

4 Overview of imaging orders by general practitioners

4.1 Overview of imaging order rates

At least one imaging test was ordered by the GP at 6,979 (6.7%) of the 104,856 encounters. Orders for imaging occurred at a rate of 7.6 per 100 encounters, or 5.1 per 100 problems managed. A total of 7,919 specific orders for imaging were recorded at a rate of 113.5 per 100 imaging encounters. That is, at encounters where an imaging order occurred, the average number of tests ordered was 1.14 or 114 per 100 imaging encounters (Table 4.1).

Extrapolated to the total number of GP-patient encounters across Australia, this suggests there were approximately 8 million orders for imaging placed by GPs over the 12-month period.

Table 4.1: Summary of imaging orders

	Number	Rate per 100 encounters (n=104,856)	Rate per 100 problems (n=153,857)
Number of encounters at least one imaging test ordered	6,979	6.7	..
Total number of imaging tests ordered	7,919	7.6	5.1
Imaging tests ordered/100 imaging encounters	7,919	113.5	..

Distribution of imaging orders across encounters

Table 4.2 describes the distribution of imaging test orders across encounters. It shows that no imaging tests were ordered at 97,878 (93.3%) consultations and one test was ordered at 6,104 (5.8%) of encounters. Orders for two or three imaging tests were rare, occurring at only 875 encounters (0.8%). However, the imaging tests ordered at these 875 encounters accounted for 22.9% of all imaging tests ordered.

Table 4.2: Distribution of imaging test orders across encounters

Number imaging tests ordered at encounter	Number of encounters	Per cent of total encounters (n=104,856)	Per cent of encounters at least one imaging (n=6,979)	Per cent total imaging tests ordered (n=7,919)
None	97,878	93.3	—	—
One	6,104	5.8	87.5	77.1
Two	810	0.8	11.6	20.5
Three	65	0.1	0.9	2.5

Relationship of imaging orders to problems managed

In Table 4.3 the problem under management is the unit of analysis. Of the 153,857 problems managed, no imaging was ordered for 146,639 (95.3%). At least one imaging order was placed in relation to the remaining 7,218 problems (4.7%) at 6,979 encounters. A single test type was most common, being ordered for 6,479 (4.2%) problems. Orders for multiple imaging tests for one problem were uncommon, occurring in the management of less than 1% of problems. However, the imaging ordered for these 739 problems represented almost 20% of all imaging tests ordered.

Table 4.3: Number of imaging tests for each problem

Number of imaging tests ordered per problem contact	Number of problems	Per cent of total problems (n=153,857)	Per cent of problems for which imaging ordered (n=7,218)	Per cent of total imaging tests ordered ^(a)
None	146,639	95.3	..	.
One	6,479	4.2	89.8	81.8
Two	695	0.5	9.6	17.5
Three	44	*	0.6	1.7

(a) Column will not add to 100% because of the many-to-many relationship between problems and imaging test orders (see section 2.2).

* Less than 0.1%.

There can be a many-to-many relationship between imaging tests and problems. That is, while multiple imaging test types may be ordered for the management of one problem (see above), it is also possible that one imaging test order may be related to more than one problem under management. However, Table 4.4 suggests that 99.0% of all imaging test orders were related to a single problem being managed at the encounter.

Table 4.4: Number of problems for which a single test type was ordered

Number of problems to which each imaging test order was related	Number of imaging tests	Per cent total imaging tests ordered (n=7,919)
One	7,840	99.0
Two	74	0.9
Three or four	5	*

* Less than 0.1%.

4.2 Distribution of GPs by imaging order rates

The mean number of imaging tests ordered by the 1,047 participating GPs was 6.9 tests per 100 encounters, with a standard deviation of 4.9 per 100. The ordering rates for the majority of GPs therefore fell between 2 and 11.8 tests per 100. There was a minimum of no tests and a maximum of 62 tests per 100 encounters. Figure 4.1 demonstrates the distribution of the participating GPs across this range.

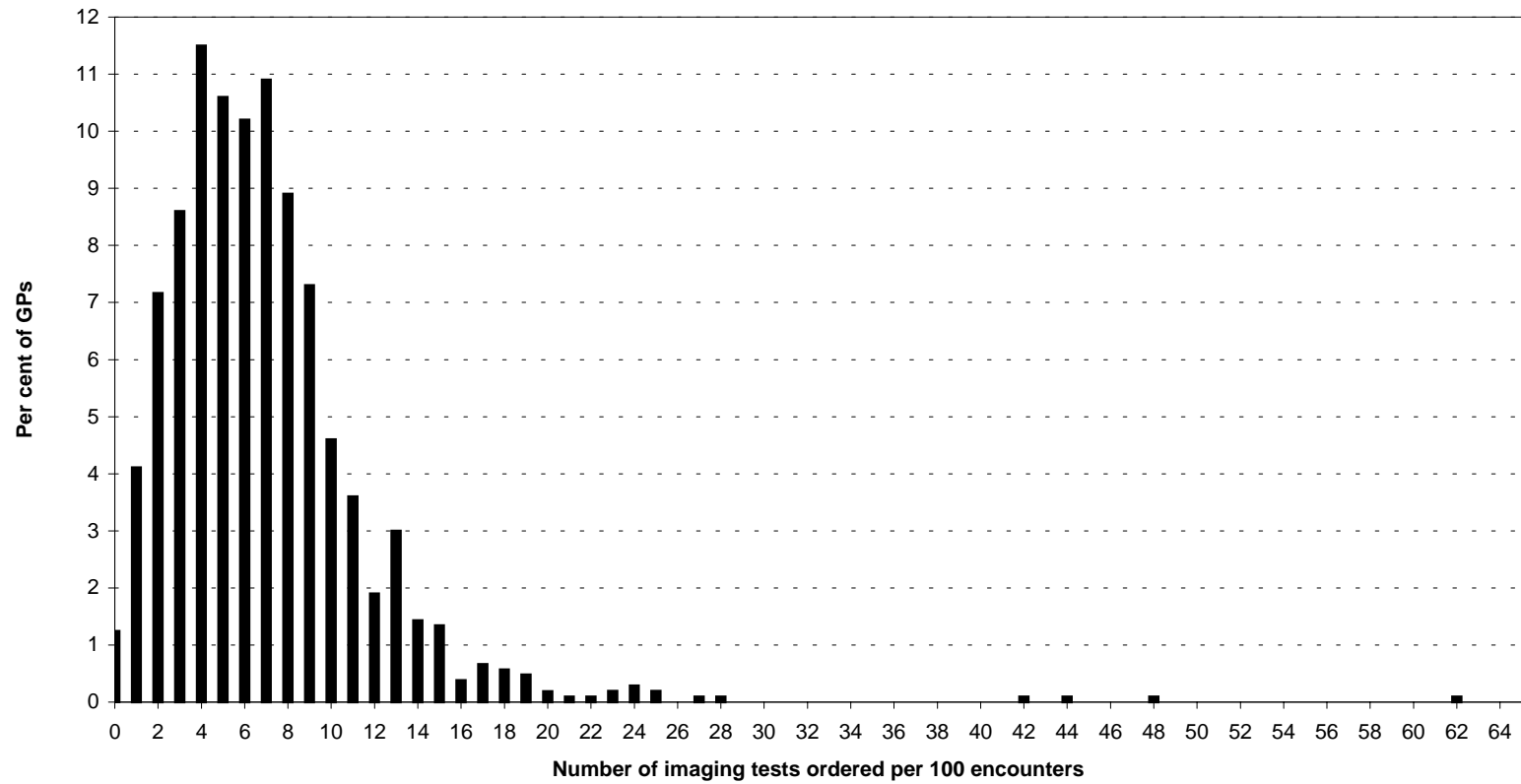


Figure 4.1: Distribution of GPs by imaging order rate

4.3 Imaging order rates by selected GP characteristics

The relative imaging order rates for particular groups of GPs are presented in Table 4.5.

Age and sex of GP

Female GPs ordered imaging tests at a rate of 8.6 per 100 encounters (95% CI: 7.8–9.3), a significantly higher rate than male GPs (7.3 per 100, 95% CI: 6.9–7.7). In contrast, the age group of the GP did not influence ordering rates, which ranged from 7.3 tests ordered per 100 encounters for GPs aged less than 35 years, to 6.6 per 100 encounters for those aged between 35 and 44 years.

Sessions per week

There were also no significant relationship between the number of sessions worked per week and the overall imaging order rates per 100 encounters. Imaging order rates ranged from 7.0 per 100 encounters for GPs working 11 or more sessions per week, to 7.8 per 100 for part-time GPs.

Size of practice

There was a definite trend for increasing order rates with increased size of practice. Solo practitioners placed imaging orders at a significantly lower rate of 6.4 per 100 encounters (95% CI: 5.6–7.1, than those in practices of 5–10 GPs (8.0 per 100, 95% CI: 7.4–8.5) or those in large group practices of 11 or more GPs (8.6 per 100, 95% CI: 7.1–10.1).

State

The State/Territory-specific ordering rates ranged from 5.2 per 100 encounters in South Australia to 8.6 per 100 in Western Australia. The South Australian rate was significantly lower than that of Victoria, New South Wales, Queensland and Western Australia. The smaller sample sizes in the Australian Capital Territory, Tasmania and the Northern Territory generated wide confidence intervals that rendered their rates not significantly higher than that of South Australia.

Rurality

Using grouped categories of the RRMA classification (Britt et al. 2001), the GPs were grouped according to their rurality. While the imaging order rate appeared to be slightly higher in small rural areas (8.4 per 100 encounters), when compared with that in the large rural stratum (7.1 per 100) and the metropolitan stratum (7.4 per 100), this difference was not statistically significant.

Table 4.5: Imaging order rates by selected GP characteristics

GP characteristic	Number of encounters (weighted)	Number of imaging tests ordered	Per cent of total imaging test orders (n=7,919) ^(a)	Imaging order rate per 100 encounters ^(a)	95% LCL	95% UCL
Sex						
Male	81,929	5,957	75.2	7.3	6.9	7.7
Female	22,927	1,963	24.8	8.6	7.8	9.3
Age (missing=363)						
<35 years	33,642	749	9.5	7.3	6.2	8.4
35–44 years	34,361	2,563	32.4	7.6	7.0	8.2
45–54 years	26,197	2,592	32.7	7.5	6.9	8.2
55+ years	10,293	1,966	24.8	7.5	6.8	8.2
Sessions per week (missing=472)						
<6 per week	9,835	768	9.7	7.8	7.0	8.6
6–10 per week	69,689	5,364	67.7	7.7	7.3	8.1
11+ per week	24,860	1,740	21.9	7.0	6.2	7.8
Size of practice (missing=1,532)						
Solo	20,699	1,321	16.7	6.4	5.6	7.1
2–4 GPs	36,603	2,757	34.8	7.5	6.9	8.2
5–10 GPs	39,021	3,107	39.2	8.0	7.4	8.5
11+ GPs	7,001	602	7.6	8.6	7.1	10.1
State						
New South Wales	39,205	3,064	38.7	7.8	7.2	8.4
Victoria	20,951	1,508	19.0	7.2	6.5	7.9
Queensland	23,331	1,900	24.0	8.1	7.2	9.1
South Australia	9,029	468	5.9	5.2	4.3	6.1
Western Australia	8,612	739	9.3	8.6	7.6	9.6
Tasmania	1,952	122	1.5	6.2	4.7	7.8
Australian Capital Territory	864	59	0.7	6.8	4.0	9.6
Northern Territory	911	60	0.8	6.6	3.1	10.1
RRMA category ^(b)						
Metropolitan	77,348	5,721	72.2	7.4	7.0	7.8
Large rural	8,368	594	7.5	7.1	5.7	8.5
Small rural	19,140	1,604	20.3	8.4	7.6	9.2
Total	104,856	7,919	100.0	7.6	7.2	7.9

(a) Missing data removed.

(b) Rural, Remote and Metropolitan Area classification: Metropolitan—RRMA groups 1 & 2; Large rural—RRMA groups 3 & 6; Small rural—RRMA groups 4, 5 & 7 (Britt et al. 2001)

Note: Shading indicates statistically significant differences between groups. UCL—upper confidence limit; LCL—lower confidence limit

4.4 GP characteristics by ordering rate (univariate)

The GPs were divided into three groups according to their imaging order rate during their 100 recorded encounters. The low ordering group was defined as those whose order rate was less than three test orders per 100 encounters (i.e. the mean minus one standard deviation). The medium ordering group were those GPs whose order rate was within the range of the mean (6.9 per 100 encounters) plus or minus one standard deviation (i.e. 3–11 tests per 100 encounters). The high ordering group was defined as those GPs whose test rate was above this range.

The characteristics of the GPs falling into each of these imaging order groups are compared in Table 4.6. These data were drawn from the self-reported characteristics from each of the GPs in their GP profile questionnaire. A few differences between the groups emerged.

Age and sex of GPs

There was a significant difference in the gender distribution of GPs in the low and high ordering groups. In the high imaging order group there was a larger proportion of female GPs (39.5%) than in the low ordering group (22.9%). There were no significant differences in the age distribution of the GPs in the three ordering groups.

Sessions per week

Considering the high proportion of women in the high ordering group and the low proportion in the low ordering group, it might have been expected that a greater proportion of the high ordering group would be in part-time general practice. However, as demonstrated in Table 4.6, there were no significant differences in the proportion of part-time, full-time and 'busy' (at least 11 sessions per week) GPs in each of the ordering groups.

Size of practice and rurality

There was an overall trend for increased ordering level with increased size of practice, such that GPs from practices of five or more GPs represented 36.9% of the low ordering GPs, but 53.4% of the high ordering GPs. However, the single statistical difference was that the high ordering group was significantly less likely to be in solo practice (10.3%) than the low ordering group (30.8%), the difference between high and medium not reaching significance.

There was also an overall trend for increased imaging order rates with increased rurality of practice. Those practising in small rural areas represented a significantly larger proportion of the high ordering group (28.6%) than of the low ordering group (13.7%), while the reverse was true of metropolitan GPs who accounted for 78.6% of the low ordering group and 62.2% of the high.

Table 4.6: GP characteristics of the high, medium and low imaging order groups

GP variable		Low ordering GPs (n=131)				Medium ordering GPs (n=797)				High ordering GPs (n=119)			
		Number	Per cent	LCL	UCL	Number	Per cent	LCL	UCL	Number	Per cent	LCL	UCL
Gender	Male	101	77.1	69.9	84.3	556	69.8	66.6	73.0	72	60.5	51.7	69.3
	Female	30	22.9	15.7	30.1	241	30.2	27.0	33.4	47	39.5	30.7	48.3
Age	<35	12	9.2	4.3	14.1	67	8.4	6.5	10.3	9	7.6	2.8	12.4
	35–44	34	26	18.5	33.5	268	33.8	30.5	37.1	36	30.5	22.2	38.8
	45–54	42	32.1	24.1	40.1	259	32.6	29.3	35.9	37	31.4	23.0	39.8
	55+	43	32.8	24.8	40.8	200	25.2	22.2	28.2	36	30.5	22.2	38.8
Years in general practice	<2	1	0.8	0.0	2.3	5	0.6	0.1	1.1	1	0.9	0.0	2.6
	2–5	8	6.2	2.1	10.3	65	8.2	6.3	10.1	10	8.5	3.4	13.6
	6–10	22	16.9	10.5	23.3	127	16.0	13.4	18.6	17	14.5	8.1	20.9
	11–19	32	24.6	17.2	32.0	262	33.1	29.8	36.4	37	31.6	23.2	40.0
	20+	67	51.5	42.9	60.1	333	42.0	38.6	45.4	52	44.4	35.4	53.4
Sessions per week	<6	16	12.2	6.6	17.8	124	15.7	13.2	18.2	19	16.1	9.5	22.7
	6–10	87	66.4	58.3	74.5	523	66.0	62.7	69.3	80	67.8	59.4	76.2
	11+	28	21.4	14.4	28.4	145	18.3	15.6	21.0	19	16.1	9.5	22.7
Size of practice	Solo	40	30.8	22.9	38.7	135	17.3	14.6	20.0	12	10.3	4.8	15.8
	2–4	42	32.3	24.3	40.3	289	37.0	33.6	40.4	42	36.2	27.5	44.9
	5–10	39	30.0	22.1	37.9	314	40.2	36.8	43.6	47	40.5	31.6	49.4
	11+	9	6.9	2.5	11.3	44	5.6	4.0	7.2	15	12.9	6.8	19.0
Rurality	Metropolitan	103	78.6	71.6	85.6	583	73.1	70.0	76.2	74	62.2	53.5	70.9
	Large rural	10	7.6	3.1	12.1	63	7.9	6.0	9.8	11	9.2	4.0	14.4
	Small rural	18	13.7	7.8	19.6	151	18.9	16.2	21.6	34	28.6	20.5	36.7
Total		131	100.0	..	..	797	100.0	..	..	119	100.0	..	..

Note: UCL—upper confidence limit; LCL—lower confidence limit; shading indicates statistically significant differences between the groups.

Other GP characteristics

There were no significant differences between the groups in terms of their country of graduation, whether they were Fellows of the Royal Australian College of General Practitioners, or whether they conducted more than half their consultations in a language other than English (results not shown).

In summary, GPs in the high ordering group were more likely to be female and more likely to work in small rural areas than those in the low ordering group. They were also less likely to be in solo practice. Those in the low ordering group were more likely to be male and to work in metropolitan areas and in solo practices.

4.5 GP Characteristics by ordering rate: analysis of variance

The factors that affect GP imaging rates were explored using analysis of variance and linear regression. The variables of interest are listed below. Of the 1,047 GPs, 1,001 had data recorded for all variables of interest. The analysis of variance was restricted to these 1,001 GPs and was performed on unweighted data because the GP weighting variables (GP age and GP sex) were adjusted for in the analysis.

GP characteristics

- Number of MBS services per year
- Sex of GP
- Age of GP
- Years in practice
- Number of sessions per week
- Place of graduation (Australia, United Kingdom, other)

Practice characteristics

- Size of practice (Solo, 2-4, 5-10, 11-15, 15+)
- Location of practice (urban, large rural, small rural)

Patient characteristics

- Rate of male patients
- Rate of patients < 5
- Rate of patients 5-14
- Rate of patients 15-24

- Rate of patients 25–44
- Rate of patients 45–64 (The final group aged 65 years and over is excluded as it is a linear combination of the other five age groups).
- Rate of new patients
- Rate of patients with a health care card or Department of Veterans' Affairs card.

Problems managed

- Rate of problems in each of the ICPC–2 chapters
- Rate of problems in ICPC–2 component 1, Symptoms and Complaints (codes 1–29)
- Rate of problems in ICPC–2 components 3–6, Process components (codes 30–69)
- Rate of problems in ICPC–2 component 7, Diagnosis, disease (codes 70–99).

Univariate analysis

The proportion of variance in imaging rates explained by each variable alone was determined using simple linear regression. The results of the univariate analyses are summarised in Table 4.7.

Variables that were significant univariate predictors of imaging rates when fitted alone were:

- GP sex, practice location and size of practice
- sex of patients, rates of new patients, rates of health care/Veterans Affairs card holders
- management rates of musculoskeletal, psychological, respiratory, urinary, female genital problems and pregnancy were all significant univariate predictors of imaging rates
- relative rate of problems described as symptoms or complaints.

Multivariate analysis

General linear modelling was used to find the independent predictors of imaging order rates. When all variables of interest were entered, the model explained 17.8 per cent of the variance in imaging order rates. The full additive model explained a significant amount of the variance in imaging rates ($F(45, 955) = 4.58, p < 0.0001$).

The model was reduced using backward elimination with predictor variables fitted in 'families' in the following order: 'GP demographics', 'practice', 'patient demographics', 'problems managed'. The model was reduced family by family.

Families were reduced in order, the variables most directly related to imaging rates (problem characteristics) being reduced first, after adjusting for all other families.

If a family was significant (global alpha = 0.1) when fitted last it was reduced further by fitting each individual variable last. Significant variables (alpha = 0.05) or those that improved the fit of the model were kept. The reduced family was then fitted first and the next family fitted last. The final reduced model is summarised in Table 4.8.

Table 4.7: Univariate analysis of GP characteristics and imaging order rates

Variable	Regression coefficient	Effect size (standard Beta)	Per cent of variance explained	F-value	P-value
GP characteristics	..	..	1.34	1.11	0.344
GP sex	0.905	0.090	0.812	8.180	0.0043
GP age	..	..	0.132	0.440	0.7248
Annual A1 Medicare claims	-0.000	-0.059	0.348	3.489	0.0621
Place of graduation	..	..	0.125	0.627	0.5346
Years in practice	..	..	0.032	0.106	0.956
Sessions per week	..	..	0.133	0.665	0.515
Practice characteristics	..	..	2.74	4.66	<0.0001
Size of practice	..	..	1.565	3.958	0.0034
Location of practice	..	..	1.044	5.266	0.0053
Patient characteristics	..	..	6.9	9.19	<0.0001
Rate of male patients	-0.042	-0.112	1.257	12.716	0.0004
Rate of patients < 5	0.0047	0.006	0.000	0.850	0.853
Rate of patients 5–14	0.0012	0.001	0.000	0.001	0.972
Rate of patients 15–24	0.0350	0.050	0.250	2.470	0.116
Rate of patients 25–44	-0.0019	-0.005	0.100	0.020	0.887
Rate of patients 45–64	0.0360	0.060	0.270	3.663	0.0559
Rate of patients 65 +	-0.0132	-0.047	0.120	2.235	0.1353
Rate of card holders	-0.018	-0.089	0.793	7.986	0.0048
Rate of new patients	0.085	0.190	3.614	37.454	<.0001
Problems managed	..	..	10.25	5.90	<0.0001
Total problems managed	0.011	0.064	0.409	4.101	0.0432
Rate of new problems	0.005	0.026	0.069	0.694	0.4049
Rate of A chapter (General/unspecified)	-0.009	-0.016	0.025	0.251	0.6165
Rate of B chapter (Blood/blood forming)	0.002	0.001	0.000	0.001	0.9695
Rate of D chapter (Digestive)	0.003	0.003	0.001	0.008	0.9283
Rate of F chapter (Eye)	-0.023	-0.010	0.010	0.101	0.7504
Rate of H chapter (ear)	-0.024	-0.014	0.020	0.199	0.6556
Rate of K chapter (Circulatory)	-0.002	-0.005	0.003	0.026	0.8724
Rate of L chapter (Musculoskeletal)	0.070	0.127	1.613	16.386	0.0001
Rate of N chapter (Neurological)	0.034	0.019	0.038	0.376	0.5402
Rate of P chapter (Psychological)	-0.048	-0.103	1.052	10.621	0.0012
Rate of R chapter (Respiratory)	-0.036	-0.073	0.540	5.420	0.0201
Rate of S chapter (Skin)	-0.003	-0.005	0.003	0.027	0.8688
Rate of T chapter (Endocrine, metabolic)	0.038	0.052	0.273	2.729	0.0988
Rate of U chapter (Urinary)	0.306	0.138	1.895	19.298	0.0001
Rate of W chapter (Pregnancy/family plan)	0.100	0.106	1.132	11.438	0.0007
Rate of X chapter (Female genital)	0.116	0.191	3.661	37.958	0.0001
Rate of Y chapter (Male genital)	0.014	0.005	0.002	0.024	0.8768
Rate of Z chapter (Social)	-0.029	-0.016	0.026	0.262	0.6087
Rate of Component 1 (Symptoms/complaints)	0.031	0.091	0.828	8.341	0.004
Rate of Component 7 (Diagnosis/disease)	0.002	0.008	0.007	0.069	0.7932
Rate of Components 2–6 (Process)	0.008	0.023	0.050	0.547	0.4599

Note: Shading indicates variables significantly associated with imaging rates at the univariate level.

The results of this multivariate analysis indicated that:

- GPs from practices with 11–15 GPs had significantly higher imaging order rates than solo GPs, and
- GPs from small rural/remote practices had significantly higher imaging order rates than those from urban practices.

Significant predictors of higher rates of imaging order rates were:

- higher rates of new patients
- higher rates of management of musculoskeletal, urinary and female genital problems
- higher rates of problems described in symptomatic terms

and

- lower rates of patients aged 25–44
- lower rates of health card holders
- lower rates of management of psychological, skin and general/unspecified problems.

Together, the independent predictors explained 17.0 per cent of the variance in imaging rates ($F(16, 984) = 12.64, p < 0.001$). The strongest independent predictor of imaging order rates was the rate of encounters with new patients. This rate uniquely explained 3.7% of the variance and had the largest standardised effect size ($Beta = 0.2$).

Table 4.8: Final model of independent predictors of GP imaging order rates

Predictor (explanatory variable)		Regression coefficient ^(a)	Effect size (standard Beta) ^(b)	T-Value (F-partial)	P-value ^(c)	Per cent of Unique variance ^(d)
Rate of patients aged 25–44 years		-0.05	-0.11	-3.12	0.0018	0.82
Rate of health card holders		-0.02	-0.10	-2.76	0.0059	0.64
Rate of new patients		0.09	0.20	6.62	0.0001	3.69
Rate of A chapter (General/unspecified)		-0.06	-0.10	-3.02	0.0026	0.77
Rate of L chapter (Musculoskeletal)		0.08	0.15	4.69	0.0001	1.85
Rate of P chapter (Psychological)		-0.07	-0.15	-3.77	0.0002	1.20
Rate of S chapter (Skin)		-0.05	-0.07	-2.22	0.0268	0.41
Rate of U chapter (Urinary)		0.26	0.12	3.86	0.0001	1.25
Rate of X chapter (Female genital)		0.10	0.16	4.84	0.0001	1.97
Rate of symptoms/complaints		0.05	0.13	3.04	0.0024	0.78
Region of practice		..	..	(7.72)	0.0005	1.30
Versus urban	Large rural	0.17	0.01	0.33	0.7401	0.00
	Small rural	1.39	0.12	3.91	0.0001	0.00
Size of practice		..	..	(3.85)	0.0041	1.30
Versus solo	2–4 GPs	0.46	0.05	1.16	0.2466	..
	5–10 GPs	0.82	0.09	2.05	0.0405	..
	11–15 GPs	2.56	0.13	3.79	0.0002	..
	16 + GPs	0.61	0.01	0.44	0.6595	..

(a) Unit change in imaging rate for every unit change in the predictor variable. Units are original measurement units. Negative values represent a reduction in imaging rates with an increasing rate of the predictor.

(b) The standardised effect of the variable on imaging rates. Measured as standard deviation change in imaging rate for every standard deviation change in the predictor.

(c) Significance when all other variables in the model are held constant.

(d) The per cent of variance in imaging rates attributable uniquely to the variable, after taking into account the variance explained by all other variables in the model.

4.6 Discussion

The relationship between practice size and imaging ordering is not well documented in the published literature. A study by Njalsson et al. in Iceland found that ordering rates decreased with increasing practice size. However, the maximum practice size was five practitioners and this is below the size at which this study found increased ordering (Njalsson et al. 1995). Njalsson's study did, however, reveal much higher ordering rates in rural health centres which performed their imaging almost totally in the practice.

In reviewing imaging orders for gastrointestinal disorders in Germany, Busse et al. found that physicians (GPs and general internists) ordered imaging according to poor certainty of diagnosis and to severity of illness but the best predictor of imaging ordering was ownership of the imaging technology (Busse et al. 1999). Hillman et al. similarly found a significant correlation between ordering and practice ownership of the imaging process (Hillman et al. 1990). It would be useful in the Australian context to explore the imaging technology ownership of the large practices with high ordering revealed by this study.

Also consistent with this study, Rosen et al. found that in an outpatient setting female doctors were 40% more likely to order imaging (Rosen et al. 1997). Increasing feminisation of the GP workforce in Australia could therefore lead to higher overall imaging ordering.