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Title: Practice Characteristics and Service Provision Rates of Dental Hygienists in Australia

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Abstract

Dental hygienists (DHs) have been practising in Australia since the early 1970s. Objective: This study describes the clinical activity of Australian DHs. Methods: A questionnaire was mailed to members of two professional associations representing DHs. Practitioner characteristics, employment characteristics and clinical activity on a self-reported typical practice day were collected. The proportion of each service item of all services provided was estimated. Associations between practice characteristics and service provision were assessed by log-binomial regression models. Results: Adjusted response rate was 60.6%. Of the DHs included in analysis (n=341), 80% were employed in general practice, and nearly all (96%) worked in the private sector. About half (53.7%) of all service provided were preventive services and one-fourth (23.9%) were diagnostic. Service provision varied by practice and practitioner characteristics, with the largest variations observed by practice type. Unadjusted analysis showed that general practice DHs provided a higher mean number of periodontal instrumentation and coronal polishing (0.92 versus 0.26), fluoride applications (0.64 versus 0.08), oral examinations (0.51 versus 0.22) and intraoral radiographs (0.33 versus 0.07) per patient visit and a lower mean number of impressions (0.05 versus 0.17) and orthodontic services (0.02 versus 0.59) than specialist practice DHs. In adjusted analysis, rates of periodontal services also significantly varied by practice type; other associations persisted. Conclusion: Service provision of DHs varied by practice type. Practice activity was dominated by provision of preventive services while provision of periodontal treatments, fissure sealants and oral examinations was relatively limited indicating areas in which DHs are possibly underutilised.

Keywords: Dental hygienists, General practice, Practice characteristics, Service provision, Specialist practice

Introduction

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The registered dental practitioner workforce in Australia, in addition to dentists and dental prosthetists, includes oral health practitioners, namely, Dental Hygienists (DHs), Dental Therapists (DTs) and Oral Health Therapists (OHTs). Oral Health Therapists are a relatively new addition to the oral health workforce; they combine the skills and scope of practice of both dental therapists and dental hygienists. DHs represent nearly 44% of the oral health practitioner workforce (1, 2). Motivated by the delivery of preventive care in Great Britain, dental hygiene programs were established in South Australia and Western Australia in the early 1970s while programs in other Australian states and territories were established later, between 1989 and 2000 (3, 4). Consequently, the DH workforce has had a varied history across jurisdictions. Dental therapists, the oldest profession among these three groups in Australia, were introduced in 1965 while oral health therapists graduated with Diplomas in 1997 and Bachelors' degrees from 2000 (4). In 2010, a national health professions registration board was established, replacing state dental boards, and registration requirements and regulations were made uniform across Australia.

In 2012, a total of 1,600 DHs were registered, of which 93% were employed in dental hygiene clinical practice (1). With a mean age of approximately 37 years, DHs are younger than DTs (mean age = 46 years) but older than OHTs (mean age = 31 years) (1). Nearly all DHs (96%) are female, a prominent characteristic shared by all three practitioner groups (1). Although DHs are the largest workforce among these three groups, the cessation of most of the training programs in dental hygiene and their replacement with oral health therapy programs suggests that numbers of hygiene only practitioners are likely to decline (1, 2).

Analogous with other health practitioners in Australia, it is compulsory for DHs to register with the Australian Health Practitioner Regulation Agency (AHPRA). Traditionally hygienists worked on the prescription of a dentist, but legislation changes that were introduced between 2006 and 2010 had recognised their ability to autonomously diagnose and treatment plan. As of 2010, the scope of DHs practice encompassed oral examination, preventive services, diagnosis and treatment planning, periodontal treatment, and other oral care (e.g., orthodontic procedures)

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for patients of all ages. While DHs mainly focus on providing periodontal treatment and preventive services for adults DTs' scope of practice includes diagnostic and preventive services as well as restorative treatment and tooth removal, particularly for children and young adults. OHTs on the other hand are qualified to practise all aspects of both dental therapy and dental hygiene (1, 2, 5, 6). Similar to DTs and OHTs, DHs are now required to work within a structured professional relationship with a dentist or dental specialist (1, 2, 5-7). DHs, like DTs and OHTs, practise autonomously within their scope of practice in collaborative and referral relationships with dentists. Although there is no requirement for a dentist to be onsite, the structured professional relationship requires that a dentist is accessible to provide advice and referral pathways if required. Hence DHs (and DTs and OHTs) can work in settings outside the traditional dental clinic such as hospitals, community clinics, outreach programs and residential aged care settings.

Australian research has shown that DHs have necessary skills and knowledge to appropriately diagnose and treatment plan care for older patients in residential care settings (8). Moreover, general practices employing DHs, compared to those not employing DHs, were found to be more productive in terms of services provided per patient, and the aggregate service mix of the practice was orientated more towards the provision of periodontal and preventive services (9). This study further indicated that practices with DHs provided more periodontally-related services than practices without DHs, pointing to a complementary capacity of DHs as opposed to a substitutional role.

Despite evidence that the provision of oral hygiene instruction and patient motivation was more effective when delivered by DHs (10), using DHs in substitutional capacity within dental practices appears limited. Research from Norway indicated that while more than half of dentists (60%) report a desire to delegate more work to DHs, they spend about 40% of their time on activities that DHs can perform (11). Similarly, in Australia, dentists' service provision is consistently dominated by diagnostic and preventive services (12) and therefore DHs could

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potentially provide a proportion of services typically provided by dentists. These findings raise questions as to whether DHs are used appropriately in oral health care provision.

A first step in considering the extension of the role of DHs in the practice team, or whether DH's could play a greater substitutional role, is to gain a better understanding of the current practice activity. Dental workforce surveys in Australia have provided detailed information about DHs on their area of practice (that is, clinical, administrative, education), working hours and geographic location, but little is known about service provision. A previous Australian study (5) has compared the broad practice activity of OHTs, DTs and DHs in terms of patients per hours and total services per patient but rates of specific services have not been previously reported. Thus, the aim of this study was to describe service provision of Australian DHs and assess if service provision varied by practice characteristics.

Methods

Ethics approval for this study was obtained from the University of Adelaide Human Research Ethics Committee (HRECH-288-2011). Academics in the field of oral hygiene and therapy were consulted to develop a self-report survey. The survey was mailed to all current members of the Dental Hygienists' Association of Australia (DHAA) and Australian Dental and Oral Health Therapists Association (ADOHTA) between March and June 2013. Up to four reminder mailings were sent at approximately three to four-week intervals while the members who were not contactable via their postal address were communicated through emails and invited to participate in the study.

Information on demographics, qualifications, employment status and the current AHPRA registration types of the participants were collected. Those who were registered as both a DH and a DT were categorised as either a DT or a DH by applying the criteria used in Australian Institute

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of Health and Welfare (AIHW) Oral health labour force reports (1). Applying the AIHW criteria allowed benchmarking of characteristics and the use of national workforce estimates for weighting of data. While these criteria were mainly based on the practitioner's area of employment, other registration types held by the practitioner and state of residence were also taken into account.

Practice type (general versus specialist), sector (public versus private), total hours usually worked, number of clinical practitioners employed, the number of years and months worked at each location and practice postcode were collected as employment characteristics from up to four practice locations. Hours reported across all locations were summed to compute usual total hours per week. Information about practitioners with an unusual or irregular working pattern was collected (that is, they may have only worked at a reported location every 2nd week) and where appropriate information provided was used to reflect usual hours worked over one working week. Australian Standard Geographic Classification of Remoteness Areas was used to categorise practice postcodes. Practitioners working in outer regional, remote or very remote areas were few and hence grouped as outer regional/remote.

Clinical activity on a self-selected typical day of practice was collected at the location where practitioners usually worked the most hours. Participants were instructed to keep a tally of their activity during the day or to refer to their records and report on a day recently worked. A clinical activity questionnaire collected total hours worked, hours dedicated to direct patient care, the total number of patient visits (by age group), and number and type of services provided. Age profile of patients treated was described by reporting the proportion of all patients treated across five age groups. Patient age groups were based on previous published reports identifying variations in services provided by Australian private dentists by patient age (13) In order to assess associations between patient age distribution and services provided in this sample, the age distribution of patients was summarised into a single categorical variable: the proportion of patients aged 45 years or older. The decision to group DHs on the basis of the proportion of patients they treated aged over 45 years was based on the authors' earlier report that showed that

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DHs treat mainly adults (5), and also on *a previous report* indicating that dentist rates of preventive and diagnostics services per patient were lower for patients aged 45 years or older (13).

The distribution of proportions reported was assessed, and practitioners were grouped into tertiles reflecting lower, medium and higher proportions of older adult patients treated. The activity questionnaire collected provision of 18 services representing key services from each service area of the Australian Dental Association (ADA) schedule (12). In addition, participants were asked to specify other services provided in 'other/specify' fields. Services reported in 'other' fields that did not correspond to items on the ADA schedule were not included in service activity totals (14).

In line with the AIHW 2012 oral health workforce estimates (1) data were weighted to reflect the age and state distribution of registered practitioners. Practitioners who were not currently employed or were on an extended break from clinical practise (3 months or longer) were not included in the analysis. Other exclusions included those who did not provide a completed activity log. To assess the potential of response bias, the characteristics of participants who did and did not provide complete data were compared (Chi-square, $p<0.05$).

To describe practice activity the proportion of each service item, of all services provided, was computed stratified by practice type. The mean number of services per patient visit (service provision) was also described (PROC GENMOD, $p<0.05$). Negative binomial regression models were used to test for significant associations between practice characteristics and provision of services, as they accommodate the typically highly skewed distribution of services data (PROC GENMOD, $p<0.05$). Unadjusted and adjusted associations between characteristics and service provision were assessed. A separate model was constructed for each dependent variable (count of each service type). The natural log of the number of patient visits provided was entered as an offset variable; thereby models assessed associations by estimating unadjusted ratios of mean services per patient. SAS 9.3 (Research Triangle, Research Triangle Park, USA) was used to perform data analysis.

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Results

The questionnaire was mailed to 1,861 registered members of ADOHTA and DHAA. The overall response rate was 60.6% after adjusting for non-contactable members (2.0%) and other exclusions (1.9%) such as student members or honorary members. Applying AIHW registration criteria resulted in 28.7% of the participating practitioners categorised as OHTs, 29.0% categorised as DTs, and 42.3% categorised as DHs (n=459). Of these, 341 DHs were included in the analysis sample (those with incomplete data (n=60) and not employed in clinical work (n=3) were excluded).

Nearly all DHs were female (97%), and about two-thirds were working in only one practice location. Approximately 57% of them had been practising less than ten years (that is, years since graduation) while a similar proportion (57%) worked more than 30 hours per week across all locations. About one in eight DHs had worked for less than one year, and one-half had worked over 4 years at their main practice location (results not tabulated).

Nearly four-fifths (79%) of DHs were employed in general practice, and almost all were working in the private sector. Practitioner and practice characteristics varied by clinical practice type (general versus specialist). Compared to DHs working in general practice (20%), a significantly higher proportion of their counterparts in specialist practice (32%) were working in larger clinical teams ($p<0.05$). Overall the majority of DHs (86.2%) were practising in major cities. However, a significantly higher proportion of DHs in specialist practice were working in major cities (96%) when compared to their colleagues in general practice (84%, $p<0.05$, Table 1).

The distribution of patients across patient age groups varied by practice type: practitioners in specialist practice had a higher proportion of younger patients than those who worked in general practices. Those working in specialist practice reported that 16% of their patients were aged <12 years, 51% were aged 12 to 17 years, and the remaining 33% were adult patients (18 years and older). In contrast, DHs working in general practice treated only small percentages of child

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patients (7% aged <12 years and 6% aged 12 to 17 years) and the large majority (87%) were adult patients (results not tabulated).

Across all DHs, the average proportion of 45 years or older patients treated was 45%. One-third of DHs treated 33% or fewer patients aged 45 years or older (lower tertile), one-third treated between 34 % and 57% (middle tertile), and one-third treated 58% or more patients aged 45 years or older (higher tertile). The age distribution of patients treated significantly differed by type of clinical practice ($p<0.01$). Relative to specialist practice DHs (35%), there were higher proportions of general practice DHs (73%) in the groups reporting higher proportions of patients aged over 45 years (the middle and higher tertiles). In other words, general practice DHs on average had higher proportions of older patients than those in specialist practice.

Approximately 54% of the services provided by the DHs were preventive services followed by diagnostic (24%), periodontal (9.7%), orthodontic (11%) and other services (1.8%). The proportions varied by type of practice worked; DHs in general practice provided mainly preventive services and DHs in specialist practice provided a sizeable proportion of orthodontic services (41.5%, Table 2).

Table 3 presents results of negative binomial regression analysis (unadjusted) and accordingly the mean rates of services per patient visit for eight selected dental services; these eight services represented just over 95% of all services provided by DHs. Service rates did not vary by practitioner age group, but some services were associated with clinical team size [for example, a significantly higher number of impressions were taken by practices with 1-2 practitioners (mean=0.18, SE=0.04) than practices with ≥8 practitioners (mean=0.06, SE=0.01); $p<0.01$] and region of practice [practices in major cities provided significantly higher number of orthodontic services (mean=0.15, SE=0.02) than practices in outer regional/remote (mean=0.01, SE=0.01); $p<0.01$]. With the exception of fluoride applications all service types significantly varied by the proportion of patients aged over 45 years ($p<0.01$), and with the exception of periodontal services all service types varied by practice type ($p<0.01$).

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In the adjusted analysis, accounting for all characteristics, most bivariate associations observed persisted, and some previously non-significant associations became statistically significant (Table 4). Practitioner age group was associated with the rate of orthodontic services [for example, the rate of orthodontic services provided by practitioners aged 50+ years was nearly 4.5 times (rate ratio=4.46) higher than that provided by practitioners aged <30 years; p<0.01], and clinical team size was associated with the rate of taking impressions [the rate of impressions taken by practices with 1-2 practitioners was 2.4 times (rate ratio=2.37) higher than that taken by practices with ≥8 practitioners; p<0.01], but there were no variations in services rates by region of practice. DHs with a relatively higher proportion of patients aged over 45 years provided higher rates of periodontal instrumentation and coronal polishing (rate ratio=1.41; p<0.01), oral examinations (rate ratio=2.29; p<0.01) and periodontal services (rate ratio=3.39; p<0.01) than DHs with a lower proportion. Having a relatively older patient profile was also associated with providing lower rates of taking impressions (rate ratio=0.27; p<0.01) and orthodontic services (rate ratio=0.16; p<0.01). In comparison to DHs working in specialist practice, DHs in general practice provided a higher rate of all services with the exception of taking impressions and orthodontic services. For the latter services, general practice DHs had significantly lower rates of services per patient visits (rate ratios were 0.42 and 0.03, respectively, for impression taking and orthodontic services; p<0.01) than specialist DHs.

Discussion

This study provides a description of dental service provision by Australian DHs in 2013. The estimates derived in this study are useful for workforce planning and for projecting supply capacity by this growing workforce. The main finding was that DHs primarily provided preventive and diagnostic services and that service rates varied by practice characteristics, with the largest variations observed by type of practice. In comparison to DHs in specialist practice, general practice DHs had higher rates of preventive, diagnostic and periodontal services and lower rates of taking impressions and orthodontic services. DHs in specialist practice treated

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lower proportions of patients aged over 45 years than DHs working in general practice and consequently the differences in service provision most likely related to the differences in patient treatment needs. However, accounting for all characteristics did not attenuate the observed associations. The practice activity of DHs in specialist practice was also consistent with the pattern of employment across types of specialist practices; nearly two-thirds of DHs in specialist practice are employed in orthodontic clinics (5).

These findings raise several questions about the efficient use of these practitioners. There were comparatively low proportions of oral examinations and periodontal treatments. Also the reporting of fissure sealants was very low. These patterns of service provision were observed despite the relatively high prevalence of periodontal disease in the Australian adult population (15) as well as the educational preparation, local research and regulation supporting the abilities and role of DHs to provide these services. However, it should be noted that while periodontal treatments and oral examinations did not comprise a sizeable proportion of services provided, the rate of periodontal services per patient was higher than the rate provided by general private dentists (<0.1 services per patient visit). Also, the rate of oral examinations was comparable to that of general private dentists (approximately 0.5 exams per adult patient visit). Overall, the pattern of services provided reflected the pattern of employment which was nearly entirely in the private sector, treating mostly adult patients. This low utilisation of DHs in the public sector and alternative settings is an important indicator of their potential for an expanded role in terms of meeting public health goals to improve dental access for underserved populations.

Even though research on DH practice activity is limited, the present findings in regards to the distribution of basic characteristics of DHs were broadly comparable to the national estimates reported by AIHW (1). For example, in line with the national estimates a majority of the DHs in our study were younger, female, employed in dental hygiene, working in private practice and located in major cities. Even though not directly comparable to our study, a survey conducted in the UK showed that the demographic and employment characteristics of DHs in the UK were somewhat comparable to those reported in the present study (16). For example, according to their

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findings, DHs in the UK were younger, mostly female and employed predominantly in private practice.

It would be worthwhile discussing both strengths and limitations of the study. The strengths of this study are that it had a relatively large sample size and an acceptable response rate. The sampling frame for this study covered approximately 58% of the DH, DT and OHT workforce (1) but younger practitioners were underrepresented in the respective Associations' membership and thereby were underrepresented in the analysis (5, 6). However, there were no observable differences in service provision by practitioner age group and data was weighted to reflect the age and state distribution of registered practitioners. Therefore the likelihood of bias of total service provision means was considered to be low. Further, the weighted distribution of these practitioners in regards to key variables such as age, sex, practice sector and type were comparable to distributions reported from Australian national data (1) hence these findings can be considered to be generalizable to the Australian DH workforce. Moreover, about 15% of the DHs did not provide complete practice activity data and subsequently excluded from the analysis. However, no differences in the characteristics of those included and not included were observed and as such potential bias was considered minimal. Finally, the results presented for orthodontic and periodontal services should be interpreted with caution due to small numbers of these less frequently provided services. Interpretation should focus on the direction of associations, and more precise estimates of mean service rates could be derived from service provision logs capturing activity over longer periods of time (that is, one-week service log).

In conclusion, the present findings indicated that the service provision and practice characteristics of DHs varied by their practice type. Overall patterns of service provision reflected patterns of employment and the age profiles of the patients treated across different practice settings. Preventive and diagnostic services dominated the service provision of DHs employed in general practice, while those in specialist practice had higher orthodontic service rates; a similar pattern of associations between patient age profile and service provision was observed. The comparatively small proportions of fissure sealants, periodontal services, and oral

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examinations, of all services provided, indicated areas of the DH practice scope that is possibly underutilised. The practice activity described in this study also highlights a missed opportunity for the DH workforce to be engaged in providing services to underserved populations. This information is useful for planning and implementing oral health care policies as well as projecting supply of services by the DH workforce.

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Clinical Relevance

Scientific rationale:

Although dental hygienists (DHs) have been practising in Australia for several decades, little is known about their service provision. This study describes dental service provision by Australian DHs and evaluates if service provision varies by practice characteristics.

Principal findings:

DHs provided relatively few oral examinations, fissure sealants and periodontal services. Service provision of DHs varied by practice type. General practice DHs had higher preventive and diagnostic service rates but lower orthodontic service rates than specialist practice DHs.

Practical implications:

These findings can be used in dental service projection models and to identify areas where DHs are possibly underutilised.

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Table 1: Practitioner and practice characteristics of employed dental hygienists by type of clinical practice

	All		General		Specialist	
	(%)	n=341	(%)	n=272	(%)	n=69
Age group						
<30 years	26.5	90	27.7	75	21.4	15
30–39 years	35.9	122	34.3	93	42.9	30
40–49 years	25.3	86	25.1	68	25.7	18
50+ years	12.4	42	12.9	35	10.0	7
Clinical team size*						
1–2 practitioners	9.4	32	8.8	24	11.6	8
3–7 practitioners	68.4	234	71.7	195	56.5	39
8 or more practitioners	22.2	76	19.5	53	31.9	22
Sector of practice						
Private	95.9	327	94.9	258	100.0	69
Public	4.1	14	5.1	14	–	–
Proportion of patients over 45 years**						
Lower tertile	34.9	119	27.1	74	65.3	45
Middle tertile	33.6	115	39.9	109	8.7	6
Higher tertile	31.5	107	32.9	90	26.0	18
Region of practice*						
Major City	86.2	294	83.5	227	95.7	67
Inner Regional	7.9	27	9.6	26	2.9	2
Outer Regional /remote	5.9	20	7.0	19	1.4	1
Practice type						
General	79.0	272	n.a.		n.a.	
Specialist	20.0	69	n.a.		n.a.	
Total	100.0	341	100.0	272	100.0	69

Chi-square statistic: *p<0.05, **p<0.01

Notes:

1. General practice types included private general practice, defence clinics, health fund clinics, dental hospitals and school dental services. Specialist practice types included orthodontic, periodontic, prosthodontic and paedodontic clinics.
2. Data weighted, number of observations reported (n) is weighted.
3. Some rows and columns do not sum to totals due to rounding.

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Table 2: Proportion of all services provided by employed dental hygienists by practice type

Distribution of services provided		General (%)	Specialist (%)	Total (%)
		n=9,062	n=3,175	n=12,237
		(%)	(%)	(%)
Preventive	OHI	20.7	20.5	20.6
	Periodontal instrumentation and coronal polishing	23.8	6.4	19.3
	Fluoride application	16.6	1.8	12.8
	Fissure sealants	0.6	0.0	0.5
	Tooth whitening	0.6	0.1	0.4
	Other preventive services	0.1	0.1	0.1
Diagnostic	Oral examination	13.5	6.2	11.6
	Intraoral radiographs	8.6	1.6	6.8
	Extraoral radiographs	1.2	2.3	1.5
	Taking impressions	1.3	9.7	3.5
	Other diagnostic services	0.4	1.0	0.5
Periodontal	Periodontal maintenance	6.5	5.3	6.2
	Root debridement	3.9	2.5	3.5
Orthodontic	Orthodontic services	0.3	41.5	11.0

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Other services	1.9	1.0	1.8
Total	100.0	100.0	100.0

Note: Total number of services provided by DHs in each practice type is denoted by ‘n’

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Table 3: Mean number of dental services per patient visit by practitioner and practice characteristics

	OHI		Periodontal instrumentation and coronal polishing		Fluoride Application		Oral exam		Intraoral radiograph		Taking Impressions		Periodontal services		Orthodontic services	
	Means	**(SE)**	**Means**	**(SE)**	**Means**	**(SE)**	**Means**	**(SE)**	**Means**	**(SE)**	**Means**	**(SE)**	**Means**	**(SE)**	**Means**	**(SE)**
Age group																
<30 years (Ref)	0.73	(0.05)	0.80	(0.05)	0.59	(0.06)	0.53	(0.06)	0.29	(0.03)	0.07	(0.01)	0.35	(0.07)	0.16	(0.05)
30–<40 years	0.69	(0.04)	0.76	(0.04)	0.48	(0.04)	0.44	(0.04)	0.27	(0.03)	0.08	(0.02)	0.37	(0.05)	0.14	(0.03)
40–<50 years	0.71	(0.04)	0.78	(0.04)	0.53	(0.04)	0.39	(0.04)	0.29	(0.03)	0.08	(0.01)	0.48	(0.05)	0.10	(0.03)
50 + years	0.76	(0.04)	0.82	(0.04)	0.52	(0.05)	0.46	(0.05)	0.26	(0.03)	0.08	(0.02)	0.44	(0.06)	0.12	(0.05)
Clinical team size																
1–2 practitioners	0.61	(0.07)	0.69	(0.07)	0.50	(0.08)	0.48	(0.08)	0.26	(0.04)	0.18	(0.04)**	0.20	(0.06)*	0.27	(0.09)
3–7 practitioners	0.73	(0.02)	0.82	(0.02)	0.55	(0.03)	0.45	(0.03)	0.30	(0.02)*	0.07	(0.01)	0.42	(0.03)	0.10	(0.02)
8 or more practitioners (Ref)	0.71	(0.05)	0.70	(0.05)	0.46	(0.05)	0.46	(0.06)	0.21	(0.02)	0.06	(0.01)	0.42	(0.06)	0.18	(0.04)
Proportion of patients over 45 years																
Lower tertile (Ref)	0.64	(0.04)	0.62	(0.04)	0.44	(0.04)	0.28	(0.04)	0.25	(0.03)	0.14	(0.02)	0.23	(0.04)	0.35	(0.04)
Middle tertile	0.80	(0.03)**	0.89	(0.02)**	0.60	(0.04)	0.55	(0.04)**	0.32	(0.02)*	0.05	(0.01)**	0.40	(0.04)**	0.02	(0.01)**
Higher tertile	0.71	(0.04)	0.85	(0.03)**	0.54	(0.04)	0.55	(0.04)**	0.28	(0.03)	0.03	(0.01)**	0.60	(0.06)**	0.02	(0.02)**
Region of practice																
Major City	0.70	(0.02)	0.77	(0.02)	0.51	(0.03)	0.45	(0.03)	0.27	(0.02)	0.08	(0.01)	0.39	(0.03)	0.15	(0.02)**
Inner Regional	0.83	(0.05)	0.81	(0.06)	0.54	(0.08)	0.39	(0.08)	0.26	(0.04)	0.06	(0.02)	0.34	(0.07)	0.06	(0.04)*
Outer Regional /remote (Ref)	0.74	(0.09)	0.99	(0.06)	0.77	(0.09)	0.56	(0.10)	0.44	(0.08)	0.07	(0.02)	0.61	(0.15)	0.01	(0.01)
Type of practice																
General	0.79	(0.02)**	0.92	(0.01)**	0.64	(0.02)**	0.51	(0.03)**	0.33	(0.02)**	0.05	(0.01)**	0.40	(0.03)	0.02	(0.01)**
Specialist (Ref)	0.43	(0.05)	0.26	(0.05)	0.08	(0.03)	0.22	(0.05)	0.07	(0.02)	0.17	(0.03)	0.41	(0.08)	0.59	(0.06)
All practitioners	0.71	(0.02)	0.78	(0.02)	0.53	(0.02)	0.45	(0.02)	0.28	(0.02)	0.08	(0.01)	0.40	(0.03)	0.13	(0.02)

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Notes:

1. Unadjusted associations between characteristics and service provision were assessed by negative binomial regression models.

2. Statistically significant differences in means are indicated by asterisks (*p<0.05, **p<0.01)

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Table 4: Adjusted ratio of mean services per patient visit by practitioner and practice characteristics

	OHI Rate ratio		Periodontal instrumentation and coronal polishing Rate ratio		Fluoride Application Rate ratio		Oral exam Rate ratio		Intraoral radiograph Rate ratio		Taking Impressions Rate ratio		Periodontal services Rate ratio		Orthodontic services Rate ratio	
Age group																
<30 years	Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref	
30–<40 years	1.08		1.06		0.96		0.98		1.00		1.17		1.20		0.63	*
40–<50 years	1.06		1.08		1.02		0.88		1.07		1.20		1.60		0.39	**
50 + years	1.11		1.06		1.01		0.97		1.06		1.55		1.29		4.46	**
Clinical team size																
1–2 practitioners	0.78		1.00		1.01		0.94		1.06		2.37	**	0.53		1.69	
3–7 practitioners	0.95		1.17		1.24		0.97		1.24		1.23		1.14		1.63	
8 or more practitioners	Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref	
Per cent patients over 45 years																
Lower tertile	Ref		Ref		Ref		Ref		Ref		Ref		Ref			
Middle tertile	1.11		1.28	**	1.29		1.97	**	1.25		0.58	**	2.14	**	0.25	**
Higher tertile	1.01		1.41	**	1.23		2.29	**	1.27		0.27	**	3.39	**	0.16	**
Region of practice																
Major City	1.07		0.88		0.84		0.94		0.81		0.68		0.81		0.8	

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Inner Regional	1.14		0.72		0.67		0.54		0.58		0.68		0.52		1.13				
Outer Regional /remote	Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref				
Type of practice																			
General	1.99	**	5.04	**	9.71	**	2.74	**	6.20	**	0.42	**	1.71	*	0.03	**			
Specialist	Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref				

Notes: Adjusted associations between characteristics and service provision were assessed by negative binomial regression models estimating ratio of mean services per patient visit.

** p<0.01

* p<0.05

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