Capitation funding: population, age, and mortality adjustments for regional and district health authorities in England

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Abstract

Objective—To assess the effect of each of the components of the national capitation funding formula—population projections and age and mortality weighting—at regional and district level.

Design—Application of age-cost and mortality weights to the projected 1997 populations of regions and districts, based on the Department of Health public health common dataset.

Setting—Regional and district health authorities in England.

Results—The application of the age-cost and mortality weights to projected populations resulted in greater changes in the shares of weighted populations relative to the estimated 1991 population at district level (mean 0, range -17% to 28%) than at regional level (mean 0, range -9% to 6%). At district level mortality weights had less scope for influence (mean 0, range -9% to 14%) than population projections (mean 0, range -16% to 31%) or age weights (mean 0, range -20% to 30%).

Conclusions—The adjustments to the 1991 population shares due to the application of the national capitation funding formula depend on the interaction of three elements: the projected population by age group, the age-cost weight, and the mortality weight. Since each is open to uncertainty, either in terms of measurement (projected population, particularly for births and the over 85s) or method (derivation of the age-cost and mortality weights), the formula should be implemented cautiously at district level. Ways should be considered of incorporating elements of uncertainty into the model. Further research is required on the elements and degree of uncertainty in each of these components, as well as on the relative health needs of different populations.

Introduction

Capitation funding, whereby health authorities receive NHS funds on the basis of the relative size and composition of their resident populations, is one of the distinguishing characteristics of the reformed National Health Service, although it has existed for much longer.¹ In 1976, for example, the Resource Allocation Working Party (RAWP) set funding targets for regions based on populations weighted for age, sex, and mortality with adjustments for cross boundary flows, local costs (such as London weighting), and teaching.² Capitation funding implies a strong commitment to geographical equity by providing equal public funding for health care per head throughout England and Wales, with the age and mortality weightings reflecting judgments about differential needs.

Following RAWP, disparities in funding between

the 14 regions narrowed from a 27% range between the best off and the least well off in 1977-8³ to 4% in 1986-7.¹ The NHS reforms of 1991 led to regions being funded entirely on the basis of weighted capitation in 1992-3. Before 1991 regions applied various forms of subregional capitation to districts, based around the share of hospital centred "planning populations" in the region's total population. By separating purchasers and providers and funding the purchaser for resident as opposed to planning populations the NHS reforms made weighted capitation more important at district level.⁴ In applying capitation funding to districts, however, regions are permitted to make adjustments—for example, over the pace of change and for social deprivation. Since different social deprivation indexes give different results, many regions are currently engaged in lively debates about which to use.

The main focus hitherto in the debate on capitation funding has been on the appropriate adjustments for mortality (taken to be a proxy for morbidity) and for social deprivation.⁵ Less attention has been paid to the impact of population projections and age weights. This paper assesses the contribution of each of the three main elements in the national formula—population projections and age and mortality weights—to the changes implied by capitation targets.

Elements in the formula

The age-cost weights used in the national formula for hospital and community health services (table I) indicate relatively high expenditure at birth and on each of the elderly age groups, especially the over 85s, whose average spend is over £2000 a year. Sexes are not weighted separately. Since the average overall spending on these services was £308 a head per year, births and the over 85s cost five to seven times that average. The weights⁶ are based on the national average age-use profiles of 29 programmes⁷ and apply to the whole hospital and community health services budget. The 1993-4 age-cost weights, used in this analysis, average the three years 1988-91.

Mortality adjustment—The RAWP formula adjusted populations for morbidity by using disease specific standardised mortality ratios to give "need weighted populations." In 1987, on the basis of multivariate analysis of differences in hospitalisation rates, a national review suggested that the mortality adjustment should be based on the square root of the all cause standardised mortality ratio and that the relevant standardised mortality ratio should be that for the population aged under 75.⁸ These suggestions were incorporated into the national formula for weighted capitation.

The national capitation formula takes some account of random variation by using five year standardised mortality ratios and three year average age weights.⁷

Since regions contain 2-5 million residents the level of random variation to be expected in applying age-cost or mortality weights is relatively small. The greater level of random variation in mortality to be expected in districts, which typically have populations of 250 000-500 000, has generated considerable debate.⁹⁻¹² The variations likely to be associated with particular age groups have received less attention.¹³

Design and methods

This study replicates the core elements of the national capitation formula by combining publicly available data on projected populations by age group with age and mortality weights at both regional and district levels. Although use of the publicly available data necessitates some slight departures from the national method, these are small enough to enable the broad effects of capitation weighting to be assessed. The national formula requires data on three elements: (a) mid-year population projections by age group for the year of allocation,¹ (b) application of age-cost weights to that population by age group, and (c) adjustment of the total population by the square root of the all cause standardised mortality ratio for people aged under 75.

The public health common dataset provides estimates of mid-year 1991 populations by age group with similar projections for 1997.¹⁴ Although these six year projections refer to a slightly longer period than the five year planning horizons of most regions, they indicate the likely scale of population changes.

The age-cost weights shown in table I were applied to each age group for 1997 and the resulting expenditure aggregated. The share of each health authority in total expenditure was used to drive an age weighted population, which, although the same at national level (mean change 0), shows differences at subnational levels.

The public health common dataset also provides data on several all cause standardised mortality ratios by regional and district health authority: that for all ages, for under 15s, for the 15-64 age group, and for the over 65s. Given the lack of a measure relating specifically to the population under 75, the all age, all cause standardised mortality ratio was used. Mortality weights were derived by taking the square root of this ratio. As with the age weights, the mortality weighted population was identical with the projected 1997 population at national level (mean change 0) but not at subnational levels.

Since the share of national population in each region and district, rather than absolute population size, determines capitation targets the changes in shares due to the various elements were calculated relative to 1991 shares.

Results

OVERALL EFFECTS

Regional level—The application of these various weights to the projected 1997 populations resulted in considerable changes at regional level (table II), with a mean change of zero on the 1991 population and a range from -9% (North West Thames region) to 6% (South Western region). Population projections accounted for slightly less of the projected changes (mean 0, range -3 to 4%) than age weights (mean 0, range -6% to 7%) or mortality (mean 0, range -4% to 7%). Since the changes implied by each component tended to offset each other in most regions, the range of their combined effects was only slightly greater than that for each component.

District level—Although the mean change nationally was 0, much greater swings occurred at district level, with losses of up to -17% and gains of up to 28%. Table III shows the projected changes in share of national weighted population compared with 1991 for the top two overall gainer and loser districts in each region. A few districts gained by over 20%, though none lost by more than 17% (Haringey and Hampstead). Overall 99 districts were losers and 87 gainers. All regions except one had some gainers and losers, but two (Northern and South Western) had only three losers. By contrast, all the districts in North West Thames and all but one in North East Thames were losers. The widest spread of losers and gainers was in South East Thames (-15% to 28%) and South West Thames (-14% to 27%).

POPULATION PROJECTION EFFECTS

Population projections had a very different pattern from the total change, with many of the districts which were large gainers in total capitation projected to lose on the population projection element. The range of change in projected population share was from -16% to 31% around a mean of zero. Largest projected increases were for the "new towns" of Milton Keynes and Huntingdon. The largest losers included older urban areas such as North Manchester, Central Manchester, Liverpool, Hull, Haringey, and Hampstead.

AGE-COST WEIGHTS

Table III shows the effects due to age-cost weights. The mean change was 0, with a range of -20% to 30%. Some districts lost heavily due to age weighting, including towns such as Milton Keynes and Huntingdon which were projected to have large total population increases. Projected population increases in these districts were mainly in the younger age groups, which had relatively low age-cost weights.

All regions had gainers and losers, with a strong tendency for the gainers to be seaside resorts (because

TABLE I—Age-cost weights used in national capitation⁷

Age group (years)	Estimated NHS expenditure per head in 1993-4 (£)
Birth	1505
≤ 4	220
5-14	116
15-44	128
45-64	273
65-74	595
74-84	1082
≥ 85	2027
Average	308

TABLE II—Estimated and projected weighted populations, with percentage changes in population share for regional health authorities in England 1991 and 1997^{7,15}

Region	Estimated population 1991	Projected population 1997	Age weighted population 1997	Mortality weighted population 1997	% Changes in population share due to:			
					Population projection	Age weight	Mortality weight	Combined effects
Northern	3 077 265	3 063 568	3 048 405	3 246 613	-2.39	-0.49	6.50	3.44
Yorkshire	3 673 134	3 722 729	3 728 290	3 811 418	-0.63	0.15	2.23	1.74
Trent	4 721 798	4 822 283	4 779 754	4 855 779	0.13	-0.88	1.59	0.83
East Anglian	2 083 650	2 189 324	2 264 445	2 177 697	3.02	3.43	-3.83	2.47
North West Thames	3 566 541	3 593 289	3 436 920	3 296 291	-1.22	-4.35	-4.09	-9.38
North East Thames	3 759 039	3 798 278	3 709 451	3 628 658	-0.93	-2.34	-2.18	-5.36
South East Thames	3 671 311	3 763 819	3 872 067	3 787 732	0.51	2.88	-2.18	1.15
South West Thames	2 985 216	3 023 141	3 103 752	2 970 263	-0.71	2.67	-4.30	-2.45
Wessex	2 955 108	3 112 419	3 239 322	3 110 160	3.26	4.08	-3.99	3.19
Oxford	2 578 359	2 729 734	2 554 979	2 471 699	3.80	-6.40	-3.26	-6.01
South Western	3 271 643	3 435 961	3 673 093	3 545 750	2.97	6.90	-3.47	6.26
West Midlands	5 228 424	5 300 899	5 211 934	5 343 445	-0.60	-1.68	2.52	0.20
Mersey	2 406 555	2 384 109	2 372 925	2 482 162	-2.87	-0.47	4.60	1.12
North Western	4 030 378	4 026 436	3 970 651	4 210 104	-2.05	-1.39	6.03	2.42
England	48 008 421	48 965 977	48 965 926	48 965 926	0.00	0.00	0.00	0.00

of their high proportion of retired people) and the losers inner cities.

MORTALITY WEIGHTS

The effect of mortality weights is also shown in table III. The mean contribution of mortality weights was

equal to 0 and ranged from -9% to 14%. The northern districts tended to gain owing to their raised relative mortality compared with the south. Against this trend, several of the inner London districts had raised mortality and hence gained due to this weighting.

TABLE III—Estimated and projected weighted populations, with percentage changes in population share for district health authorities in England 1991 and 1977¹⁵

District	Estimated population 1991	Projected population 1997	Age weighted population 1997	Mortality weighted population 1997	% Changes in population share due to:			
					Population projection	Age weight	Mortality weight	Combined effects
Northern region								
Hartlepool	89 927	83 950	82 371	89 492	-8.47	-1.88	8.64	-2.43
Durham	236 577	229 340	226 068	238 309	-4.95	-1.43	5.41	-1.24
Darlington	125 191	125 987	126 260	139 312	-1.33	0.22	10.34	9.10
South Cumbria	170 723	178 395	191 192	190 135	2.45	7.17	-0.55	9.19
Yorkshire region								
Pontefract	171 466	167 346	160 819	169 144	-4.31	-3.90	5.18	-3.28
Hull	298 103	271 723	284 060	296 046	-10.63	4.54	4.22	-2.63
Scarborough	150 407	153 923	175 967	173 749	0.34	14.32	-1.26	13.26
East Yorkshire	206 351	238 886	241 938	238 766	13.50	1.28	-1.31	13.45
Trent region								
Leicestershire	903 789	936 135	913 175	895 621	1.55	-2.45	-1.92	-2.84
Nottingham	621 042	617 727	612 252	615 922	-2.48	-0.89	0.60	-2.76
South Lincolnshire	318 356	334 611	344 689	341 392	3.05	3.01	-0.96	5.14
North Lincolnshire	278 010	287 794	287 319	300 408	1.49	-0.16	4.56	5.94
East Anglian region								
Cambridge	284 692	279 239	280 122	262 592	-3.83	0.32	-6.26	-9.57
Huntingdon	142 947	172 390	147 612	142 034	18.24	-14.37	-3.78	-2.58
West Norfolk and Wisbech	193 165	208 256	220 093	214 169	5.70	5.68	-2.69	8.71
Great Yarmouth and Waveney	203 850	216 602	236 502	229 527	4.18	9.19	-2.95	10.39
North West Thames region								
Ealing	291 911	287 057	265 598	258 039	-3.59	-7.48	-2.85	-13.33
Barnet	312 944	309 658	288 469	277 418	-2.99	-6.84	-3.83	-13.09
North Hertfordshire	188 588	190 496	185 664	182 285	-0.96	-2.54	-1.82	-5.23
North Bedfordshire	256 011	270 788	250 908	249 268	3.70	-7.34	-0.65	-4.54
North East Thames region								
Haringey	194 749	180 365	164 926	165 091	-9.20	-8.56	0.10	-16.89
Hampstead	112 632	103 727	101 706	95 883	-9.71	-1.95	-5.73	-16.54
West Essex	249 102	257 266	259 380	253 863	1.26	0.82	-2.13	-0.08
North East Essex	321 227	348 120	372 658	355 262	6.25	7.05	-4.67	8.43
South East Thames region								
Bexley	221 778	215 512	204 329	192 414	-4.73	-5.19	-5.83	-14.94
Camberwell	211 727	204 135	188 324	190 855	-5.47	-7.75	1.34	-11.62
Eastbourne	246 495	269 585	332 062	304 463	7.23	23.18	-8.31	21.10
Hastings	168 963	182 605	228 789	220 620	5.96	25.29	-3.57	28.02
South West Thames region								
Wandsworth	187 676	176 362	159 427	165 155	-7.87	-9.60	3.59	-13.72
West Surrey and NE Hampshire	277 738	283 592	261 135	248 533	0.11	-7.92	-4.83	-12.27
Chichester	183 196	201 127	238 675	230 647	7.64	18.67	-3.36	23.44
Worthing	243 777	258 619	335 366	315 988	4.01	29.68	-5.78	27.09
Wessex region								
Basingstoke and NE Hampshire	225 412	242 877	223 615	210 932	5.64	-7.93	-5.67	-8.25
Winchester	214 718	221 663	217 892	211 465	1.22	-1.70	-2.95	-3.44
East Dorset	453 297	484 441	577 088	535 082	4.78	19.12	-7.28	15.73
Isle of Wight	129 409	136 212	158 900	153 473	3.20	16.66	-3.42	16.28
Oxford region								
Wycombe	271 482	251 872	254 921	238 286	-9.04	1.21	-6.53	-13.94
Oxfordshire	558 276	580 406	545 913	509 411	1.93	-5.94	-6.69	-10.54
Kettering	264 187	275 356	273 107	272 147	2.19	-0.82	-0.35	1.00
Milton Keynes	187 869	251 052	201 805	202 310	31.02	-19.62	0.25	5.58
South Western region								
Southmead	236 601	238 187	234 897	231 578	-1.30	-1.38	-1.41	-4.04
Frenchay	220 386	228 024	235 675	221 179	1.44	3.36	-6.15	-1.60
Exeter	316 608	331 264	386 689	365 167	2.58	16.73	-5.57	13.08
Torbay	248 189	278 813	330 643	312 416	10.14	18.59	-5.51	23.42
West Midlands region								
West Birmingham	209 069	196 142	181 155	198 644	-8.02	-7.64	9.65	-6.84
Solihull	203 474	207 421	207 322	193 571	-0.05	-0.05	-6.63	-6.73
North Birmingham	160 550	168 709	164 221	172 722	3.03	-2.66	5.18	5.48
Herefordshire	158 880	169 373	178 129	173 884	4.52	5.17	-2.38	7.30
Mersey region								
St Helens and Knowsley	346 061	335 110	320 187	336 914	-5.06	-4.45	5.22	-4.55
South Sefton	177 033	165 986	168 213	172 540	-8.07	1.34	2.57	-4.44
Wirral	353 733	356 362	364 613	382 792	-1.23	2.32	4.99	6.10
Southport and Formby	122 216	130 110	137 905	144 781	4.38	5.99	4.99	16.15
North Western region								
Central Manchester	116 886	105 873	101 847	107 603	-11.19	-3.80	5.65	-9.74
North Manchester	143 106	121 958	121 060	138 168	-16.44	-0.74	14.13	-5.34
Lancaster	134 119	137 207	149 141	149 141	0.30	8.70	0.00	9.03
Blackpool, Wyre, and Fylde	320 849	332 466	376 411	391 932	1.59	13.22	4.12	19.77

Overall, however, although the seaside resorts tended to lose on the mortality weighting, the loss was much less than the gains due to the age weights, so that they emerged as the major gainers.

Discussion

Disaggregating the components in the national capitation formula shows complex interactions between the three main elements, leading to much larger swings at district than at regional level. The range of these swings was -17% to 28% at district level but only -9% to 6% at regional level. Regions which included inner city and seaside resorts tended to have the widest range of gainers and losers.

The combination of relatively large gainers and losers within certain regions seems likely to pose problems with pace of adjustment in these regions. The magnitude of the changes suggests that some degree of discretion will continue to be required in the capitation funding of districts.

AGE-WEIGHTS

Since age weights accounted for the bulk of the total gains in those relatively few districts with large gains, the robustness of the estimation of these weights deserves particular attention. As the age weights imply that about 20% of total capitation funding goes to the over 85s, with over 50% of total funding to the over 65s, the importance of the elderly is clear.

Although these age weights have been routinely reported in Department of Health publications,⁶ the calculations on which they are based have received little attention.¹ Apart from problems about the degree to which they are based on the appropriate units (for example, admissions or bed days) and the quality of the data (particularly in relation to unit costs), the interface between the NHS and other services also requires attention. In particular, patterns of service use among the elderly are likely to be affected by the availability of nursing and residential home places.

POPULATION CHANGES

Furthermore, the impact of selective migration by the elderly on population health requirements in both home and host districts remains unclear. The use of the under 75 all cause standardised mortality ratio could mitigate such effects, but to an unknown degree. In general, much more remains to be known about the actual and the most appropriate patterns of service use by elderly people not only of NHS services but also of services provided by local authorities, voluntary agencies, and the private sector. The scope for discretion by regions to allow for such variations without appearing to be biased remains to be determined.

Population projections also played an important part in the total projected changes. What matters is not only the total projected population of each district but also that of each of the age groups. The highest age-cost weights apply to two relatively small groups, births and the over 85s, each of which amount to about 750 000 people nationally, or 3500 in each district. Greater imprecision inevitably surrounds projections for such relatively small groups than for the total population, an imprecision which is then magnified by the high age weights attached to these groups.

ADJUSTING FOR MORTALITY

Despite the intense debate over the use of a mortality adjustment in the capitation formula, it had much less impact than either the population projections or the age weights. The use of the square root of the

standardised mortality ratio rather than the full standardised mortality ratio has the effect of attenuating the mortality weight by around half. The case for the use of the square root of mortality, which was based on large scale analysis of hospitalisation rates by electoral wards in six regions,^{15 16} has, however, been subject to considerable criticism.¹⁷

Conclusions

The robustness of the methods used to derive projected capitation populations requires re-examination to ensure that changes of the magnitude shown here are well founded. The intensity of the debate over the adjustments for mortality and social deprivation may well reflect unease the scale of change, although it is the application of age-cost weights to projected populations that accounts for the bulk of the change in those districts projected to gain or lose the most. The worry must be that unless the age-cost weights are well founded their application could lead to much larger swings in funding than those associated with the workings of the internal market. Such large changes in funding could have irreversible effects, such as the closure of units.

More research is required on the health needs and associated costs of the elderly, particularly the over 85s, including patterns of selective migration and interfaces with other types of care such as nursing and residential homes.

Finally, since a level of uncertainly surrounds estimation of each of the elements of the capitation formula, the formula should be used only with caution and over the shorter term. Although the use of five year standardised mortality ratios and three year age weights reduce some of the uncertainty, the inevitable lack of precision in projections of relatively small age groups suggests the need for close monitoring of population changes year by year. There may well be scope for incorporating such uncertainties into the capitation formula, perhaps along the lines recently suggested for dealing with similar problems in funding local authorities.²⁰

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