

1 **TITLE:**

2 Do variations in NHS practice payments in England reflect population health needs?

3

4 **AUTHORS:**

5 Names:

6 Louis S Levene¹, Richard Baker¹, Andrew Wilson¹, Nicola Walker¹, Kambiz Boomla², John Bankart¹

7

8 Affiliations:

9 ¹Department of Health Sciences, College of Medicine, Biological Sciences and Psychology,
10 University of Leicester, Centre for Medicine, University Road, Leicester LE1 7RH, UK

11 ²Clinical Effectiveness Group, Centre for Primary Care and Public Health, Blizard Institute, Queen
12 Mary University of London, Yvonne Carter Building, 58 Turner Street, London E1 2AB, UK

13

14 Lead Author:

15 Louis S Levene

16 E-mail: ls17@le.ac.uk

17

18

19 **ABSTRACT:**

20 Background:

21 NHS general practice payments in England include pay for performance elements and a weighted
22 component designed to compensate for workload, but without specific deprivation or ethnicity
23 measures.

24

25 Aim:

26 To determine whether population factors related to health needs predicted variations in NHS
27 payments to individual general practices in England.

28

29 Design and Setting:

30 Cross-sectional study, all practices in England, financial years 2013-14 and 2014-15.

31

32 Method:

33 We undertook descriptive statistics, univariable analyses (examining correlations between payment
34 and predictors), and multivariable analyses (undertaking multivariable linear regressions for each
35 year, with logarithms of payments as the dependent variables, and with population, practice and
36 performance factors as independent variables).

37

38 Results:

39 Several population variables predicted variations in adjusted total payments, but inconsistently.
40 Higher payments were associated with increases in deprivation, elderly, African-Caribbean ethnicity
41 and asthma prevalence. Lower payments were associated with an increase in smoking prevalence.
42 Long-term health conditions, South Asian ethnicity and diabetes prevalence did not predict. The
43 adjusted R-squared values were 0.359 (2013-14) and 0.374 (2014-15). A slightly different set of
44 variables predicted variations in the payment component designed to compensate for workload. Lower
45 payments were associated with increases in elderly, deprivation, and diabetes prevalence. Smoking
46 prevalence did not predict. There was a geographical differential.

47

48 Conclusion:

49 Population factors related to health needs were, overall, poor predictors of variations in adjusted total
50 practice payments and in the payment component designed to compensate for workload. Revising the
51 weighting formula and extending weighting to other payment components might better support
52 practices to address these needs.

53

54 **KEYWORDS:**

55 Primary health care; Funding; Inequalities; Health Services Needs; Populations, Underserved; Work
56 load.

57

58

59 **HOW THIS FITS IN:**

60 Funding allocation to English general practices currently uses a formula designed to compensate for
61 workload (age being a very substantial element), but without specific measures of socio-economic
62 deprivation and ethnicity (both associated with population health needs and with adverse health
63 outcomes). Population actors related to health needs were poor predictors, overall, of variations in
64 adjusted total practice payments (and the component designed to compensate for workload); and the
65 directions of the predictive effects of these population factors, including deprivation and ethnicity,
66 were inconsistent with each other. Revising the formula's weighting and extending weighting to other
67 payment components might better help practices to address population health needs and reduce health
68 inequalities.

69

70 **MAIN TEXT:**

71

72 **Introduction**

73 General practice's share of total National Health Service (NHS) expenditure was 8% (£8.8bn) in
74 2013-14¹, steadily declining from 14% in 2005-06 and 10.5% in 2010-11. However, in 2010-14, total
75 NHS spending increased by 4.4%¹⁻³ and UK primary care consultation rates increased by 10.5%⁴.

76 From the total NHS expenditure allocated to general practice, payments are made to each practice. In
77 England, General Medical Services (GMS) practices have a standard, nationally negotiated contract,
78 with some local flexibility to opt in or out of providing certain services. Since 2004 the GMS
79 contract⁵ has included a Global Sum Allocation Formula (also known as Carr-Hill), which aims to
80 ensure funding reflects practices' workloads and to reimburse the 'unavoidable costs of delivering...
81 care to the local population'⁶. Weighting includes adjustments for age and sex structure, morbidity
82 and mortality measures, and list turnover. Ethnicity and deprivation measures are not included, as
83 reliable data on the workload implications were not available in 2004, although previous contracts
84 included area-based weighting for workload associated with deprivation, as well as age and sex⁷⁻⁸. To
85 protect practices from income loss due to the contract, a 'Minimum Practice Income Guarantee'
86 (MPIG) was included.

87 The 2004 contract also included a substantial pay for performance element. The Quality and
88 Outcomes Framework (QOF) rewards practices for the provision of 'quality care'⁵. Although
89 participation is voluntary, most practices take part in QOF. Practices can also opt in to provide a range
90 of Enhanced Services (ES), intended to reduce the burden on secondary care. ES include Directed
91 (nationally determined) and Local (commissioned locally and which vary between areas) services⁹.
92 Both QOF and ES have been updated regularly since 2004.

93 The Personal Medical Services (PMS) contract was introduced in 1998 as a local alternative to the
94 GMS contract. PMS contracts are voluntary, locally negotiated contracts between practices and
95 primary care administrative organisations, allowing flexible service provision in accordance with
96 specific local circumstances¹⁰. The Alternative Provider Medical Services (APMS) contract is a more
97 flexible contract, open to a wider range of providers including the independent sector¹¹. Neither PMS
98 nor APMS practices receive the GMS global sum.

99 Health needs are objectively determined deficiencies in health that require healthcare, from promotion
100 to palliation¹². These needs are linked to adverse health outcomes, strongly predicted by socio-
101 economic deprivation¹³, which is associated with earlier and greater multimorbidity¹⁴, including an up
102 to 18-year gap in disability-free life expectancy between most and least deprived populations¹⁵. Health
103 inequalities persist, despite absolute and relative decreases in all-cause mortality in lower socio-
104 economic groups between 1990 and 2010¹⁶. Adverse health outcomes are more likely in non-White
105 British ethnic groups, with increasing deprivation and age as important determinants, but patterns vary
106 between health conditions and by gender within individual ethnic groups¹⁷.

107 NHS primary care is currently under mounting professional and financial pressures. In April 2016
108 NHS England announced a five-year plan to increase investment in general practice¹⁸. If practices are
109 to help in reducing health inequalities, then allocation of new and existing funding should take
110 account of population needs.

111 Our main research question was: were variations in total NHS payments to English general practices
112 in 2013-2015 predicted by factors related to populations' health needs? Additionally, we compared
113 predictions, by these factors, of variations in total payments with variations in GMS global sum
114 payments, the component designed to compensate for workload. The study was exploratory, because
115 many variables were examined and, thus, multiple hypotheses were tested.

116

117

118

119 **Methods**

120

121 Overview

122 We undertook a cross-sectional study across all practices in England, repeated for two consecutive
123 financial years, 2013-14 & 2014-15.

124

125 Dependent variables

126 The main dependent variable in each year was the adjusted total payment per patient, calculated from
127 the sum of all payments due to a practice for providing NHS services (using data from the Health and
128 Social Care Information Centre [HSCIC]) payments system), then subtracting pensions, levies,
129 prescription charge income, and premises payments; finally, dividing this remainder by the number of
130 registered patients.¹⁹⁻²⁰

131 The additional analyses were limited to practices with a GMS contract, as only these practices were
132 paid the global sum. The dependent variable was the global sum (plus MPIG) per registered patient.
133 We also compared prediction of variations in adjusted total payments per patient in GMS practices
134 with all practices.

135

136 Independent variables

137 Variable selection was determined by data availability and relevance to the research questions, using a
138 model where population factors strongly predict health outcomes²¹. Variables' data sources are given
139 in Table 1. The population variables covered:

- 140 • Socio-economic factors: deprivation, using the English Index of Multiple Deprivation (IMD)²²;
141 unemployed²³; on long term sick or claiming disability²³; self-reported confidence in managing
142 health²³.
- 143 • Demographic factors: aged 75 years or more²²; ethnicity (African-Caribbean; South Asian)²³,
- 144 • Lifestyle factor: smokers²³,
- 145 • Morbidity factors: self-reported with long-standing health condition²³; and prevalences from QOF
146 registers of diabetes, heart failure, asthma, and chronic obstructive pulmonary disease (COPD)²⁴⁻
147 ²⁵.

148 In order to explain as much as possible of the variation in payments, two further groups of variables,
149 comprising practice^{19-20, 26} and performance factors²³⁻²⁴, were added. Descriptions and data sources for
150 these variables are given in Table 1. QOF hypertension registers were used as performance variables
151 because hypertension is under-detected. QOF register prevalence was 13.7% in 2013-14²⁴ compared
152 to a Health Survey for England estimated prevalence of 28.6% in 2013²⁷; thus, these registers measure
153 performance in detection more than true prevalence. Two of the practice factors were nominal
154 variables: contract type and geographical sub-region¹⁹⁻²⁰. The remaining variables were treated as
155 continuous in the statistical models.

Descriptive statistics, univariable analyses (examining correlations between payment and each predictor, and between IMD scores and payments), and multivariable analyses (undertaking a multivariable linear regression for each year) were performed. Performance factors were excluded when the dependent variable was the global sum, as this is not based on performance. The assumptions of linearity, normality of residuals and homogeneity of variance were checked. Multicollinearity was checked, and variables with a 1/Variance Inflation Factor [i.e. tolerance] value of less than 0.2 from the final model were omitted.

STATA 14 statistical software was used²⁸.

Results

Descriptive statistics

Payment data were published in England for 8,060 practices in 2013-14 and 7,959 practices in 2014-15. A small number received implausibly large or small (including negative) payments per patient, and were treated as erroneous and omitted. On this basis, practices with fewer than 500 patients and practices with total adjusted payments per patient of less than £10 or more than £500 in either year were excluded, leaving 7,693 practices for analysis in the two years. Further practices were excluded due to missing data, with numbers per analysis provided in the tables.

The distribution of adjusted total payments per patient was slightly positively skewed in both years. Although these payments increased between 2013-14 and 2014-15, the percentage paid for the performance-related components declined from 21.9% to 18.1%: the QOF-derived percentage declined from 12.9% to 9.0%, whereas the ES-derived percentage increased from 8.1% to 10.0%. The numbers of practices with GMS, PMS or APMS contracts were 4,440, 3,126, and 221, respectively. The number of practices in the North, Midlands and South of England were 2,337, 2,299, and 3,151, respectively.

Table 1 summarises the descriptive statistics for all the variables.

Univariable analyses

The Spearman correlation coefficient between payments in the two years was strong (ρ 0.86, $p < 0.01$). The correlations between total payments and the independent variables were mostly small, but significant due to the large sample size.

IMD scores and total or QOF payments were not correlated. The Spearman correlation coefficients were negative between IMD scores and ES payments, and positive between IMD scores and global sum payments (all $p < 0.01$). However, when all practices were divided into deciles by IMD scores, the trends in the median values of total, global sum, and ES payments showed most change across the two most deprived deciles (Figure 1).

Multivariable analyses

Natural logarithm transformations were undertaken, as the dependent variables' values were positively skewed. This transformation generally improved normality. For adjusted total payments in all practices, the adjusted R-squared values were 0.359 (2013-14) and 0.374 (2014-15); explaining only just over one third of payment variations, despite a wide range of plausibly relevant variables being modelled.

Table 2 shows the variables predicting variations in adjusted total payments. Higher payments were associated with increases in deprivation (socio-economic), elderly, African-Caribbean ethnicity (demographic) and asthma prevalence (morbidity). However, lower payments were associated with increases in smokers (lifestyle) and having a long-term health condition (morbidity). Some population

variables were not significant either at all or across both years. These included South Asian ethnicity and the prevalences of diabetes, heart failure and COPD. We excluded QOF coronary heart disease (CHD) and stroke (CVA) prevalences from the final model, as these variables had high collinearity.

Higher payments were associated with increases in three practice variables: GP numbers per patient, non-clinical staff numbers per patient, and numbers of registered patients. There was a geographical effect: in 2014-15, practices in the North were paid 5.8% (8.7% in 2013-14) and 1.9% (4.0% in 2013-14) less than practices in the Midlands and in the South, respectively. Higher payments were also associated with increases in two performance variables, hypertension detection and good appointment experience.

Less of the variations in global sum payments were accounted for (Table 3). Higher payments were associated with increases in both African-Caribbean and South Asian ethnicity, and numbers of GPs per patient, and non-clinical staff per patient. Lower payments were associated with increases in elderly, deprivation, diabetes prevalence, and numbers of registered patients. Smoking prevalence was not significant.

Of variations in adjusted total payments, slightly more were accounted for in GMS practices than in all practices, but not with all the same variables (Table 4). Higher payments were associated with increases in hypertension detection, continuity and good appointment 'experience'. Lower payments were associated with an increase in smokers. Age, deprivation, both ethnicity variables, and diabetes prevalence were either not significant at all or only in one year.

Table 5 shows the independent effects of changes to individual significant variables on income in a hypothetical practice of 7,000 patients.

Residuals from all models were approximately normally distributed, and plots of the residuals versus predicted values showed no pattern.

Discussion

Summary

Ideally, funding allocation should help practices to respond better to their entire populations' health needs. However, our multivariable analyses found that population factors related to health needs were poor predictors, overall, of variations in both total payments, including English practices with all types of contract, and global sum payments, designed to compensate for workload in GMS practices only.

Although deprivation was a predictor in most of the analyses, some other population variables were either not significant or were associated with lower payments when the value of the variable increased. These suggest only a weak association between population factors and funding. Less of the variations in global sum payments than in total payments were accounted for, with different significant variables and with increases in some variables (including deprivation) associated with lower payments. Age-sex structure is a substantial element in Carr-Hill, but an increase in elderly was associated with lower global sum payments. A geographical differential was also found. Some effect sizes were small, but combinations of several changes could substantially alter funding when applied to average-sized practices.

Deprivation and ethnicity may be correlated with elements in Carr-Hill. However, univariable analyses examining deprivation deciles suggest that the weighting helped practices mainly in very deprived areas. Practices serving moderately deprived largely South Asian populations would receive equivalent total and global sum payments to those serving affluent white populations. Practices in more deprived areas may be less able or willing to undertake ES, and not generate additional income by delivering more services.

Practices' workloads, strongly driven by demand, are focused mainly on known morbidity and not necessarily on whole populations' health needs. If weighting of payments aimed primarily at compensating for workload does not include measures related to population health needs, then practices serving populations with greater needs may not receive sufficient funding to tackle these needs and potentially reduce health inequalities.

Strengths and limitations

This study covered a whole nation, using recent time-matched variables in a model that focused on a specific research question. Comparison of covariates between excluded (due to erroneous or missing data) and included practices showed no major differences.

Only one third of the variation in total payments was accounted for, despite a wide range of predictors. Factors explaining the remaining two-thirds' variation were not identified or measured, due to unknown or unmeasured factors, to the formula's complexity, or to both.

Since validated measures of multimorbidity were unavailable, we used single disease morbidity registers, which had limited predictive effect. Adding a multimorbidity variable might weaken the predictive effect of deprivation due to intercorrelation, because deprivation is associated with

multimorbidity²⁹. Unmet health needs include deficiencies in identifying morbidity, in accessing healthcare and in delivering effective interventions. The lack of multimorbidity measures in populations and in practices limited us finding associations between funding variations and unmet needs, but our analyses included access and treatment effectiveness measures.

The GP Patient Survey has low response rates. However, its methodology has been modified, with ‘proportionately stratified, unclustered samples drawn from each practice’³⁰ and data weighted to account for unequal probability of selection, differences between responders and non-responders, and the demographic characteristics of the eligible population.

Comparison with existing literature

Higher payments are associated with several indicators of better quality general practice: lower secondary care usage, higher patient satisfaction³¹, better Care Quality Commission practice ratings³², and our finding of increased numbers of GPs per patient (associated with lower mortality²¹) and of non-clinical staff per patient. In 2004-14, the gap in GP numbers per patient narrowed between areas with high and low deprivation, using Lower-layer Super Output Areas (LSOA) as the population unit³³; our study was cross-sectional and used practices, a larger population unit not always configured geographically.

Deprivation increases workload: consultation rates of patients aged 50 in the most deprived quintile equaled those aged 70 in the least deprived quintile. If weighting the age-sex workload in Carr-Hill included consultation rates by deprivation decile, it could deliver one third more global sum funding to Tower Hamlets, a deprived borough³⁴.

In Scotland there are associations between deprivation and multimorbidity, between deprivation and consultation rates, but not between deprivation and practice funding²⁹. The differences in total payment per patient between the first and third most deprived deciles were similar to our findings, despite differences between definitions (and their using means) of total payments and in how Scottish IMD is calculated²⁹.

Implications for research and/or practice

Better measures of population health needs are required. Our findings are important for discussions about allocating additional primary care investment. If public health policies involving primary care are to better address local health needs and succeed in reducing health inequalities, then the following should be considered:

1. Ensure better alignment of Carr-Hill’s weighting to population health needs, by including (e.g.) suitable measures of deprivation, population multimorbidity, and ethnicity.

2. Extend weighting to other payment components, e.g. QOF.

The effects of such changes on health inequalities will need monitoring.

303
304 **ADDITIONAL INFORMATION**
305

306 **Funding:**

307 This work had no dedicated funding. No funding organisations had a role in the design and conduct of
308 the study, in the collection, analysis, and interpretation of the data, or in the preparation, review, or
309 approval of the manuscript.

310
311 **Provenance:**

312 Freely submitted; externally peer reviewed.

313
314 **Ethical approval:**

315 Ethical approval was not required, as the study used only published data with no individuals or
316 practices identified.

317
318 **Conflict of interest statements:**

319 None

320
321 **Acknowledgements:**

322 None

323
324 **Word count:**

325 Abstract- 248

326 Main text- 2,496

REFERENCES

- ¹ Health and Social Care Information Centre. *Investment in general practice 2009/10 to 2013/14 England, Wales, Northern Ireland and Scotland*. Published 19 September 2014. Available from: www.hscic.gov.uk/catalogue/PUB14900/inve-gene-prac-eng-wal-ni-scot-09-14-rep.pdf [Accessed 13th April 2016]
- ² Health and Social Care Information Centre. *Investment in general practice 2003-04 to 2009-10 England, Wales, Northern Ireland and Scotland*. Published September 2010. Available from: www.hscic.gov.uk/catalogue/PUB01378/inve-gene-prac-eng-wal-ni-scot-03-10-rep.pdf [Accessed 13th April 2016]
- ³ Health and Social Care Information Centre. *Investment in general practice 2008/09 to 2012/13 England, Wales, Northern Ireland and Scotland*. Published 25 September 2013. Available from: www.hscic.gov.uk/catalogue/PUB11679/inve-gene-prac-eng-wal-ni-scot-08-13.pdf [Accessed 13th April 2016]
- ⁴ Hobbs FDR, Bankhead C, Mukhtar T, et al, on behalf of the National Institute for Health Research School for Primary Care Research. Clinical workload in UK primary care: a retrospective analysis of 100 million consultations in England, 2007–14. *Lancet* 2016. [http://dx.doi.org/10.1016/S0140-6736\(16\)00620-6](http://dx.doi.org/10.1016/S0140-6736(16)00620-6) [Accessed 16th April 2016]
- ⁵ NHS Employers. *GMS contract changes 2003/04*. Available from: <http://www.nhsemployers.org/your-workforce/primary-care-contacts/general-medical-services/gms-contract-changes/contract-changes-2003-04> [Accessed 30th March 2016]
- ⁶ Health & Social Care Information Centre. *Appendix A: Global Sum Calculation Process*. Available from: <http://systems.hscic.gov.uk/ssd/downloads/newgpcontractpay/ngms-content/appaglobalsum> [Accessed 6th November 2015]
- ⁷ Jarman B. Identification of underprivileged areas. *Br Med J*. 1984; 286: 1705-9.
- ⁸ Jarman B. Underprivileged areas: validation and distribution of scores. *Br Med J*. 1984; 289: 1587-92.
- ⁹ Department of Health. *Enhanced Services (archived)*. Available from: <http://webarchive.nationalarchives.gov.uk/+/www.dh.gov.uk/en/Healthcare/Primarycare/PMC/Enhanced/index.htm> [Accessed 10th April 2016]
- ¹⁰ NHS Employers. Personal Medical Services. Personal Medical Services contracts. Available from: <http://www.nhsemployers.org/your-workforce/primary-care-contacts/general-medical-services/personal-medical-services-contracts> [Accessed 20th April 2016]
- ¹¹ NHS England. Standard Alternative Provider Medical Services Contract 2014/15. Published June 2014. Available: <https://www.england.nhs.uk/wp-content/uploads/2014/06/apms-standard-contract-june14.pdf> [Accessed 20th April 2016]
- ¹² World Health Organization. Health Systems Strengthening Glossary. Available: http://www.who.int/healthsystems/hss_glossary/en/index5.html [Accessed 9th August 2016].

365 ¹³ Marmot M. *The Health Gap: The Challenge of an Unequal World*. London: Bloomsbury, 2015.
 366 ISBN: HB: 978-1-4088-5799-1.

367 ¹⁴ Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity
 368 and implications for health care, research, and medical education: a cross-sectional study. *Lancet*
 369 2012. Doi:10.1016/S0140-6736(12)60240-2 [Accessed 13th April 2016]

370 ¹⁵ Marmot M, Bell R. Fair society, healthy lives. *Public Health*. 2012;126(suppl 1):S4-10.

371 ¹⁶ Mackenbach JP, Kulhánová I, Artnik B, et al. Changes in mortality inequalities over two decades:
 372 register based study of European countries. *Br Med J* 2016;353:i1732.
 373 <http://dx.doi.org/10.1136/bmj.i1732> [Accessed 16th April 2016]

374 ¹⁷ Bécares L. Dynamics of diversity: evidence from the 2011 census. Which ethnic groups have the
 375 poorest health? Ethnic health inequalities 1991 to 2011. Centre on Dynamics of Ethnicity, University
 376 of Manchester. October 2013. Available:
 377 [http://www.ethnicity.ac.uk/medialibrary/briefingsupdated/which-ethnic-groups-have-the-poorest-](http://www.ethnicity.ac.uk/medialibrary/briefingsupdated/which-ethnic-groups-have-the-poorest-health.pdf)
 378 [health.pdf](http://www.ethnicity.ac.uk/medialibrary/briefingsupdated/which-ethnic-groups-have-the-poorest-health.pdf) [Accessed 5th August 2016]

379 ¹⁸ NHS England. General Practice Forward View. Published April 2016. Available:
 380 <https://www.england.nhs.uk/wp-content/uploads/2016/04/gpfv.pdf> [Accessed 5th August 2016]

381 ¹⁹ Health and Social Care Information Centre. *NHS Payments to General Practice, England, 2013-14:*
 382 *Experimental Statistics*. Publication date: 12th February 2015. Available from:
 383 [http://www.hscic.gov.uk/article/2021/Website-](http://www.hscic.gov.uk/article/2021/Website-Search?productid=17301&q=practice+payment&sort=Relevance&size=10&page=1&area=both#top)
 384 [Search?productid=17301&q=practice+payment&sort=Relevance&size=10&page=1&area=both#top](http://www.hscic.gov.uk/article/2021/Website-Search?productid=17301&q=practice+payment&sort=Relevance&size=10&page=1&area=both#top)
 385 [Accessed 30th March 2016]

386 ²⁰ Health and Social Care Information Centre. *NHS Payments to General Practice, England, 2014-15*.
 387 Publication date: 17 September 2015. Available from: [http://www.hscic.gov.uk/article/2021/Website-](http://www.hscic.gov.uk/article/2021/Website-Search?productid=18806&q=practice+payment&sort=Relevance&size=10&page=1&area=both#top)
 388 [Search?productid=18806&q=practice+payment&sort=Relevance&size=10&page=1&area=both#top](http://www.hscic.gov.uk/article/2021/Website-Search?productid=18806&q=practice+payment&sort=Relevance&size=10&page=1&area=both#top)
 389 [Accessed 30th March 2016]

390 ²¹ Baker R, Honeyford K, Levene LS, et al. Population characteristics, mechanisms of primary care
 391 and premature mortality in England: a cross-sectional study. *Br Med J Open*. 2016; 6: e009981.
 392 Doi:10.1136/bmjopen-2015-009981 [Accessed 13th April 2016]

393 ²² Public Health England. *National General Practice Profiles*. Available from:
 394 <http://fingertips.phe.org.uk/profile/general-practice/data> [Accessed 30th March 2016]

395 ²³ GP Patient Survey. *Survey results and other information*. Available from: [https://gp-](https://gp-patient.co.uk/surveys-and-reports#july-2015)
 396 [patient.co.uk/surveys-and-reports#july-2015](https://gp-patient.co.uk/surveys-and-reports#july-2015) [Accessed 30th March 2016]

397 ²⁴ Health and Social Care Information Centre. *Quality and Outcomes Framework (QOF) – 2013-14*.
 398 Published 28 October 2014. Available from: <http://www.hscic.gov.uk/catalogue/PUB15751>
 399 [Accessed 30th March 2016]

400 ²⁵ Health and Social Care Information Centre. *Quality and Outcomes Framework (QOF) – 2014-15*.
 401 Published 29th October 2015. Available from:

402 <http://www.hscic.gov.uk/searchcatalogue?productid=19196&topics=0%2fPrimary+care+services&sort=Relevance&size=10&page=1#top> [Accessed 30th March 2016]

403

404 ²⁶ Health and Social Care Information Centre. *NHS Workforce Statistics – December 2014*,
 405 *Provisional statistics*. Publication date: 25 March 2015. Available from:
 406 <http://www.hscic.gov.uk/catalogue/PUB16922> [Accessed 27th January 2016]

407 ²⁷ Health and Social Care Information Centre. *Health Survey for England- 2013, Trend Tables [NS]*.
 408 Published 10 December 2014. Available from: <http://www.hscic.gov.uk/catalogue/PUB16077>
 409 [Accessed 8th April 2016]

410 ²⁸ Stata Data Analysis and Statistical Software. Available from: <http://www.stata.com/products/>
 411 [Accessed 30th March 2016]

412 ²⁹ McLean G, Guthrie B, Mercer SW, Watt GCM. General practice funding underpins the persistence
 413 of the inverse care law: cross-sectional study in Scotland. *Br J Gen Pract* 2015; 65 (641): e799 –e805.
 414 DOI: 10.3399/bjgp15X687829 [Accessed 7 June 2016]

415 ³⁰ Ipsos MORI Social Research Institute. *GP Patient Survey – National summary report*. Published 7
 416 January 2016. Available from: [http://gp-survey-
 417 production.s3.amazonaws.com/archive/2016/January/January+2016+National+Summary+Report.pdf](http://gp-survey-production.s3.amazonaws.com/archive/2016/January/January+2016+National+Summary+Report.pdf)
 418 [Accessed 1st April 2016]

419 ³¹ Esperance VL, Parkin D, Durbaba S, Ashworth MA. A cross-sectional study exploring the
 420 relationship between GP practice funding and practice achievement. Abstract presented at the Society
 421 for Academic Primary Care (SAPC) 45th annual scientific meeting, Dublin 2016. Available from:
 422 [https://sapc.ac.uk/conference/2016/abstract/cross-sectional-study-exploring-relationship-between-gp-
 423 practice-funding](https://sapc.ac.uk/conference/2016/abstract/cross-sectional-study-exploring-relationship-between-gp-practice-funding) [Accessed 8th June 2016]

424 ³² Torjesen I. News: GP practices rated “outstanding” are better funded, BMA research finds. *Br Med*
 425 *J* 2016;353:i2769. Doi: <http://dx.doi.org/10.1136/bmj.i2769> [Accessed 7th June 2016]

426 ³³ Asaria M, Cookson R, Fleetcroft R, Ali S. Unequal socioeconomic distribution of the primary care
 427 workforce: whole-population small area longitudinal study. *Br Med J Open*. 2016;6:e008783
 428 doi:10.1136/bmjopen-2015-008783 [Accessed 13th April 2016]

429 ³⁴ Boomla K, Hull S, Robson J. GP funding formula masks major inequalities for practices in deprived
 430 areas (letter). *Br Med J*. 2014;349:g7648

431

432

433 **TABLES**

434 **Table 1** Descriptive statistics of dependent and independent variables used in analyses.

435 In each cell, values in the first line are for 2013-2014 and in the second line for 2014-2015.

436 For the continuous variables, if the distribution was skewed (not normal) on visual inspection of the histogram, then the median and interquartile range are
437 presented instead of the mean and standard deviation.

Variable	Data source	Number of practices with data	Mean	Standard deviation	Median	Interquartile range
Dependent						
Adjusted total payments per patient (all contracts) (Datasheet included practices with payments for both years)	HSCIC ¹⁷⁻¹⁸	7,693			£102.64 £105.79	£92.27, £118.05 £96.35, £121.38
Global sum plus MPIG payments per patient (GMS contracts)	HSCIC ¹⁷⁻¹⁸	4,451 4,451			£67.53 £74.67	£63.77, £72.02 £70.48, £79.48
Adjusted total payments per patient (GMS contracts only)	HSCIC ¹⁷⁻¹⁸	4,451 4,451			£98.14 £102.61	£89.25, £113.59 £93.69, £116.01
Population						
IMD 2010 score (used for 2013-14) ^a IMD 2015 score (used for 2014-15) ^a	Public Health England ²⁰ . Individual practices' scores were calculated by the Office for National Statistics (ONS), using patients' postcodes.	7,575 7,584			21.64 21.74	13.60, 31.83 13.88, 31.51
Percentage of practice register aged 75 years or more	Public Health England ²⁰	7,585 7,584	7.61 7.66	3.12 3.17		
Percentage with African-Caribbean ethnicity	General Practice Patient Survey reports (weighted) for both years ²¹	7,513 7,430			0.86 0.84	0.00, 3.85 0.00, 3.99
Percentage with South Asian ethnicity	General Practice Patient Survey ²¹	7,485 7,513			2.20 1.39	0.00, 7.80 0.00, 5.58
Percentage of smokers	General Practice Patient Survey ²¹	7,678	17.79	6.84		

		7,668	17.01	6.87		
Percentage with self-reported long term condition	General Practice Patient Survey ²¹	7,689 7,684	53.96 54.01	7.77 8.00		
Percentage self-reported confident about managing own health	General Practice Patient Survey ²¹	7,689 7,684			92.91 93.02	89.85, 95.21 89.81, 95.39
Percentage self-reported unemployed	General Practice Patient Survey ²¹	7,675 7,667			4.9 4.3	2.28, 8.95 1.86, 8.01
Percentage self-reported on long term sick or disability register	General Practice Patient Survey ²¹	7,639 7,628			4.02 3.88	2.22, 6.47 2.12, 6.37
Percentage on practice diabetes register	HSCIC –QOF annual reports ²²⁻²³	7,573 7,586	6.47 6.65	1.85 1.91		
Percentage on practice CHD register ^b	HSCIC –QOF annual reports ²²⁻²³	7,573 7,585	3.32 3.27	1.14 1.13		
Percentage on practice CVA register ^b	HSCIC –QOF annual reports ²²⁻²³	7,573 7,585	1.69 1.70	0.64 0.65		
Percentage on practice heart failure register	HSCIC –QOF annual reports ²²⁻²³	7,573 7,581			0.68 0.69	0.49, 0.89 0.50, 0.90
Percentage on practice asthma register	HSCIC –QOF annual reports ²²⁻²³	7,573 7,587	5.89 5.95	1.29 1.32		
Percentage on practice COPD register	HSCIC –QOF annual reports ²²⁻²³	7,573 7,581			1.72 1.75	1.20, 2.33 1.23, 2.39
Practice						
Number of registered patients	HSCIC ¹⁷⁻¹⁸	7,693 7,693			6,342 6,441	3,819, 9,687 3,891, 9,776
Whole time equivalent GPs per 10,000 patients – 2014 only (calculated by dividing whole time equivalent number in practices by number of registered patients, then multiplying by 10,000)	NHS workforce statistics ²⁴	7,649			5.99	4.73, 7.43
Whole time equivalent nurses per 10,000 patients – 2014 only (calculated as above)	NHS workforce statistics ²⁴	7,125			2.42	1.78, 3.17
Whole time equivalent staff per 10,000 patients – 2014 only (calculated as above)	NHS workforce statistics ²⁴	7,125			15.24	12.80, 18.15
Contract type – GMS ^c	HSCIC ¹⁷⁻¹⁸	4,405				
Contract type – PMS ^c	HSCIC ¹⁷⁻¹⁸	3,085				
Contract type – APMS ^c	HSCIC ¹⁷⁻¹⁸	203				

Geographical sub region – North ^{cd}	HSCIC ¹⁷⁻¹⁸	2,310				
Geographical sub region – Midlands ^{cd}	HSCIC ¹⁷⁻¹⁸	2,254				
Geographical sub region – South ^{cd}	HSCIC ¹⁷⁻¹⁸	3,129				
Performance						
Total QOF points achieved ^e 900 points maximum in 2013-14 559 points maximum in 2014-15	HSCIC -QOF annual reports ²²⁻²³	7,573 7,586			866.67 542.83	828.28, 887.15 523.41, 553.44
Percentage on practice hypertension register	HSCIC -QOF annual reports ²²⁻²³	7,573 7,587	13.96 14.02	3.58 3.59		
Percentage of hypertension register with last blood pressure reading ≤150/90 mmHg	HSCIC -QOF annual reports ²²⁻²³	7,676 7,587			80.50 81.06	75.68, 84.28 77.35, 84.37
Percentage of diabetes register with last HbA1c ≤7.5% (59mmol/mol)	HSCIC -QOF annual reports ²²⁻²³	7,676 7,586			61.84 70.41	56.72, 66.45 63.64, 76.41
Percentage unable to obtain appointment	General Practice Patient Survey ²¹	7,683 7,672			9.53 9.53	5.7, 14.11 5.66, 14.70
Percentage able to see a GP or nurse within 48 hours	General Practice Patient Survey ²¹	7,583 7,584	51.01 48.68	14.95 14.93		
Percentage having a preferred GP	General Practice Patient Survey ²¹	7,688 7,683	53.32 50.47	12.89 13.16		
Percentage reporting good appointment 'experience'	General Practice Patient Survey ²¹	7,583 7,584	76.33 75.01	12.83 13.47		

438

439 ^a Index of Multiple Deprivation (IMD) is the official measure of relative deprivation for small areas. IMD ranks each small area (called Lower-layer Super Output Areas
440 [LSOA] of which there are 32,844 with an average of 1,500 residents each) in England. IMD combines information from seven domains: income deprivation, employment
441 deprivation, education, skills and training deprivation, health deprivation and disability, crime, barriers to housing and services, and living environment deprivation. ^b Dropped
442 from the final model

443 ^c As these variables are nominal, only numbers of practices are provided.

444 ^d There are 13 geographical sub regions in England, which were collapsed into three larger regional identities: North, Midlands and South. North included four sub-regions:
445 Cheshire and Merseyside, Cumbria and North East, Lancashire and Greater Manchester, and Yorkshire and Humber. Midlands included four sub-regions: Central Midlands,
446 East Midlands, West Midlands and North Midlands. South included five sub-regions: London, Wessex, South Central, South East and South West.

447 ^e As part of the 2014-15 GMS contract changes, a total of 40 QOF indicators were retired, 'releasing' 341 points. The resource from these points was transferred to the Global
448 sum and to ES, including a new ES aimed at avoiding unplanned admissions and delivering proactive case management for vulnerable people.

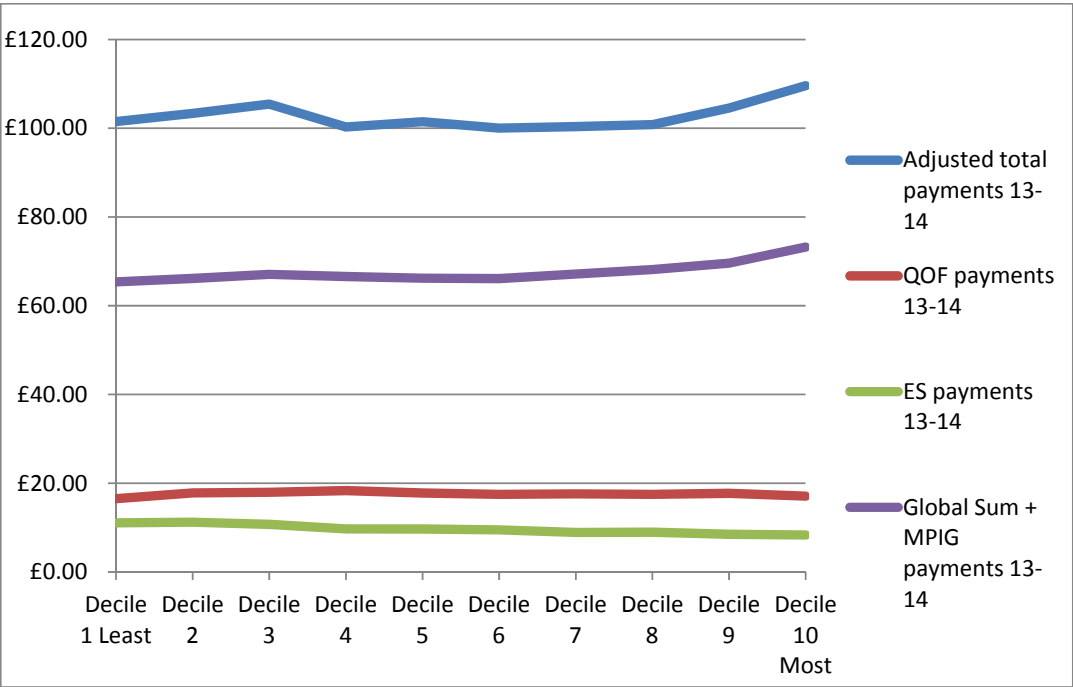
449 .

450

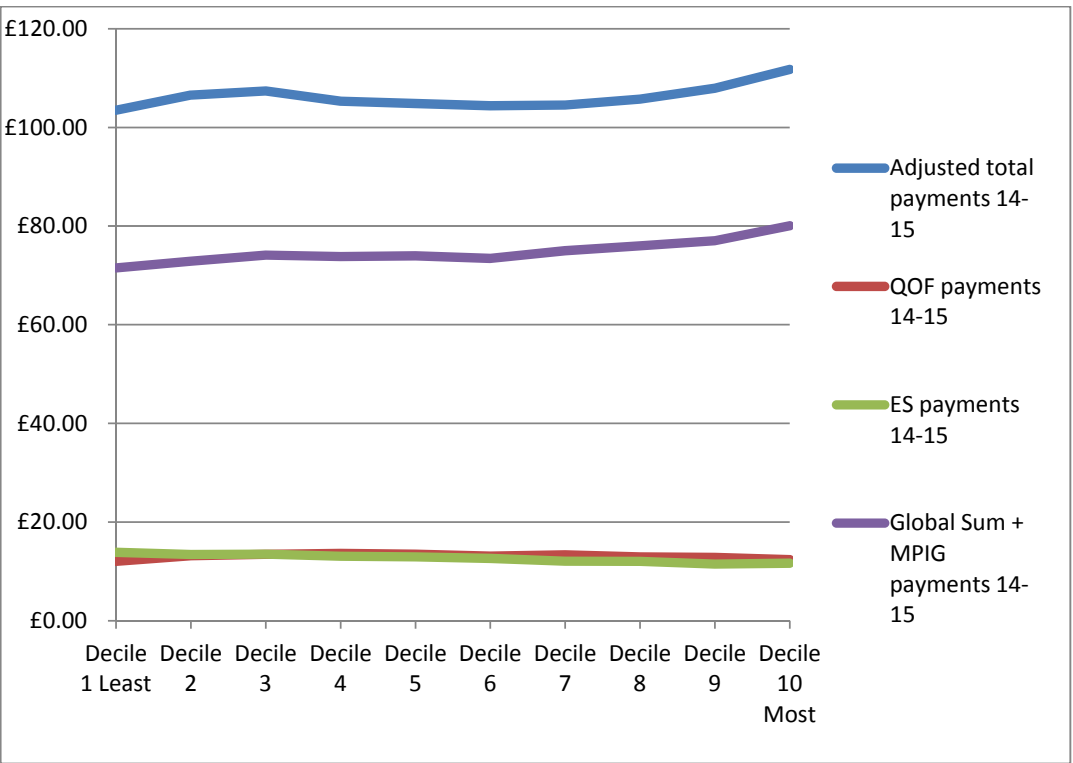
451

Figure 1 Univariable analyses: median payments by ascending IMD decile, and correlation coefficients between IMD and payments

2013-14



2014-15



458

459 **Spearman correlation coefficients (p value) between payments and IMD score**

460

Financial year	Adjusted total payments	QOF payments	ES payments	Global sum + MPIG payments^b
2013-14	0.0003 (0.98)	0.0006 (0.96)	-0.15 (<0.01)	0.27 (<0.01)
2014-15	0.023 (0.045)	0.0066 (0.57)	-0.18 (<0.01)	0.30 (<0.01)

461

462 ^b GMS practices only

463

464 **Table 2** Linear regression results for 2013-2014 and 2014-2015

465 Dependent variable: logarithm of adjusted total payments per registered patient

466 Contract type: all

467 Adjusted R-squared values: 2013-14 = 0.359 (6,209 practices); 2014-15 = 0.374 (6,282 practices)

468 Mean Variance Inflation Factor (VIF): 2.90 in 2013-14; 2.88 in 2014-15

469 **Significant values in bold type** (the 95% confidence interval does not cross zero)

Predictor	2013-2014 Beta coefficient (95% confidence interval)	2014-2015 Beta coefficient (95% confidence interval)
Population		
Percentage of list aged 75 years or more	.0035 (.00021, .0067)	.0064 (.0031, .0095)
IMD score	.00098 (.00068, .0019)	.00099 (.00012, .0019)
Percentage with Afro-Caribbean ethnicity	.16 (.051, .28)	.16 (.059, .27)
Percentage with South Asian ethnicity	-.25 (-.10, .054)	.028 (-.048, .10)
Percentage of smokers	-.36 (-.47, -.26)	-.21 (-.31, -.12)
Percentage with self-reported long term condition	-.15 (-.25, -.062)	-.11 (-.19, -.022)
Percentage of self-reported on long term sick or disability register	-.21 (-.44, .0088)	-.30 (-.50, -.10)
Percentage of self-reported confident about managing own health	-.050 (-.23, .13)	.048 (-.11, .21)
Percentage of self-reported unemployed	-.028 (-.18, .13)	-.088 (-.24, .060)
Percentage on practice diabetes register	-.0022 (-.0079, .0034)	-.0069 (-.012, -.0019)
Percentage on practice heart failure register	.010 (-.012, .032)	-.016 (-.036, .0037)
Percentage on practice asthma register	.0073 (.0021, .012)	.0054 (-.000063, .010)
Percentage on practice COPD register	-.011 (-.021, .00015)	-.0072 (-.017, .0028)
Practice		
Number of registered patients	-2.43e-06 (-3.90e-06, -9.54e-07)	-2.67e-06 (-4.01e-06, -1.32e-06)
Contract type: GMS with APMS as reference	-.14 (-.17, -.10)	-.18 (-.21, -.14)
Contract type: PMS with APMS as reference	-.089 (-.13, -.052)	-.14 (-.17, -.11)
Geographical region: Midlands with North as reference	.087 (.072, .10)	.056 (.042, .07)
Geographical region: South with North as reference	.040 (.025, .056)	.015 (.0056, .029)

Whole time equivalent GPs per 10,000 patients	.016 (.014, .019)	.015 (.013, .017)
Whole time equivalent nurses per 10,000 patients	-.0011 (-.0042, .0065)	-.0013 (-.0063, .0038)
Whole time equivalent staff per 10,000 patients	.024 (.023, .026)	.024 (.023, .026)
Performance		
Total QOF points achieved	.00019 (.000075, .00030)	.00015 (-.000049, .00034)
Percentage on practice hypertension register	.0061 (.0031, .0092)	.0077 (.0048, .011)
Percentage of the hypertension register with the last blood pressure reading $\leq 150/90$ mmHg	-.00095 (-.0020, .00014)	.00073 (-.00033, .0018)
Percentage of the diabetes register with the last HbA1c $\leq 7.5\%$ (59mmol/mol)	.00031 (-.00050, .0011)	.00024 (-.00046, .00093)
Percentage self-reported unable to obtain appointment	-.057 (-.20, .086)	.084 (-.044, .21)
Percentage self-reported able to see a GP or nurse within 48 hours	.00031 (-.000069, .00069)	.00033 (-.000016, .00068)
Percentage having a preferred GP	.025 (-.021, .071)	.023 (-.020, .065)
Percentage reporting good appointment 'experience'	.0030 (.0027, .0037)	.0025 (.0019, .0032)

470

471 *Negative figures indicate a reduction in adjusted total payment.

472

Table 3 Linear regression results for 2013-2014 and 2014-2015

Dependent variable: logarithm of the global sum plus MPIG payments per patient

Contract type: GMS

Adjusted R-squared values: 2013-14 = 0.283 (3,530 practices); 2014-15 = 0.202 (3,621 practices)

Mean Variance Inflation Factor (VIF): 2.06 in 2013-14, 2.03 in 2014-15

Significant values in bold type

Predictor	2013-2014 Beta coefficient (95% confidence interval)	2014-2015 Beta coefficient (95% confidence interval)
Population		
Percentage of list aged 75 years or more	-.012 (-.014, -.011)	-.010 (-.012, -.0086)
IMD score	-.0019 (-.0025, -.0014)	-.0011 (-.0016, -.00063)
Percentage with Afro-Caribbean ethnicity	.16 (.083, .24)	.075 (.0044, .14)
Percentage with South Asian ethnicity	.15 (.11, .20)	.089 (.045, .13)
Percentage of smokers	.014 (-.051, .079)	.012 (-.046, .069)
Percentage with self-reported long term condition	-.092 (-.15, -.037)	-.034 (-.082, .014)
Percentage of self-reported on long term sick or disability register	-.080 (-.22, .058)	-.13 (-.25, -.0078)
Percentage of self-reported confident about managing own health	-.11 (-.22, -.0042)	-.028 (-.12, .067)
Percentage of self-reported unemployed	-.0010 (-.098, .096)	.022 (-.070, .11)
Percentage on practice diabetes register	-.0064 (-.0094, -.0034)	-.0041 (-.0068, -.0014)
Percentage on practice heart failure register	.0048 (-.0083, .018)	-.00039 (-.012, .011)
Percentage on practice asthma register	.0016 (-.0015, .0047)	-.00014 (-.0026, .0029)
Percentage on practice COPD register	-.0041 (-.0011, .0024)	-.0077 (-.014, -.0019)
Practice		
List size	-3.36e-06 (-4.25e-06, -2.48e-06)	-2.89e-06 (-3.67e-06, -2.10e-06)
Geographical region: Midlands with North as reference	.016 (.0065, .025)	.019 (.011, .027)
Geographical region: South with North as reference	.024 (.015, .033)	.026 (.017, .034)
Whole time equivalent GPs per 10,000 patients	.0060 (.0047, .0074)	.0050 (.0038, .0062)
Whole time equivalent nurses per 10,000 patients	-.00047 (-.0030, .0040)	.0032 (-5.16e-07, .0065)
Whole time equivalent staff per 10,000 patients	.0043 (.0035, .0052)	.0037 (.0029, .0045)

*Negative figures indicate a reduction in payment.

482 **Table 4** Linear regression results for 2013-2014 and 2014-2015

483 Dependent variable: logarithm of adjusted total payments per registered patient

484 Contract type: GMS

485 Adjusted R-squared values: 2013-14 = 0.440 (3,596 practices); 2014-15 = 0.392 (3,621 practices)

486 Mean Variance Inflation Factor (VIF): 2.17 in 2013-14, 2.20 in 2014-15

487 **Significant values in bold type**

Predictor	2013-2014 Beta coefficient (95% confidence interval)	2014-2015 Beta coefficient (95% confidence interval)
Population		
Percentage of list aged 75 years or more	-.00050 (-.0038, .0046)	.0048 (.00036,.0093)
IMD score	.00027 (-.00098, .0015)	.0017 (.00041 .0030)
Percentage with Afro-Caribbean ethnicity	.038 (-.13, .21)	.011 (-.17, .19)
Percentage with South Asian ethnicity	-.075 (-.18, .030)	-.037 (-.15, .076)
Percentage of smokers	-.33 (-.47, -.18)	-.34 (-.48, -.19)
Percentage with self-reported long term condition	-.24 (-.36, -.12)	-.047 (-.17, .078)
Percentage of self-reported on long term sick or disability register	-.16 (-.46, .15)	-.48 (-.79, -.17)
Percentage of self-reported confident about managing own health	.0046 (-.24, .25)	.19 (-.052, .44)
Percentage of self-reported unemployed	-.26 (-.47, -.044)	-.24 (-.47, .0028)
Percentage on practice diabetes register	-.0045 (-.0079, .0070)	-.0022 (-.0010, .0056)
Percentage on practice heart failure register	.022 (-.0072, .051)	-.013 (-.042, .017)
Percentage on practice asthma register	.011 (.0035, .017)	.0035 (-.0037, .011)
Percentage on practice COPD register	-.0028 (-.017, .012)	-.0090 (-.024, .0062)
Practice		
List size	-8.06e-06 (-2.98e-06, 1.37e-07)	-1.19e-06 (-3.42e-06, 1.05e-06)
Geographical region: Midlands with North as reference	.099 (.079, .12)	.048 (.027, .068)
Geographical region: South with North as reference	.062 (.041, .082)	.021 (-.00016, .043)
Whole time equivalent GPs per 10,000 patients	.020 (.017, .023)	.017 (.013, .020)
Whole time equivalent nurses per 10,000 patients	-.015 (-.023, -.0075)	-.018 (-.026, -.010)
Whole time equivalent staff per 10,000 patients	.030 (.028, .032)	.029 (.026, .031)
Performance		
Total QOF points achieved	.000064 (-.000087, .00022)	.00014 (-.00014, .00043)
Percentage on practice hypertension register	.0090 (.0050, .013)	.012 (.0078, .016)
Percentage of the hypertension register with the last blood pressure reading ≤150/90 mmHg	-.00031 (-.0014, .0015)	.00085 (-.00071, .0024)
Percentage of the diabetes register with	.00062 (-.0011, .00010)	-.00034 (-.0014, .00071)

the last HbA1c $\leq 7.5\%$ (59mmol/mol)		
Percentage self-reported unable to obtain appointment	-.068 (-.27, .13)	-.089 (-.28, .11)
Percentage self-reported able to see a GP or nurse within 48 hours	.00015 (-.00036, .00065)	.00032 (-.00022, .00085)
Percentage having a preferred GP	.091 (.031, .15)	.12 (.060, .18)
Percentage reporting good appointment 'experience'	.0034 (.0024, .0044)	.0025 (.0015, .0034)

488

489 *Negative figures indicate a reduction in payment.

490

491

Table 5 Effect size: the independent effects of changes to values of significant predictors on total payments in a hypothetical practice of 7,000 patients.

Median total (predicted) payments for a 7,000 patient list were £718,480 in 2013-14 and £740,530 in 2014-15.

In each cell, values in the first line are for 2013-2014 and in the second line for 2014-2015. Numbers inside the parentheses are the percentage changes to total payments.

Predictor	Predicted change in total payment based upon a value at quartile 1 of the predictor's distribution, assuming all other predictors remained at their median.	Predicted change in total payment based upon a value at quartile 3 of the predictor's distribution, assuming all other predictors remained at their median.
Over 75 years	£-5,491.21 (-0.76%) £-10,812.45 (-1.46%)	£4,811.95 (0.67%) £9,458.35 (1.28%)
IMD score	£-5,682.24 (-0.79%) £-6,173.92 (-0.83%)	£7,209.35 (1.00%) £7,677.80 (1.04%)
Smokers	£ 11,070.20 (1.54%) £ 6,452.63 (0.87%)	£-13,118.16 (-1.83%) £-7,878.13 (-1.06%)
Black ethnicity	£-1,016.04 (-0.14%) £-1,025.27 (-0.14%)	£3,538.72 (0.49%) £3,852.10 (0.52%)
With self-reported long term condition	£5,688.65 (0.79%) £4,189.69 (0.57%)	£-5,688.65 (-0.79%) £-4,056.20 (-0.55%)
On long-term sick or disability register	Not a predictor in 2013-14 £3,932.06 (0.53%)	Not a predictor in 2013-14 £-5,569.10 (-0.75%)
On diabetes register	Not a predictor in 2013-14 £50.61 (0.0068%)	Not a predictor in 2013-14 £-52.18 (-0.0070%)
On asthma register	£-44.34 (-0.0062%) £-33.7 (-0.0045%)	£40.69 (0.0057%) £32.57 (0.0044%)
List size	£4,418.45 (0.61%) £5,059.10 (0.68%)	£-5,863.86 (-0.82%) £-6,623.46 (-0.89%)
Whole time equivalent GPs per 10,000 patients	£-15,008.89 (-2.09%) £-14,034.61 (-1.90%)	£17,178.46 (2.39%) £16,061.15 (2.17%)
Whole time equivalent staff per 10,000 patients	£-43,943.07 (-6.12%)	£52,711.27 (7.34%)

	£-45,428.78 (-6.13%)	£54,494.37 (7.36%)
Total QOF points achieved	£-4,229.76 (-0.59%) Not a predictor in 2014-15	2,253.37 (0.31%) Not a predictor in 2014-15
On hypertension register	£-94.74 (-0.013) £-128.23 (-0.017%)	£88.45 (0.012%) £123.06 (0.017%)
Reporting good appointment experience	£-208.46 (-0.029%) £-176.01 (-0.024%)	£171.78 (0.024%) £164.34 (0.022%)

500

501 Calculations assumed a reference point of the total payments per patient being at the median (£102.64 in 2013-
502 14 and £105.79 in 2014-15). For each predictor, the predicted change in total payment is presented based upon a
503 value at either quartile 1 or quartile 3 of the predictor's distribution, assuming all other predictors remained at
504 their median.

505 Equations used in the calculations:

506 1. Change in payment (amounts) = List size x Median total payment per patient x $[e^{(\text{beta-coefficient} \times \text{difference between median and quartile values})} - 1]$
507

508 2. Change in payments (percentage) = $[e^{(\text{beta-coefficient} \times \text{difference between median and quartile values})} - 1] \times 100$

509 e = exponential function (2.71828)

510 Reference: UCLA Institute for Digital research and Education. FAQ How do I interpret a regression model
511 when some variables are log transformed? Available from:
512 http://www.ats.ucla.edu/stat/mult_pkg/faq/general/log_transformed_regression.htm [Accessed 26 May 2016]

513