Original Research

Better Together? A Mediation Analysis of French General Practitioners' Performance in Multi Professional Group Practice

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Abstract

Background: Integrated primary care teams remain a debatable policy in family medicine that could be a convenient response to French shortages in medical density.

Objectives: To analyse how general practitioners (GPs) respond to insufficient GP supply in their practice area in terms of quantity and quality of care, and how this response is mediated by enrolment in integrated primary care teams – multi-professional group practices (MGPs).

Methods: We used structural equation modelling on 3 representative cross-sectional surveys (2019-2020) of 1209 French GPs. Quantity and quality of care were approximated by latent variables comprising respectively GPs' demand absorption capacity and frequencies of vaccine recommendations.

Results: In the absence of potential mediators, low GP density was negatively associated with quantity (−0.221, unstandardized direct effects), but not with the quality of care. In the presence of mediators, low GP density was associated with higher work-related stress (0.120), which was consecutively associated with deteriorated demand absorption capacity (−0.202). Higher use of e-health tools was associated with greater involvement in vaccine recommendations (0.357). GPs in MGPs tended to use more e-health tools than those practicing outside MGPs (0.032), with a favourable effect on vaccine recommendations.

Conclusion: Lower level of work-related stress is the key mediator in handling patients' requests. When correcting for self-selection into MGPs, we found no significant mediation effect of enrolment in MGPs on the quantity of care but rather an effect on the quality of care. Our results pinpoint an added value of an enrolment in an MGPs to care quality that advocates for its further development.

JEL Classification: I14, I18

Keywords

general practitioners, medically underserved area, integrated care, primary care teams, France

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Introduction

Primary care remains an important concern for the policy-makers, as emphasized by the 2018 Astana declaration following the Global Conference on Primary Health Care, which celebrated the 40th anniversary of the Declaration of Alma-Ata.[1] Resulting from this meeting, the 2019 Global Monitoring Report on progress on universal health coverage[2] indicates that reorganization of care provision, and especially the improvement of primary care coordination is one of the key strategies to tackle the inequalities in access to primary care and achieve universal health coverage.

As other developed countries, France is currently facing a shortage of primary care workforce, due to mass retirement of self-employed general practitioners (GPs) that are ensuring more than 90% of primary care associated with population growth and population ageing as well as lack of anticipation of this demographic evolution.[3]

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According to the French Ministry of Health, the number of GPs is supposed to decline at least up to 2026. Once adjusted for healthcare demand, the 2021 GP density level should be attained once again by 2036.

In the meantime, there is an obvious trend towards the integration of primary care providers: in 2010, 54% of GPs indicated practicing in a group practice; there were already 61% in 2019.[4] However, the majority of these practices share solely their physical locations and/or back-office functions.

In France, several integrated primary care models currently coexist, with different degree of integration and territorial coverage. Key initiatives include multi-professional primary care group practice ('*maisons de santé pluriprofessionnelles'*, MGP), primary care teams ('*équipes de soins primaires*'), and territorial professional health communities ('*communautés professionnelles territoriales de santé*'). While more recent initiatives, such as territorial professional health communities, aim to integrate a wider range of actors across a territory, MGPs remain key players in local primary care delivery and represent the most advanced form of integrated primary care teams currently available. Similar models of practice exist in other countries, such as *Gesundheitszentren* and *Medizinische Versorgungszentren* in Germany, *Gezondheidscentra* in the Netherlands, and *Maisons médicales/Wijkgezondheidscentra* in Belgium. Comparable structures are also found in the US (Community Health Centres and Patient-Centred Medical Homes) and Canada (Community Health Centres and Family Health Teams).

The MGPs are created voluntary by the health professionals with the minimum requirement of 2 full-time equivalent GPs and 1 paramedic (most often nurses),[5] and might receive funding (on project engineering, operating costs or building costs) from the Social Security or regional councils conditional on their location in underserved areas.[6] MGPs are usually managed autonomously by the healthcare professionals themselves, who remain self-employed and, with some exceptions, continue to be paid individually through a fee-for-service system. Introduced in 2007 and promoted as a solution to GP shortages by offering a wide range of primary care services in one location by policymakers, this policy has gained significant popularity among GPs. By 2020, over 1 300 MGPs were actively operating in France, a substantial increase from the fewer than 20 in 2008.[7] The primary goal of MGPs is to ensure that patients receive comprehensive care through the coordinated efforts of the enrolled professionals. As a proof of this coordinated practice, participating health professionals are required to draw up a so-called 'health project', tailored to specific population needs in their catchment area, for example, chronic care management or extra prevention efforts. Another advantage of MGPs is their potential to enhance the attractiveness (greater presence of peers, leading to more favourable workforce trends and demographic prospects) of and improve retention rates in medically underserved areas.[7]

In the context of shortage of care provision in GPs' practice area, one possible adjustment choice is to integrate or establish an MGP (or a similar multiprofessional team), which facilitates the delegation of certain tasks between doctors and other health professionals, for example, nurses. The literature indicates that integrated primary care teams designed to foster substitution, for example, between GPs and nurses,[8] can increase time that GPs spend with patients. Conversely, when the teams are designed with a logic of complementarity, they rather impact the quality of care provided.[9] Policymakers often promote multiprofessional teams and task delegation as a strategy for achieving cost containment.[10]

Current literature mostly demonstrates improvements in the quantity of care provided in integrated healthcare teams, for example, longer patient lists and more home and office visits.[11-15] However, evidence is mixed and scarce regarding the gains related to integrated practices in terms of quality of care (possibly because quality is difficult to measure, particularly for newer, patient-centred approaches, where discrepancies between patient-reported outcomes and GPs' perceptions exist.[16]

The literature typically distinguishes two other types of policies aimed at tackling GPs' local shortage.[17] First, interventions aimed at adjusting the number of future graduates, with a significant focus on the so-called 'rural pipeline', that is, the observation that individuals with rural origins or prior professional experience in rural areas are more likely to choose rural practice location. While these interventions have proven to be quite effective,[18-26] they require a significant amount of time to yield results. The second array of measures concentrates mostly on providing pecuniary and/or non-pecuniary incentives to relocate the workforce. However, financial incentives alone often have limited efficiency[27-30] and may occasionally result in windfall effects.[31] The effectiveness of these measures is also constrained by GPs' willingness to relocate: for instance, less than 10% of French GPs relocate after they have established their first practice.[32,33] For these reasons, combining pecuniary and non-pecuniary incentives has shown more promising, albeit still limited, outcomes.[18,34] Thus, on paper, the reorganization (integration) of care appears to be the most logical solution to address the GP shortage, particularly in the short to mid-term.

This paper contributes to this literature exploring the impact of existing variability in GPs' accessibility both on quantity and quality of care using data from a representative panel of 1209 French self-employed GPs. In addition, we sought to provide evidence on the efficiency of the MGP policy by estimating the mediation effect of MGP enrolment on quantity and quality of primary care provided. To our knowledge, this is the first study to analyse the effects of GP density on quantity and quality of primary care using mediation analysis, which allows to disentangle indirect and direct effects of GP density and provide insight on how MGP policy might affect quantity and quality of care provided, which contributes to ongoing debate on the efficiency of MGPs. To preface our results, we provide limited evidence on the efficiency of the MGP policy – at least the way it has been implemented in France.

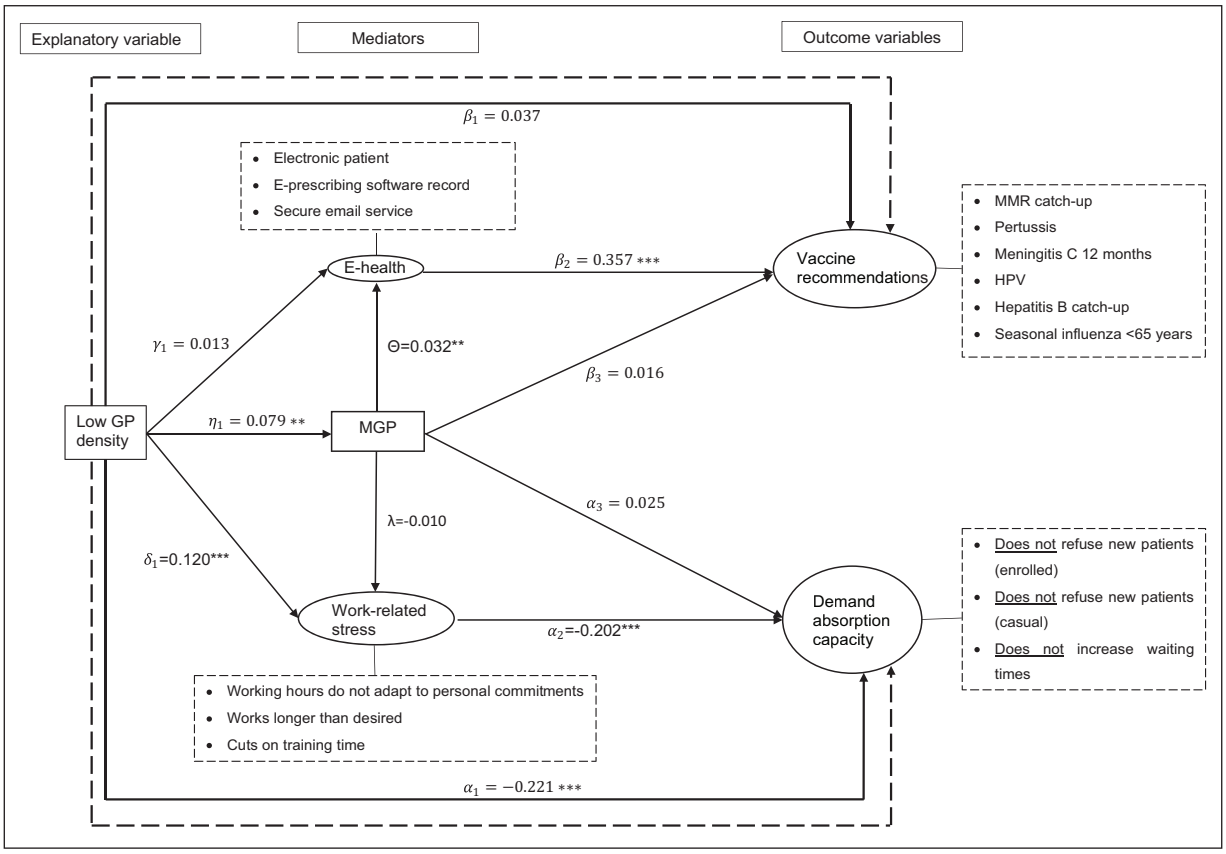

Figure 1. The direct and indirect effects between GP density and quantity and quality of care. Unstandardized effects of paths on demand absorption capacity and vaccine recommendation frequency (Model 2, n = 1010).

Latent variables (factors) are represented by circles, and measured variables (items) by rectangles; arrows point in the hypothesized direction of influence. The total effect of low GP density on quantity (DV1) and quality of care (DV2) is represented by dashed arrows. The effect of low GP density on each potential mediator is represented by paths δ_1, γ_1 and η_1. The effect of potential mediators on quantity and quality of care is represented by paths α_2, β_2, α_3 and β_3. The direct effect, that is, the effect not explained by the use of mediators, of low GP density on quantity and quality of care is represented by paths α_1 and β_1.

Regression results, *P* value: $^*P < 0.1$. $^{**}P < 0.05$. $^{***}P < 0.01$. Non-weighted data. Coefficients are estimated from linear regression equations. Model was adjusted for age, gender, deprivation index and occasional practice of complementary medicine. Latent variables (factors) are represented by circles, and measured variables (items) by rectangles; arrows point in the hypothesized direction of influence.

Goodness of fit interpretation: Root mean squared error of approximation (RMSEA): $0 \leqslant \text{RMSEA} < 0.05$ (close fit), $0.05 \leqslant \text{RMSEA} < 0.08$ (acceptable fit); Comparative fit index (CFI) > 0.90; Tucker–Lewis index (TLI) > 0.90; Standardized root mean squared residual (SRMR): $0 \leqslant \text{SRMR} < 0.05$ (good fit), $0.05 \leqslant \text{SRMR} < 0.10$ (acceptable fit).

Goodness of fit: RMSEA = 0.029; CFI = 0.926; TLI = 0.902; SRMR = 0.031; $R^2 = 0.462$.

Conceptual Framework

We start by arguing that low GP density might hinder both the quality and the quantity of care provided. This section presents the conceptual framework (based on relevant literature) that sheds light on the potential mechanisms, both direct and indirect, that might explain this relationship. Following this theoretical framework, we were inclined to assess the following chain of pathways (Figure 1): low density leads to (1) increase in work-related stress that influences GPs' productivity and (2) higher use of e-health tools, that in turn improves the quality of care provided. We then add (3) enrolment in MGP as an 'opening' mediator that influences both the other two mediators and the outcome variables.

Extensive literature documents higher workload for GPs practicing in rural or remote areas.[35-38] In addition, higher workload might result in shorter consultation length.[39,40] Growing literature points out work-related stress as one of the important mediators of the GP productivity.[41,42] According to a recent French study in the Upper Normandy region, GP density below 7.75 per 10 000 inhabitants is positively correlated with all of three dimensions (emotional exhaustion, depersonalization and personal accomplishment) of Maslach Burnout Inventory.[43,44] Wallace *et al*[42] also argue that lack of GPs is one of the reasons for their professional burnout. Overall, GPs have been found to have relatively important levels of burnout: two recent literature reviews indicate that the burnout prevalence is around a third among the GPs.[45,46] Higher levels of burnout are in turn associated with suboptimal productivity.[42,46] Recent studies that took place during the Covid-19 pandemic indicate that work-related stress among healthcare professionals was entirely due to subjective factors, that is, the perceptions of their working conditions.[47] This motivated our decision to use the perceived density indicator as the starting point of the framework.

Empirically, practice in underserved areas is frequently associated with worse patients' health outcomes obtained from the use of primary care services, especially regarding time-consuming activities such as prevention.[48-50] This is precisely the case for vaccination activity, in which GPs may play a key role in many countries.

In France, vaccination coverage remains suboptimal, especially against seasonal influenza[51] and human papillomavirus,[52] while almost half of the population is vaccine-hesitant.[53,54] Moreover, a quarter of GPs declare that some of the recommended vaccines are not useful.[55] In France, GPs prescribe 90% of all purchased vaccines.[55] While most GPs are supportive of vaccination, those practicing complementary medicine are known to be more hesitant.[56] Other known factors that might influence GP' vaccine recommendation behaviour include distrust in public health institutions and concerns about vaccine safety.[55,57] This is the reasoning that motivated our choice of using the frequency of vaccine recommendation as a proxy for the quality of care.

While the evidence is mixed, expanding literature suggests that e-health solutions, for example, use of electronic health records combined with automated reminders, might be a convenient tool to improve the vaccination rates from 5 up to 20 percentage points.[58-61] For example, an US study indicates that introduction of automated reminders within the electronic health record significantly improves the pertussis postpartum immunization rate.[62] Two recent literature reviews reveal greater levels of HPV vaccine initiation and completion using communication technologies, including electronic health records.[63,64] Another review[65] pinpoints an important increase (19%) in seasonal influenza in adult patients and a smaller, but still significant, increase in paediatric patients associated with the use of e-health tools.

Greater use of e-health tools is also promoted to bridge inequalities in access to primary care.[66,67] The implementation of e-health technologies, and especially, telemedicine has been even more encouraged since the beginning of Covid-19 pandemic, both by the patients and the health authorities.[68,69] In addition, use of e-health tools appears cost-saving due to better administrative efficiency.[70]

Finally, as mentioned above, French policymakers have designed the MGP policy to attract and retain GPs in the underserved areas.[6] Interprofessional collaboration is supposed to deal with both the quantity and the quality of care provided. On the one hand, it is beneficial to the GPs well-being and is supposed to reduce their workload due to better practice organization.[15,71] On the other hand, better coordination and proximity with specialists and other health professionals allows to improve the quality of care, especially for the patients with complex needs.[15,72-74] Recent empirical evidence using staggered difference-in-differences approach[8] also suggests that task-shifting in integrated primary care teams might free up more time for GPs to spend with patients, allowing them to focus on more time-consuming tasks such as prevention, that is one of the popular 'public health projects' of health professionals in MGPs and similar structures. These points suggest that the practice in an integrated care setting is an 'upstream' (opening) determinant of both the quantity and quality of care. Nonetheless, GPs might have diverse attitudes towards cooperation and prescriptions management with specialists and other health professionals.[75]

This is the theoretical framework which will be evaluated by using an appropriate statistical analysis (see next section).

Materials and Methods

Study Population

We used data from the fourth round (2018-2022) of a national panel survey of French self-employed GPs, designed to collect information about GPs' medical behaviours, working conditions and opinions on public health policies.

The study population included all self-employed GPs practicing in mainland France and overseas departments (except Mayotte; Figure 2). Participating GPs were randomly selected from exhaustive French National Registry of Health Care Workers (RPPS) as of January 1st, 2018. The RPPS data was further matched with the National Health Insurance fund (*Assurance Maladie*) data on number of office consultations and home visits made in 2017 and number of patients for whom the physician acts as a gatekeeper. This process identified 59 765 GPs practicing at least part-time as self-employed in 2017. We then excluded GPs with fewer than 200 patients as gatekeepers, resulting in a final sample frame of 48 642 GPs.

Sampling was stratified for gender, age (<50 (Q1 of age distribution in the GP population in France at the time of inclusion), 50-59 (Q2-Q3), 60+(Q4)), workload (annual number of office and home visits in 2017; Q1, Q2-Q3, Q4) and GP density of practice area (<2.8 consultations available per patient per year (lowest 10% of national GP density distribution), ⩾2.8 consultations).[76] The survey is representative of GPs practicing in France (except Mayotte), for the stratification variables. We excluded GPs practicing alternative medicine full-time or those planning to retire or to move before the end of data collection.

The initial sampling was conducted with the aim to interview approximately 2350 GPs in the third (median) wave of the survey.[77] To calculate the number of GPs to contact, we used information from the previous panel on attrition rates, response rates, and the proportion of out-of-scope cases. Thus, 12 022 eligible GPs were contacted, and 3304 (27%) completed the inclusion questionnaire and undertook to answer 6 future cross-sectional surveys (1 every 9 months).

The sample benefits from the French 'public statistics' label of the National Authority for Statistical Information (*Conseil National de l'Information Statistique n° 114/H030*) that confirms the quality of the processes used to produce the data and their compliance with the best practices, for example, the burden that the survey implies for the subjects and the degree of consultation with users.

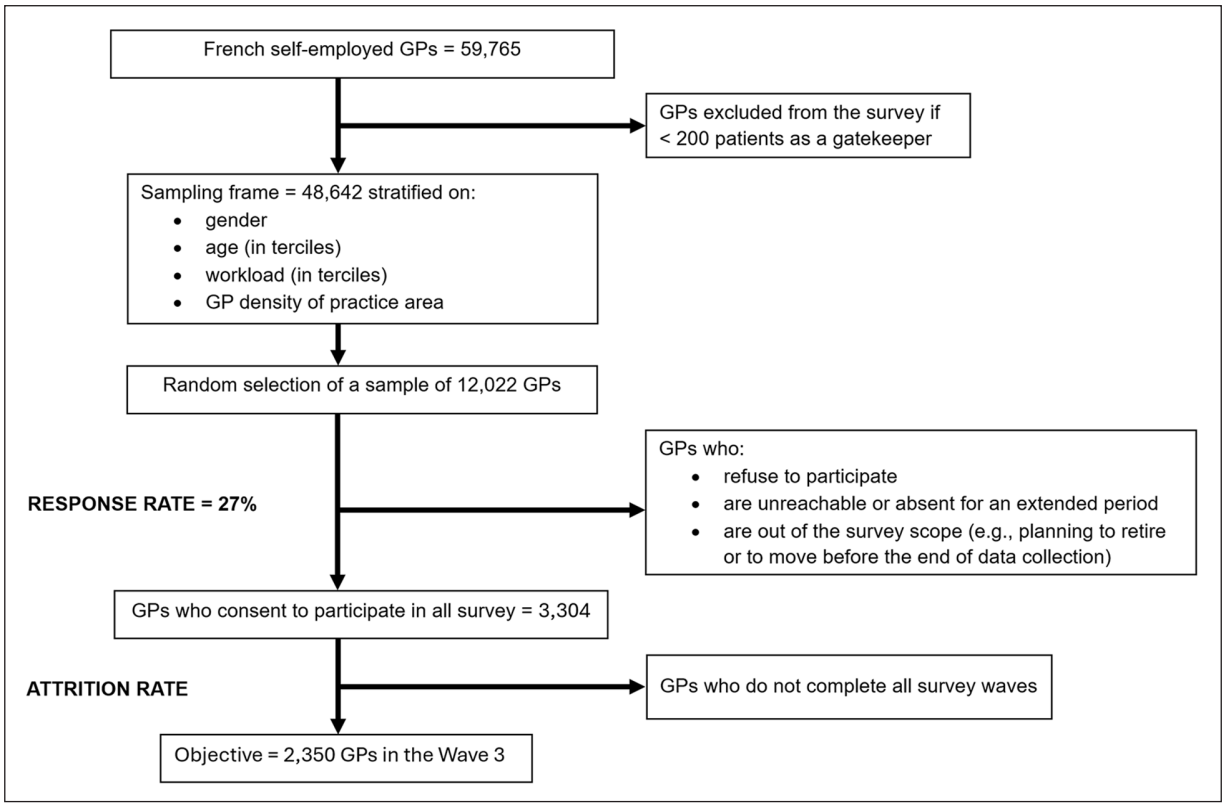

Figure 2. Flow diagram of the sample design.

Procedure and Questionnaire

We exploit 3 waves of the survey with data collected respectively between October 2018 and April 2019 (first questionnaire), December 2019 and March 2020 (dummy variable described below) and October 2020 and November 2020 (second questionnaire; see Supplemental File). All the questionnaires were developed by multidisciplinary groups of experts that included practicing GPs. Each wave was supervised by an expert committee – '*Comité de vague*' – composed of GPs, public health experts, representatives from the French Ministry of Health and social scientists). The questionnaires were based on extensive literature reviews as well as on questionnaires used in previous editions of the panel[78,79] and pilot-tested for clarity and face validity. Data collection was conducted either online or through professional interviewers, who received training to administer the questionnaires using computer-assisted telephone interviews. GPs received compensation equivalent to 1 consultation fee (25 euros) for their participation in each survey.

First questionnaire dealt with GPs' perceptions regarding the evolution of availability of medical services in their practice area. More precisely, it collected information about (1) their perception of the GP density of their practice area (from 1 = very insufficient to 4 = completely sufficient); (2) perceived difficulties when dealing with patients' requests (3 items): whether these difficulties resulted in refusing new patients (both enrolled or casual) or increasing waiting times; (3) work-related stress (3 items): whether the working hours adapted well to their personal commitments, they worked longer than desired or cut on training time and (4) use of e-health tools (3 items): electronic patient records, e-prescribing software and secured email service. We constructed a dummy variable to isolate the GPs reporting a practice in an area with 'very insufficient' GP density.

In an alternative specification described in the next section, we also use questions related to GPs' motivations for choosing their current practice location (5 items): healthcare services available in the area, the possibility of creating or joining a group practice, the search for an area with low GP density, available amenities for the GPs' families, and a previous experience as an intern, locum, or associate in the area. Respondents could select multiple items simultaneously.

Second questionnaire addressed GPs' self-reported vaccine recommendation frequency (1 = never-4 = always) in 6 specific vaccine situations, referring to specific populations cited below, chosen because their current vaccination coverage rates in France do not meet official public health objectives: (1) measles, mumps, and rubella for non-immune adolescents (catch-up), (2) pertussis in the immediate postpartum period for new mothers who did not receive a dose prior to their pregnancy, (3) meningococcal C for 12-month-old infants, (4) human papillomavirus for children aged 11 to 14, (5) hepatitis B for adolescents (catch-up) and (6) seasonal influenza for adults under 65 with chronic condition.

We use a dummy variable indicating GPs reporting enrolment in MGP. GPs were also asked about their (part-time) practice of alternative medicine, for example, homoeopathy and acupuncture.

Table 1. Sample characteristics, national panel of French GPs (n = 1209).

%	n	Total	MGP
Perceived low GP density			
Very insufficient	1184	21.59	29.47**
Rather insufficient		47.66	40.94**
Sufficient		25.25	24.97**
Completely sufficient		5.50	4.62**
MGP	1137	11.69	-
Age			
<50	1209	33.68	48.97
50-59		40.67	34.72
60+		25.65	16.31
Female	1209	39.13	40.62
Occasional practice of complementary medicine	1205	15.83	15.62
French DEPrivation index > 0	1209	56.44	69.87***
Work-related stress			
Working hours do not adapt well to their personal commitments	1198	40.96	42.76
Works longer than desired	1194	70.70	76.01
Cuts on training time	1194	43.10	49.03
Use of e-health tools			
Uses electronic patient records	1189	91.59	99.66***
Uses e-prescribing software	1172	84.53	93.77***
Uses secure email service	1188	91.49	98.87***

Source: DREES, ORS and URPS Provence-Alpes-Côte d'Azur and Pays de la Loire, 4ème Panel d'observation des pratiques et des conditions d'exercice en médecine générale de ville.
Abbreviations: GPs, general practitioners; MGP, multi-professional group practices.
Weighted data.
P value: *$P < 0.1$; **$P < 0.05$; ***$P < 0.01$.

We also enriched the survey data by the French Deprivation index (FDEP) calculated at the municipality level in 2015.[80] This score was constructed by the French National Institute of Health and Medical Research (Inserm) from National Institute of Statistics and Economic Studies (Insee) data on 4 dimensions: (1) the unemployment rate in the active population aged 15 to 64; (2) the percentage of blue-collar workers in the active population aged 15 to 64; (3) the percentage of high school graduates in the population aged over 15 years old and (4) the median income per consumption unit. The FDEP index varies between −4 and 4: the higher the score, the greater the deprivation. We used a dummy variable to isolate the most deprived municipalities (with positive FDEP index).

Statistical Analysis

For the descriptive analyses, data were weighted to match the nationwide GP population in terms of stratification variables to correct for possible systematic non-response bias.

We used confirmatory factor analysis (CFA) to construct 4 latent variables of interest: (1) difficulties when dealing with patients' requests (*demand absorption capacity*, a proxy of quantity of care, DV1), (2) self-reported vaccine recommendation frequency (a proxy for quality of care, DV2), (3) work-related stress (mediator 1, M1) and (4) use of e-health tools (mediator 2, M2). Full list of variables used to construct the latent variables is presented in Tables 1 and 2. The results of CFA are available in Table A1.

We draw on the conceptual framework described above to motivate our mediation analysis. We assumed that low GP density influences GPs' work-related stress (M1) as well as their use of e-health tools (M2) and ultimately the quantity of care (DV1) and the quality of care (DV2; Model 1; see Appendix 1 for details of the empirical strategy).

The issue of the potential endogeneity of variables (MGP in particular) due to omitted variables is addressed through the inclusion of adequate controls (age, gender, workload, positive FDEP index, and occasional practice of complementary medicine) in the multiple-stage least squares analysis (since instrumental variables method is not recommended to deal with omitted variables, as it would require a specific instrument for each link assessed in the SEM). The risk of reverse causality is handled by the outline of the structural equation modelling.[81-83] For example, note that in our case (Model 2) the endogeneity of practice in MGP to GP density is included in the structural modelling, with the reverse causality excluded (that practice in MGP causes GP density to decline, which is not a plausible assumption). However, we do provide the results that include bidirectionality between practice in MGP and GP density (the causality flows both ways) as a robustness

Table 2. Dependent variables, national panel of French GPs (n = 1209).

Demand absorption capacity, %		n	No		Yes	
Does not refuse new patients (enrolled)	Total	1194	55.62		44.38	
	in MGP	1126	49.88		50.12	
Does not refuse new patients (casual)	Total	1194	42.97		57.03	
	in MGP	1126	48.60		51.40	
Does not increase waiting times	Total	1194	53.66		46.34	
	in MGP	1126	67.61***		32.39***	
Vaccine recommendations, %		n	Never	Sometimes	Often	Always
Measles, mumps, and rubella for non-immune adolescents (catch-up)	Total	1193	1.42	13.80	24.90	59.89
	in MGP	1121	0.18	14.81	21.30	63.71
Pertussis in the immediate postpartum period for new mothers who did not receive a dose prior to their pregnancy	Total	1174	7.73	10.76	20.05	61.46
	in MGP	1104	5.01	10.81	22.27	61.90
Meningococcal C for 12-month-old infants	Total	1187	1.19	6.80	12.17	79.84
	in MGP	1116	0.37***	2.33***	6.03***	91.27***
Human papillomavirus for children aged 11 to 14	Total	1194	3.31	14.85	42.26	39.58
	in MGP	1122	3.15	7.82	41.10	47.93
Hepatitis B for adolescents (catch-up)	Total	1199	1.97	23.25	37.10	37.68
	in MGP	1127	2.20	21.71	39.54	36.56
Seasonal influenza for adults under 65 with chronic condition	Total	1203	0.09	6.71	37.88	55.31
	in MGP	1131	0.18	5.75	40.29	53.78

Source: DREES, ORS and URPS Provence-Alpes-Côte d'Azur and Pays de la Loire, 4ème Panel d'observation des pratiques et des conditions d'exercice en médecine générale de ville.
Abbreviations: GPs, general practitioners; MGP, multi-professional group practices.
Weighted data.
P value:*$P < 0.1$; **$P < 0.05$; ***$P < 0.01$.

check. We also test a model that includes the effects of work-related stress on quality of care and that of use of e-health tools on quantity of care.

To provide additional robustness checks and reinforce the evidence, we also run another specification where, in addition to previously described control variables, we included a set of dummy variables regarding GPs' motivations for choosing the current practice location (as detailed in Zaytseva *et al.*[5]). This strategy represents, in our view, an initial attempt to address the potential endogeneity of MGP status (see results in Appendix 3). A second strategy to address endogeneity, as suggested by the reviewer, involved implementing a balanced control-group/treatment-group design using a matching method as a pre-processing step (Appendix 4). In the first step, coarsened exact matching (CEM) was applied, based on the previously described set of control variables, to account for enrolment in MGP. In the second step, we conducted the SEM analysis using the previously defined framework (as presented in Figure 1) on the matched samples, MGP versus non-MGP practices.

Model fit was assessed by the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the standardized root mean square residual (SRMR). Models with $CFI > 0.90$, $TLI > 0.90$, $RMSEA < 0.08$ and $SRMR < 0.08$ were considered to fit reasonably or well.[84]

All analyses were based on two-sided *P*-values and conducted with Stata 14 (StataCorp. College Station, Texas). We used the STROBE cross sectional checklist when writing our report.[85]

Results

Summary Statistics

Out of 3304 GPs who completed the inclusion questionnaire, 3076 (a response rate of 93% compared to the inclusion wave) responded to the first wave used in this study (collected from October 2018 to April 2019), 2412 (73%) to the second wave (December 2019 and March 2020), and 1209 (37%) to the last wave (October 2020 and November 2020). When comparing respondents of the last wave according to stratification variables, male or older GPs, as well as those with the highest workload were among those who did not participate in the last wave ($P < 0.01$ for all 3 variables). There was no significant difference regarding GP density of practice area.

Of 1209 French GPs still enrolled in 2020, 40% of GPs were female, about a third were younger than 50 years old (Table 1). Twelve percent were enrolled in an MGP and 15% occasionally practiced complementary medicine.

Twenty-one percent reported that they practiced in an area with very insufficient GP density and 48% declared practicing in an area with insufficient GP supply. When compared to objective indicator of practicing in an underserved area, that is, an area where a patient could have had access to less than 2.8 consultations per year, that corresponds to lowest 10% of national GP density distribution, among the GPs that were objectively practicing in an area with very insufficient GP supply, only 38% had the matching perception. This justifies the use of the dichotomized (very insufficient, other) indicator of perceived density.

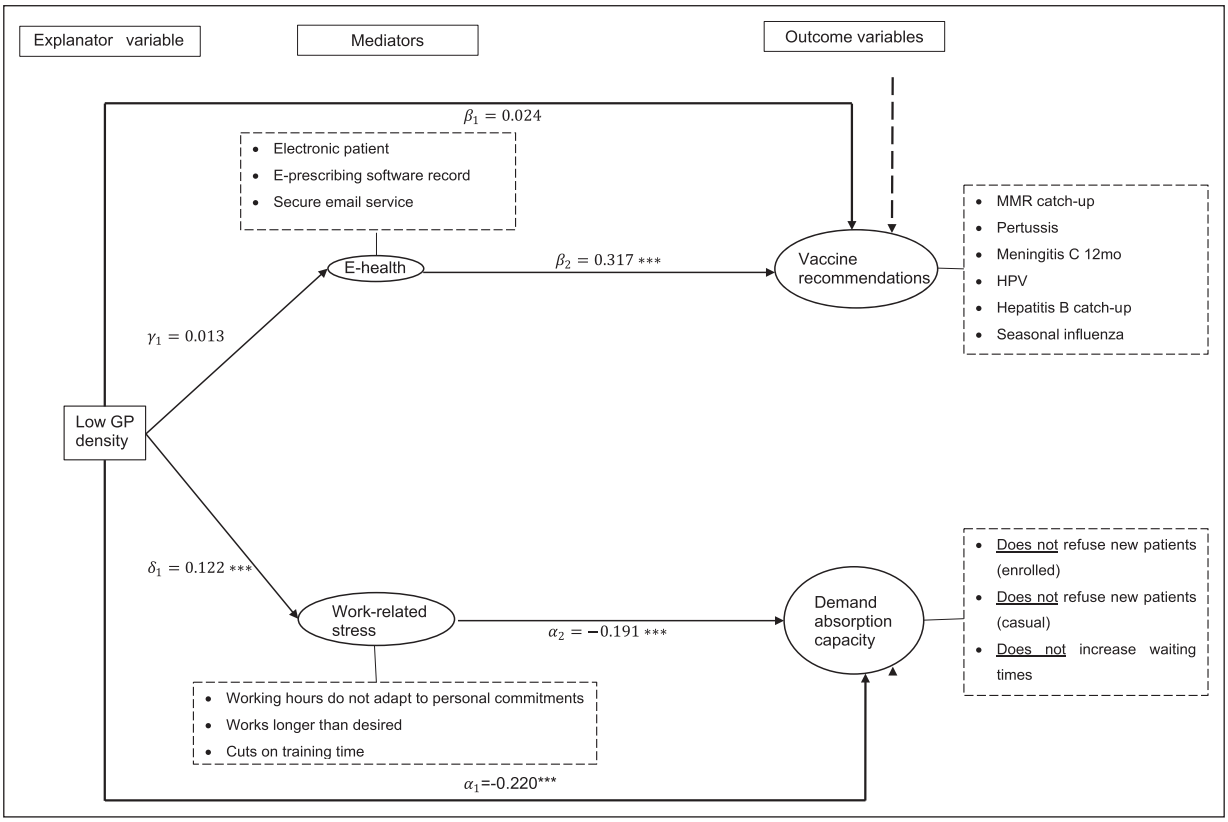

Figure 3. Unstandardized direct effects of paths of the multiple mediation model on demand absorption capacity and vaccine recommendation frequency (Model 1: n = 1070).
Non-weighted data. Coefficients are estimated from linear regression equations.
Model was adjusted for age, gender, deprivation index and occasional practice of complementary medicine. Latent variables (factors) are represented by circles, and measured variables (items) by rectangles; arrows point in the hypothesized direction of influence.
Goodness of fit interpretation: Root mean squared error of approximation (RMSEA): $0 \leqslant RMSEA < 0.05$ (close fit), $0.05 \leqslant RMSEA < 0.08$ (acceptable fit); Comparative fit index (CFI) > 0.90; Tucker–Lewis index (TLI) > 0.90; Standardized root mean squared residual (SRMR): $0 \leqslant SRMR < 0.05$ (good fit), $0.05 \leqslant SRMR < 0.10$ (acceptable fit).
Goodness of fit: RMSEA = 0.028; CFI = 0.933; TLI = 0.915; SRMR = 0.030; $R^2 = 0.427$.
P value: *$P < 0.1$; **$P < 0.05$; ***$P < 0.01$.

The proportion of those reporting to practice in an area with very insufficient GP density was significantly higher (29%) for those practicing in an MGP. More than a half (56%) were practicing in deprived areas; this proportion was significantly higher (70%) for those enrolled in MGP.

More than 4 GPs out of 10 reported that their working hours did not adapt well to their personal commitments or that they had to cut on training time. Seventy percent reported that they had to work longer than desired.

Most GPs declared using diverse e-health tools: 92% used electronic patient record and secure email services, and 85% used e-prescribing software. These proportions were significantly higher for GPs enrolled in MGP (99%, 99% and 94% respectively).

Around half of GPs were able to accept new patients: 44% for consultations with enrolled patients and 57% for casual consultations (Table 2). Forty-six percent managed to maintain their waiting times compared to 32% of GPs in MGP.

Almost all GPs (92%) claimed to always or often recommend meningococcal C vaccine for 12-month-old infants (97% in MGP) and seasonal influenza for adults with chronic conditions. More than 80% recommended measles, mumps and rubella catch-up for adolescents, pertussis for new mothers and human papillomavirus vaccines for children aged 11 to 14. Two-third of GPs declared recommending hepatitis B catch-up for adolescents. Some vaccines, for example, hepatitis B catch-up, human papillomavirus, a seasonal influenza, were less systematically recommended by the GPs.

Mediation Analysis Results

The unstandardized direct effects of the mediation analysis are presented in Figures 1 and 3. Table 3 provides the full results with total standardized effects, which allows for comparison across both models.

Overall, the quantity of care delivered was negatively affected by perceived GP density as well as work-related stress with standardized effects indicating a large mediation effect for perceived GP density (−0.371 in both specifications) and a moderate mediation effect for work-related stress (−0.187 in Model 1 and −0.192 in Model 2), consistent with Cohen's benchmarks (Table 3). The quality of care was not significantly affected by the GP density, while higher levels of quality were linked to greater use of

Table 3. Mediation analysis results, SEM estimation, standardized total effects (Model 1: n = 1070, Model 2: n = 1010).

		Outcome variables				Mediators				
		Quantity of care		Quality of care		Work-related stress		E-health		MGP
Standardized coefficients, total effects		Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 2
Mediators	Work-related stress	–0.187*** (0.061)	–0.192*** (0.041)	-	-	-	-	-	-	-
	E-health	-	-	–0.166*** (0.047)	–0.168*** (0.036)	-	-	-	-	-
	MGP	-	0.043 (0.062)	-	0.022 (0.049)	-	–0.018 (0.043)	-	0.096** (0.036)	-
Explanatory variable	Perceived low GP density (ref. No)	–0.371** (0.040)	–0.371*** (0.043)	0.034 (0.035)	0.053 (0.039)	0.210*** (0.042)	0.211*** (0.047)	0.037 (0.035)	0.039 (0.039)	0.078** (0.032)
Control variables	Female	–0.179*** (0.042)	–0.171*** (0.044)	0.142*** (0.038)	0.134*** (0.040)	–0.081 (0.046)	–0.062 (0.038)	–0.047 (0.047)	–0.053 (0.039)	–0.055 (0.032)
	Age (ref. <50y)									
	50-59	0.062 (0.042)	0.070 (0.046)	–0.024 (0.038)	–0.023 (0.045)	0.005 (0.046)	–0.003 (0.037)	–0.166*** (0.050)	–0.155*** (0.039)	–0.179*** (0.033)
	⩾60	0.132*** (0.044)	0.159*** (0.041)	–0.070 (0.044)	–0.064 (0.036)	–0.054 (0.049)	–0.067 (0.037)	–0.394*** (0.043)	–0.370*** (0.036)	–0.191*** (0.030)
	Complementary medicine (ref. No)	0.056 (0.039)	0.054 (0.041)	–0.087** (0.035)	–0.086** (0.037)	0.029 (0.043)	0.012 (0.035)	–0.049 (0.044)	–0.050 (0.037)	0.022 (0.030)
	French DEPrivation index > 0	–0.024 (0.039)	–0.038 (0.048)	–0.051 (0.035)	–0.061 (0.043)	–0.030 (0.043)	–0.016 (0.035)	0.078** (0.051)	0.066 (0.042)	0.150*** (0.035)
	Workload (ref. Q1)									
	Q2-Q3	–0.038 (0.046)	–0.037 (0.051)	0.061 (0.041)	0.064 (0.043)	0.085 (0.050)	0.095 (0.041)	0.073 (0.051)	0.077 (0.044)	0.054 (0.036)
	Q4	–0.001*** (0.049)	0.016 (0.031)	0.146*** (0.042)	0.145*** (0.037)	0.216*** (0.051)	0.230*** (0.042)	–0.012*** (0.042)	–0.030 (0.045)	–0.025 (0.085)

Non-weighted data.
Effect size interpretation: <0.1 small, <0.3 moderate, <0.5 large.
Goodness of fit interpretation: Root mean squared error of approximation (RMSEA): 0 ⩽ RMSEA < 0.05 (close fit), 0.05 ⩽ RMSEA < 0.08 (acceptable fit); Comparative fit index (CFI) > 0.90; Tucker–Lewis index (TLI) > 0.90; Standardized root mean squared residual (SRMR): 0 ⩽ SRMR < 0.05 (good fit), 0.05 ⩽ SRMR < 0.10 (acceptable fit).
Goodness of fit, Model 1: RMSEA = 0.028; CFI = 0.933; TLI = 0.915; SRMR = 0.030; $R^2 = 0.427$.
Goodness of fit. Model 2: RMSEA = 0.029; CFI = 0.926; TLI = 0.902; SRMR = 0.031; $R^2 = 0.462$.
P value:*$P < 0.1$; **$P < 0.05$; ***$P < 0.01$.

e-health tools, showing a moderate mediation effect with coefficients of similar magnitude (−0.166 vs −0.168) across both specifications. Adding MGP as a mediator (Model 2) had no significant impact on the outcome variables. As for other mediating factors, low perceived GP density was associated with higher levels of work-related stress, with the coefficients for both variables of the same magnitude in both models (moderate mediation effect: 0.210 vs 0.211). Additionally, low GP density was associated with greater enrolment in MGPs, although this demonstrated only a small mediation effect (0.078 in Model 2).

Female GPs were likely to have lower demand absorption capacity (−0.179 in Model 1 vs −0.171 in Model 2) and to recommend vaccines more often (0.142 vs 0.134), with both effects being moderate in magnitude. Older GPs were more likely to absorb demand more efficiently (moderate effect), even more so in the second specification. They were also less likely to use e-health tools (large effect, to a lesser extent in Model 2) and enrol in MGP (moderate effect). Practice of complementary medicine was associated with lower frequency of vaccine recommendations (small effect), while greater workload had a positive and moderate impact on quality; the coefficients for both variables were of the same magnitude in both models. A higher workload was also associated with greater work-related stress (moderate effect with higher impact in Model 2). Additionally, in Model 1, a higher workload was linked to lower demand absorption capacity and lower use of e-health tools with both effects being of small magnitude. Finally, there was a positive and moderate association between practice in a deprived area and enrolment in an MGP.

When disentangling between direct and indirect (unstandardized) effects, in the absence of potential mediators, our results suggest that the relation between GP density and quantity of care delivered was negative and significant ($\alpha_1 = -0.220$); there was no significant effect found on the quality of care (Figure 3). In the presence of mediators (work-related stress (M1) and use of e-health tools (M2)), GP density was significantly and positively associated with work-related stress ($\delta_1 = 0.122$), which was consecutively associated with a degraded demand absorption capacity ($\alpha_2 = -0.191$). This sequence of correlations shows that the initial correlation between GP density and demand absorption capacity is mediated by work-related stress and this mediating effect can be quantified by the product of these coefficients ($\delta_1 \times \propto_1 = -0.023$). Moreover, higher use of e-health tools (M2) was associated with greater vaccine recommendations frequency ($\beta_2 = 0.317$). Lastly, after the introduction of enrolment in MGP as a 'mediator of mediators' (Figure 1), we found that GPs in MGP tended to use more e-health tools, with a favourable effect on our measure of quality of care, vaccine recommendations. However, we failed to find any significant improvements of practice in MGP on work-related stress. These results hold when accounting for the covariance between GP density and practice in MGPs, as well as when including the effects of work-related stress on the quality of care and the use of e-health tools on the quantity of care (results available on request). Additionally, they remain consistent when we add control variables related to GPs' motivations for choosing their current practice location (in Model 2 only), although the goodness-of fit was slightly lower (Tucker–Lewis index between 0.80 and 0.90). The quantity of care was negatively affected by perceived GP density (Table A2; large mediation effect: −0.367 in Model 2) and by work-related stress (moderate effect: −0.182). Higher quality of care was linked to greater use of e-health tools, showing a moderate mediation effect (0.148). Moreover, perceived low GP density was moderately associated with higher levels of work-related stress (0.203) and greater enrolment in MGPs (0.062). Among the control variables related to GPs' motivations for choosing their current practice location, seeking an area with low GP density and the possibility of creating or joining a group practice had a moderate positive effect on enrolling in an MGP (0.132 and 0.278, respectively).

Finally, using coarsened exact matching (CEM) as a preprocessing step yields consistent results. The CEM constructs a balanced sample of 1070 individuals, who exhibit comparable characteristics related to 'being in an MGP' (120 individuals in treatment group). Subsequently, within this sample of 1070 GPs (915 in the second model), the same SEM was re-estimated. We obtained some differences in the magnitude of certain coefficients, but no changes in their direction or statistical significance (See Appendix 4: Figures A1 and A2). For instance, the quantity of care was negatively affected by perceived GP density (Table A3; large mediation effect: −0.371 in Model 1 and −0.385 in Model 2) and by work-related stress (moderate effect: −0.187 in Model 1 and −0.170 in Model 2). Higher quality was linked to greater use of e-health tools, showing a moderate to small mediation effect (0.166 vs 0.092). Moreover, perceived low GP density was moderately associated with higher levels of work-related stress (0.210 vs 0.202) and with greater enrolment in MGPs (0.086 in Model 2).

Discussion

To the best of our knowledge, this is the first study to analyse the underlying mediation effects behind the relationship between GP density and quantity and quality of primary care that also analyses integrated primary care teams' option as a possible response to the decreasing density.

We found that lower density is associated with lower demand absorption capacity as a proxy for quantity of care. We confirmed, at the country level, the existence of a negative relationship between GP density and work-related stress, in line with Picquendar *et al*.[43] We show that lower level of work-related stress is a key mediator in handling patients' requests.[42,46]

As the statistical framework (using structural equations) allows correcting for the self-selection into MGP, we also amend some unstable results contained in the related literature: contrary to Cassou *et al.*[11] we did not find a significant impact of enrolment in MGP on the demand absorption capacity. A difference between their work and ours might stem from the sample of GPs that are included in both

research papers. While the study population of Cassou *et al.*[11] originates from an exhaustive anonymous administrative database of self-employed GPs, it is restricted to MGPs accredited by Social Security that represent about half of French MGPs, that are subject to stricter requirements from the health authorities to receive an add-on payment. For instance, the accredited MGPs are supposed to have extended hours to ensure the continuity of care, which might explain the increase in the number of patients seen by the GP that they observe. Unfortunately, our data does not allow us to verify the number of GPs practising in an accredited MGP within the sample. Additionally, our study utilizes declared demand absorption capacity rather than the number of office visits, home visits, and technical procedures used in the other study. It should be also mentioned that the number of GPs in MGP within our sample is smaller than that in the other study (270 GPs vs 813 GPs).

Even outside the French context, the finding that there is no significant effect of an enrolment in integrated practices on absorption capacity is unusual (but not without precedent, see Nolte and McKee[86]). The heterogeneity in configuration of the integrated practices that we have in our study might be an explanation: while MGPs require two full-time equivalent GPs and 1 paramedic to be recognized as such by health authorities, the size and list of professionals available at the practice might vary across the country. Therefore, the size of the integrated practices might be insufficient to fully absorb the demand and/or its composition (eg, in paramedics) might not be adapted to the characteristics of the practice area, for example, does not consider the part of the ageing population that generates more care demand. Moreover, while there is a minimum composition requirement to create an MGP, there is no obligation to demonstrate that vertical integration, such as task delegation, is employed successfully. Another plausible explanation might be that once enrolled in an MGP, GPs adjust their working hours to achieve better work-life balance. Finally, it is possible that the efficiency gains generated by enrolment in an MGP are not reflected in quantity, but rather in quality.[5,15]

GP density indirectly affects the quality of care. As expected, more MGPs are located in underserved areas.[6] While we do not find a direct effect of practicing in MGP on the quality of care, we found that practicing in MGP is indirectly able to generate better quality of care. Enrolment in MGP was associated with higher use of e-health tools and, consecutively, with higher frequency of vaccine recommendations: e-health tools can be used to systematically identify unvaccinated patients in a practice and send an automated reminder to the GP that a vaccination is due.[58-62,64,65]

A limitation of our research is the use of survey data, so social desirability or conformity biases cannot be ruled out. For instance, these biases might be particularly relevant regarding GPs' self-reported vaccine recommendation behaviours. To mitigate potential selection bias resulting from specific opinions or attitudes, the GPs had no prior information on the survey topics before consenting to participate in the panel. Furthermore, we control for age, gender, workload, and occasional practice of complementary medicine, as these characteristics are known to be associated with vaccine recommendation behaviour.[55] Additionally, it seems plausible that social desirability bias might be higher during Covid-19 pandemic. However, when comparing with a survey on vaccination that was conducted in 2014 among 1582 GPs using a very similar sampling strategy,[55] the frequency of vaccine recommendations remains relatively stable for measles, mumps, and rubella vaccine (59.9% 'always' recommend this vaccine both in 2014 and our 2020 sample), hepatitis B catch-up (34.0% in 2014% vs 37.7% in 2020) and seasonal influenza vaccine (57.6% in 2014% vs 55.3% in 2020). In contrast, there is a significant improvement regarding the recommendation of the meningococcal C vaccine for 12-month-old infants (from 51.7% to 79.8%). This improvement can be attributed to the extension of vaccination mandates for children from 3 (diphtheria, tetanus and poliomyelitis) to 11 vaccinations in 2018,[87] with GPs becoming aware of and aligning with these new requirements.

Another limitation is that we consider only a set of 3 mediators (work-related stress, use of e-health tools and enrolment in an MGP), while other factors, such as consultation length or trust in institutions, may be of importance both in prevention activities and vaccination. While the choice of mediators is justified by our conceptual framework, existing literature and data availability, further studies are needed to consider a broader set of mediators and/or outcome variables related to the quality and quantity of care.

Conclusion

This study shows that an enrolment in MGP as a response to a decreasing medical density, although disappointing in terms of quantity of care supplied, has the potential to improve the quality of care provided to the patients. While a previous study that investigated the performance of GPs in MGP during Covid-19 pandemics found that GPs in MGP ensured better follow-up of patients with chronic conditions during the lockdown than those practicing outside MGP,[5] our results strengthen the evidence of better qualitative performance of GPs when considering their regular practice styles, such as their vaccination recommendation practices. Thus, further development of integrated primary care teams similar to MGPs appears beneficial to the patients located in underserved areas. This appears particularly relevant to address challenges of the provision of preventive measures (such as vaccination), since one of the requirements to establish an MGP is the participation in public health, prevention and health education activities in their catchment area. One remaining difficulty is the heterogeneity in MGP configurations in France, which carries the risk of insufficient integration among health professionals and, consequently, does not fully succeed in reallocating medical time towards improved labour productivity and quality gains.[5,8] Future policies should enforce stricter criteria for MGP composition, including mandatory vertical task delegation – particularly between GPs and nurses.

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Ethical Considerations

The sample benefits from the French 'public statistics' label of the National Authority for Statistical Information (*Conseil National de l'Information Statistique*; no. 114/H030 on October 18, 2017) ensures the quality of data production processes and their compliance with the best practices. These include minimizing respondent burden, consulting data users, and adhering to personal data protection regulations, particularly the General Data Protection Regulation (GDPR). All procedures performed involving human participants were in accordance with relevant guidelines and regulations.

Consent to Participate

Informed written consent to participate was obtained from all individual participants included in the study.

Consent for Publication

Not applicable.

Author Contributions/Credit

The study was conceived jointly by all the authors. AZ was responsible for data analysis and wrote the first draft of the manuscript. BV and PV were involved in methodology, project administration, and funding acquisition. All authors contributed to previous versions of the manuscript and read and approved the final version.

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Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability

The data from national panel survey of French self-employed GPs that support the findings of this study are available from Directorate of Research, Studies, Evaluation and Statistics of the French Ministry of Health (DREES; *Direction de la Recherche, des Études, de l'Évaluation et des Statistiques du ministère des Solidarités, de l'Autonomie et des Personnes handicapées*). However, restrictions apply to the availability of these data, which were used under licence for the current study and are not publicly available. The data on French Deprivation index (FDEP) are available to the public via the French National Institute of Health and Medical Research (Inserm) Centre for Epidemiology of Medical Causes of Death (CépiDc) website: https://www.cepidc.inserm.fr/documentation/indicateurs-ecologiques-du-niveau-socio-economique.

Supplemental Material

Supplemental material for this article is available online.

References

1. WHO UNICEF. *Declaration of Astana. Global Conference on Primary Health Care*. World Health Organization and the United Nations Children's Fund; 2018:12. https://www.who.int/publications/i/item/WHO-HIS-SDS-2018.61
2. WHO. *Primary Health Care on the Road to Universal Health Coverage. 2019 Monitoring Report*. World Health Organization; 2019. https://www.who.int/publications/i/item/9789240029040
3. Anguis M, Bergeat M, Pisarik J, Vergier N, Chaput H. Quelle démographie récente et à venir pour les professions médicales et pharmaceutique ? Constat et projections démographiques [What is the recent and future demography of the medical and pharmaceutical professions? Findings and demographic projections.]. *Les Dossiers de la DREES*. 2021; No. 76: 1–74.
4. Chaput H, Monziols M, Fressard L, et al. Plus de 80 % des médecins généralistes libéraux de moins de 50 ans exercent en groupe [More than 80% of private GPs under 50 years old are enrolled in a group practice]. *Etudes et résultats*. 2019; No.1114:1–2.
5. Zaytseva A, Verger P, Ventelou B. United, can we be stronger? Did French general practitioners in multi-professional groups provide more chronic care follow-up during lockdown? *BMC Health Serv Res*. 2022;22(1):519.
6. Chevillard G, Mousquès J, Lucas-Gabrielli V, Rican S. Has the diffusion of primary care teams in France improved attraction and retention of general practitioners in rural areas? *Health Policy*. 2019;123(5):508-515.
7. Chevillard G, Mousquès J. Medically underserved areas: are primary care teams efficient at attracting and retaining general practitioners? *Soc Sci Med*. 2021;287:114358.
8. Loussouarn C, Franc C, Videau Y, Mousquès J. Can general practitioners be more productive? The impact of teamwork and cooperation with nurses on GP activities. *Health Econ*. 2021;30(3):680-698.
9. Gilles de la Londe J, Afrite A, Mousquès J. How does the quality of care for type 2 diabetic patients benefit from gps-nurses' teamwork? A staggered difference-in-differences design based on a French pilot program. *Int J Health Econ Manag*. 2023;23(3):433-466.
10. Davin-Casalena B, Scronias D, Videau Y, Verger P. How general practitioners in France are coping with increased healthcare demand and physician shortages. A panel data survey and hierarchical clustering. *Health Policy*. 2024;149:105175.

11. Cassou M, Mousquès J, Franc C. General practitioners' income and activity: the impact of multi-professional group practice in France. *Eur J Health Econ*. 2020;21(9):1295-1315.
12. Kerrissey MJ, Clark JR, Friedberg MW, et al. Medical group structural integration may not ensure that care is integrated, from the patient's perspective. *Health Aff*. 2017;36(5):885-892.
13. Lalani M, Bussu S, Marshall M. Understanding integrated care at the frontline using organisational learning theory: a participatory evaluation of multi-professional teams in East London. *Soc Sci Med*. 2020;262:113254.
14. Mousquès J, Daniel F. The impact of multiprofessional group practices on the quality of general practice. Results of the evaluation of multidisciplinary group practices (MGP), health care networks (HCN) and health care centers (HCC) participating in experiments with new modes of remuneration (ENMR). *Questions d'économie de la santé*. 2015;211:5.
15. Singer SJ, Sinaiko AD, Tietschert MV, et al. Care integration within and outside health system boundaries. *Health Serv Res*. 2020;55(S3):1033-1048.
16. Fineschi D, Acciai S, Napolitani M, et al. Game of mirrors: health profiles in patient and physician perceptions. *Int J Environ Res Public Health*. 2022;19(3):1201.
17. Ono T, Schoenstein M, Buchan J. *Geographic Imbalances in Doctor Supply and Policy Responses*. OECD Health Working Papers, No. 69, OECD Publishing, Paris; 2014. doi:10.1787/5jz5sq5ls1wl-en
18. Buykx P, Humphreys J, Wakerman J, Pashen D. Systematic review of effective retention incentives for health workers in rural and remote areas: towards evidence-based policy. *Aust J Rural Health*. 2010;18(3):102-109.
19. Carson DB, Schoo A, Berggren P. The 'rural pipeline' and retention of rural health professionals in Europe's northern peripheries. *Health Policy*. 2015;119(12):1550-1556.
20. Elma A, Nasser M, Yang L, et al. Medical education interventions influencing physician distribution into underserved communities: a scoping review. *Hum Resour Health*. 2022;20(1):31.
21. Farmer J, Kenny A, McKinstry C, Huysmans RD. A scoping review of the association between rural medical education and rural practice location. *Hum Resour Health*. 2015;13(1):27.
22. Kwan MMS, Kondalsamy-Chennakesavan S, Ranmuthugala G, Toombs MR, Nicholson GC. The rural pipeline to longer-term rural practice: general practitioners and specialists. *PLoS One*. 2017;12(7):e0180394.
23. McGrail MR, O'Sullivan BG. Increasing doctors working in specific rural regions through selection from and training in the same region: national evidence from Australia. *Hum Resour Health*. 2021;19(1):132.
24. Russell D, Mathew S, Fitts M, et al. Interventions for health workforce retention in rural and remote areas: a systematic review. *Hum Resour Health*. 2021;19(1):103.
25. Verma P, Ford JA, Stuart A, et al. A systematic review of strategies to recruit and retain primary care doctors. *BMC Health Serv Res*. 2016;16(1):126.
26. Witter S, Hamza MM, Alazemi N, et al. Human resources for health interventions in high- and middle-income countries: findings of an evidence review. *Hum Resour Health*. 2020;18(1):43.
27. Fichera E, Pezzino M. Pay for performance and contractual choice: the case of general practitioners in England. *Health Econ Rev*. 2017;7(1):6.
28. McIsaac M, Scott A, Kalb G. The role of financial factors in the mobility and location choices of general practitioners in Australia. *Hum Resour Health*. 2019;17(1):34.
29. Swami M, Scott A. Impact of rural workforce incentives on access to GP services in underserved areas: evidence from a natural experiment. *Soc Sci Med*. 2021;281:114045.
30. Yong J, Scott A, Gravelle H, Sivey P, McGrail M. Do rural incentives payments affect entries and exits of general practitioners? *Soc Sci Med*. 2018;214:197-205.
31. Vigier P. Rapport sur la proposition de Loi visant à garantir un accès Aux soins égal sur l'ensemble du territoire [Report on the law proposal to guarantee equal access to care throughout the country]. *Assem Natl*. 2012;132. http://www.assemblee-nationale.fr/14/rapports/r0401.asp
32. Delattre E, Samson AL. Are location strategies of French general practitioners driven by economic or hedonic mechanisms? *Economie et statistique*. 2012;455-456. doi:10.3406/estat.2012.10020
33. Dumontet M, Samson AL, Franc C. Comment les médecins choisissent-ils leur lieu d'exercice ? [How do physicians choose their place of practice?]. *Revue française d'économie*. 2016;XXXI(4):221-267.
34. Ramos P, Alves H, Guimarães P, Ferreira MA. Junior doctors' medical specialty and practice location choice: simulating policies to overcome regional inequalities. *Eur J Health Econ*. 2017;18(8):1013-1030.
35. Groenewegen PP, Bosmans MW, Boerma WG, Spreeuwenberg P. The primary care workforce in Europe: a cross-sectional international comparison of rural and urban areas and changes between 1993 and 2011. *Eur J Public Health*. 2020;30(Supplement_4):iv12-iv17.
36. van Hassel D, Verheij R, Batenburg R. Assessing the variation in workload among general practitioners in urban and rural areas: an analysis based on SMS time sampling data. *Int J Health Plann Manage*. 2019;34(1):e474-e486.
37. Lurquin K, Letrilliart C. Comparison of rural and urban French GPs' activity: a cross-sectional study. *RRH*. 2021;21(3):5865. doi:10.22605/RRH5865
38. Steinhaeuser J, Joos S, Szecsenyi J, Miksch A. A comparison of the workload of rural and urban primary care physicians in Germany: analysis of a questionnaire survey. *BMC Fam Pract*. 2011;12(1):112.
39. Deveugele M, Derese A, van den Brink-Muinen A, Bensing J, De Maeseneer J. Consultation length in general practice: cross sectional study in six European countries. *BMJ*. 2002;325(7362):472.
40. Irving G, Neves AL, Dambha-Miller H, et al. International variations in primary care physician consultation time: a systematic review of 67 countries. *BMJ Open*. 2017;7(10):e017902.
41. Soler JK, Yaman H, Esteva M, et al. Burnout in European family doctors: the EGPRN study. *Fam Pract*. 2008;25(4):245-265.
42. Wallace JE, Lemaire JB, Ghali WA. Physician wellness: a missing quality indicator. *Lancet*. 2009;374(9702):1714-1721.
43. Picquendar G, Guedon A, Moulinet F, Schuers M. Influence of medical shortage on GP burnout: a cross-sectional study. *Fam Pract*. 2019;36(3):291-296.
44. Maslach C, Jackson SE, Leiter MP eds. Maslach burnout inventory. In: *Evaluating Stress: A Book of Resources*. 3rd ed. Scarecrow Education, Lanham; 1997;191-218.
45. Karuna C, Palmer V, Scott A, Gunn J. Prevalence of burnout among GPs: a systematic review and meta-analysis. *Br J Gen Pract*. 2022;72(718):e316-e324.

46. Shen X, Xu H, Feng J, et al. The global prevalence of burnout among general practitioners: a systematic review and meta-analysis. *Fam Pract*. 2022;39(5):943-950.
47. Spányik A, Simon D, Rigó A, Griffiths MD, Demetrovics Z. Subjective COVID-19-related work factors predict stress, burnout, and depression among healthcare workers during the COVID-19 pandemic but not objective factors. *PLoS One*. 2022;17(8):e0270156.
48. Lane NE, Ling V, Glazier RH, Stukel TA. Primary care physician volume and quality of care for older adults with dementia: a retrospective cohort study. *BMC Fam Pract*. 2021;22(1):51.
49. Silhol J, Ventelou B, Zaytseva A. How French general practitioners respond to declining medical density: a study on prescription practices, with an insight into opioids use. *Eur J Health Econ*. 2020;21(9):1391-1398.
50. Zyzanski SJ, Stange KC, Langa D, Flocke SA. Trade-offs in high-volume primary care practice. *J Fam Pract*. 1998;46(5):397-402.
51. Robert J, Detournay B, Levant MC, et al. Flu vaccine coverage for recommended populations in France. *Med Mal Infect*. 2020;50(8):670-675.
52. Eliès A, Bonneau C, Houzard S, Rouzier R, Héquet D. Impact of catch-up human papillomavirus vaccination on cervical conization rate in a real-life population in France. *PLoS One*. 2022;17(3):e0264821.
53. Larson HJ, de Figueiredo A, Xiahong Z, et al. The state of vaccine confidence 2016: global insights through a 67-country survey. *EBioMedicine*. 2016;12:295-301.
54. Rey D, Fressard L, Cortaredona S, et al. Vaccine hesitancy in the French population in 2016, and its association with vaccine uptake and perceived vaccine risk–benefit balance. *Eurosurveillance*. 2018;23(17):17-00816.
55. Verger P, Fressard L, Collange F, et al. Vaccine hesitancy among general practitioners and its determinants during controversies: a national cross-sectional survey in France. *EBioMedicine*. 2015;2(8):891-897.
56. Pulcini C, Massin S, Launay O, Verger P. Factors associated with vaccination for hepatitis B, pertussis, seasonal and pandemic influenza among French general practitioners: a 2010 survey. *Vaccine*. 2013;31(37):3943-3949.
57. Raude J, Fressard L, Gautier A, et al. Opening the 'vaccine hesitancy' black box: how trust in institutions affects French gps' vaccination practices. *Expert Rev Vaccines*. 2016;15(7):937-948.
58. Derrough T, Olsson K, Gianfredi V, et al. Immunisation information systems – useful tools for monitoring vaccination programmes in EU/EEA countries, 2016. *Eurosurveillance*. 2017;22(17):30519.
59. Dumit EM, Novillo-Ortiz D, Contreras M, Velandia M, Danovaro-Holliday MC. The use of eHealth with immunizations: an overview of systematic reviews. *Vaccine*. 2018;36(52):7923-7928.
60. Groom H, Hopkins DP, Pabst LJ, et al. Immunization information systems to increase vaccination rates: a community guide systematic review. *J Public Health Manag Pract*. 2015;21(3):227-248.
61. Jacobson Vann JC, Jacobson RM, Coyne-Beasley T, Asafu-Adjei JK, Szilagyi PG. Patient reminder and recall interventions to improve immunization rates. *Cochrane Database Syst Rev*. 2018;1(1):CD003941.
62. Morgan JL, Baggari SR, Chung W, et al. Association of a best-practice alert and prenatal administration with tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccination rates. *Obstet Gynecol*. 2015;126(2):333-337.
63. Francis DB, Cates JR, Wagner KPG, et al. Communication technologies to improve HPV vaccination initiation and completion: a systematic review. *Patient Educ Couns*. 2017;100(7):1280-1286.
64. Niccolai LM, Hansen CE. Practice- and community-based interventions to increase human papillomavirus vaccine coverage: a systematic review. *JAMA Pediatr*. 2015;169(7):686-692.
65. Okoli GN, Reddy VK, Lam OLT, et al. Interventions on health care providers to improve seasonal influenza vaccination rates among patients: a systematic review and meta-analysis of the evidence since 2000. *Fam Pract*. 2021;38(4):524-536.
66. Petrie S, Carson D, Peters P, et al. What a pandemic has taught us about the potential for innovation in rural health: commencing an ethnography in Canada, the United States, Sweden, and Australia. *Front Public Health*. 2021;9:768624.
67. Wakerman J, Humphreys JS. Sustainable primary health care services in rural and remote areas: innovation and evidence: sustainable rural and remote PHC services. *Aust J Rural Health*. 2011;19(3):118-124.
68. Davin-Casalena B, Jardin M, Guerrera H, et al. The impact of the COVID-19 epidemic on primary care in south-eastern France: implementation of a real-time monitoring system based on regional health insurance system data. *Revue d'Épidémiologie et de Santé Publique*. 2021;69(5):255-264.
69. Woodall T, Ramage M, LaBruyere JT, McLean W, Tak CR. Telemedicine services during COVID-19: considerations for medically underserved populations. *J Rural Health*. 2021;37(1):231-234.
70. Patel KK, Cigarroa JE, Nadel J, Cohen DJ, Stecker EC. Accountable care organizations: ensuring focus on cardiovascular health. *Circulation*. 2015;132(7):603-610.
71. Kerrissey M, Tietschert M, Novikov Z, et al. Social features of integration in health systems and their relationship to provider experience, care quality and clinical integration. *Med Care Res Rev*. 2022;79(3):359-370.
72. Colla C, Yang W, Mainor AJ, et al. Organizational integration, practice capabilities, and outcomes in clinically complex medicare beneficiaries. *Health Serv Res*. 2020;55(S3):1085-1097.
73. De Sutter M, De Sutter A, Sundahl N, Declercq T, Decat P. Inter-professional collaboration reduces the burden of caring for patients with mental illnesses in primary healthcare. A realist evaluation study. *Eur J Gen Pract*. 2019;25(4):236-242.
74. Smith SM, Wallace E, O'Dowd T, Fortin M. Interventions for improving outcomes in patients with multimorbidity in primary care and community settings. *Cochrane Database Syst Rev*. 2021; 10:271. https://doi.org/10.1186/s13643-021-01817-z
75. Carrier H, Zaytseva A, Bocquier A, et al. General practitioners' attitude towards cooperation with other health professionals in managing patients with multimorbidity and polypharmacy: a cross-sectional study. *Eur J Gen Pract*. 2022;28(1):109-117.
76. Ministère des solidarités et de la santé. Arrêté du 1er octobre 2021 modifiant l'arrêté du 13 novembre 2017 relatif à la méthodologie applicable à la profession de médecin pour la détermination des zones prévues au 1° de l'article L. 1434-4 du code de la santé publique [Decree of October 1,

2021, amending the decree of November 13, 2017, regarding the methodology applicable to the medical profession for determining the areas specified in 1° of Article L. 1434-4 of the Public Health Code]. 2021: 1–4. Accessed October 6, 2023. https://www.legifrance.gouv.fr/eli/arrete/2021/10/1/SSAH2129881A/jo/texte

77. Le Maréchal M, Collange F, Fressard L, et al. Design of a national and regional survey among French general practitioners and method of the first wave of survey dedicated to vaccination. *Med Mal Infect*. 2015;45(10):403-410.
78. Collange F, Zaytseva A, Pulcini C, Bocquier A, Verger P. Unexplained variations in general practitioners' perceptions and practices regarding vaccination in France. *Eur J Public Health*. 2019;29(1):2-8.
79. Verger P, Bocquier A, Bournot MC, et al. Le panel de médecins généralistes de ville : éclairages sur les enjeux de la médecine de premier recours d'aujourd'hui [The panel of self-employed general practitioners: insights into today's challenges in primary care]. *Rev Fr Aff Soc*. 2017;3:213-235. doi:10.3917/rfas.173.0213
80. Rey G, Jougla E, Fouillet A, Hémon D. Ecological association between a deprivation index and mortality in France over the period 1997 - 2001: variations with spatial scale, degree of urbanicity, age, gender and cause of death. *BMC Public Health*. 2009;9:33.
81. Collier JE. *Applied Structural Equation Modeling Using AMOS: Basic to Advanced Techniques*. Routledge; 2020.
82. Pearl J, ed. *Causality: Models, Reasoning, and Inference*. 2nd ed. Cambridge University Press; 2009.
83. VanderWeele TJ, Shpitser I. A new criterion for confounder selection. *Biometrics*. 2011;67(4):1406-1413.
84. Hooper D, Coughlan J, Mullen MR. Structural equation modelling: guidelines for determining model fit. *Electron J Bus Res Methods*. 2008;6(1):53-60.
85. von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol*. 2008;61(4):344-349.
86. Nolte E, McKee M. Integration and chronic care: a review. In: Olte E, McKee M, eds. *Caring for People with Chronic Conditions: A Health System Perspective*. European Observatory on Health Systems and Policies Series. Open University Press; 2009. https://eurohealthobservatory.who.int/docs/librariesprovider3/studies—external/caring-for-people-with-chronic-conditions.pdf
87. Lévy-Bruhl D, Fonteneau L, Vaux S, et al. Assessment of the impact of the extension of vaccination mandates on vaccine coverage after 1 year, France, 2019. *Eurosurveillance*. 2019;24(26): 1900301. doi:10.2807/1560-7917.ES.2019.24.26.1900301