EXTENDED REPORT

The epidemiology of medical treatment for glaucoma and ocular hypertension in the United Kingdom: 1994 to 2003

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Aims: To study trends in the prevalence of being treated for glaucoma and ocular hypertension from 1994 to 2003, and to examine factors determining treatment in 2002.

Methods: Computerised data (the DIN-LINK database) from 131 general practices across the United Kingdom, in which half a million patients aged 40 years or more were registered annually, were used. On average 10 000 patients were treated for glaucoma and ocular hypertension annually.

Results: Prevalence of being treated for glaucoma and ocular hypertension increased from 1.7% in 1994 to 2.3% in 2003. Those aged 85 years or more were 13 times (95% CI 12.2 to 13.8) more likely to be treated than those aged 40–64 years. Men were more likely to be treated than women (OR 1.24, 95% CI 1.19 to 1.28). Subjects "hard pressed" were less likely to be treated than "wealthy achievers" (OR 0.92, 95% CI 0.86 to 0.99). While use of topical β blocker only medications has declined since 1995, use of topical prostaglandins and combination therapies has increased. In 2003, use of prostaglandins overtook β blocker only medications.

Conclusion: Prevalence of being treated for glaucoma has increased over time, and rises with age. Differences in treatment by sex and social status could be explained by use of or access to health care or by underlying prevalence of disease. Trends in treated glaucoma emphasise the shift from use of topical β blockers to newer therapies.

Glaucoma is the leading cause of irreversible vision loss worldwide and is of major public health importance, leading to loss of mobility and independence.^{1–3} Primary open angle glaucoma (POAG) (accounting for 90–96% of all glaucomas)^{4–5} has been estimated to affect 230 000 people (3%) in England and Wales aged over 65 years.⁶ This puts a considerable burden on secondary care services (the hospital eye service) that manage patients with glaucoma.⁷ Management of glaucoma is palliative rather than curative and involves pharmaceutical and/or surgical management to reduce intraocular pressure (IOP). Evidence from clinical trials has shown that pharmaceutical reduction of IOP delays glaucomatous progression.⁸ Topical β blockers have formed the mainstay of glaucoma management for the last 20 years or so, although concerns about bronchial side effects have been raised, especially in the elderly where glaucoma is more prevalent.^{9–11} New modes of topical treatment for glaucoma and ocular hypertension have emerged since 1995, including prostaglandins, carbonic anhydrase inhibitors, α_2 agonists, and combination therapies.¹² Although the uptake of these treatments has been described in Scotland from 1994 to 1999,^{13–14} little is known about the therapeutic cost and prescribing patterns for glaucoma medications elsewhere in the United Kingdom.

General practice databases form a unique source of longitudinal population based clinical information on health service use and the prevalence and management of diagnosed disorders such as glaucoma and/or ocular hypertension, allowing the incidence, prevalence, and risk factors associated with treatment to be explored. In this paper we use information from a large scale general practice database (DIN-LINK) to provide information on treatment for glaucoma in the United Kingdom. The DIN-LINK database is used to (i) document trends in prevalence of treated glaucoma, (ii) examine who is treated by age, sex, socioeconomic position, and region, and (iii) document changes in drugs used.

METHODS

The DIN-LINK database

DIN-LINK is an ongoing anonymised computerised UK primary care database from practices that use iSOFT (formerly Torex) software from 1989 onwards. This report is based on 131 practices that run an updated version of the software used in an earlier version of the database, previously described.^{15–16} We have outlined methodology for identifying

Table 1 Read codes used in the DIN-LINK database for treatment for glaucoma

Drug group	Read codes
(i) β blockers only	k83 (betaxolol hydrochloride), k85 (cartelol hydrochloride), k8b (metipranolol), k8f (timolol maleate), k8g (levobunolol hydrochloride)
(ii) Prostaglandins only	k8i (latanoprost), k8n (travoprost), k8o (bimatoprost)
(iii) Cholinergic agents	k84 (carbachol), k86 (demecarium bromide), k89 (ecothiopate iodide), k8c (physostigmine sulphate), k8d (pilocarpine hydrochloride), k8e (pilocarpine nitrate)
(iv) Sympathomimetics	k82 (adrenaline), k88 (dipverfine hydrochloride), k8a (guanethidine monosulphate), k8j (brimonidine tartrate)
(v) Carbonic anhydrase inhibitors only	k81 (acetazolamide), k87 (dichlophenamide), k8h (dorzolamide), k8l (brinzolamide)
(vi) Carbonic anhydrase inhibitors and β blocker	k8k (dorzolamide + timolol)
(vii) Prostaglandins and β blockers	k8m (latanoprost + timolol)

Abbreviations: ACORN, A Classification of Residential Neighbourhoods; IMD, index of multiple deprivation; IOP, intraocular pressure; POAG, primary open angle glaucoma

good quality data in DIN-LINK,¹⁶ and the selected practices had to provide at least 5 years of continuous high quality data.

The completeness and accuracy of DIN-LINK data have been demonstrated, by comparisons with other national data sources. The practices and general practitioners (GPs) in DIN-LINK are as comparable to the UK norm as the practices and GPs in other GP research databases.^{15 16} Morbidity and drug data are coded using Read codes. Subjects' postcodes in the database are associated with two sociodemographic indicators at a small area level—the index of multiple deprivation (IMD) and the ACORN index. IMD was produced by the office of the deputy prime minister from the 2001 census,¹⁷ and ranks census “super output areas” in England (average 1500 residents) from most deprived to least. ACORN¹⁸ also uses data from the 2001 census to classify postcodes. Multiple levels of aggregation of the index are available, but commonly, the most aggregated level—a five level classification from “wealthy achievers” through to “hard pressed” is used. Out of the 131 practices, ACORN scores were available for most patients in 125 of these, while IMD was available for 104 practices (three practices in Scotland and two in Wales were excluded from the IMD linkage). Practices were also classified by their region.

Patient selection

We selected patients aged 40 years or more who were fully registered with a practice on 31 December of a given year, and had been continuously registered for at least 6 months before this date. This approach has been used in our earlier work and follows the methods used in key health statistics.^{19 20} This resulted in a denominator of approximately 500 000 patients annually, from 1994 to 2003. Although glaucoma or ocular hypertension is a secondary care diagnosis, pharmaceutical management for glaucoma can be picked up using primary care databases with a high degree of accuracy, as continuing prescriptions for glaucoma medications are issued in primary care irrespective of the completeness of recording of secondary care diagnosis. Treatment for glaucoma or ocular hypertension was defined as the presence of a coded entry for a prescription for glaucoma before 31 December in the year of interest; codes are listed in table 1. In this paper we focus on treatment for glaucoma or ocular hypertension because diagnostic codes for glaucoma are not consistently reported.

We extracted data for patients on age, sex, registered practice, NHS region, smoking status, ACORN score, IMD index, and number of consultations with their general practitioner per year. Data were also available on the type of medication prescribed and classified into seven categories (table 1): (i) β blockers, (ii) prostaglandins, (iii) cholinergic agents, (iv) sympathomimetics, (v) carbonic anhydrase inhibitors, (vi) carbonic anhydrase inhibitors and β blockers, (vii) prostaglandins and β blockers. All were topical medications except for category (v) which included oral and injected preparations.

Analysis

We examined the period prevalence of recorded treatment for glaucoma annually from 1994 to 2003, by age group (40–64, 65–74, 75–84, ≥ 85 years), for males and females separately. The percentage of those treated for glaucoma on different categories of active treatment listed (i) to (vii) above, including combination therapies, were examined by year for males and females separately. Patients receiving a β blocker or prostaglandin monotherapy therapy were counted in the “only” category. Combined percentages are greater than 100% as categories are not mutually exclusive. Odds ratios (ORs) were derived from logistic regressions to identify factors associated with treatment for glaucoma in 2002, including, age, sex, geographic region (north, mid, south), markers of socioeconomic status (ACORN and IMD indices), and propensity to consult. Basic ORs adjusted for age, sex, practice (except region and sociodemographic indicators which are adjusted for age and sex only), and ORs adjusted for all factors (except ACORN and IMD which are not adjusted for each other) were calculated. The year 2002 was chosen because of the large number of patients and to give contemporary influences on treatment. Similar ORs were observed when data from 1994 were used (data not presented).

RESULTS

Period prevalence of treatment for glaucoma

From 1994 to 2003, nearly half a million patients aged 40 years or more were registered annually (table 2) with the 131 practices. The percentage of the population treated for glaucoma increased gradually over time from 1.7% in 1994 for both sexes, to 2.3% in males and 2.4% in females in 2003

Figure 1 Percentage of subjects treated for glaucoma in each year from 1994 to 2003: (A) men and (B) women.

Table 2 Period prevalence of being treated for glaucoma in DIN-LINK for men and women, 1994 to 2003

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Men										
Number*	174 130	189 512	208 551	216 253	231 085	244 603	246 219	249 660	253 600	246 024
r†	2881	3239	3745	4036	4491	4886	5122	5323	5550	5532
%	1.65	1.71	1.80	1.87	1.94	2.00	2.08	2.13	2.19	2.25
40–64 years										
Number	121 012	131 959	145 438	151 094	161 801	171 361	172 683	175 267	178 089	172 341
r	732	849	989	1070	1194	1307	1328	1383	1422	1419
%	0.60	0.64	0.68	0.71	0.74	0.76	0.77	0.79	0.80	0.82
65–74 years										
Number	32 948	35 102	37 906	38 676	40 803	42 886	42 768	43 029	43 660	42 587
r	956	1011	1136	1188	1313	1397	1460	1484	1528	1534
%	2.90	2.88	3.00	3.07	3.22	3.26	3.41	3.45	3.50	3.60
75–84 years										
Number	16 160	18 069	20 261	21 195	22 779	24 209	24 576	25 028	25 577	25 127
r	859	1019	1189	1313	1463	1608	1743	1809	1901	1902
%	5.32	5.64	5.87	6.19	6.42	6.64	7.09	7.23	7.43	7.57
85+ years										
Number	4010	4382	4946	5288	5702	6147	6192	6336	6274	5969
r	334	360	431	465	521	574	591	647	699	677
%	8.33	8.22	8.71	8.79	9.14	9.34	9.54	10.21	11.14	11.34
Women										
Number*	198 457	214 511	234 899	241 846	257 155	270 981	271 856	274 176	277 440	267 794
r	3366	3743	4350	4715	5187	5695	5928	6192	6448	6429
%	1.70	1.74	1.85	1.95	2.02	2.10	2.18	2.26	2.32	2.40
40–64 years										
Number	121 313	131 739	144 611	149 395	159 889	169 192	170 567	172 865	175 828	169 787
r	604	671	768	848	939	1026	1058	1092	1156	1174
%	0.50	0.51	0.53	0.57	0.59	0.61	0.62	0.63	0.66	0.69
65–74 years										
Number	39 586	41 623	44 688	45 094	46 930	48 736	48 245	47 920	48 119	46 633
r	934	1000	1115	1180	1288	1379	1429	1464	1488	1456
%	2.36	2.40	2.50	2.62	2.74	2.83	2.96	3.06	3.09	3.12
75–84 years										
Number	26 353	29 083	32 285	33 372	35 298	37 171	37 189	37 397	37 816	36 644
r	1154	1299	1560	1690	1848	2046	2127	2263	2372	2403
%	4.38	4.47	4.83	5.06	5.24	5.50	5.72	6.05	6.27	6.56
85+ years										
Number	11 205	12 066	13 315	13 985	15 038	15 882	15 855	15 994	15 677	14 730
r	674	773	907	997	1112	1244	1314	1373	1432	1396
%	6.02	6.41	6.81	7.13	7.39	7.83	8.29	8.58	9.13	9.48

*Number of registered patients in year aged 40 years or more.

†r, number from number with history of glaucoma treatment in their electronic record.

(table 2). The proportionate rise in treatment for glaucoma was similar in younger and older age groups, despite the prevalence of treatment being far greater in older age groups (fig 1, table 2). In those aged 40–64 years, 0.6% of males were treated in 1994 rising to 0.8% in 2003 (a rise of 37%), for females the prevalence rose from 0.5% to 0.7% (38% increase) over a similar time period (fig 1, table 2). In those aged 85 years or more, 8.3% and 11.3% were treated in males respectively (a rise of 36%), a slightly greater increase (57%) was observed in females (from 6% to 9.5%) (fig 1, table 2).

Changes in treatment of glaucoma

Figure 2 and table 3 show the proportions of treated patients receiving different types of therapy for glaucoma from 1994 to 2003, for men and women separately. Decreases in prescribing of topical β blocker only medications since 1995 have been accompanied by rising levels of prostaglandins and combination therapies; in 2003 for the first time topical prostaglandins were prescribed more frequently (59% of prescriptions) than β blockers (50%) in both men and women (fig 2, table 3). Although the prescribing of β blocker only medications has declined, the decline in β blocker therapy is less as there has been an increase in combination therapies (fig 2, table 3). Other types of treatment were prescribed for less than 30% of patients. It is notable that the use of cholinergic agents and sympathomimetic therapies (including older sympathomimetic and newer α_2 agonist therapies) has also declined. Decreases in the use of carbonic anhydrase inhibitors since the late 1990s coincide with the introduction

of topical prostaglandins and the emergence of topical therapies combining β blockers and carbonic anhydrase inhibitors. Grouping carbonic anhydrase inhibitors into systemic and topical medications shows the rapid decrease in the use of systemic preparations; in 1994 all patients ($n = 219$) received systemic carbonic anhydrase inhibitors, in 1995, 88% ($n = 243/276$) were treated with systemic preparations, in 2002 this had fallen to 9% ($n = 124/1402$).

Factors influencing treatment for glaucoma and ocular hypertension in 2002

There was a steep increase in prescribing treatment for glaucoma with age; those 85 years or more were 13 times (95% CI 12.2 to 13.8) more likely to be treated than those aged 40–64 years (table 4). Men were more likely to be treated than women (OR 1.24, 95% CI 1.19 to 1.28) once sex differences in the distribution of age were adjusted for (table 1). The ACORN index showed that those from less privileged areas were less likely to be treated; those “hard pressed” were less likely to be treated than “wealthy achievers” (OR 0.92, 95% CI 0.86 to 0.98). There was no evidence of a trend in being treated across IMD scores, although treatment in patients classified as “most deprived” was marginally less than in those “least deprived” (OR 0.92, 0.84 to 1.02). There was no evidence of a regional trend in treatment. Smokers were less likely to be treated and ex-smokers more likely to be treated than non-smokers. Increased consultations were associated with higher levels of treatment. Odds ratios were not materially altered when

Figure 2 Type of treatment for glaucoma in DIN-LINK by year for (A) men and (B) women, 1994 to 2003.

the analysis was restricted to practices contributing data throughout the study period.

DISCUSSION

The period prevalence of glaucoma treatment has risen steadily since the mid-1990s and rises steeply with age. Prevalence rates of treatment for glaucoma for different adult age groups in the mid-1990s are consistent with a recent meta-analysis of 24 studies (mostly published in the 1990s with 53 874 subjects, including 999 with glaucoma) that examined the prevalence of glaucoma in white populations, ascertained by clinical examination (Rudnicka *et al*, personal communication, 2005). Prevalence estimates from this review were 0.7% (95% CI 0.3% to 1.4%) in those aged 40–64 years, 2.1% (0.6% to 7.4%) aged 65–74 years, 4.1% (0.9% to 17.6%) aged 75–84 years, and 7.9% (1.2% to 36.5%) in those aged 85 years or more (estimates for comparable age groups provided by study authors, Rudnicka *et al*, personal communication, 2005). The majority of the older population of Britain are white,²¹ hence comparing these prevalence rates with a meta-analysis of white populations was considered appropriate. While it is tempting to infer from this similarity

that most glaucoma patients are known to health services, apparently refuting the finding from population studies that half of glaucoma patients in the population remain undetected,^{5 22–25} patients receiving treatment for glaucoma will include both those with glaucoma (mostly POAG)^{4 5} and those with ocular hypertension (a group at considerably increased risk of developing the condition). Hence, our estimate of the prevalence of treated glaucoma will tend to overestimate the number with glaucoma. Conversely, the number receiving treatment excludes those who have borderline or early signs of the glaucoma who continue to be monitored but remain untreated, and those who have had successful surgery for glaucoma or non-progressive normal tension glaucoma; this would act to underestimate the number with disease.

The proportion of patients in the United Kingdom receiving treatment solely for glaucoma or ocular hypertension is unclear. It was difficult to rely on diagnostic codes for glaucoma to examine this issue further as glaucoma diagnoses were inconsistently recorded. Seventy per cent of diagnostic codes were for “glaucoma” (with no further information as to the type of glaucoma), 10% for “primary open angle glaucoma”; the

Table 3 Type of treatment for glaucoma in DIN-LINK by year for men and women, 1994 to 2003

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Men										
Number of registered age ≥ 40 years*	No	No	No	No	No	No	No	No	No	No
Number treated in year	174 130	189 512	208 551	216 253	231 085	244 603	246 219	249 660	253 600	246 024
	2509	2769	3149	3347	3717	4036	4218	4375	4542	4568
	1.44	1.46	1.51	1.55	1.61	1.65	1.71	1.75	1.79	1.86
<i>Type of treatment†</i>										
β blockers only	No	No	No	No	No	No	No	No	No	No
	2241	2466	2763	2879	3089	3246	3134	2929	2649	2322
	89	89	88	86	83	80	74	67	58	51
Prostaglandins only	No	No	No	No	No	No	No	No	No	No
	0	0	0	101	424	901	1366	1889	2347	2697
	0	0	0	3	11	22	32	43	52	59
Cholinergic agents (parasympathomimetics)	No	No	No	No	No	No	No	No	No	No
	674	710	741	657	577	492	402	292	258	209
	27	26	24	20	16	12	10	7	6	5
Sympathomimetics (α agonists)	No	No	No	No	No	No	No	No	No	No
	458	475	442	367	526	598	556	510	471	419
	18	17	14	11	14	15	13	12	10	9
Carbonic anhydrase inhibitors	No	No	No	No	No	No	No	No	No	No
	92	129	484	766	933	948	817	770	692	688
	4	5	15	23	25	23	19	18	15	15
Carbonic anhydrase inhibitors and β blockers	No	No	No	No	No	No	No	No	No	No
	0	0	0	0	0	106	241	362	442	482
	0	0	0	0	0	3	6	8	10	11
Prostaglandins and β blockers	No	No	No	No	No	No	No	No	No	No
	0	0	0	0	0	0	0	0	118	237
	0	0	0	0	0	0	0	0	3	5
Women										
Number of registered age ≥ 40 years	No	No	No	No	No	No	No	No	No	No
Number treated in year	198 457	214 511	234 899	241 846	257 155	270 981	271 856	274 176	277 440	267 794
	2898	3162	590	3789	4139	4541	4684	4893	5092	5109
	1.46	1.47	1.53	1.57	1.61	1.68	1.72	1.78	1.84	1.91
<i>Type of treatment†</i>										
β blockers	No	No	No	No	No	No	No	No	No	No
	2530	2805	3127	3264	3458	3567	3384	3171	2904	2531
	87	89	87	86	84	79	72	65	57	50
Prostaglandins	No	No	No	No	No	No	No	No	No	No
	0	0	0	97	469	1082	1615	2142	2667	3044
	0	0	0	3	11	24	34	44	52	60
Cholinergic agents (parasympathomimetics)	No	No	No	No	No	No	No	No	No	No
	792	820	873	795	657	577	458	375	320	244
	27	26	24	21	16	13	10	8	6	5
Sympathomimetics (α agonists)	No	No	No	No	No	No	No	No	No	No
	463	466	437	393	537	607	550	499	426	380
	16	15	12	10	13	12	10	10	8	7
Carbonic anhydrase inhibitors	No	No	No	No	No	No	No	No	No	No
	127	147	536	798	945	971	816	749	721	714
	4	5	15	21	23	21	17	15	14	14
Carbonic anhydrase inhibitors and β blockers	No	No	No	No	No	No	No	No	No	No
	0	0	0	0	0	126	275	391	456	478
	0	0	0	0	0	3	6	8	9	9
Prostaglandins and β blockers	No	No	No	No	No	No	No	No	No	No
	0	0	0	0	0	0	0	0	114	249
	0	0	0	0	0	0	0	0	2	5

*Percentage of total registered.

†Percentage of number treated in year.

Table 4 Logistic regression of factors affecting treatment for glaucoma in 2002

		No*	tr†	%	Basic OR (95% CI)	Adj OR (95% CI)
Total		531 040	11 998	2.26		
Sex	Male	253 600	5550	2.19	1.20 (1.15 to 1.24)	1.24 (1.19 to 1.28)
	Female	277 440	6448	2.32	1.00	1.00
Age	40–64	353 917	2578	0.73	1.00	1.00
	65–74	91 779	3016	3.29	4.64 (4.40 to 4.89)	3.98 (3.77 to 4.2)
	75–84	63 393	4273	6.74	9.98 (9.49 to 10.49)	8.23 (7.81 to 8.67)
	85+	21 951	2131	9.71	15.12 (14.23 to 16.07)	12.98 (12.18 to 13.82)
ACORN	Wealthy achievers	176 979	3854	2.18	1.00	1.00
	Urban prosperity	31 188	711	2.28	0.95 (0.86 to 1.05)	0.97 (0.88 to 1.07)
	Comfortably off	168 384	3982	2.36	0.98 (0.94 to 1.03)	0.97 (0.93 to 1.02)
	Moderate means	51 524	1056	2.05	0.97 (0.90 to 1.04)	0.97 (0.90 to 1.04)
	Hard pressed	77 380	1816	2.35	0.93 (0.87 to 0.99)	0.92 (0.86 to 0.98)
	Missing	25 585	579	2.26	0.98 (0.86 to 1.12)	1.05 (0.92 to 1.2)
IMD	Least deprived (5)	119 663	2645	2.21	1.00	1.00
	4	111 352	2605	2.34	1.03 (0.96 to 1.09)	1.04 (0.97 to 1.1)
	3	77 640	1775	2.29	1.01 (0.94 to 1.09)	1.02 (0.95 to 1.09)
	2	51 558	1242	2.41	1.03 (0.94 to 1.11)	1.03 (0.95 to 1.12)
	Most deprived (1)	43 485	890	2.05	0.92 (0.83 to 1.01)	0.92 (0.84 to 1.02)
	Missing	127 342	2841	2.23	0.90 (0.80 to 1.02)	0.97 (0.86 to 1.1)
Smoking	Never	210 560	4703	2.23	1.00	1.00
	Ex	121 746	3750	3.08	1.1 (1.05 to 1.15)	1.05 (1.01 to 1.1)
	Current	106 815	1600	1.50	0.89 (0.84 to 0.95)	0.90 (0.85 to 0.96)
	Missing	91 919	1945	2.12	0.76 (0.72 to 0.8)	0.87 (0.82 to 0.92)
Region	North	152 395	3333	2.19	0.99 (0.95 to 1.04)	
	Mid	181 516	4039	2.23	1.01 (0.97 to 1.06)	
	South	197 129	4626	2.35	1.00	
Number of consultations in 2002	0	88 704	559	0.63	0.47 (0.43 to 0.51)	0.43 (0.35 to 0.52)
	1 to 5	264 316	4981	1.88	1.00	1.00
	6 to 10	112 297	3607	3.21	1.29 (1.24 to 1.35)	1.28 (1.22 to 1.34)
	11 to 15	36 241	1433	3.95	1.42 (1.34 to 1.51)	1.4 (1.32 to 1.49)
	16+	29 482	1418	4.81	1.59 (1.49 to 1.70)	1.57 (1.47 to 1.67)

*Number of registered patients in year aged 40 years or more.

tr, number from number with history of glaucoma treatment in their electronic record.

OR, odds ratio; ACORN, A Classification of Residential Neighbourhoods; IMD, index of multiple deprivation. IMD is presented here in quintiles. Basic OR adjusted for age, sex, and practice (except region, ACORN, and IMD, which are adjusted for age and sex only). Adjusted OR adjusted for all factors except ACORN and IMD which are not adjusted for each other.

remainder had other codes for glaucoma including open angle, low tension and closed angle glaucoma. Less than 1% of codes were given for glaucoma related surgery (that is, trabeculectomy, filtering operations on the iris). The accuracy of these diagnoses depends on GPs recording diagnoses from secondary care, which is likely to be influenced by the completeness and convenience of the computerised coding system used; this contrasts with the systematic recording of prescriptions that are issued from primary care.

The similarity between clinically measured prevalence of glaucoma and the prevalence of treatment for glaucoma is in agreement with a recent audit that found population estimates of open angle glaucoma were not statistically significantly different from those registered with the disease in a select area of southern England.²⁶ However, lack of consistency in case definition was given as an artefactual explanation for this apparent similarity.²⁷ A large study in Sweden also showed that glaucoma patients who present to health services have different disease characteristics from glaucoma patients identified from population screening; the latter have a higher prevalence of normal tension glaucoma.²⁸ A population based study carried out within a geographically defined area of north London showed that a quarter of those with definite glaucoma are known to health services.²⁹ Hence, those treated for glaucoma are unlikely to represent the population distribution of the disease.

The sex difference in treatment for glaucoma, where men are more likely to receive treatment than women (OR 1.24, 95% CI 1.19 to 1.28) has recently been confirmed in a large healthcare database of 44 000 patients with suspected and diagnosed glaucoma in the United States (OR 1.32, 95% CI 1.25, 1.41).³⁰ These differences in treatment may be explained by sex differences in access or use of health services, sex inequalities in medical care, or real differences in the

underlying prevalence of disease. Sex inequalities in the field of cardiovascular medicine, where men are more likely than women to receive treatment^{31–32} and specialist medical care,^{33–34} have been previously shown in the United Kingdom. Hence, these differences in treatment may reflect inequalities in uptake or delivery of eye care. Alternatively, there may be a genuine sex difference in the underlying prevalence of POAG. The reporting of sex differences in clinically measured glaucoma has been controversial to date; some studies have found the prevalence to be higher in men,^{22–29–35–36} conversely some have reported a higher prevalence in women,^{25–37–38} while other studies report no sex difference in prevalence.^{4–5–24–39–42} Heterogeneity in the reporting of these sex effects may be explained by lack of power, with insufficient numbers of glaucoma cases within individual studies to detect consistent sex effects. While a meta-analysis of five studies in populations examined from the United States, Australia, and one from Holland (22 557 subjects) found no significant differences by sex (OR 1.03, 95% CI 0.83 to 1.27),⁴³ a more recent meta-analysis, including a further 21 studies of mostly white Europeans (a further 20 803 subjects), showed that the prevalence of glaucoma was higher in men than women (OR 1.23, 95% CI 1.06 to 1.42) (Rudnicka *et al*, personal communication 2005). This point estimate from population based studies is remarkably similar to the odds ratio from the current study (OR 1.24, 95% CI 1.19 to 1.28). Despite the similarity, further study is needed before concluding that this sex difference does not represent an inequity in treatment, as those receiving treatment for glaucoma differ from those with disease.

Geographical and social inequalities in morbidity and mortality have recently been highlighted in the United Kingdom.⁴⁴ Although there was no regional trend in treatment, the finding that those in the least privileged

group were 8% less likely to be treated than those in the most privileged group may indicate another social inequality in health. Whether this reflects social class variations in the prevalence or incidence of POAG,²⁹⁻⁴⁵ or that those from less advantaged circumstances are less likely to participate in health care and present with different stages of glaucomatous disease remains unclear.⁴⁶ If we assume that the underlying prevalence of glaucoma is similar across socioeconomic groups this would imply slight under-treatment in those most deprived. In fact, the situation is likely to be more extreme than this since we know that ethnic minorities who are known to have a greater risk of glaucoma (especially those of African-Caribbean origin)³⁹ are likely to have low socioeconomic status. It was not possible to examine the effect of ethnicity in this study. The association between cigarette smoking and treatment, where smokers were less likely and ex-smokers more likely to be treated than non-smokers, is in keeping with findings examining the treatment of cardiovascular related diseases, where smokers are less likely and ex-smokers more likely, than non-smokers to be treated for hypertension and to receive statins.¹⁹⁻⁴⁷

Recent trends showing the fall in prescribing of topical β blocker only medications (as well as older cholinergic and sympathomimetic agents) and the rise in topical prostaglandins and combination therapies in this study have also been shown in Scotland and Australia.¹³⁻¹⁴⁻⁴⁸ It remains unclear whether these new treatments are as effective as each other, or whether they prevent or delay the need for surgery.¹³⁻¹⁴ However, the rise in the number of new medications for glaucoma has been associated with a reduction in operation rates for glaucoma in Scotland over recent years.¹³⁻¹⁴ It was not possible to identify those who had received surgery with any certainty in the present study.

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CONTRIBUTORS

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