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Associations of primary care workforce composition with population, professional and system outcomes: retrospective cross-sectional analysis

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Keywords: primary care, workforce, skill-mix, access, quality, efficiency, job satisfaction

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Background

Diversification of types of staff delivering primary care may affect professional, population and system outcomes.

Aim

To estimate associations between workforce composition and outcomes

Design and Setting

Cross-sectional analysis of 6210 GP practices in England in 2019

Method

Multivariable regression analysis relating numbers of staff in four groups (GPs; Nurses; Health Professionals; and Health Associate Professionals) to patient access and satisfaction, quality of clinical care and prescribing, use of hospital services, GP working conditions (sub-sample of practices), and costs to National Health Service.

Results

More GPs were associated with higher satisfaction for patients and GPs, More workers of other types had opposite associations with these outcomes. More Nurses and Health Associate Professionals were associated with lower cost per prescription but more prescribing activity. More GPs were associated with higher costs per prescription and lower use of narrow-spectrum antibiotics. Except for Health Associate Professionals, more staff were associated with more hospital activity. Higher NHS costs were associated most with more Nurses and least with more Health Professionals. The effects of different staff types on outcomes were largely independent.

Conclusion

Professional, population and system outcomes show a variety of associations with primary care workforce composition. More Nurses are associated with lower quality in some aspects and higher costs and activity. More Health Professionals and Health Associate Professionals associates less than additional GPs with higher costs, but is associated with lower patient and GP satisfaction.

Keywords. Workforce, Primary care, Outcome measures

How this fits in

An increasing number of staff from diverse healthcare backgrounds are changing the general practice workforce in England.

These changes provide a new opportunity to investigate whether and how workforce composition may be associated with outcome measures.

This analysis indicates that professional, population and system outcomes show a variety of associations with primary care workforce composition.

Our findings demonstrate that different types of healthcare professionals are not simple substitutes for one another, and the quantity and quality of services will depend on who is employed to work in this setting

Ethics

HRA approval REC reference: 18/NW/0650

Introduction

The supply of general practitioners is under strain in most countries, with workload and other pressures driving burnout and early exit from the workforce.(1-4) One proposed solution is to broaden the workforce, introducing new types of practitioners to supplement care provided by medically-qualified practitioners.(5, 6) The NHS in England has been particularly affected by these pressures(2-4, 7) and has gone further than most countries in seeking to broaden the primary care workforce. A substantial investment of £746 million has been pledged in 2021/22 to employ a wide range of new types of practitioner, including pharmacists, physician associates, care co-ordinators, physiotherapists and mental health support workers.(8)

However, there is limited high-quality evidence to support these developments as much of the existing research has been more narrowly focused on the mix of physicians and nurses,(9) on the performance of particular types of practitioners in their roles,(10-12) and on a narrow range of outcomes.(13) There has been little focus on the wider impacts of employing a more diverse range of practitioners. We do not know whether such practitioners can substitute for general practitioners (GPs),(14) nor do we know their impact on quality of care and patient satisfaction. Existing evidence does not consider cost-effectiveness or the impact on care provision at practice level.(15)

Primary care in England is a good setting in which to explore the impact of skill-mix change for several reasons. Firstly, it is delivered by a large number of small practices which have discretion over their employment, leading to considerable variation in workforce composition. Secondly, more detailed data on workforce composition at practice level have recently become available.(16) Finally, national policy is driving further changes in workforce and their potential impacts need to be understood. We use nationwide data from a large sample of practices to examine whether the inputs of GPs, nurses and other healthcare professionals are associated with a wide range of population, professional and system outcomes.

Methods

Data

We obtained data on different types of practitioners employed in general practices across England in September 2019 from NHS Digital. Information on headcounts and full-time equivalents are available for 35 categories of professionals providing direct patient care.

We obtained data on outcomes from the following sources: GP Patient Survey; Quality and Outcomes Framework (QOF); Prescribing Data; Hospital Episode Statistics; NHS Payments to General Practice; and the GP Worklife Survey (see Appendix 1). All sources provide practice-level figures for all practices in England except the GP Worklife Survey, which includes a sample of individual GP respondents.⁽⁷⁾

We analysed outcomes experienced by the population, practitioners, and the healthcare system. For the population, we consider patient experience of access using data from the GP Patient Survey, and consider clinical quality using measures of QOF points scored and measures of prescribing quality including ratio of broad to narrow antibiotics prescribed and volume of prescribing. For the healthcare system we use Hospital Episode Statistics to look at use of hospital services, including attendance at Emergency Departments, emergency admissions and hospital outpatient referral, and we consider costs to the system based upon payments to practices using NHS Payments Data and prescribing data and costs associated with hospital activity using average unit costs. We address practitioner outcomes in a subset of practices using data from the GP Worklife Survey. These data sources are described in more detail in the supplementary appendix.

We sourced data on a range of population and practice characteristics that may be associated with workforce composition and outcomes and were included as covariates. These included registered population size and age structure, indicators of population healthcare needs, local area income deprivation and average wages, the practice's dispensing status, contract type, rural location, and NHS region.

There were 6,770 practices open in September 2019 with at least 1,000 registered patients. Practice workforce data is self-reported by practices through the National Workforce Reporting System (NWRS). Where practices have not provided any or only incomplete data, NHS Digital imputes values. We only analysed practices that provided a complete set of workforce information, which in September 2019 were 6,296 (93%) practices. Of these, 6,210 practices had full data availability across all covariates and were included in our analysis. For the analyses of the GP Worklife survey, the sample size varies between 1,191 and 1,270 responding GPs.

Analysis

We measured levels of staff input in full-time equivalents (FTEs). The current pattern of employment of new types of clinical staff in England is complicated, with incentive payments available to employ 12 different types of staff (8), including health coaches, clinical pharmacists, nursing assistants and many others. The roles undertaken by these groups vary significantly. In order to make sense of the potential impact of such a wide range of staff

on patient care we followed the World Health Organization classification (17), which distinguishes between staff able to provide therapeutic interventions in their own right and those carrying out delegated tasks and groups staff into four broad categories: GPs; Nurses; Health Professionals (excluding GPs and Nurses); and Health Associate Professionals (Table 1). The Health Professionals category contains staff that make professional assessments or deliver therapeutic interventions, such as pharmacists or physician associates. The Health Associate Professionals category contains any other staff involved in patient treatment, such as healthcare assistants, dispensers, trainees, and apprentices.

[Table 1 here]

We used linear regression to relate practice outcomes to cubic functions of the levels of each staff type.(18, 19) We also included interactions between GPs and each of the other three staff types to test for direct substitution (negative interaction coefficient) or direct complementarity (positive interaction coefficient) between staff groups. We standardised all outcome measures using z-scores to aid comparisons. We weighted all analyses by the denominator of the outcome (size of registered population for most outcomes, see Appendix 3).

We summarised the estimated effects of the staff variables by calculating the changes in each outcome for unit-changes in the FTEs of each staff type, holding all other characteristics at their median values for continuous variables and mean values for discrete variables. These are marginal effects of staff changes for the average practice. We also graphed means for the outputs at key percentiles of staff input levels, conditional on the covariates.

We ran similar analysis for total costs, calculated as the sum of the payments made to the practice by the NHS for providing primary care services, the costs of the prescriptions generated by the practice, and the volumes of four types of hospital activity used by the practice's patients costed using national unit-costs.(20) To account for the skewed distribution of these costs, we estimated a generalised linear model (GLM) using a log link function and a gamma distribution.(21) We estimated this model for total costs and for six components of total costs. To check the stability of the coefficients to the inclusion of covariates, we also estimated the model for total costs adding covariates sequentially.

We used Stata version 15.1. We computed Huber-White *robust* standard errors to allow for heteroscedasticity. We also checked the sensitivity of the results to allowing the errors to be correlated across different outcomes using seemingly unrelated regression equations(22). We measured goodness-of-fit using R-squared and Root Mean Squared Error statistics and estimated the joint significance of the workforce variables using F-tests.

Results

There is considerable variation in staffing levels across practices (Table 2). The median practice employs 4.3 full-time equivalent GPs, 1.9 Nurses, zero Health Professionals and 1.0 Health Associate Professional.

[Table 2 here]

Full regression results are shown in Appendix 4. For the majority of outcomes, the staff input variables are statistically significant at $p < 0.05$ and mostly at $p < 0.01$. The interaction terms between numbers of GPs and numbers of other staff are generally not statistically significant. This indicates a lack of substitution or complementarity for most outcomes. As exceptions, we find a small degree of complementarity between GPs and Nurses in the achievement of QOF points and between GPs and Health Professionals in relation to outpatient attendances and time since last Nurse appointment. The only substitution effects that were statistically significant were between GPs and Health Associate Professionals for prescribing of narrow-spectrum antibiotics and for total items prescribed.

The effects for the average practice are summarised in Table 3. The full patterns of the associations between staff levels and the outcomes are shown in the margin plots in Appendix 5. We examined the variance inflation factors (VIFs) and these were all below 10 except for the workforce and age category variables, which would be expected to be correlated.

The estimated effects are statistically significant but quite small in magnitude, with a one FTE difference in staff input associated with less than 0.1 standard deviation difference in outcome. Additional GPs are associated with shorter times since patients had a GP appointment and longer times since patients had a Nurse appointment, lower proportions of work that GPs think can be delegated and higher job satisfaction for GPs. Additional nurses have the opposite effects on practice functioning and environment. Health Professionals and Health Associate Professionals have similar effects to Nurses on practice functioning and environment, except Health Professionals have a much larger effect on perceived opportunities for work delegation and Health Associate Professionals are associated with lower GP job satisfaction.

Additional staff of any type is associated with achievement of higher QOF points. More GPs is associated with higher patient satisfaction and more of the other three staff groups is associated with lower patient satisfaction. Figures 1 and 2 show the marginal effect of additional staff members on patient satisfaction with making an appointment and their overall satisfaction with the practice. Additional Nurses and Health Associate Professionals are associated with more prescribing activity but lower average cost per prescription. Additional GPs increase costs per prescription and lower the use of narrow-spectrum antibiotics, while Health Professionals increase the use of narrow-spectrum antibiotics.

Additional staff in primary care is associated with more hospital activity of all types, with the exception of Health Associate Professionals. More Health Professionals have the largest impact on hospital activity, particularly outpatient attendances and emergency admissions.

The analysis of overall practice costs (Table 4) shows that a one FTE increase in Nurses results in the largest increase in costs (£512,000 per practice per year, 95% CI £446,000 to £579,000), followed by GPs (£362,000, 95% CI £326,000 to £398,000) and Health Associate Professionals (£256,000, 95% CI £195,000 to £318,000). The effect of Health Professionals on costs is the smallest and not statistically different from zero (£182,000, 95% CI -£33,000 to £396,000). The effects of different staff groups are similar across the components of costs, except that Health Professionals do not increase prescribing costs and Health

Professionals and Health Associate Professionals do not increase hospital activity as much as GPs and Nurses.

The seemingly unrelated regression models and other sensitivity checks confirm our main results (Appendix 6).

[Table 3 and 4 here]

Discussion

Summary

The composition of the workforce in primary care practices is associated significantly with most indicators of professional, population and system outcomes, but the nature of these associations varies across outcomes. The number of GPs is associated positively with GP job satisfaction and with patient satisfaction. The numbers of Nurses, Health Professionals, and Health Associate Professionals relate to these outcomes in the opposite direction. More Nurses and Health Associate Professionals is associated with more prescribing activity but lower average cost prescribing. More GPs is associated with lower use, and more Health Professionals is associated with higher use, of narrow-spectrum antibiotics. With the exception of Health Associate Professionals, more staff in primary care is associated with higher levels of hospital activity per head of population. More staff increases the costs of the practice to the NHS, with the largest effect being for Nurses and the smallest effect being for Health Professionals.

Although the numbers of staff in each group is associated with outcomes, these effects are largely independent of the numbers of staff in the other groups. There are few instances where there is evidence of significant substitution or complementarity between GPs and the other three staff groups.

Strengths and limitations

We used nationwide data from a large number of primary care practices. Because practices are generally small organisations with substantial discretion over how they organise services, there is substantial variation in workforce composition to analyse. We obtained data from several sources and considered professional and patient satisfaction, as well as indicators of healthcare activity and quality. In addition, we considered how workforce composition was associated with costs. We adjusted for several population and practice characteristics associated with workforce composition and with outcomes.

In analysing the relationship between workforce composition and outcomes, we used a flexible regression model. This cubic function has been shown to be an acceptable alternative to the most flexible translog specification used in economic studies of production and less susceptible to multicollinearity in applied work because it requires fewer interaction terms (18, 19). Although the cubic production function, like many flexible functions, results in correlated variables we are interested in their combined effect rather than the coefficients on individual measures which may be estimated imprecisely due to multicollinearity.

We relied on workforce data collected by the NHS. We worked closely with the data provider to identify practices where they had imputed values because of known problems with missing or incomplete data and excluded them from our analysis. This affected 7% of practices.

National data on primary care activity, for example numbers of patient consultations, are not currently available at practice level. Instead, we used indicators from the GP Patient Survey on how many months ago respondents had last seen a GP and last seen a Nurse. These showed the expected associations with numbers of GPs and Nurses but better quality data might have shown stronger relationships.

We did not include all aspects of costs that practices create for the National Health Service. However, all six of the cost components that we included showed similar patterns suggesting our results are not driven by one aspect of cost. We are not able to comment on health and social care expenditure more generally; it may be that increased expenditure in primary care results in lower costs in social care, for example.

Although we included several population and practice characteristics that may otherwise have confounded the relationship between workforce composition and outcomes, this is a cross-sectional study and may be prone to bias from unmeasured confounding.

Comparison with existing literature

Studies have shown that GP practices that are well organised tend to deliver high quality care(23) and tasks that can be guided by clinical protocols can be successfully delegated to nurses (e.g. chronic conditions management) (9, 24, 25). This is consistent with our finding of a small degree of complementarity between GPs and Nurses in the achievement of QOF points. However, it remains unclear whether the overlap in roles performed by nurses described by Lukewich et al also extends to other workers and whether this enhances care(26). Our finding that workforce composition is associated with mixed effects on the use of hospital services is consistent with research highlighting the complexity of this area (27, 28). Our finding of both positive and negative outcomes associated with the Health Professional group is consistent with prior evidence highlighting the challenge of managing inter-professional interactions and negotiating role boundaries and regulations(29). Similarly, our results confirm the positive effects of pharmacists on prescribing practices and patient safety(30). However, broader integration of pharmacists in practice seems to be still lacking(31, 32).

Implications for Research and/or practice

Overall, our analysis highlights that workforce composition matters for professional, population and system outcomes. Because labour is such an important input to the production of healthcare, these findings are not surprising. However, they have rarely been investigated at the organisational level before, despite their obvious relevance for decision-making and future policy. Our findings demonstrate that different types of healthcare professionals are not simple substitutes for one another, and the quantity and quality of services generated in primary care will depend on who is employed to work in this setting.

We also show that the employment of different types of healthcare professionals has different effects on GPs' experience of their working lives.

We have shown also that employment of more of each of the different types of staff leads to higher costs to the NHS. This also may not seem surprising, but it should be noted that the costs we consider are not directly affected by staff employment costs. We find that employment of more staff means that a practice can claim more payments from the NHS for the services they provide and generate additional costs through increases in prescribing and increases in their populations' use of hospital services. This is particularly the case for the employment of Nurses but seems to be less the case for Health Professionals.

Finally, we find very little evidence of direct interactions between the effects of different types of workers on outcomes at the organisation level. This may indicate that different staff groups are not co-ordinating their work and are working quite independently. There may be gains to be made from encouraging more effective team-working.

We have only examined the effects of workforce composition on the work experiences of GPs because the available survey data is collected only from this staff group. Future work should consider the effects of workforce composition on the working lives of other primary care practitioners.

We have shown significant associations between cross-sectional variations in workforce composition across primary care practices and a range of outcomes and outcomes. As workforce composition continues to diversify over time, it will be important to examine how this affects outcomes and costs.

Author statement

JG wrote the first draft of the manuscript. SS led the cross-disciplinary collaborative development and completion of the study in which this analysis is embedded. JG and IF undertook the analysis. All authors contributed to the writing of the final manuscript. JG is the guarantor.

The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. JG affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Competing interests declaration

Competing interests: All authors have completed the ICMJE uniform disclosure form and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three

years; no other relationships or activities that could appear to have influenced the submitted work.

Public involvement

Following early discussion with a patient and public involvement and engagement group, two members of the group maintained engagement with the research team throughout the study.

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Table 1 Primary care staff groups

WHO classification	NHS roles used in General Practice Workforce Statistics
GPs	Partners Salaried GPs Locum GPs Registrar GPs, Foundation 1-2, Speciality 1-4 Retainer GPs
Nurses	Practice Nurses Advanced and Specialist Nurses Trainee Nurses
Healthcare Professionals	Pharmacists Physiotherapists Physician Associates Paramedics Podiatrists Counsellors Occupational and other therapists Other allied health professionals
Healthcare Associate Professionals	Dispensers Health Care Assistants Nurse Associates Pharmacy technicians Psychological well-being practitioners Social Prescribing Link Workers Apprentices (therapists, pharmacists, physiotherapists, and others)

Note: Created by the authors

Table 2. Distribution of full-time equivalent numbers of different staff across practices

Staff group	Percentiles ^{a)}									
	Mean	St. Dev.	5	10	25	50	75	85	90	95
General Practitioners	5.14	3.76	1.00	1.37	2.34	4.29	7.06	8.66	9.88	11.73
Nurses	2.50	2.33	0.40	0.56	1.00	1.91	3.26	4.19	4.96	6.47
Health Professionals	0.30	0.77	0.00	0.00	0.00	0.00	0.16	0.80	1.00	1.71
Health Associate Professionals	1.57	1.94	0.00	0.00	0.48	1.00	1.97	2.77	3.23	5.15
Observations	6,210									

Note: ^{a)} Percentiles show the distribution of staff FTE in our core sample. Percentile values are the same used in the plots included in Appendix 5. Created by the authors

Table 3. Associations between practice workforce and population, professional and system outcomes

	Observations	Mean (SD) value	Estimated effects on z-score transformation of outcome of one unit differences in full-time equivalent number of:			
			GPs	Nurses	Health Professionals	Health Associate Professionals
<i>Practice activity</i>						
Time since last GP appointment (months)	6210	5.451 (0.660)	-0.043 (-0.057 to -0.028)	0.105 (0.077 to 0.134)	0.128 (0.042 to 0.215)	0.016 (-0.019 to 0.050)
Time since last Nurse appointment (months)	6210	8.139 (1.237)	0.047 (0.034 to 0.060)	-0.145 (-0.171 to -0.120)	-0.001 (-0.071 to 0.069)	-0.141 (-0.172 to -0.109)
<i>GP working conditions</i>						
Average hours worked per week by GPs	1195	41.019 (14.458)	-0.021 (-0.048 to 0.005)	0.047 (-0.014 to 0.108)	0.060 (-0.133 to 0.254)	0.010 (-0.055 to 0.074)
Percentage of GP work that could be delegated	1171	26.893 (17.649)	-0.037 (-0.064 to -0.011)	0.086 (0.026 to 0.145)	0.217 (0.016 to 0.417)	0.032 (-0.035 to 0.099)
GP job satisfaction	1270	4.428 (1.534)	0.052 (0.025 to 0.080)	0.007 (-0.052 to 0.066)	0.112 (-0.085 to 0.310)	-0.068 (-0.135 to -0.002)
<i>Quality of care</i>						
Percentage of QOF points achieved	6210	96.744 (5.596)	0.058 (0.036 to 0.079)	0.007 (-0.020 to 0.033)	0.054 (-0.039 to 0.147)	0.012 (-0.026 to 0.050)
Patient experience with making an appointment	6210	67.451 (14.349)	0.052 (0.038 to 0.066)	-0.086 (-0.113 to -0.059)	-0.157 (-0.243 to -0.071)	-0.060 (-0.092 to -0.028)
Overall patient experience of practice	6210	83.116 (9.635)	0.080 (0.066 to 0.094)	-0.068 (-0.095 to -0.042)	-0.200 (-0.294 to -0.106)	-0.066 (-0.099 to -0.034)
<i>Prescribing activity</i>						
Items prescribed (per thousand patients)	6210	19021.060 (6298.436)	-0.009 (-0.020 to 0.002)	0.050 (0.033 to 0.067)	-0.062 (-0.138 to 0.013)	0.026 (0.004 to 0.047)
Cost per item prescribed (£)	6210	7.478 (1.295)	0.021 (0.011 to 0.032)	-0.034 (-0.055 to -0.012)	0.030 (-0.032 to 0.092)	-0.046 (-0.074 to -0.018)
Percentage of narrow-spectrum to total antibiotics	6210	95.913 (1.538)	-0.018 (-0.030 to -0.007)	-0.015 (-0.039 to 0.009)	0.093 (0.021 to 0.164)	0.017 (-0.017 to 0.050)
<i>Hospital activity</i>						
A&E attendances (per thousand patients)	6210	238.472 (79.267)	0.024 (0.013 to 0.035)	0.020 (-0.001 to 0.041)	0.029 (-0.033 to 0.092)	0.023 (-0.005 to 0.051)
Outpatient attendances (per thousand patients)	6210	1471.976 (446.682)	0.038 (0.027 to 0.050)	0.009 (-0.014 to 0.032)	0.084 (0.015 to 0.153)	-0.040 (-0.069 to -0.010)
Elective admissions (per thousand patients)	6210	156.607 (52.245)	0.032 (0.020 to 0.044)	0.038 (0.017 to 0.059)	0.019 (-0.051 to 0.089)	-0.022 (-0.050 to 0.005)
Emergency admissions (per thousand patients)	6210	90.386 (26.908)	0.041 (0.030 to 0.053)	0.055 (0.033 to 0.076)	0.075 (0.012 to 0.137)	-0.029 (-0.057 to -0.002)

Notes: Created by the authors. 95% confidence intervals in brackets. Outcome mean and regressions are weighted by the outcome denominator (see Appendix 3 for details). Full results from Ordinary Least Squares (OLS) regression model used to derive marginal effects are included in Appendix 4. Margin plots showing the effects graphically for a range of staffing percentiles are included in Appendix 5. The results of sensitivity checks are available in Appendix 6. Full diagnostic indicators for all regression models are in Appendix 7.

Table 4. Associations between practice workforce and costs of practice to National Health Service

Annual practice costs	Mean (SD) value	Estimated effects on costs of one unit differences in full-time equivalent number of...			
		GPs	Nurses	Health Professionals	Health Associate Professionals
Total cost (£'000)	7,950 (4,808)	362 (326 to 398)	512 (446 to 579)	182 (-33 to 396)	256 (195 to 318)
NHS payments to practice (£'000)	1,265 (805)	49 (44 to 55)	86 (75 to 96)	41 (5 to 77)	72 (61 to 84)
Costs for prescriptions (£'000)	1,261 (850)	50 (44 to 56)	78 (67 to 89)	-8 (-58 to 42)	41 (31 to 50)
Costs of A&E attendances (£'000)	361 (232)	15 (13 to 17)	20 (16 to 24)	9 (-2 to 19)	13 (10 to 18)
Costs of emergency admissions (£'000)	1,390 (893)	71 (64 to 78)	100 (85 to 114)	46 (4 to 88)	41 (27 to 54)
Costs of elective admissions (£'000)	1,927 (1,263)	93 (82 to 105)	128 (108 to 148)	37 (-22 to 95)	45 (25 to 66)
Costs of outpatient attendances (£'000)	1,746 (1,122)	85 (76 to 94)	97 (79 to 115)	60 (10 to 111)	36 (18 to 53)

Notes: Created by the authors. 95% confidence intervals in brackets. Full results for generalized linear regression models used to derive the marginal effects of different staff groups are included in Appendix 4. Margin plots showing the effects graphically for a range of staffing percentiles are included in Appendix 5. The results of our sensitivity checks are available in Appendix 6. Full diagnostic indicators for all regression models are in Appendix 7.

Figure 1: Patient experience with making an appointment

Figure 2: Overall patient experience of practice