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Healthcare utilisation by diabetic patients in Denmark: the role of primary care in reducing emergency visits

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ABSTRACT

Improving the management of diabetic patients is receiving increasing attention in the health policy agenda due to increasing prevalence in the population and raising pressure on healthcare resources. This paper examines the determinants of healthcare services utilisation in patients with type-2 diabetes, investigating the potential substitution effect of general practice visits on the utilisation of emergency department visits. By using rich longitudinal data from Denmark and a bivariate econometric model, our analysis highlights primary care services that are more effective in preventing emergency department visits and socioeconomic groups of patients with a weak substitution response. Our results suggest that empowering primary care services, such as preventive assessment visits, may contribute to reducing emergency department visits significantly. Moreover, special attention should be devoted to vulnerable groups, such as patients from low socioeconomic background and older patients, who may find more difficult achieving a large substitution response.

1. Introduction

The rise of chronic diseases constitutes a serious concern for the financial stability of many public health systems [1–3]. Chronic illnesses are associated with a high demand for healthcare services, including high rates of Emergency Departments (ED) visits that are considered one of the main drivers of increasing healthcare costs. Among chronic diseases, diabetes, with a prevalence of around 8 percent in the population of many high-income countries, poses a serious challenge to health policies aiming at managing the demand for health services.

Preventing ED visits in patients with diabetes goes beyond financial considerations. Diabetic patients experience a noticeable risk of acute episodes related to the insurgence of health complications, including heart disease, chronic kidney disease, and nerve damages that may lead to limb amputation, vision and hearing loss, and mental health issues. Therefore, the prevention of acute episodes of diabetes is a key objectives of health policies aimed at improving population health and also containing healthcare costs.

Studies have shown that diseases management in primary care may reduce the risk of acute complications and ED visits in patients with type-2 diabetes [4–6] achieving similar clinical outcomes to specialized disease management in outpatient setting [5,7,8]. Therefore, a key challenge for the public health system is to improve the management of diabetic patients by directing the demand for healthcare towards less expensive primary care services and to prevent the risk of acute exacerbation of the disease that may lead to ED visits. Achieving this goal is likely to result in higher benefits to patients' health and, at the same time, lower costs to the health system, freeing resources that can be allocate to other health priorities [9].

Moreover, some authors have highlighted a gradient from high to low income in the utilisation of GP services for diabetic patients [10], and the presence of socioeconomic barriers in preventing diabetes related complications [11–13]. However, to the extent of our knowledge, the existing literature has not devoted much attention to the potential impact of socioeconomic status and age on the substitution between primary care and ED visits. Given the increasing role of primary care in the management of patients with type-2 diabetes, it is relevant to produce new evidence on the potential impact of an additional GP visits on the utilisation of more expensive ED visits (i.e., the substitution effect) and how such impact may differ according to patients' socioeconomic characteristics.

The present study investigates this research question by using a

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bivariate econometric model of demand for primary care and emergency second care that allows us to identify the relationship between GP and ED visits after controlling for unobservable confounding effects [14]. We focus on a population of individuals with a clinical diagnosis of type-2 diabetes accessing health services provided by the Danish National Health System (DNHS) between 2012 and 2017. Denmark represents an ideal case study for two main reasons: first, the Danish population shares similar characteristics to other European high-income countries with respect to aging population and prevalence of diabetes; second, the DNHS shares similar characteristics to many public healthcare systems with a universal coverage and free of charge at the point of access, which reduce the confounding effects associated with differences in health insurance and the ability to pay for healthcare.

2. Methods and data

2.1. Methods

In order to estimate the substitution effect between GP care and ED visits, i.e., to what extent one additional GP visit contributes to reduce ED visit utilisation, the researcher has to address the correlation between these two types of healthcare services that makes difficult the identification of the substitution effect. Three main sources of correlation can be highlighted. The first deals with the fact that the past utilisation of a specific type of care may explain the current utilisation pattern. The literature refers to this form of correlation as state dependence [15–17], which may occur either within or between type of healthcare services. That is, it may happen that a GP visit in the previous period requires an additional visit in the current period in case of no improvement in the health conditions (state dependence within), or prevents a ED visit (state dependence between). The second source of correlation is related to unmeasured individual characteristics, such as health status and preferences for health, that may affect both the demand for GP and ED care, and may also change over time as a result of a health shock or a specific treatment. We refer to this correlation as time-varying heterogeneity. Lastly, the third source of the correlation between GP and ED is due to a residual component which is not captured by state dependence or time-varying heterogeneity. That is, there may be some occasional time-specific shocks affecting health conditions, thereby explaining demand for GP and ED care.

We address these three distinct sources of correlation by adopting the Hidden Markov Bivariate Poisson (HMBP) model proposed by [14], which extends the class of finite mixture models for longitudinal (health) count data [16,18,19] to the bivariate case. In our setting, this means that the utilisation of GP and ED visits is conditionally independent and can be jointly modeled by using a discrete distribution of latent states, which is assumed to follow a first-order Markov chain with latent states capturing patients' heterogeneity (i.e., unmeasured health). A detailed description of the model is in [14].

2.2. Data description

We use data from the Danish National Patient Register (DNPR) that collects information on utilisation of healthcare services and clinical diagnoses for all residents in Denmark; the DNPR is then linked to other population registries by using a unique identification number that is assigned to each Danish resident [20]. This allows us to examine the clinical pathway and socioeconomic characteristics of patients with type-2 diabetes, including information on hospital ED visits and GP visits. The latter can be distinguished into *standard face-to-face consultations* at the general practitioner practice, *home visits*, which may occur when the patient is unable to reach the general practitioner practice, and *preventive assessment visits*, during which the general practitioner evaluates the progress of the chronic condition and agrees a set of preventive efforts with the patient, including behavioral changes and pharmaceutical therapies aimed at reducing the risk of complications. We also use a set of indicators measuring the health status of individuals, such as number of comorbidities (i.e., total diagnoses), the risk of mortality measured by the Charlson index, and indicators for the presence of highly prevalent conditions, such as acute myocardial infarction (AMI), cardiovascular disease (CeVD) and cancer. Moving to socioeconomic indicators, we use individual annual income after taxes, level of education classified into compulsory, upper secondary and tertiary education, and living alone status capturing individuals who may have uneasy access to informal care. Lastly, we include a measure of accessibility to emergency secondary care expressed as the travel distance from the individual's place of residence to the nearest ED hospital.

Our study sample consists of a panel of 7,546 individuals with a clinical diagnosis of type-2 diabetes who experienced at least one ED visit in 2012, i.e., the first year of our study. This allows us to use patient-level information including the clinical diagnosis of type-2 diabetes and comorbidities reported during the ED visit, which are likely to affect utilisation of primary and secondary care over the study period. Individuals are followed for five years, from 2012 to 2017, examining their utilisation of GP and ED visits in interval periods of three months. We included individuals aged 40 and over as they are at higher risk of developing the disease.

Table 1 summarizes the characteristics of the study sample. In each interval period, patients experience on average 0.29 ED visits and 2.37 GP visits, with standard face-to-face consultations being the most common type. The majority of the sample (60 percent) are men, the average age is 63.66 years old, 42 percent live alone and the average annual income is 187,833 DKK (about 25,000 Euros). The majority of the sample achieved a compulsory level of education (43 percent) or an upper secondary level of education (43 percent), while only a small share reached a tertiary level (14 percent).

3. Results

3.1. Determinants of healthcare utilisation

Table 2 reports the determinants of healthcare utilisation and the relationship between types of care estimated by our model, including the impact of a GP visit in the past period on the utilisation of GP visits (i.e., state dependence) and ED visits (i.e., substitution effect) in the present period.

Estimated coefficients from the model can be interpreted as semi-elasticities, namely each coefficient shows the percentage variation in the mean of the dependent variable produced by a one unit variation in the independent variable.

In addition, Model II in Table 2 disentangles the effect of different

Table 1
Summary statistics.

Variable Name	Mean	SD
ED visits	0.29	0.80
GP visits	2.37	2.57
standard visits	2.21	2.49
home visits	0.10	0.49
assessment visit	0.11	0.34
female	0.40	-
age	63.66	10.96
living alone	0.42	-
income	187,833.33	580,247.99
compulsory education	0.43	-
upper secondary education	0.43	-
tertiary education	0.14	-
travel time to ED	13.08	10.10
total diagnoses	0.32	1.08
Charlson index	1.69	1.45
AMI	0.07	-
CeVD	0.11	-
cancer	0.05	-

Number of observations = 115,469; Number of patients = 7,546.

Table 2
Estimated coefficients.

	Model I		Model II	
	ED visit	GP visit	ED visit	GP visit
Panel A				
ED	0.1811***	-0.0452***	0.1705***	-0.0448***
	(0.00)	(0.00)	(0.00)	(0.00)
GP	-0.0794***	0.0482***		
	(0.00)	(0.00)		
standard visits			-0.0804***	0.0493***
			(0.00)	(0.00)
home visits			-0.0078	0.0456***
			(0.01)	(0.00)
assessment visits			-0.2812***	-0.0075
			(0.02)	(0.01)
female	0.0203	0.0730***	0.0151	0.0703***
	(0.02)	(0.01)	(0.02)	(0.01)
age	-0.0379***	0.0073*	-0.0359***	0.0065
	(0.01)	(0.00)	(0.01)	(0.00)
age^2	0.0002***	-0.0001*	0.0002***	-0.0001*
	(0.00)	(0.00)	(0.00)	(0.00)
living alone	0.1671***	-0.0214**	0.1618***	-0.0239**
	(0.02)	(0.01)	(0.02)	(0.01)
inc. 2nd quintile	-0.1384***	-0.0378***	-0.1399***	-0.0339**
	(0.02)	(0.01)	(0.02)	(0.01)
inc. 3rd quintile	-0.0796***	0.0217	-0.0764***	0.0246*
	(0.02)	(0.01)	(0.02)	(0.01)
inc. 4th quintile	-0.0258	-0.0030	-0.0306	-0.0017
	(0.02)	(0.02)	(0.02)	(0.02)
inc. 5th quintile	-0.3690***	-0.1213***	-0.3630***	-0.1185***
	(0.03)	(0.02)	(0.03)	(0.02)
upper secondary education	0.0409***	0.0180*	0.0422***	0.0171*
	(0.02)	(0.01)	(0.02)	(0.01)
tertiary education	0.0385*	-0.0176	0.0374	-0.0190
	(0.02)	(0.01)	(0.02)	(0.01)
travel time to ED	-0.0100***	0.0036***	-0.0103***	0.0035***
	(0.00)	(0.00)	(0.00)	(0.00)
total diagnoses	0.3529***	0.0487***	0.3528***	0.0490***
	(0.00)	(0.00)	(0.00)	(0.00)
Charlson index	0.1699***	0.0319***	0.1669***	0.0313***
	(0.00)	(0.00)	(0.00)	(0.00)
AMI	-0.1072***	-0.0473***	-0.0971***	-0.0424***
	(0.02)	(0.01)	(0.02)	(0.01)
CeVD	0.0950***	-0.0130	0.0892***	-0.0119
	(0.02)	(0.01)	(0.02)	(0.01)
cancer	-0.1675***	-0.0571***	-0.1616***	-0.0566***
	(0.03)	(0.02)	(0.03)	(0.02)
Panel B				
α_1	-1.3240***	-0.9744***	-1.3723***	-0.9551***
	(0.21)	(0.13)	(0.21)	(0.13)
α_2	-0.4308**	0.4568***	-0.4426**	0.4831***
	(0.20)	(0.13)	(0.21)	(0.13)
α_3	0.6342***	1.2673***	0.6028***	1.2918***
	(0.20)	(0.13)	(0.21)	(0.13)
Panel C				
λ		0.1866***		0.1684***
		(0.06)		(0.06)

Standard errors are in parentheses. * significant at 10%, ** significant at 5%,*** significant at 1%.

types of GP visits, namely standard face-to-face visits, home visits, and preventive assessment visits. An additional GP visit in the past period (i.e., past three months) reduces the utilisation of ED visits in the present period by about 8 percent (i.e., estimated coefficient -0.0794 in Model I). However, different types of GP visits have different preventive effects on ED visits. Model II, indeed, shows that a preventive assessment visit has a substitution effect of 28.12 percent on ED visits, which is a much larger effect as compared with a standard visit (about 8 percent) or a home visit (less than 1 percent). Such a result can be explained by the specific purpose of the preventive assessment visits that aim to reduce the risks of diabetes related complications. In contrast, home visits are directed to patients who are unable to reach the general practitioner practice due to health related conditions, and who may also find difficult to reach the hospital ED for the same reasons.

We also find evidence of state dependence in the patterns of GP visits utilisation. Model I indicates that an additional GP visit in the past period results in a about 5 percent increment of GP visits in the present period. Model II highlights that such an aggregated effect is mainly driven by the utilisation of both standard and home visits, while preventive assessment visits show no state-dependence effect. This is not surprising as the general practitioner normally arranges a preventive assessment visit to monitor diabetic patients only once a year.

Moving to the impact of socioeconomic characteristics, we find evidence that healthcare utilisation pattern changes with income, with individuals in the top quintile of the income distribution using about 12 percent less GP visits and 37 percent less ED visits than individuals in the bottom quintile. Individuals living alone, who are generally less likely to rely on informal care from other family members, tend to make 2 percent less GP visits and 16 percent more ED visits than other people. In terms of demographic characteristics, utilisation of ED visits decreases with age, while female use about 7 percent more GP visits than male. Individuals with a poor health status, as measured by a high Charlson index and a large number of diagnoses, experience a higher utilisation of both GP and ED visits as expected.

Lastly, the three parameters α in Panel B indicate that our model identifies three distinct types of healthcare users in the study population, with a low, medium and high propensity to use healthcare services. Fig. A1 in the Online Appendix depicts the simulated joint utilisation of the three types obtained using the parameters α. As indicated by the parameter λ in Panel C, utilisation of GP and ED visits are significantly correlated within these three users groups suggesting that the HMBP model is required to model such a correlation [14].

3.2. Heterogeneity analysis

Table 3 reports the estimated coefficients for the relationship between healthcare utilisation and patient socioeconomic status by interacting the GP-visit variable with patient socioeconomic characteristics, i.e., income (Column 1), education (Column 3) and living alone status (Column 4). The estimated coefficients of the interacted terms can be interpreted as a bonus (if positive) or a penalty (if negative) to be added to the coefficient of the baseline group (non-interacted). The GP-visit variable is then unpacked into different types of visits in Column 2. When considering aggregated GP visits, we find no significant socioeconomic gradient in the substitution effect between GP and ED visits (Column 1). However, a significant gradient appears when considering different types of GP visits. In particular, an additional assessment visit reduces the utilisation of ED visit by about 23 percent (i.e., estimated coefficient -0.2312) for individuals in the bottom quintile of the income distribution (the base-line group), while such a reduction is more than double for individuals in the top quintile. This suggests that individual with a high SES are able to achieve a greater preventive effect from their preventive assessment visit than individual with low SES. This could be considered consistent with evidence that the former make fewer GP and ED visits than the latter as shown in Table 2.

We find no significant gradient in the substitution effect with respect to education level and living alone status (Columns 3 and 4). Overall, we find modest differences in state dependence along all socioeconomic dimensions examined, namely an additional GP visit in the past three months increases current utilisation of GP service slightly more for individuals with high income, high education and living alone.

Fig. 1 completes the heterogeneity analysis by showing how the substitution effect of GP visits changes with age for different types of healthcare users, i.e., individuals with low, medium and high propensity to use healthcare services. Specifically, Fig. 1 plots the reduction in number of ED visits that diabetic patients with different ages and utilisation profiles can achieve by making an additional GP visit (per

Table 3
Estimated state dependence and cross effects by some relevant groups.

	1		2		3		4	
	ED	GP	ED	GP	ED	GP	ED	GP
ED	0.1802***	-0.0452***			0.1812***	-0.0451***	0.1805***	-0.0455***
	(0.01)	(0.00)			(0.00)	(0.01)	(0.00)	(0.01)
GP	-0.0841***	0.0418***			-0.0764***	0.0462***	-0.0822***	0.0435***
	(0.00)	(0.00)			(0.00)	(0.00)	(0.00)	(0.00)
GP × inc. 2nd quintile	0.0074	0.0020						
	(0.01)	(0.00)						
GP × inc. 3rd quintile	-0.0021	0.0087***						
	(0.01)	(0.00)						
GP × inc. 4th quintile	0.0184***	0.0109***						
	(0.01)	(0.00)						
GP × inc. 5th quintile	-0.0079	0.0143***						
	(0.01)	(0.00)						
standard visits			-0.0804***	0.0492***				
			(0.00)	(0.00)				
home visits			-0.0076	0.0456***				
			(0.01)	(0.00)				
assessment visit			-0.2312***	-0.0274**				
			(0.04)	(0.01)				
assessment visit × inc. 2nd quintile			-0.0046	0.0147				
			(0.06)	(0.02)				
assessment visit × inc. 3rd quintile			-0.0562	0.0314*				
			(0.06)	(0.02)				
assessment visit × inc. 4th quintile			0.0108	0.0819***				
			(0.06)	(0.02)				
assessment visit × inc. 5th quintile			-0.2748***	-0.0391**				
			(0.07)	(0.02)				
GP × upper sec. edu.					-0.0068	0.0019		
					(0.00)	(0.00)		
GP × tertiary edu.					-0.0020	0.0084***		
					(0.01)	(0.00)		
GP × living alone							0.0058	0.0105***
							(0.00)	(0.00)

Standard errors are in parentheses. * significant at 10%, ** significant at 5%,*** significant at 1%.

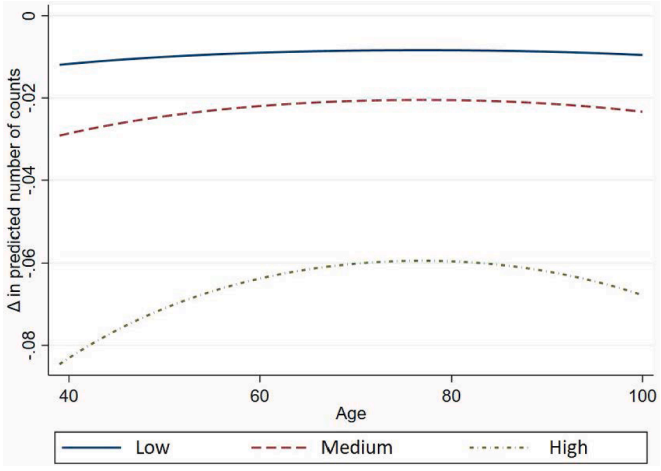

Fig. 1. Estimated average marginal effects of ED and GP visits.

period). We find large differences across different types of healthcare users with the substitution effect of an additional GP visit achieving between -0.08 and -0.06 ED visits for high users of healthcare services, and only -0.03 ED visits for medium users and -0.01 ED visits for low users. We find evidence of a marked age gradient in the group of high users with the substitution effect of an additional GP visit decreasing rapidly with age in the interval 40-60 years old and remaining relatively constant thereafter. A similar age gradient can be found in the group of medium users, while low users show no age gradient.

Fig. A2 in the Online Appendix describes the three types of healthcare users identified in our analysis with respect to their health status (Panel B in Table 2). The left panel plots the correlation between user profiles and health status indicators, i.e., the number of chronic conditions, total comorbidities and the Charlson index. High users have a larger number of comorbidities, suffer from more chronic conditions and have a larger Charlson index than medium and low users. The right panel of Fig. A2 adds further evidence in this direction by showing that the probability of being a high user increases with the total number of comorbidities of the patient.

4. Discussion

The present study produces new evidence on the preventive effect of primary care on utilisation of emergency secondary care in patients with type-2 diabetes in Denmark. We show that advantage of an additional preventive assessment GP visit is a reduction of 28.12 per cent of ED visits per person and per year quarter; with respect to the population of diabetic patients included in our study, this means that a total of 2,461 ED visits could be prevented by an increment of 30,184 preventive assessment GP visits per year.

Our analysis highlights socioeconomic groups, age groups and GP services with the greatest scope for reducing the utilisation of ED visits. We find that patients with a low socioeconomic status and older patients are less capable of reducing the utilisation of ED visits than patients with high socioeconomic status and younger patients. This suggests that future health policies on primary care services for diabetic patients should consider devoting additional attention and resources to these patients to avoid that they are left behind. In this respect, our evidence supports health policies introducing a casemix adjusted capitation payment for general practitioners, including a top-up payment for general practitioner practices with high prevalence of patients from low socioeconomic background and older patients [21].

Our analysis shows that a preventive assessment visit is considerably more effective than a standard GP visit in reducing the utilisation of

emergency secondary care. Preventive assessment visits are recommended to be delivered once a year to all diabetic patients in the general practitioners list, although compliance with such a recommendation is left to the initiative of the general practitioners who are supposed to contact the patient when the visit is due, and also to the patient who is supposed to attend the visit. Over the past decade, Denmark introduced policy interventions for strengthening case management and quality of care of diabetes patients in primary care, although general practitioners participation to some of these initiatives has been weak [22]. In 2011, an electronic monitoring system was introduced to support general practitioners in managing diabetic patients, including performing the assessment visit when due; some evidence showed a positive impact of the policy on ED visits [23], unfortunately the policy was discontinued due to legal issues with the management of the data collected.

Our findings support health policies aimed at improving health outcomes for diabetic patients by empowering the management of the disease in primary care [24] and preventing the insurgence of health complications leading to ED visits, including heart disease, chronic kidney disease, and nerve damages that may lead to limb amputation, vision and hearing loss [25–27]. Also, our findings have implications for health policies aiming at containing healthcare costs by reducing the utilisation of unnecessary emergency care and promoting the utilisation of less expensive primary care [6]. A future study could be devoted to assessing the full economic implications of our finding, which goes beyond the scope of the present study, and it would require costing the clinical pathway that follows a GP visit, including the share of GP visits that result in a referral to specialist secondary care, and comparing it with the cost of the clinical pathway that follows an ED visit, including the share of ED visits resulting in an emergency hospital admission.

The present study contributes to the empirical literature investigating the substitution effect between primary care and emergency secondary care. Many existing studies examined the impact of primary care after the implementation of a new policy that introduces variation in the supply of primary care, for instance by improving accessibility of primary care [28–33], or by introducing financial incentives to improve the quality of health services [4,34–37]. The policy evaluation approach has been the main identification strategy for the impact of primary care, since the introduction of a new policy provides the exogenous variation that allows the researcher to disentangle the effect of primary care from secondary care and unobserved patient heterogeneity. In contrast, our analysis is based on a bivariate econometric model of the demand for healthcare that allows for studying the substitution effect outside a policy evaluation framework, thus extending the scope and flexibility of the analysis. The dynamic hidden Markov approach built in our econometric model offers an alternative tool to the researcher for the identification of the effect of primary care allowing for the confounding effect of unobserved patient heterogeneity and circularity in the effect of primary care and secondary care [14].

Our analysis presents a number of limitations. First, we are unable to examine the substitution effect of primary care on specific types of ED visits, for instance visits for minor conditions or visits for major complications, since the total number of acute episodes experienced by patient per quarter is too low for such a heterogeneity analysis. Second, we do not investigate the mechanisms and channels through which GP visits may affect ED visits. In particular, we do not assess the impact of GP visits with respect to their outcomes, for instance a GP visit may result in a simple medical advice, a treatment prescription, or a prompt referral to specialist care, which may have different preventive impacts with respect to ED visits. Previous studies have investigated several aspects of primary care that can potentially impact ED visits, including the use of economic incentives for general practitioners, the introduction of structured clinical pathways, and adherence to guidelines [24,25,34,37]. Third, our study sample includes diabetic patients who experienced at least one ED visit in the first year of our study; on the one hand this allows us to measure the substitution effect of primary care on a population of users of both primary and emergency services, on the other hand the results of our study may not be generalized to the whole population of diabetic patients including individuals who have never used emergency services. Finally, our study considers access to primary and secondary care services in Denmark and may not be generalized to other countries with different healthcare systems.

5. Conclusion

Diabetes is one of the most prevalent chronic disease in high-income countries leading to a number of complications with serious consequences for patients and healthcare systems. In Denmark, the prevalence of diabetes is estimated to increase each year by about 10,000-20,000 new patients and that about 7 percent of the total health service budget fund expenditures related with diabetes complications [38]. With such projections, the prevention of diabetes related complications and the reduction of utilisation of emergency care are high priority objectives in the health policy agenda. The present study contributes to the existing literature highlighting the importance of empowering primary care services and supporting vulnerable patient groups as valuable tools for achieving these targets.

Using a rich longitudinal dataset from Denmark and a bivariate econometric model of the demand of healthcare, we examined to what extent primary care services are effective in preventing ED visits among different socioeconomic groups of patients. Results indicate that some primary care services, such as preventive assessment visits, may contribute to reducing ED visits significantly. However, this substitution effect is heterogeneous across different groups of patients, such as patients from low socioeconomic background and older patients, who may find more difficult achieving a large substitution response. Our analysis yields novel information that may support policymakers in understanding the relationship between GP and ED visits and shaping new policy interventions.

Declaration of competing interest

None.

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Supplementary material

Supplementary material associated with this article can be found, in the online version, at 10.1016/j.healthpol.2024.105079

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