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Variation in attendance at emergency departments in England across local areas: A system under unequal pressure

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ABSTRACT

Background: Crowding in Accident and Emergency Departments (AEDs) and long waiting times are critical issues contributing to adverse patient outcomes and system inefficiencies. These challenges are exacerbated by varying levels of AED attendance across different local areas, which may reflect underlying disparities in primary care provision and population characteristics.

Method: We used regression analysis to determine how much variation across local areas in England of attendance at emergency departments remained after controlling for population risk factors and alternative urgent care provision.

Findings: There is substantial residual variation of the order of 3 to 1 (highest to lowest) in per person attendance rate across different areas. This is not related to in-hospital capacity as proxied by the per person number of hospital emergency doctors in an area.

Conclusion: Some areas in England have emergency departments that are under much greater pressure than others, and this cannot be explained in terms of their population characteristics or the availability of alternative treatment options. It is imperative to better understand the drivers of this variation so that effective interventions to address utilisation can be designed.

1. Introduction

Increasing utilisation of hospital-based emergency and urgent healthcare services is an international phenomenon [1] and is a cause for concern because it leads to increased costs, increased waiting times and crowding in emergency departments [2]. Delays in emergency departments leading to postponed admissions give rise to unnecessary deaths [3]. In England, emergency department attendance increased 27 % per person between 2002/03 to 2022/23. This growing utilisation not only worsens outcomes, but also threatens the healthcare system's ability to respond to crises or natural disasters and therefore undermines health system *resilience* [4].

In the UK primary care physicians are called General Practitioners and operate in groupings called practices, and hence we refer to GP practices. General practices (GP) manage chronic conditions and are usually the first point of contact for non-emergency medical care. Patients do not require referrals from GPs to access AED.

Attendances to AED occur when individuals seek care after becoming suddenly and seriously ill. Depending on the seriousness of their condition, they could have been seen at their GP practice or other healthcare facilities. This study investigates the drivers of AED utilisation and variation across local areas to inform strategies aimed at mitigating these pressures and enhancing system resilience.

Managing utilisation of in-hospital urgent care is a policy priority in many countries, and interventions have included increasing out-of-hospital provision and targeting assistance on people with long-term conditions who are established frequent users of urgent care [5]. Recent studies have highlighted the relationship between primary care quality and emergency attendance, suggesting that improvements in primary care could reduce unnecessary AED visits [6,7]. Similarly, extending access to primary care reduces emergency department visits [8,9], further underscoring the importance of primary care services in managing AED utilisation. The National Health Service in England is implementing a system-wide recovery plan for hospital-based urgent care services [10]. Against the background of high and growing utilisation there are substantial regional and local variations. We later document geographic differences in per person attendance rates for hospital-based urgent care in England that differ by a factor of 4 across

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administrative areas that comprise populations average 300,000 people.

Regional variation and its determinants are important from a policy perspective. Knowing which areas are subject to the highest utilisation of urgent care provides a means to target interventions where they can have the most impact. Knowing whether variation is driven by the characteristics of a population, or the decisions being made about supply of services, guides that intervention; if an area is subject to a particularly demanding population, it may require increased resources whereas if it is not managing existing resources in line with other areas it may need guidance or managerial input.

We examine the use of in-hospital urgent care facilities, denoted Accident and Emergency Departments (AEDs), in the English National Health Service (NHS). We establish the extent AED utilisation varies across administratively defined local healthcare systems, which at the time of our study (2018/19) were defined in terms of Clinical Commissioning Groups (CCGs). We conducted our investigation at the GP practice level, and used the most detailed and relevant information on patient characteristics, accessibility and quality of other healthcare services, mainly for primary care. This approach ensures that our findings are closely aligned with factors that directly influence AED utilisation, providing insights into the drivers and the level of variation across local areas.

We use regression analysis to adjust for population characteristics affecting the variation in AED utilisation and discover significant variation remains, indicating supply-side factors. To determine if this variation is due to more resources being available in an area – where high-utilisation in-hospital resources – we investigate the association between patient-adjusted AED utilisation rates and emergency system capacity, proxied by the number of emergency doctors. We find no correlation which suggests that areas with the highest utilisation may have the most pressured in-hospital services.

For policymakers concerned with the utilisation of in-hospital urgent care in England, our study provides the following insights: high utilisation fluctuates considerably across local areas; it is not explained by population characteristics; it is not a reflection of an abundance or shortage of clinicians. Altogether, these suggest that interventions to limit utilisation should potentially focus on the management and utilisation of urgent care outside hospitals (e.g. community care).

Geographical variation in healthcare utilisation has been documented for nearly a century, starting with Glover [11]. Corallo et al. [12] and Skinner [13], provide extensive reviews of this subject. A key research question is the extent to which variation can be explained by differences between populations and their health needs or preferences (the *demand-side*) versus differences in healthcare provision and clinical decisions (the *supply-side*). Many studies conclude that variation cannot be explained by the demand side [13–16]. Our findings support that conclusion for in-hospital urgent care in England, quantify the extent of the variation and confirm that it cannot be accounted for by patient factors alone.

Previous studies of AED attendance in England have focused on the role of demographic factors and alternative provisions on utilisation. Closest to the setting of our study are Scantlebury et al. [17] and Downing and Wilson [18] who identified deprivation, population morbidity, ethnic group and age were strong predictors of AED attendance. These influences have been further examined by Rudge et al. [19] and Arain et al. [20] who establish that distance and availability of alternative urgent care options predict in-hospital utilisation. Variation in emergency department utilisation has recently been studied in Israel by Zeltzer et al. [21] whose approach is close to ours methodologically, in seeking to distinguish between supply- and demand-side influences. Our setting is however importantly different; the local areas that we study correspond to administrative units and therefore our findings have a strong policy focus – areas with high utilisation could, in our setting, be subject to specific targeted policy intervention within a supporting administrative structure.

2. Materials and methods

2.1. Data

The Hospital Episodes Statistics Accident and Emergency dataset provides details of attendances to National Health Service (NHS) AEDs, including information on diagnosis, investigation, treatment, time and method of arrival and departure [22,23], patient's age, sex, area of residence and their primary care (GP) practice. We study the variation in 2018/19 across 191 local healthcare systems (CCGs) in AED attendance rates in England and focus on attendance at major AED facilities. *Major* AED facilities are consultant-led 24-hour centres with full resuscitation capability.

To adjust for population health risks and accessibility to other healthcare services, we use data on observable characteristics from several sources (Appendix Table A.1) regarding: patient demographics, life expectancy, chronic diseases, healthcare workforce, clinical quality, patient satisfaction, extended hours provision and geographical distance to other emergency healthcare services. We aggregate from the more local GP practice level, with an average patient list of 8780 to CCGs which have an average population of 294,696. We attribute the total number of AED attendances from patients registered at any English GP practice to one of the 191 CCGs. CCGs were clinically-led statutory NHS bodies responsible for the planning and commissioning of healthcare services for their area from 1st April 2013 to 1st July 2022.

Our sample includes 6277 English GP practices. We assign 14,781,624 AED attendances from 150 AEDs to the practices where the patient is registered. We restrict to practices with a patient list of at least 1000 patients and at least one full time GP (in Appendix Table A.2.) to ensure that we only included GP practices open throughout 2018/19. This is consistent with the number of active practices reported by NHS Digital for March 2019 [24]. To identify the number of AED consultants/doctors, is established from the Electronic Staff Record (ESR) dataset, provided by NHS England.

2.2. Method

We estimate a linear regression model of the GP Practice AED attendance percentage is calculated as the total number of AED attendances divided by the number of patients registered with a GP practice. Each practice is attributed to a single local healthcare system(CCG). We consider as explanatory factors a set of practice characteristics: patient demographic and socioeconomic factors, quality indicators, and practice workforce. The two specifications include a set of GP practice list characteristics and includes variables such as the proportion of patients by age group, sex, ethnicity, deprivation quintile and rurality/ urbanicity, patient's life expectancy and prevalence rates of major conditions. The second specification also includes the set of practice quality indicators which includes measures from the clinical Quality Outcome Framework, the workforce characteristics including factors such as the number of staff FTE per 1000 patients (registered with the practice), the practice contract type, the percentage of GPs per certain characteristics such as gender, country of qualification and salaried status. We also consider in the second specification the distance from the GP practice to the nearest 'major' AED, the weighted distance from patient's LSOA of residence to the GP practice, the number of surgeries per GP practice and if the practice is providing extended hours. The GP practice provision of extended hours access and a set of indicators of the provision of AED services near the practice, such as if the nearest AED provider to the practice is a major, consultant-led mono speciality AED service, minor injury services, walk-in centres or other, and whether a GP practice is within 10 km radius of each AED by type is also included in the second specification.

The CCG fixed effects(Appendix A.1.) are included to capture the area-level factors and the adjusted proportion of individuals who seek care through the hospital emergency department after considering all other factors. The differences between GP practices within the same local area are captured by the GP practice-level variables.

Table 1
Summary statistics for patient characteristics in GP Practices.

Variable	Mean	Std. dev.	Min	Max
AED attendances:				
AED attendances (number)	2203.75	1449.59	36	21,211
AED attendance percentage (%)	25.75	8.18	1.47	142.81
AED attendance percentage (%) at CCG level	25.65	5.87	4.01	44.13
Practice List size 2018 (1000 patients)	8.78	5.44	1.03	73.37
Patient list demographics:				
Aged 0–4 (%)	5.52	1.44	0	16.49
Aged 5–14 (%)	11.88	2.56	0	29.8
Aged 15–44 (%)	39.19	9.17	15.76	97.06
Aged 45–64 (%)	25.92	4.13	1.35	40.64
Aged 65 plus (%)	17.49	6.81	0.19	49.41
Female patients (%)	49.85	2.14	16.75	56.73
Ethnicity:				
White (%)	82.45	22.45	0	100
Mixed (%)	1.48	2.04	0	17.75
Asian (%)	9.99	16.55	0	98.92
Black (%)	3.79	7.04	0	64.09
Other ethnic groups (%)	2.2	3.84	0	65.58
Employment status:				
Unemployed (%)	4.3	4.12	0	51.17
Smoking status:				
Never smoker (%)	58.55	8.64	5.57	92.89
Former smoker (%)	26.51	7.33	0	51.15
Occasional smoker (%)	6.95	3.72	0	31.57
Regular smoker (%)	7.99	4.65	0	68.86
QOF - GP practice disease prevalence (% of practice list)				
Atrial fibrillation	1.96	0.87	0.01	5.71
Asthma	6.07	1.33	0.8	14.87
Cancer	2.96	1.12	0.1	8.06
Coronary heart disease	3.16	1.08	0.03	8.07
Chronic kidney disease(18+)	4.13	2.02	0.03	15.05
Chronic obstructive pulmonary disease	1.99	0.93	0.01	7
Cardiovascular disease-primary prevention (30–74)	1.14	0.53	0	9.3
Dementia	0.77	0.44	0.01	8.92
Depression	10.65	4.1	0.66	41.79
Diabetes mellitus(17+)	7.27	2.08	0.43	18.97
Epilepsy(18+)	0.8	0.26	0.04	2.86
Heart failure	0.93	0.45	0.01	4.18
Hypertension	14.28	3.65	0.44	29.41
Learning disability	0.51	0.28	0.01	4.13
Mental health	0.98	0.44	0.16	14.7
Obesity	10.49	3.89	0.56	30.79
Osteoporosis	0.69	0.67	0	4.25
Peripheral arterial disease	0.61	0.3	0.01	2.63
Palliative care	0.41	0.41	0	9.38
Rheumatoid arthritis(16+)	0.78	0.26	0.02	2.54
Stroke and transient ischaemic attack	1.78	0.68	0.03	5.56
Life expectancy:				
Life expectancy at birth for GP practice patient list (years)	81.28	2.07	73.74	89.19
Deprivation[2]:				
Percentage of practice patients living in least deprived quartile of LSOAs	21.7	24.29	0	99.21
Percentage of practice patients living in most deprived quartile of LSOAs	28.39	28.8	0	99.61

[1]There are three GP practices with more AED attendances than patients. This is due to their small patient list (<1500 patients) and likely frequent attenders among their patients, i.e., patients who have 5 or more AED attendances in a year.

[2] Deprivation is measured at LSOA level and attributed to GP practices as a percentage of patient list. Therefore, the average percentage of practice patients living in each deprivation quartile of LSOAs differsfrom the expected 25 %.

3. Results

3.1. Descriptive statistics

Table 1 reports summary statistics on AED attendances across a sample of 6, 277 GP practices. There are on average 2204 AED attendances per practice, with a minimum of 11 AED attendances. The mean AED attendance rate across practices is 26 %, with at least one practice having 1.5 % and another 143 %. The practice with over 100 % AED attendance is one of the three GP practices with more AED attendance than patients, who have a small patient list (<1500 patients) and have likely frequent attenders among their patients.

The mean AED attendance rate across the local healthcare system (CCGs) is 26 %. The practice list has on average almost 50 % of patients who are women. Those in the age range of 15–44 constitute the largest share of the patient list (40 %), 25 % constitute those between 45 and 64,17 % over 65 and 12 % between 5- 14 years, while 5 % consist of those between 0 and 4 years of age. Using patient characteristics from the GP practice survey(GPPS), 82 % of the practice list are from a white ethnic group, while those of Asian, Black, Mixed and other ethnic backgrounds constitute 10 %, 3.8 %, 1.5 % and 2.2 % respectively. Nearly 4 % of those on the practice list are unemployed 58 % are non-smokers and 8 % smoke regularly, and 26 % identify as former smokers and 7 % smoke occasionally. The highest average prevalence is for hypertension, 14 %, followed by depression and obesity, with 10.5 % and 10.6 % of patients, on average. Patients' average life expectancy is 81 years and on average practices have about 8800 patients registered with them. Most of the practice list patients reside in urban areas and, on average, a practice has 28 % of their patients living in the most deprived quartile. Table A.3 in Appendix A shows the descriptive statistics for the full set of control variables which includes GP practice's characteristics such as the QOF scores across different clinical areas, indicators for accessibility to primary care services such as the distance between patients' residence and GP practices and AEDs, measures of their awareness and satisfaction with their GP practice, information about extended hours, primary care workforce data, GP doctors distribution of age, education and full-time equivalent hours.

3.2. Regression results

Estimating equation (A.1) but omitting all variable except the local healthcare systems (CCG) fixed effect (ν_c) provides the variation across different them. Figure A. 1 shows a wide variation in AED attendance rates ranging as low as 5 % to above 45 %.

Regression results including control variables are shown in Table 2. Column 1 includes only patient characteristics and explains 44 % of the variation in AED attendance. Further adding controls for accessibility of primary care, accessibility to AED, primary care workforce, GP practice contracts and GP practice quality to adjust the local area-level provision of healthcare services (Column 2) increases this to 52 %.

Both models include GP practice-level variables and CCG-level fixed effects to capture variations in AED attendance rates. This design allows us to distinguish between differences attributable to patient demographics and practice characteristics, and those arising from local areas factors, such as local area funding and service availability.

We find that practices with a higher percentage of children, between the ages of 0–4 years, are associated with higher AED attendance rate, compared to practices with a higher percentage of patients in the age group of 15–44 years. An increase of one percent of patients over 65 reduces the practice attendance rate by 0.09 %. Practices with a higher percentage of females have a lower attendance rate, and practices with more unemployed individuals and regular smokers have a higher attendance rate. Practices with a greater percentage of patients living in the lowest (most deprived) income quartile are associated with higher AED attendance rate compared to practices where patients reside in affluent areas. We also found that practices with higher prevalence rates

Table 2
Regression results on AED attendance rate models.

Variables	(1) Including Patient characteristics	(2) Including Patient and GP practice characteristics
GP practice patient list characteristics:		
% Aged 0–4 (Ref: Age 15–44)	0.670***	0.638***
	(0.077)	(0.074)
% Aged 5–14 (Ref: Age 15–44)	−0.027	−0.070*
	(0.045)	(0.043)
% Aged 45–64 (Ref: Age 15–44)	0.036	0.106***
	(0.027)	(0.026)
% Aged 65 plus (Ref: Age 15–44)	−0.096**	−0.074*
	(0.043)	(0.040)
% Female patients	−0.230***	−0.055
	(0.039)	(0.039)
Ethnicity:		
% Mixed (Ref: White)	−0.055	−0.076**
	(0.034)	(0.031)
% Asian (Ref: White)	−0.026***	−0.021**
	(0.009)	(0.008)
% Black (Ref: White)	0.052***	0.024*
	(0.014)	(0.013)
% Other ethnic groups (Ref: White)	−0.083***	−0.057***
	(0.021)	(0.020)
% of Unemployed	0.144***	0.113***
	(0.020)	(0.018)
% Regular smoker	0.118***	0.119***
	(0.016)	(0.015)
Patients living in second least deprived quartile of LSOAs	0.009*	0.008*
	(0.005)	(0.005)
Patients living in second most deprived quartile of LSOAs	0.001	0.005
	(0.005)	(0.005)
Patients living in most deprived quartile of LSOAs	0.028***	0.036***
	(0.007)	(0.006)
Patients living in urban areas	0.016***	0.002
	(0.003)	(0.003)
GP practice disease prevalence:		
Atrial fibrillation	0.331	0.431*
	(0.262)	(0.244)
Cancer	−0.259*	−0.226
	(0.152)	(0.139)
Coronary heart disease	1.019***	0.724***
	(0.184)	(0.170)
Chronic obstructive pulmonary disease	0.693***	0.658***
	(0.144)	(0.133)
Cardiovascular disease-primary prevention (30–74)	0.298**	0.167
	(0.121)	(0.112)
Dementia	0.547***	0.461**
	(0.210)	(0.192)
Depression	0.051**	0.025
	(0.021)	(0.019)
Diabetes mellitus(17+)	0.163**	0.090
	(0.076)	(0.070)
Epilepsy(18+)	2.538***	2.576***
	(0.385)	(0.355)
Heart failure	−0.706***	−0.657***
	(0.248)	(0.226)
Learning disability	−0.622**	−0.516**
	(0.276)	(0.254)
Mental health	3.938***	3.768***
	(0.189)	(0.176)
Obesity	−0.050**	−0.008
	(0.023)	(0.022)
Palliative care	−0.501***	−0.322**
	(0.179)	(0.163)
Rheumatoid arthritis(16+)	1.120***	0.806**
	(0.344)	(0.317)
Accessibility of primary care:	No	Yes
Accessibility to AED:	No	Yes
Primary care workforce:	No	Yes
GP practice contracts:	No	Yes
GP practice quality:	No	Yes
Constant	51.828***	50.298***
	(6.246)	(6.206)
Observations	6505	6277
R-squared	0.440	0.518
Number of CCGs	191	191

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Full results in Table A.4 of the Appendix.

of some health conditions such as coronary heart disease, COPD, dementia, mental health, epilepsy and rheumatoid arthritis have higher AED attendance. While practices where patients with a higher prevalence rate of heart failure, learning disability and palliative care have lower attendance rates.

Better primary care accessibility is associated with lower AED attendance rates. Practices further away from their patients have higher AED attendance rates, while those that provide weekday morning extended hours, have patients satisfied with their ability to see GP the next day and satisfied with GP care have lower attendances. We observed lower attendances for patients whose GP practice is within a 10 km radius of another AED, with the exception of type 4 (Walk-in Centre) and when the GP practice is over 20 km from a type 1 'major' AED unit. Type 1 AED attendance rates decreases when patients are registered at a GP practice nearer to another AED provider. In terms of the workforce, an increase in the number of full-time equivalent GPs (per 1000 patients registered patients) increases attendance and an increase in the proportion of female GP doctors leads to a significant reduction in AED attendances. Attendances are positively correlated with a higher proportion of GPs with a non-European qualification. Practices with the APMS and the APMS by Limited Company contracts also show higher attendance rate. No significant effects were found regarding GP's age. Lower AED attendance rates are associated with better QOF scores for asthma, diabetes, coronary heart disease and heart failure, while better scores for hypertension are associated with increased attendances rate. Practices with higher average life expectancy at birth have lower AED attendance rates.

Taking all controls into account the remaining variation in attendance rates across CCGs is shown in Fig. 1. There remains wide variation CCGs from around 5 % to 35 % attendance.

Overall, our adjusted AED attendance rate estimates are consistent across the two specifications. Full results with all the controls of both model specifications are available in Table A.4 in the Appendix. On the comparison with the estimates between columns (1) and (2) we do not observe any major differences in the reported estimates. The resulting variation across local healthcare systems (CCGs) is also quite similar, as shown in Figures A.1 (in Appendix A) which plots the CCG-specific effects for column (1) from Table 2. The overall robustness of the observed relationships is supported by the data we have used, the Oster test [25] on GP practice characteristics variables suggests some sensitivity to potential omitted variable bias, indicating that unobserved factors could influence the results.

One possible determinant of emergency care relates to the number of doctors available for AED, which is a proxy of capacity. Fig. 2 plots the *adjusted* CCG attendance rate on the *y-axis* and the number of AED doctors per thousand CCG residents as a capacity measure on the *x-axis*. Each point in Fig. 2 can be interpreted as a reflection of the performance of a local emergency healthcare system in terms of the two dimensions – attendance and capacity. We are looking at areas here which have

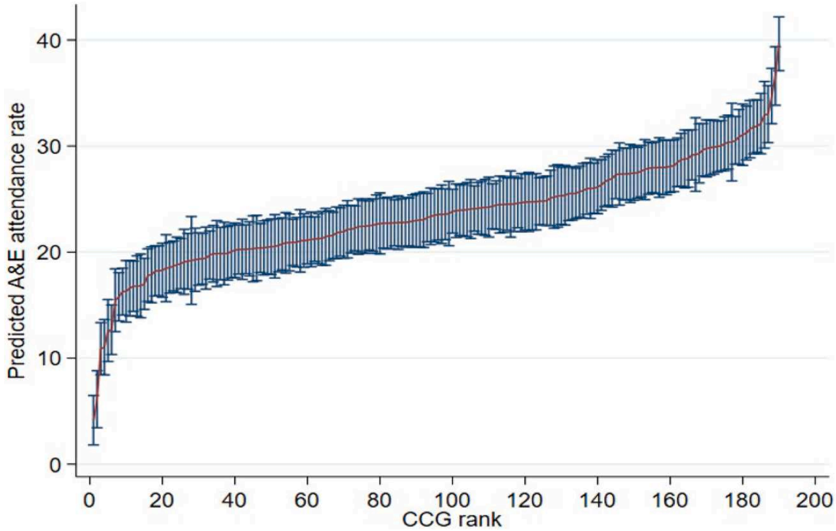

Fig. 1. Adjusted AED attendance rates across Clinical Commissioning Groups (CCGs) (after adjusting for patient, GP practice and accessibility).

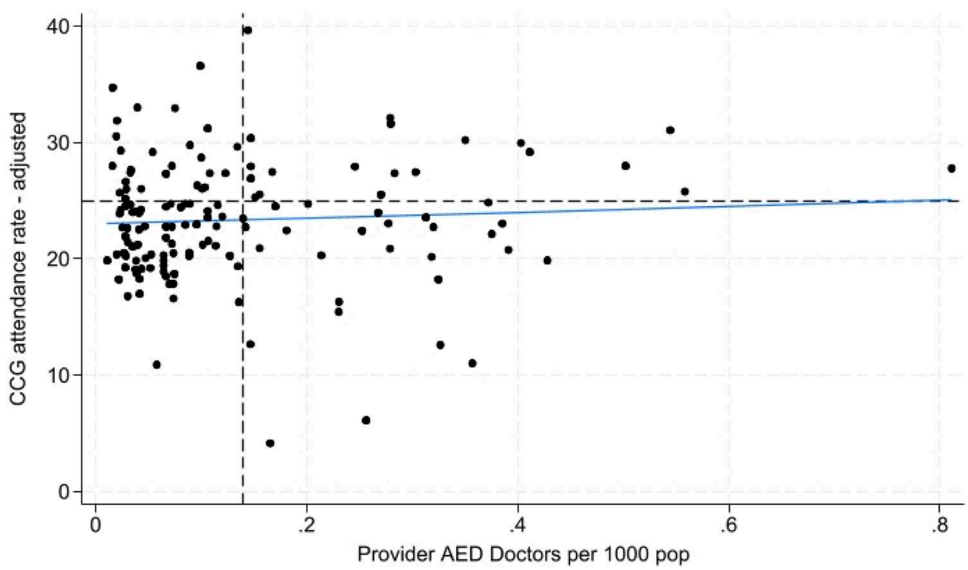

Fig. 2. Scatter plot showing adjusted AED attendance rates and staff.

extensive AED resources reflected in higher numbers of AED doctors and areas where there are fewer resources. The figure is divided into four quadrants, and we observe that systems represented by markers in quadrant one are those that have higher attendances and higher capacity, while systems in quadrant two are those that have very high attendances and make use of fewer hospital resources. In quadrant three, systems have lower than average attendance rates and lower capacity while in quadrant four, they have lower attendances and lots of doctors. As such systems in quadrant two seem to be the most vulnerable and those in quadrant four the least vulnerable. After accounting for capacity, using the proxy of the number of AED doctors, we observe no relationship between the number of AED attendances and the number of doctors per population and this is also confirmed by the regression analysis which demonstrates that there is no correspondence between the number of doctors and the intensity of usage.

4. Discussion

Using English NHS data on Accidents and Emergency Department attendance for 2018/19, we examined how AED attendance varies across CCGs during a pre-pandemic period. Our GP practice level model shows that variations between GP practices (even adjacent ones) serviced by the same AED may not directly reflect AED pressure. However, these differences are essential for understanding the broader factors influencing AED utilisation. By identifying the drivers of these variations, particularly at the GP practice level, our analysis reveals that much of the variation in AED attendance remains unexplained despite accounting for differences between the health risks of the population, accessibility to alternative sources of healthcare and GP practice characteristics which fall under the influence of CCGs. This indicates high variation in AED attendance across different administrative authorities.

The findings about the impact of socio-economic factors on AED attendance are in accord with previous studies. For example, AED use was high for children aged 0–4 years in line with Downing and Wilson [18]. Like them we found no differences with respect to sex when including patient and practice level controls. More deprived neighbourhoods, unemployment, prevalence of smoking, ethnic differences and disease prevalence rates were among the key predictors of higher AED use. This was also found by Scantlebury et al. [17] and Hull et al. [26] along with Harris et al. [27] which found deprivation to be the strongest predictor of AED use. We also found that improved primary care accessibility is associated with lower emergency attendances, consistent with Arain et al. [20]. Similarly, Dolton and Pathania [28] and Bruni et al. [29] found causal evidence in for emergency care in England and Italy, respectively.

Considering a wide range of factors covering the ambit of population and primary care practices, including accessibility and quality of GP services, can explain 52 % of the variation in AED attendances, while 48 % of the residual variation remains unexplained and could be due to differences in local management or system level disparities. The geographic alignment and informal networks between GP practices and local areas may also contribute to this residual variation, suggesting that further research is needed to explore these spatial dynamics. To unpick these local differences and shed light on the divergences in the availability of healthcare resources we plotted the residual variation against the number of AED doctors and found no relationship between the two. It is likely that in areas that have very high utilisation of AED also have a very low number of AED doctors and be under pressure and therefore are less resilient to potential shocks.

During this study period the local healthcare commissioners(CCGs) were responsible for assessing population healthcare needs, deciding priorities and strategies and buying healthcare services on behalf of the population from providers such as hospitals, clinics and community health bodies. These have now been replaced by integrated care boards (ICBs) which cover wider geographical areas. This may warrant further investigation to shed light on the efficiency of healthcare markets in even wider geographical settings and understanding factors that may lead to even larger differences in rates of utilisation and quality of care that are not be explained by patient and practice level elements.

One important caveat to our findings is that we use observable patient characteristics that are available at the GP practice level, but local authorities such as CCGs are much wider areas. Additionally, our analysis does not account for unobservable patient characteristics such as patients' propensity to seek care or the severity of their conditions when attending AED, which could lead to residual variation that we cannot fully account for. Therefore, we may not be able to account for this wider variation in patient-specific features. Furthermore, while the linear regression model is adequate for our goal, other models, such as, beta regression could be a suitable alternative. Smaller GP practices might be disproportionately affected by frequent AED attendees resulting in higher observed variation in AED attendance rates. Although we account for attendances at major (Type 1) AED units, we are unable to differentiate these attendances with respect to urgency. Moulton and Mann [30] shown that not all AED (even those that arrived by ambulance) are severe cases. Easier access to the nearest AED unit could mean that low severity cases also inflate the attendance rate, which can be substituted through alternative local services such as community care or co-located services, thereby creating a mismatch between demand for urgent care and hospital capacity.

Future research could address some limitations identified in our analysis as additional data sources become available. For instance, more detailed information on patient complexity and propensity to seek care could refine our understanding of AED attendance variations, particularly in relation to smaller GP practices. Furthermore, availability of out-of-hospital services including public health, social care, and community care interventions, can be seen as the measure taken by CCGs to alleviate the burden of higher attendances on hospital emergency departments. These measures are generally unobserved but can be viewed as indicators of CCGs investment in greater accessibility to a range of services including primary care and out-of-hospital emergency services in patients' residential areas. Such measures can relieve the burden on providers and free up hospital resources for major cases and thus, improve the resilience of hospital emergency departments. It is also important to highlight that Integrated Care Systems (ICS) / Integrated Care Boards (ICB), which replaced CCGs post-study period, are designed to integrate different sectors, namely health and social care services, which is not solely a matter of geographical boundaries. Future studies should contextualise their analyses within the ICS/ICB framework, which may impact variation in AED attendance and healthcare delivery across regions. Thus, our findings should be viewed within the broader context of evolving healthcare system organisations, and further research should consider the implications of these newer systems.

5. Conclusion

High and rising utilisation of hospital-based urgent care is viewed as problematic internationally. Existing research has established factors associated with greater utilisation. Excessive utilisation could be assisted by targeting those areas where it is most prevalent other things equal. Our results show how much variation in utilisation prevails even after accounting for a large set of controls across geographic administrative units in England. Establishing why some areas are subject to very high utilisation after accounting for population risk factors and alternative urgent care provision is an important policy priority for reducing hospital-based urgent care utilisation.

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CRediT authorship contribution statement

Nikita Jacob: Writing – review & editing, Writing – original draft, Formal analysis, Data curation. **Martin Chalkley:** Writing – review & editing, Writing – original draft, Funding acquisition, Conceptualization. **Rita Santos:** Writing – review & editing, Writing – original draft, Conceptualization. **Luigi Siciliani:** Writing – review & editing, Writing – original draft, Funding acquisition.

Declaration of competing interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.healthpol.2024.105186.

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