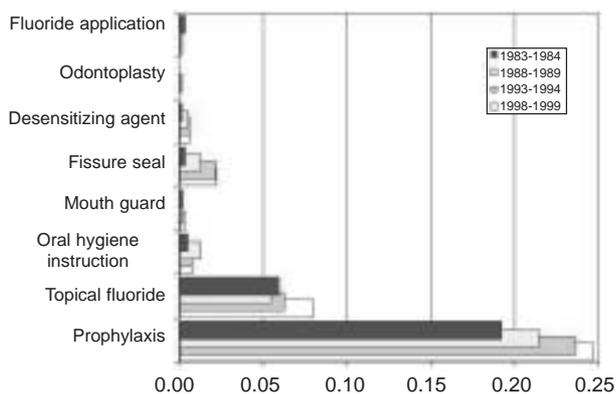


Fig 2. Preventive services per visit by time of study.

1984, but significant differences were only observed for patients in the 45-64 and 65+ year age groups.

### Multivariate analysis of service provision

Table 6 shows rate ratios from Poisson regression models of service provision by time of study and age of patient. Rates per visit were higher, Poisson regression,  $P < 0.05$ , in 1998-1999 compared to baseline for examinations, radiographs, prophylaxis and topical fluoride. Provision of diagnostic and preventive services varied by age of patient: compared to patients aged 65+ years, examinations were higher among children aged <5 years to adults aged 25-44 years, radiographs were lower among children <5 years and 5-11 years but higher among adults aged from 18-24 years to 45-64 years, prophylaxis services were lower among children

<5 years but higher among adolescents 12-17 years to adults aged 45-64 years, while topical fluoride was higher among children 5-11 years and adolescents 12-17 years.

## DISCUSSION

### Representativeness

These findings are from national surveys based on a random sample from a comprehensive sampling frame (i.e., all dentists on the State/Territory dental registers) which achieved adequate response rates (in excess of 70 per cent), was restricted to private general practitioners who comprise the majority of dentists in Australia, was weighted to reflect the age and sex distribution of private dental practitioners in Australia, hence it is likely that the results can be generalized to represent the Australian context. The use of service data from a self-selected typical day could potentially introduce bias if dentists, for example, selected a day to show their practice in the best light. This effect should be minimized through the privacy and confidentiality provisions of the survey process. A report has 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 nominated from the 10-day sampling period by the responding dentists.<sup>22</sup>

### Interpretation of rate ratios

Rate ratios indicate differences in rates of service per visit. The negative rate ratios (i.e., those <1) observed in younger age groups for radiographs and prophylaxis

Table 2. Examination services per visit by age of patient and time of study

	1983-1984		1988-1989		1993-1994		1998-1999		P
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	
Age of patient									
<5 years	0.80	(.06)	0.78	(.05)	0.80	(.05)	0.91	(.03)	NS
5-11 years	0.55	(.03)	0.58	(.04)	0.63	(.03)	0.72	(.04)	**
12-17 years	0.45	(.03)	0.47	(.03)	0.53	(.03)	0.53	(.04)	NS
18-24 years	0.32	(.02)	0.39	(.02)	0.51	(.02)	0.49	(.03)	**
25-44 years	0.32	(.01)	0.34	(.01)	0.39	(.01)	0.41	(.02)	**
45-64 years	0.28	(.02)	0.27	(.01)	0.33	(.01)	0.36	(.02)	**
65+ years	0.30	(.03)	0.25	(.03)	0.29	(.02)	0.36	(.03)	**
P	**		**		**		**		

NS (Not significant); \*\* ( $P < 0.01$ ); Poisson regression.

Table 3. Radiographic services per visit by age of patient and time of study

	1983-1984		1988-1989		1993-1994		1998-1999		P
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	
Age of patient									
<5 years	0.02	(.02)	0.03	(.03)	0.02	(.02)	0.05	(.03)	NS
5-11 years	0.05	(.01)	0.03	(.01)	0.06	(.01)	0.06	(.02)	NS
12-17 years	0.12	(.02)	0.07	(.01)	0.11	(.02)	0.11	(.02)	NS
18-24 years	0.15	(.02)	0.18	(.02)	0.23	(.02)	0.21	(.03)	*
25-44 years	0.14	(.01)	0.13	(.01)	0.23	(.01)	0.22	(.01)	**
45-64 years	0.07	(.01)	0.10	(.01)	0.16	(.01)	0.19	(.02)	**
65+ years	0.07	(.02)	0.08	(.02)	0.09	(.01)	0.16	(.03)	**
P	**		**		**		**		

NS (Not significant); \* ( $P < 0.05$ ); \*\* ( $P < 0.01$ ); Poisson regression.

**Table 4. Prophylaxis services per visit by age of patient and time of study**

	1983-1984		1988-1989		1993-1994		1998-1999		P
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	
Age of patient									
<5 years	0.06	(.03)	0.15	(.04)	0.14	(.04)	0.14	(.06)	NS
5-11 years	0.18	(.04)	0.20	(.03)	0.23	(.03)	0.22	(.04)	NS
12-17 years	0.18	(.02)	0.20	(.02)	0.27	(.03)	0.28	(.04)	*
18-24 years	0.21	(.02)	0.23	(.02)	0.28	(.02)	0.23	(.03)	*
25-44 years	0.21	(.01)	0.23	(.01)	0.24	(.01)	0.27	(.01)	*
45-64 years	0.18	(.02)	0.20	(.01)	0.23	(.01)	0.24	(.02)	*
65+ years	0.16	(.03)	0.19	(.02)	0.19	(.02)	0.21	(.02)	NS
P	NS		NS		**		NS		

NS (Not significant); \*(P<0.05); \*\*(P<0.01); Poisson regression.

indicated that children had lower rates of these services compared to the reference category of 65+ year olds. The positive rate ratios (i.e., those >1) observed over the points in time of the study indicate that, where they were significant, there has been an increase in the rate of those services per visit over time. This does not necessarily mean that an increased number of patients have received these services and whether this equates to an increased number of services per patient depends on the number of visits that were made by patients. However, findings from population surveys have shown that the number of visits made by patients who attend for dental care increased from 1.9 visits in 1979,<sup>6</sup> to 2.4 visits in both 1994,<sup>8</sup> and 1999.<sup>23</sup> The increased rates of dental visits together with the increased rates of services per visit would indicate that on average there has been an increased number of services per patient.

#### Diagnostic service trends

Examination services increased across the last two points in time of the study compared to baseline and showed a pattern of higher rates among younger patients. While the distribution of examination services was skewed towards younger patients at both the beginning and end of the study period, significant increases in examination service rates over time were mainly observed among adult age groups.

As for examination services, radiograph service rates also increased across the last two points in time of the study compared to baseline. The only significant increases in rates of radiographs occurred among adult

age groups, with the effect that by the end of the study period the distribution of radiograph service rates was skewed towards adults.

#### Preventive service trends

Provision of dental prophylaxis services increased across the last two points in time of the study, as was the case for rates of examinations and radiographs. Significant increases were observed among adolescents and adults aged up to 45-64 years. While children aged <5 years had the lowest rate of prophylaxis in each point of time of the study, there was little difference in prophylaxis rates among the older age groups.

Rates of topical fluoride services only increased at the last point in time of the study, with significant increases only observed among middle-aged to older adults. However, despite the increased rates among adult patients, children and adolescents dominated the distribution of topical fluoride services at each point in time of the study.

#### Interpretation of trends

Rates of service provision per visit from previous reports, have indicated trends such as increases in routine scheduled care such as diagnostic and preventive services, as well as interventions consistent with maintenance of a functional dentition such as endodontic and crown and bridge services.<sup>24</sup> The main component categories of diagnostic and preventive services reflect the aggregate results. However, they

**Table 5. Topical fluoride services per visit by age of patient and time of study**

	1983-1984		1988-1989		1993-1994		1998-1999		P
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	
Age of patient									
<5 years	0.04	(.02)	0.06	(.03)	0.07	(.03)	0.07	(.05)	NS
5-11 years	0.16	(.02)	0.17	(.03)	0.11	(.02)	0.17	(.04)	NS
12-17 years	0.14	(.02)	0.12	(.02)	0.14	(.02)	0.18	(.04)	NS
18-24 years	0.05	(.01)	0.05	(.01)	0.07	(.01)	0.08	(.02)	NS
25-44 years	0.04	(.01)	0.04	(.01)	0.05	(.01)	0.06	(.01)	NS
45-64 years	0.03	(.01)	0.02	(.01)	0.05	(.01)	0.06	(.01)	**
65+ years	0.03	(.01)	0.04	(.01)	0.04	(.01)	0.08	(.02)	*
P	**		**		**		**		

NS (Not significant); \*(P<0.05); \*\*(P<0.01); Poisson regression.

**Table 6. Multivariate models of services per visit by age of patient and time of study**

	Examinations		Radiographs		Prophylaxis		Topical fluoride	
	RR	(SE)	RR	(SE)	RR	(SE)	RR	(SE)
Time of study								
1983-1984	Ref.	-	Ref.	-	Ref.	-	Ref.	-
1988-1989	1.06	(.04)	0.99	(.08)	1.11	(.08)	0.96	(.12)
1993-1994	**1.23	(.05)	**1.61	(.11)	**1.25	(.09)	1.14	(.16)
1998-1999	**1.32	(.05)	**1.73	(.14)	**1.30	(.10)	**1.51	(.22)
Age of patient								
<5 years	**2.81	(.16)	**0.31	(.14)	*0.66	(.13)	1.25	(.36)
5-11 years	**2.10	(.11)	**0.56	(.08)	1.12	(.11)	**2.99	(.52)
12-17 years	**1.71	(.10)	1.13	(.14)	*1.25	(.11)	**2.94	(.50)
18-24 years	**1.45	(.07)	**2.12	(.22)	**1.31	(.10)	1.23	(.20)
25-44 years	**1.24	(.06)	**1.95	(.19)	**1.27	(.08)	0.98	(.14)
45-64 years	1.06	(.05)	**1.43	(.13)	*1.16	(.07)	0.85	(.12)
65+ years	Ref.	-	Ref.	-	Ref.	-	Ref.	-

\*(P<0.05), \*\*(P<0.01) Poisson regression.

RR=Rate ratio.

SE=Standard error.

indicate different age-specific patterns of service: examinations showed a gradient in service rates from youngest to oldest patients, radiographs were provided at higher rates to adults by the end of the study period, prophylaxis services, while lowest among preschool children, exhibited little variation among older patients, but topical fluoride was provided at higher rates to younger patients in the age range 5-11 and 12-17 years.

Age-specific patterns of service provision reflect both the oral health status of the current age cohorts of patients, and development of dental problems over the life of a patient. The higher examination and topical fluoride rates among younger patients may be expected on the basis of the historically documented decline in caries among these younger age cohorts,<sup>10</sup> with consequent service patterns reflecting an emphasis on ongoing monitoring and caries-preventive treatments. However, the continued retention of teeth into older adult cohorts is reflected in the trends over time,<sup>11</sup> which indicate that most of the increased provision of diagnostic and preventive rates has been among adult patients. This was evident for a range of services such as increased examination rates among patients aged 65+ years, and increased prophylaxis rates among 25-44 and 45-64 year olds. The increase in topical fluoride rates among 45-64 and 65+ year olds brings these rates into line with younger adults, although still well below 5-11 and 12-17 year olds. The most marked effect of a shift towards adults was observed for the provision of radiograph services, where the increase in radiographs among all adult age groups resulted in a service distribution which showed little differentiation by age at the beginning of the study period to one which was dominated by adults at the end of the study period.

While some of the increase in diagnostic services may reflect technological advances, the sub-category of 'other' diagnostic services, which includes items such as caries activity tests, remained a small component of diagnostic services. Radiographs showed an increase in rates over the study period that may reflect advances in technology. However, radiographs remained second in

order of diagnostic service rates behind examinations, which also increased over the study period and are less likely to reflect advances in technology. The finding that radiographs only increased among adult patients indicates that retention of teeth among adult patients rather than advances in radiographic technology may be more influential in the observed increase in diagnostic services over the study period.

## CONCLUSIONS

The increased numbers of dentate adults who are retaining more of their natural dentition has been linked to a greater need for adult dental services, with predictions that the dental profession should be prepared to meet these needs through increased provision of a range of treatment including diagnostic and preventive services.<sup>25</sup> Sustained rates of provision of diagnostic and preventive services were observed among children and adolescents in this study, with some increases for examination rates (e.g., among 5-11 year olds) and prophylaxis (e.g., among 12-17 year olds). However, all four of the highest ranked sub-categories of diagnostic (i.e., examinations, radiographs) and preventive (i.e., prophylaxis, topical fluoride) services showed increased rates among adult age groups of patients, with significant increases in radiograph and topical fluoride services observed only among adult patients. Trends towards increased diagnostic and preventive service rates among adults were also observed among the oldest age group (65+ years) who showed significant increases over the study period in rates of examinations, radiographs and topical fluoride services. The findings of this study support predictions of a shift to adults in provision of dental services, with the provision of major sub-categories of diagnostic and preventive services being mainly stable or showing a small number of increases among children and adolescents, but with the majority of the increases in diagnostic and preventive services being observed among adult patients.

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