ABSTRACT

Objectives The acceleration in the number of female doctors has led to questions about differences in how men and women practice medicine. The aim of this study was to assess the influence of general practitioner (GP) gender on the use of the three main categories of diagnostic procedures—clinical examinations, laboratory tests and imaging investigations.

Design Cross-sectional nationwide multicentre study.

Setting French training general practices.

Participants The patient sample included all the voluntary patients over a cumulative period of 5 days per office between November 2011 and April 2012. The GP sample included 85 males and 43 females.

Methods 54 interns in general practice, observing their GP supervisors, collected data about the characteristics of GPs and consultations, as well as the health problems managed during the visit and the processes of care associated with them. Using hierarchical multilevel mixed-effect logistic regression models, we performed multivariable analyses for each category, distinguishing screening from diagnostic or follow-up procedures. We searched for interactions between GP gender and patient gender or type of health problem managed.

Results This analysis of 45 582 health problems managed in 20 613 consultations showed that female GPs performed more clinical examinations than male GPs, both for screening (OR 1.75; 95% CI 1.19 to 2.58) and for diagnostic or follow-up purposes (OR 1.41; 95% CI 1.08 to 1.84). Female GPs also ordered laboratory tests more frequently (OR 1.41; 95% CI 1.08 to 1.84). Female GPs also ordered laboratory tests for diagnostic or follow-up purposes (OR 1.21; 95% CI 1.03 to 1.43). Female GPs performed even more clinical examinations than male GPs to diagnose or follow-up injuries (OR 1.69; 95% CI 1.19 to 2.40).

Conclusion Further research on the appropriateness of diagnostic procedures is required to determine to what extent these differences are related to underuse or overuse.

INTRODUCTION

As the number of female doctors rose during the 20th century in industrialised countries, questions have arisen about differences in how men and women practice medicine. Some patterns of their practices, including content and style, have previously been compared. Female primary care physicians (PCPs) usually have a lower workload than their male counterparts and see more female patients. According to an Australian study, female general practitioners (GPs) provide more clinical treatments while male GPs prescribe more medications. Many studies report that female doctors provide more preventive care than males, especially cardiovascular risk assessments and gynaecological cancer screening. These findings have not, however, been consistently confirmed. Female doctors are recognised to have a more patient-centred communication pattern than males. Studies from Canada and Hungary report that female GPs provided a high quality of care, assessed by compliance with guidelines (higher) and hospitalisation rates (lower). Few studies, however, have examined the influence of doctors’ gender on the routine use of diagnostic procedures. The appropriateness of their use affects the quality and cost of medical care. The main diagnostic procedures used in primary care are clinical examinations, laboratory tests and imaging. According to one study in the USA, female
PCPs perform more basic clinical measurements such as blood pressure and more specific procedures, such as rectal or gynaecological examinations.\textsuperscript{13} To our knowledge, no comprehensive data on clinical examinations by doctors’ gender are available. Studies from Australia, Israel and Canada suggest that female GPs prescribe more laboratory tests than their male counterparts.\textsuperscript{3} 14 15 and two studies from Australia and the USA report that female primary care doctors may order more imaging investigations per visit.\textsuperscript{3} 16

The aim of this study was therefore to assess the influence of doctors’ gender on the use of diagnostic procedures in French general practices.

**METHODS**

**Study design**

This study is an ancillary analysis of the ECOGEN (Eléments de la COnsultation en médecine GENérale) study, an observational cross-sectional nationwide multicentre study investigation in French general practices from 28 November 2011 to 30 April 2012. The ECOGEN study aimed to describe the clinical activity of French GPs, especially the health problems managed and the associated processes of care.\textsuperscript{17} It included 128 centres or GPs’ offices. These doctors supervised general practice interns and were attached to one of the 27 participating French medical schools. Each intern was placed in two or three different practices and no practice had more than one intern.

The study included all home and office visits of the participating GPs, in predetermined half-day blocks per week distributed across the study period, for a total of 20 consultation-days per GP. GP participants provided consent to participate in the study, after being informed by their intern. Verbal consent was obtained from the patients or the parents of minor participants. Only visits for which patients refused participation were excluded.

**Data collection**

Data were collected by 54 interns in general practice, observing their GP supervisors. They were trained for this data collection, including in the use of the International Classification of Primary Care (ICPC-2).\textsuperscript{18} They collected the data on paper forms at the end of each encounter and entered them daily in a secure central database via a dedicated website.

Data concerning the GPs’ characteristics included age, gender, fees authorised (set by the government or the GP), mode of practice (solo, group, private multiprofessional, or public health centre), practice location, number of visits by medical sales representatives, by public healthcare insurance delegates and by or to patients. The data concerning the consultations included the patient’s age, gender, socioprofessional category, health insurance status (specifically, exemption from fees due to low income, serious chronic disease, or a workplace accident or occupational disease), visit site (office or home), number of health problems managed and consultation length. The health problems managed and the associated processes of care performed as well as subsequent procedures prescribed or ordered during the visit were coded according to the ICPC-2 classification, with the support of a coding engine system.\textsuperscript{19} The care processes included various preventive, diagnostic, curative, administrative and coordinative procedures. The ICPC-2 is organised in 17 chapters: 15 based on body systems for somatic health problems, one for psychological problems (P) and one for social problems (Z). It also includes the following six components: symptoms and complaints, infections, neoplasms, injuries, congenital anomalies and other diagnoses. We recoded the ICPC-2 components in five categories by merging ‘congenital anomalies’ and ‘other diagnoses’.

**Statistical analyses**

The study sample of GPs was compared with the French GP population (Source: CNAM TS (Caisse Nationale d’Assurance Maladie des Travailleurs Salariés), 2012) using t-test for numerical data and \textit{χ}² test for categorical data.

The dependent variables analysed were the performance of a clinical examination (yes/no), an order for a laboratory test (yes/no), and the order of an imaging investigation (yes/no) for each health problem managed. The clinical examination variable included the following ICPC-2 codes: complete medical examination/health evaluation (−30), partial medical examination/health evaluation (−31). The laboratory test variable included the following ICPC-2 codes: sensitivity test (−32), microbiological/immunological test (−33), blood test (−34), urine test (−35), stool test (−36), histological/exfoliative cytology (−37), other laboratory test (−38). Imaging investigations corresponded to the ICPC-2 diagnostic radiology/Imaging code (−41).

For each dependent variable, we performed univariate and then multivariable analyses, using a logistic regression model. The multivariable analyses used hierarchical mixed-effect models with random intercepts for physician effect and including three levels: the physician, consultation and health problem.\textsuperscript{20} 21 For each of these dependent variables, we secondarily performed two specific multivariable analyses separating diagnostic procedures used for screening purposes and those for diagnostic or follow-up purposes. We identified the screening procedures in the database as the diagnostic processes of care associated with health problems coded with either no disease (A97) or health maintenance/preventive medicine (A98). The diagnostic or follow-up procedures were the diagnostic processes of care associated with health problems coded with any other ICPC-2rubric. We built the multivariable models by selecting the independent variables with a \textit{p}<0.20 in the univariate analyses.\textsuperscript{22} We forced the patient age variable in all the multivariable models, in order to adjust for this potential confounding factor. We searched for interactions between GP gender and patient gender or ICPC-2 components in each multivariable model. Finally, we searched for interactions between each of the 20 most frequent health problems managed and GP gender using dedicated multivariable, multilevel models, whenever the dependent variable was associated with GP gender. The
statistical significance threshold was set at 5%. We used Stata software (release V.16) to perform all these analyses.23

Patient and public involvement
Patients were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS
The participating GPs were mostly men (66.4%), aged 53 years on average (SD=7.9), with 5188 (SD=1708) consultations per year on average, and practising mainly in urban areas (61.7%) and group practices (61.7%). The GP sample did not differ from the French GP population for gender, mean age, mean annual number of consultations, practice location and type of fees authorised; however, the age class distribution differed (table 1). In the course of 20 613 consultations, they managed 45 582 health problems. A clinical examination was performed for 29 220 of these health problems (64.1%), a laboratory test ordered for 5766 (12.7%) and an imaging investigation ordered for 2282 (5.0%). These three types of procedures accounted for 98.7% of the 42 650 diagnostic procedures used; the main remaining 1.3% were electrical tracings (0.5%), physical function tests (0.3%) and endoscopies (0.2%).

The univariate analyses (table 2) showed that female GPs ordered more laboratory tests than their male counterparts (OR 1.17; 95% CI 1.01 to 1.35), while clinical examinations and imaging did not differ by gender. GP age had no influence on any of these procedures. In the multivariable analyses of all diagnostic procedures (table 3), however, female GPs performed more clinical examinations than males (OR 1.40; 95% CI 1.10 to 1.77) and ordered more laboratory tests (OR 1.20; 95% CI 1.03 to 1.43), with no differences for imaging. Clinical examinations were also performed more frequently by GPs who were older than 60 years or practised in semiurban areas and for patients younger than 14 years or older than 75 years. Clinical examinations were less frequently performed by GPs authorised to set their own fees, for female patients, and for patients with a workplace accident or occupational disease or those unemployed. Laboratory tests were more frequently ordered for patients aged from 15 to 29 years and from 60 to 74 years, and for those with serious chronic diseases. They were ordered less often for patients younger than 14 years, those from lower socioprofessional categories (manual workers, office workers, intermediate professions), the unemployed and the retired, those with a workplace accident or occupational disease, and during home visits. Imaging investigations were less frequently performed for patients younger than 29 years or older than 75, classified as office workers or retired, with serious chronic diseases and during home visits.

In the multivariable analyses restricted to diagnostic and follow-up procedures (table 5), female GPs performed more clinical examinations than males (OR 1.41; 95% CI 1.08 to 1.84) and ordered more laboratory tests (OR 1.21; 95% CI 1.03 to 1.43); no gender differences were observed for imaging investigations. Clinical examinations were more frequently performed by GPs who practised in semiurban areas and for patients younger than 29 years; they were less frequent for patients with workplace accidents or occupational diseases. Clinical examination was more frequently performed for infections, injuries and other diagnoses and less frequently for neoplasms, as compared with symptoms and complaints. Laboratory tests were ordered more frequently for patients aged 15–29 years or with serious chronic diseases. Inversely, they were ordered less frequently for patients younger than 14 years, for those from lower socioprofessional categories or unemployed, with workplace accidents or occupational diseases, and during home visits. Imaging investigations were less frequently ordered for patients younger than 29 years and older than 75, classified as office workers or retired, with serious chronic diseases and during home visits.

No interaction was found between GP gender and patient gender in any of the multivariable models. We found a single interaction between GP gender and health problem components, in the model restricted to procedures used for diagnostic or follow-up purposes, indicating that female GPs performed even more clinical examinations than male GPs to manage injuries, as compared with symptoms and complaints (OR 1.69; 95% CI 1.19 to 2.40) (table 5). Among the 20 most frequent health problems managed, we found positive interactions for clinical examinations between female GP gender and health maintenance/preventive medicine (OR 2.62; 95% CI 2.02 to 3.41), back syndrome without radiating pain (OR 2.70; 95% CI 1.55 to 4.70) and constipation (OR 2.15; 95% CI 1.34 to 3.45), indicating that female GPs performed even more clinical examinations than male GPs to manage these health problems, as compared with all other health problems. We also found positive interactions for laboratory tests between female GP gender and lipid disorder (OR 1.67; 95% CI 1.26 to 2.21) or osteoporosis (OR 5.79; 95% CI 2.15 to 15.58) (table 6).
**DISCUSSION**

Female compared with male GPs performed more clinical examinations for both screening and diagnostic/follow-up purposes. They also ordered more laboratory tests for the latter purpose. Imaging investigations for screening were ordered most frequently for female patients.

**Comparison with existing literature**

To our knowledge, a finding that female GPs perform more frequently clinical examinations than male GPs has not been reported before. It is consistent with

**Table 1** Participating GPs’ characteristics by gender (n=128) and comparisons with the French population of GPs (n=54 050, source: CNAM Ts) (France, 2011–2012)

|                          | Study sample   | French population |
|--------------------------|----------------|-------------------|
|                          | Male GP N=85 n (%) | Female GP N=43 n (%) | Total N=128 n (%) | Total N=54 050 n (%) | P value |
| GP gender                |                |                  |                  |                   |        |
| Male                     | 85 (66.4)      | 43 (33.6)        | 37 699 (69.8)    | 16 349 (30.2)      | 0.40    |
| Female                   |                |                  |                  |                   |        |
| Missing data             |                |                  | 2                 |                   |        |
| GP age (years)           |                |                  |                  |                   | <0.001  |
| 32–49                    | 19 (22.4)      | 18 (41.9)        | 37 (28.9)        | 17 465 (32.4)      |        |
| 50–54                    | 25 (29.4)      | 13 (30.2)        | 38 (29.7)        | 10 808 (20.0)      |        |
| 55–59                    | 28 (32.9)      | 10 (23.3)        | 38 (29.7)        | 11 195 (20.8)      |        |
| ≥60                      | 13 (15.3)      | 2 (4.7)          | 15 (11.7)        | 14 473 (26.8)      |        |
| Mean age (SD) (years)    | 53.9 (7.5)     | 50.1 (8.0)       | 52.64 (7.88)     | 52.73              | 0.90    |
| Missing data             |                |                  | 109               |                   |        |
| Annual no of consultations (SD) |                |                  |                  |                   |        |
| 0–4999                   | 43 (50.6)      | 31 (72.1)        | 74 (57.8)        |                   |        |
| 5000–10 500              | 42 (49.4)      | 12 (27.9)        | 54 (42.2)        |                   |        |
| Mean annual number of consultation (SD) | 5525.4 (1724.9) | 4519.7 (1478.2)  | 5187.5 (1708.2)  | 4960               | 0.13    |
| Practice location         |                |                  |                  |                   | 0.20    |
| Rural areas              | 12 (14.1)      | 4 (9.3)          | 16 (12.5)        | 7 696 (15.7)       |        |
| Urban clusters           | 24 (28.2)      | 9 (20.9)         | 33 (25.8)        | 14 947 (30.4)      |        |
| Urban areas              | 49 (57.7)      | 30 (69.8)        | 79 (61.7)        | 26 438 (53.9)      |        |
| Missing data             |                |                  | 4 969            |                   |        |
| Mode of practice         |                |                  |                  |                   |        |
| Solo practice            | 21 (24.7)      | 6 (14.0)         | 27 (21.1)        |                   |        |
| Group practice           | 49 (57.6)      | 30 (69.8)        | 79 (61.7)        |                   |        |
| Private multiprofessional practice | 14 (16.5) | 6 (14.0)       | 20 (15.6)        |                   |        |
| Public health centre     | 1 (1.2)        | 1 (2.3)          | 2 (1.6)          |                   |        |
| Fees                     |                |                  |                  |                   | 0.75    |
| Set by the health authorities | 79 (92.9) | 39 (90.7)     | 118 (92.2)       | 50 216 (92.9)      |        |
| Set by the GP            | 6 (7.1)        | 4 (9.3)          | 10 (7.8)         | 3 834 (7.1)        |        |
| Visits by medical sales representatives | 40 (47.1) | 18 (41.9)     | 58 (45.3)        |                   |        |
| No                       | 45 (52.9)      | 25 (58.1)        | 70 (54.7)        |                   |        |
| Yes                      |                |                  |                  |                   |        |
| Visits by public healthcare insurance delegates | 17 (20.0) | 9 (20.9)     | 26 (20.3)        |                   |        |
| No                       | 68 (80.0)      | 34 (79.1)        | 102 (79.7)       |                   |        |
| Yes                      |                |                  |                  |                   |        |

CNAM TS, Caisse Nationale d’Assurance Maladie des Travailleurs Salariés; GP, general practitioner.
Table 2  Characteristics of GPs, consultations and health problems associated with the three types of diagnostic procedures used (clinical examinations, laboratory tests, imaging) per health problem managed in univariate analyses (France, 2011–2012)

| Characteristics of consultations | Clinical examination 29 220/45 582 (64.1%) | Laboratory test 5766/45 582 (12.7%) | Imaging 2282/45 582 (5.0%) |
|---------------------------------|---------------------------------------------|-------------------------------------|---------------------------|
| GPs’ characteristics            | n (%) OR (95% CI) n (%) OR (95% CI) n (%) OR (95% CI) |
| Gender                          |                                             |                                     |                           |
| Male                            | 18300/28 580 (64.0%) Ref                    | 3388/28 580 (11.8%) Ref             | 1357/28 580 (4.8%) Ref    |
| Female                          | 10920/17 002 (64.2%) 1.12 (0.88 to 1.43)   | 2378/17 002 (14.0%) 1.17 (1.01 to 1.35) | 925/17 002 (5.4%) 1.15 (0.96 to 1.37) |
| Age (years)                     |                                             |                                     |                           |
| 32–49                           | 7168/11 389 (62.9%) Ref                     | 1463/11 389 (12.8%) Ref             | 686/11 389 (6.0%) Ref     |
| 50–54                           | 8578/13 205 (65.0%) 0.92 (0.67 to 1.25)    | 1696/13 205 (12.8%) 1.05 (0.87 to 1.28) | 632/13 205 (4.8%) 0.87 (0.69 to 1.09) |
| 55–59                           | 7942/12 395 (64.1%) 0.88 (0.65 to 1.20)    | 1454/12 395 (11.7%) 0.93 (0.77 to 1.12) | 564/12 395 (4.5%) 0.80 (0.63 to 1.00) |
| ≥60                             | 5532/8593 (64.4%) 0.98 (0.69 to 1.39)      | 1153/8593 (13.4%) 1.09 (0.88 to 1.36) | 400/8593 (4.7%) 0.82 (0.63 to 1.06) |
| Annual no of consultations      |                                             |                                     |                           |
| 0–4999                          | 16528/25 982 (63.6%) Ref                    | 3279/25 982 (12.6%) Ref             | 1307/25 982 (5.0%) Ref    |
| 5000–10 500                     | 2692/19 600 (64.8%) 1.35 (1.08 to 1.70)    | 2487/19 600 (12.7%) 1.06 (0.92 to 1.22) | 975/19 600 (5.0%) 0.92 (0.77 to 1.10) |
| Practice location               |                                             |                                     |                           |
| Rural                           | 3501/5187 (67.5%) 1.27 (0.89 to 1.80)      | 604/5187 (11.6%) 1.00 (0.80 to 1.24) | 241/5187 (4.7%) 0.91 (0.70 to 1.19) |
| Semirural                       | 8637/13 402 (64.5%) 1.36 (1.04 to 1.77)    | 1727/13 402 (12.9%) 1.02 (0.87 to 1.21) | 632/13 402 (4.7%) 0.82 (0.67 to 1.00) |
| Urban                           | 17082/26 993 (63.3%) Ref                    | 3435/26 993 (12.7%) Ref             | 1409/26 993 (5.2%) Ref    |
| Mode of practice                |                                             |                                     |                           |
| Solo practice                   | 5652/9096 (62.1%) 0.73 (0.55 to 0.97)      | 999/9096 (11.0%) 0.86 (0.72 to 1.03) | 425/9096 (4.7%) 1.01 (0.81 to 1.25) |
| Group practice                  | 17990/27 104 (66.4%) Ref                    | 3497/27 104 (12.9%) Ref             | 1272/27 104 (4.7%) Ref    |
| Private multiprofessional practice | 5257/8924 (58.9%) 0.96 (0.70 to 1.31)    | 1205/8924 (13.5%) 1.02 (0.84 to 1.25) | 564/8924 (6.3%) 1.21 (0.96 to 1.54) |
| Public health centre            | 321/458 (70.1%) 1.07 (0.43 to 2.65)        | 65/458 (14.2%) 1.17 (0.66 to 2.06)  | 21/458 (4.6%) 0.95 (0.46 to 1.95) |
| Fees                            |                                             |                                     |                           |
| Set by the health authorities   | 27384/42 274 (64.8%) Ref                    | 5350/42 274 (12.7%) Ref             | 2071/42 274 (4.9%) Ref    |
| Set by the GP                   | 1836/3308 (55.5%) 0.65 (0.43 to 0.99)      | 416/3308 (12.6%) 1.06 (0.82 to 1.38) | 211/3308 (6.4%) 1.26 (0.92 to 1.72) |
| Visits by medical sales representatives |                                            |                                     |                           |
| No                              | 12311/19 726 (62.4%) Ref                    | 2484/19 726 (12.6%) Ref             | 1034/19 726 (5.2%) Ref    |
| Yes                             | 16909/25 856 (65.4%) 1.28 (1.02 to 1.61)   | 3282/25 856 (12.7%) 0.99 (0.86 to 1.14) | 1248/25 856 (4.8%) 0.86 (0.72 to 1.02) |
| Visits by public healthcare insurance delegates |                           |                                     |                           |
| No                              | 4671/7374 (63.3%) Ref                       | 1025/7374 (13.9%) Ref               | 418/7374 (5.7%) Ref       |
| Yes                             | 24549/38 208 (64.3%) 1.15 (0.86 to 1.53)   | 4741/38 208 (12.4%) 0.89 (0.75 to 1.06) | 1864/38 208 (4.9%) 0.85 (0.68 to 1.05) |

Continued
Table 2  Continued

| Clinical examination | Laboratory test | Imaging |
|----------------------|-----------------|---------|
| 29/22/45 582 (64.1%) | 5766/45 582 (12.7%) | 2282/45 582 (5.0%) |

| n (%) | OR (95% CI) | n (%) | OR (95% CI) | n (%) | OR (95% CI) |
|-------|-------------|-------|-------------|-------|-------------|
| Male  | 11957/18 220 (65.6%) | Ref | 2342/18 220 (12.8%) | Ref | 856/18 220 (4.7%) | Ref |
| Female| 17263/27 362 (63.1%) | 0.90 (0.87 to 0.94) | 3424/27 362 (12.5%) | 0.95 (0.90 to 1.01) | 1426/27 362 (5.2%) | 1.12 (1.02 to 1.22) |

| Patient age (years) | n (%) | OR (95% CI) | n (%) | OR (95% CI) | n (%) | OR (95% CI) |
|---------------------|-------|-------------|-------|-------------|-------|-------------|
| 0–4 | 2101/2548 (82.5%) | 2.37 (2.10 to 2.66) | 78/2548 (3.1%) | 0.21 (0.17 to 0.27) | 29/2548 (1.1%) | 0.15 (0.10 to 0.22) |
| 5–14 | 1783/2136 (83.5%) | 2.55 (2.24 to 2.90) | 163/2136 (7.6%) | 0.59 (0.50 to 0.71) | 105/2136 (4.9%) | 0.68 (0.55 to 0.85) |
| 15–29 | 3080/4426 (69.6%) | 1.18 (1.08 to 1.28) | 630/4426 (14.2%) | 1.19 (1.06 to 1.34) | 246/4426 (5.6%) | 0.78 (0.66 to 0.92) |
| 30–44 | 4205/6332 (66.4%) | Ref | 783/6332 (12.4%) | Ref | 441/6332 (7.0%) | Ref |
| 45–59 | 1210/1867 (64.8%) | 0.90 (0.80 to 1.00) | 230/1867 (12.3%) | 1.02 (0.87 to 1.19) | 123/1867 (6.6%) | 0.97 (0.79 to 1.19) |
| 60–74 | 10922/18 297 (59.7%) | 0.74 (0.69 to 0.79) | 2662/18 297 (14.6%) | 1.22 (1.11 to 1.33) | 1023/18 297 (5.6%) | 0.79 (0.71 to 0.89) |
| ≥75 | 5919/9976 (59.3%) | 0.74 (0.69 to 0.79) | 1220/9976 (12.2%) | 1.03 (0.93 to 1.14) | 315/9976 (3.2%) | 0.45 (0.39 to 0.53) |

| Socioprofessional category | n (%) | OR (95% CI) | n (%) | OR (95% CI) | n (%) | OR (95% CI) |
|-----------------------------|-------|-------------|-------|-------------|-------|-------------|
| Farmer, craftsman, shopkeeper, business owner | 898/1364 (65.8%) | 0.94 (0.81 to 1.09) | 230/1364 (16.9%) | 1.04 (0.86 to 1.26) | 93/1364 (6.8%) | 0.91 (0.70 to 1.19) |
| Executive, intellectual profession | 1255/2079 (60.4%) | Ref | 336/2079 (16.2%) | Ref | 170/2079 (8.2%) | Ref |
| Intermediate profession | 1549/2298 (67.4%) | 1.15 (1.01 to 1.30) | 317/2298 (13.8%) | 0.80 (0.68 to 0.95) | 164/2298 (7.1%) | 0.88 (0.70 to 1.11) |
| Office worker | 5140/7739 (66.4%) | 1.05 (0.94 to 1.17) | 1011/7739 (13.1%) | 0.77 (0.67 to 0.89) | 476/7739 (6.2%) | 0.80 (0.66 to 0.97) |
| Manual worker | 992/1508 (65.8%) | 1.03 (0.89 to 1.19) | 172/1508 (11.4%) | 0.70 (0.57 to 0.86) | 94/1508 (6.2%) | 0.86 (0.65 to 1.12) |
| Retired | 11836/19 944 (59.4%) | 0.79 (0.71 to 0.87) | 2697/19 944 (13.5%) | 0.83 (0.73 to 0.94) | 828/19 944 (4.2%) | 0.54 (0.45 to 0.65) |
| Unemployed | 7550/10 650 (70.9%) | 1.32 (1.19 to 1.46) | 1003/10 650 (9.4%) | 0.53 (0.46 to 0.61) | 457/10 650 (4.3%) | 0.55 (0.45 to 0.66) |

| Exemption from medical fees for low income | n (%) | OR (95% CI) | n (%) | OR (95% CI) | n (%) | OR (95% CI) |
|------------------------------------------|-------|-------------|-------|-------------|-------|-------------|
| No | 28128/43 873 (64.1%) | Ref | 5572/43 873 (12.7%) | Ref | 2183/43 873 (5.0%) | Ref |
| Yes | 1092/1709 (63.9%) | 1.01 (0.91 to 1.13) | 194/1709 (11.3%) | 0.86 (0.73 to 1.00) | 99/1709 (5.8%) | 1.17 (0.95 to 1.45) |

| Exemption from medical fees for a serious chronic disease | n (%) | OR (95% CI) | n (%) | OR (95% CI) | n (%) | OR (95% CI) |
|----------------------------------------------------------|-------|-------------|-------|-------------|-------|-------------|
| No | 20874/31 322 (66.6%) | Ref | 3680/31 322 (11.8%) | Ref | 1755/31 322 (5.6%) | Ref |
| Yes | 8346/14 260 (58.5%) | 0.72 (0.69 to 0.75) | 2086/14 260 (14.6%) | 1.28 (1.21 to 1.36) | 527/14 260 (3.7%) | 0.63 (0.57 to 0.70) |

| Exemption from medical fees for a workplace accident or occupational disease | n (%) | OR (95% CI) | n (%) | OR (95% CI) | n (%) | OR (95% CI) |
|------------------------------------------------------------------------------|-------|-------------|-------|-------------|-------|-------------|
| No | 28681/44 653 (64.2%) | Ref | 5717/44 653 (12.8%) | Ref | 2219/44 653 (5.0%) | Ref |
| Yes | 539/929 (58.0%) | 0.75 (0.66 to 0.86) | 49/929 (5.3%) | 0.39 (0.20 to 0.52) | 63/929 (6.8%) | 1.44 (1.10 to 1.87) |

| Consultation length (min.) | n (%) | OR (95% CI) | n (%) | OR (95% CI) | n (%) | OR (95% CI) |
|-----------------------------|-------|-------------|-------|-------------|-------|-------------|
| 1–10 | 5672/8621 (65.8%) | Ref | 789/8621 (9.2%) | Ref | 286/8621 (3.3%) | Ref |
| 11–15 | 8420/12 683 (66.4%) | 0.99 (0.94 to 1.06) | 1504/12 683 (11.9%) | 1.34 (1.22 to 1.47) | 594/12 683 (4.7%) | 1.43 (1.24 to 1.66) |
Table 2  Continued

| Characteristics of health problems managed (components) | Clinical examination 29 220/45 582 (64.1%) | Laboratory test 5766/45 582 (12.7%) | Imaging 2282/45 582 (5.0%) |
|---------------------------------------------------------|---------------------------------------------|--------------------------------------|-----------------------------|
| n (%) | OR (95% CI) | n (%) | OR (95% CI) | n (%) | OR (95% CI) |
| 16–20 | 6584/10 344 (63.6%) | 0.87 (0.82 to 0.93) | 1383/10 344 (13.4%) | 1.57 (1.42 to 1.73) | 528/10 344 (5.1%) | 1.62 (1.39 to 1.88) |
| 21–30 | 6192/10 092 (61.4%) | 0.78 (0.72 to 0.83) | 1512/10 092 (15.0%) | 1.81 (1.64 to 2.00) | 628/10 092 (6.2%) | 2.03 (1.74 to 2.36) |
| >30 | 2352/3842 (61.2%) | 0.74 (0.67 to 0.81) | 578/3842 (15.0%) | 1.94 (1.70 to 2.20) | 246/3842 (6.4%) | 2.15 (1.77 to 2.60) |

No of health problems managed

| Number of Problems | Clinical examination 27119/42 199 (64.3%) | Laboratory test 5410/42 199 (12.8%) | Imaging 2209/42 199 (5.2%) |
|-------------------|---------------------------------------------|--------------------------------------|-----------------------------|
| 1                 | 7240/8472 (85.5%) | 9.43 (8.44 to 10.54) | 1127/8472 (13.3%) | 1.23 (1.06 to 1.42) | 763/8472 (9.0%) | 4.78 (3.71 to 6.16) |
| 2                 | 7831/11 154 (70.2%) | 3.52 (3.19 to 3.88) | 1374/11 154 (12.3%) | 1.11 (0.96 to 1.28) | 563/11 154 (5.0%) | 2.49 (1.93 to 3.21) |
| 3                 | 6139/9933 (61.8%) | 2.39 (2.16 to 2.63) | 1230/9933 (12.4%) | 1.12 (0.98 to 1.29) | 394/9933 (4.0%) | 1.90 (1.47 to 2.46) |
| 4                 | 3653/6632 (55.1%) | 1.75 (1.58 to 1.94) | 852/6632 (12.8%) | 1.19 (1.03 to 1.38) | 263/6632 (4.0%) | 1.95 (1.49 to 2.55) |
| 5                 | 2077/4085 (50.8%) | 1.42 (1.28 to 1.58) | 471/4085 (11.5%) | 1.02 (0.88 to 1.20) | 138/4085 (3.4%) | 1.60 (1.20 to 2.13) |
| 6                 | 1187/2478 (47.9%) | 1.30 (1.15 to 1.46) | 354/2478 (14.3%) | 1.33 (1.12 to 1.57) | 70/2478 (2.8%) | 1.29 (0.92 to 1.79) |
| ≥7                | 1093/2828 (38.6%) | Ref | 358/2828 (12.7%) | Ref | 91/2828 (3.2%) | Ref |

Consultation site

| Site                  | Clinical examination 2101/3383 (62.1%) | Laboratory test 356/3383 (10.5%) | Imaging 73/3383 (2.2%) |
|-----------------------|-----------------------------------------|----------------------------------|------------------------|
| GP’s office           | 27119/42 199 (64.3%) | Ref | 5410/42 199 (12.8%) | Ref | 2209/42 199 (5.2%) | Ref |
| Patient’s home        | 2101/3383 (62.1%) | 0.90 (0.84 to 0.98) | 356/3383 (10.5%) | 0.79 (0.70 to 0.89) | 73/3383 (2.2%) | 0.42 (0.33 to 0.53) |

The numerators and denominators can be read as follows: 28 580 out of 45 582 health problems were managed by male GPs and 17 002 by female GPs; among the 28 580 health problems managed by male GPs, 18 300 were associated with a clinical examination.

GPs, general practitioners.
Table 3  Characteristics of GPs, consultations and health problems associated with the three types of diagnostic procedures used (clinical examinations, laboratory tests, imaging) per health problem managed in the multivariable analyses (France, 2011–2012)

| GPs' characteristics | Clinical examination | Laboratory test | Imaging |
|-----------------------|----------------------|-----------------|--------|
|                       | 29 220/45 582 (64.1%) OR (95% CI) | 5766/45 582 (12.7%) OR (95% CI) | 2282/45 582 (5.0%) OR (95% CI) |
| Gender                |                      |                 |        |
| Male                  | Ref                  | Ref             | Ref    |
| Female                | 1.40 (1.10 to 1.77)  | 1.20 (1.03 to 1.41) | 1.13 (0.94 to 1.35) |
| Age (years)           |                      |                 |        |
| 32–49                 | Ref                  | Ref             | Ref    |
| 50–54                 | 1.05 (0.78 to 1.41)  | 1.01 (0.83 to 1.23) | 0.89 (0.71 to 1.11) |
| 55–59                 | 1.12 (0.83 to 1.51)  | 0.92 (0.75 to 1.12) | 0.83 (0.66 to 1.04) |
| ≥60                   | 1.42 (1.00 to 2.01)  | 1.06 (0.85 to 1.34) | 0.84 (0.64 to 1.09) |
| Practice location     |                      |                 |        |
| Rural                 | 1.29 (0.92 to 1.61)  | 1.01 (0.81 to 1.26) | 0.96 (0.74 to 1.24) |
| Semi-rural            | 1.46 (1.13 to 1.89)  | 1.05 (0.89 to 1.24) | 0.91 (0.75 to 1.11) |
| Urban                 | Ref                  | Ref             | Ref    |
| Fees                  |                      |                 |        |
| Set by health authorities | Ref                 | Ref             | Ref    |
| Set by GPs            | 0.57 (0.37 to 0.87)  | 0.96 (0.73 to 1.26) | 1.07 (0.78 to 1.47) |
| Characteristics of consultations | | | |
| Patient gender        |                      |                 |        |
| Male                  | Ref                  | Ref             | Ref    |
| Female                | 0.95 (0.91 to 0.99)  | 0.97 (0.91 to 1.03) | 1.14 (1.04 to 1.26) |
| Patient age (years)   |                      |                 |        |
| 0–4                   | 1.51 (1.31 to 1.74)  | 0.24 (0.19 to 0.31) | 0.18 (0.12 to 0.27) |
| 5–14                  | 1.69 (1.46 to 1.97)  | 0.69 (0.56 to 0.84) | 0.69 (0.53 to 0.89) |
| 15–29                 | 1.09 (0.99 to 1.19)  | 1.27 (1.13 to 1.43) | 0.72 (0.61 to 0.85) |
| 30–44                 | Ref                  | Ref             | Ref    |
| 45–59                 | 1.05 (0.93 to 1.18)  | 1.02 (0.87 to 1.20) | 1.08 (0.87 to 1.33) |
| 60–74                 | 1.06 (0.98 to 1.15)  | 1.18 (1.07 to 1.31) | 1.17 (1.02 to 1.34) |
| ≥75                   | 1.20 (1.09 to 1.33)  | 1.01 (0.89 to 1.16) | 0.86 (0.70 to 1.06) |
| Socioprofessional category |                  |                 |        |
| Farmer, craftsman, shopkeeper, business owner | 1.00 (0.85 to 1.17) | 1.01 (0.83 to 1.22) | 0.94 (0.71 to 1.24) |
| Executive, intellectual profession | Ref | Ref | Ref |
| Intermediate profession | 1.07 (0.93 to 1.22) | 0.78 (0.66 to 0.93) | 0.83 (0.65 to 1.05) |
| Office worker         | 1.04 (0.93 to 1.16)  | 0.77 (0.67 to 0.89) | 0.78 (0.64 to 0.94) |
| Manual worker         | 1.01 (0.86 to 1.19)  | 0.73 (0.59 to 0.90) | 0.82 (0.62 to 1.09) |
| Retired               | 1.04 (0.93 to 1.17)  | 0.80 (0.69 to 0.93) | 0.85 (0.69 to 1.05) |
| Unemployed            | 0.87 (0.77 to 0.98)  | 0.69 (0.59 to 0.80) | 0.78 (0.63 to 0.97) |
| Exemption from medical fees for a serious chronic disease | | | |
| No                    | Ref                  | Ref             | Ref    |
| Yes                   | 1.07 (1.02 to 1.13)  | 1.25 (1.17 to 1.34) | 0.80 (0.71 to 0.90) |
| Exemption from medical fees for a workplace accident or occupational disease | | | |
| No                    | Ref                  | Ref             | Ref    |
| Yes                   | 0.66 (0.57 to 0.77)  | 0.39 (0.29 to 0.52) | 0.81 (0.61 to 1.07) |

Continued
earlier studies of a few basic clinical measurements reporting that female GPs checked blood pressure, height and weight more often than males.\textsuperscript{5} \textsuperscript{13} The even higher difference observed for clinical examination for screening purposes is also consistent with the greater level of prevention and screening usually provided by female GPs.\textsuperscript{4} Conversely, KL Bertakis reported that male doctors in the USA spent more time on technical practice behaviours, such as medical history tacking and physical examination; but this result was presumably not adjusted for potential confounding factors such as patient gender and health problem number and type.\textsuperscript{24} The particularly high frequency of clinical examination by female GPs in injured patients is an original finding. A number of studies have explored patient gender issues in the management of traumatic injuries in emergency settings, but none explored the influence of physician gender.\textsuperscript{25} Our finding may be explained by a different practice style related to physician gender, as suggested in a Canadian study which found that female physicians better managed pain in emergency departments than male physicians.\textsuperscript{26} Studies of various designs, based on frequency per health problem,\textsuperscript{3} per encounter\textsuperscript{7} or per patient\textsuperscript{14} have previously reported that female GPs order more laboratory tests than male doctors. In our study, however, female GPs ordered more laboratory tests for diagnostic and follow-up but not for screening. This result is consistent with studies showing that female GPs see more patients with endocrine and female genital health problems, which are usually monitored by laboratory tests.\textsuperscript{3}\textsuperscript{27}

Beyond their overall higher frequency of clinical examination and laboratory tests, female GPs performed even more clinical examinations or ordered even more laboratory tests than male GPs in some of the most frequent health problems managed, as compared with all other health problems. In particular, female GPs performed much more clinical examinations than male GPs for preventive purposes, which is consistent with the observation that female PCPs performed pap smear tests\textsuperscript{28} and skin examination for melanoma detection\textsuperscript{29} more frequently than male PCPs in the USA. Regarding back syndrome, according to a systematic review, low back pain initial management is not exposed to doctor’s gender effect; however, no data were available on patient clinical examination.\textsuperscript{30} Our finding regarding laboratory testing to monitor lipid disorders is consistent with Hungarian data that showed that female GP gender was associated with regular lipid profile measurement in patients with diabetes or hypertension.\textsuperscript{31} The finding regarding laboratory testing to monitor osteoporosis is consistent with a study in the USA, which found much more frequent ordering of 25-OH vitamin D by female than male

| No of health problems managed | Clinical examination OR (95% CI) | Laboratory test OR (95% CI) | Imaging OR (95% CI) |
|-------------------------------|---------------------------------|-----------------------------|--------------------|
| 1                             | 7.10 (6.29 to 8.01)             | 2.02 (1.73 to 2.36)         | 5.57 (4.26 to 7.28) |
| 2                             | 3.20 (2.88 to 3.56)             | 1.45 (1.25 to 1.68)         | 2.51 (1.92 to 3.27) |
| 3                             | 2.36 (2.13 to 2.62)             | 1.29 (1.12 to 1.49)         | 1.77 (1.36 to 2.31) |
| 4                             | 1.80 (1.62 to 2.00)             | 1.27 (1.10 to 1.48)         | 1.77 (1.35 to 2.32) |
| 5                             | 1.44 (1.29 to 1.61)             | 1.06 (0.90 to 1.24)         | 1.52 (1.14 to 2.04) |
| 6                             | 1.33 (1.18 to 1.50)             | 1.33 (1.13 to 1.58)         | 1.18 (0.85 to 1.64) |
| ≥7                            | Ref                             | Ref                         | Ref                |

| Consultation place            | Clinical examination OR (95% CI) | Laboratory test OR (95% CI) | Imaging OR (95% CI) |
|-------------------------------|---------------------------------|-----------------------------|--------------------|
| GP’s office                   | Ref                             | Ref                         | Ref                |
| Patient’s home                | 0.96 (0.88 to 1.05)             | 0.75 (0.66 to 0.85)         | 0.50 (0.39 to 0.65) |

### Characteristics of health problems managed (components)

| Symptoms and complaints       | Clinical examination OR (95% CI) | Laboratory test OR (95% CI) | Imaging OR (95% CI) |
|-------------------------------|---------------------------------|-----------------------------|--------------------|
| Infections                    | 7.78 (7.00 to 8.64)             | 0.78 (0.70 to 0.87)         | 0.23 (0.20 to 0.27) |
| Neoplasms                     | 0.74 (0.63 to 0.87)             | 1.18 (0.95 to 1.47)         | 1.09 (0.83 to 1.42) |
| Injuries                      | 2.11 (1.80 to 2.47)             | 0.18 (0.12 to 0.26)         | 1.00 (0.82 to 1.24) |
| Congenital anomalies/Other diagnoses | 1.29 (1.22 to 1.36)             | 1.23 (1.14 to 1.32)         | 0.35 (0.32 to 0.39) |
| GPs’ variance                 | 0.362                           | 0.128                       | 0.141              |
| Marginal explained variance coefficient | 0.226                           | 0.088                       | 0.168              |
| Conditional explained variance coefficient | 0.303                           | 0.122                       | 0.203              |

GPs, general practitioners.
Table 4  Characteristics of GPs, consultations and health problems associated with the three types of diagnostic procedures considered (clinical examinations, laboratory tests, imaging) per health problem managed, restricted to those for screening, in the multivariable analyses (France, 2011–2012)

|                              | Clinical examination | Laboratory test | Imaging |
|------------------------------|----------------------|----------------|---------|
|                              | 3480/6224 (55.9%) OR (95% CI) | 1011/6224 (16.2%) OR (95% CI) | 144/6224 (2.3%) OR (95% CI) |

**GPs' characteristics**

**Gender**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| Male           | Ref                  | Ref            | Ref     |
| Female         | 1.75 (1.19 to 2.58)   | 1.22 (0.97 to 1.54) | 1.12 (0.71 to 1.76) |

**Age (years)**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| 32–49          | Ref                  | Ref            | Ref     |
| 50–54          | 1.18 (0.74 to 1.90)   | 0.87 (0.65 to 1.15) | 0.49 (0.28 to 0.85) |
| 55–59          | 1.13 (0.70 to 1.82)   | 0.93 (0.68 to 1.25) | 0.65 (0.36 to 1.16) |
| ≥60            | 1.70 (0.97 to 2.98)   | 1.01 (0.72 to 1.42) | 0.50 (0.25 to 0.98) |

**Annual no of consultations**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| 0–4999         | Ref                  | Ref            | Ref     |
| 5000–10 500    | 1.30 (0.91 to 1.87)   | 1.05 (0.85 to 1.31) | 0.64 (0.41 to 1.02) |

**Fees**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| Set by health authorities | Ref              | Ref            | Ref     |
| Set by GP      | 0.44 (0.22 to 0.85)   | 1.11 (0.75 to 1.64) | 1.75 (0.84 to 3.61) |

**Characteristics of consultations**

**Patient gender**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| Male           | Ref                  | Ref            | Ref     |
| Female         | 0.95 (0.84 to 1.07)   | 0.87 (0.75 to 1.01) | 3.23 (2.03 to 5.15) |

**Patient age (years)**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| 0–4            | 1.38 (1.05 to 1.82)   | 0.03 (0.01 to 0.08) | 0.21 (0.06 to 0.69) |
| 5–14           | 0.91 (0.66 to 1.25)   | 0.12 (0.06 to 0.28) | 0.62 (0.21 to 1.85) |
| 15–29          | 0.67 (0.53 to 0.84)   | 1.11 (0.84 to 1.47) | 0.46 (0.21 to 1.02) |
| 30–44          | Ref                  | Ref            | Ref     |
| 45–59          | 1.31 (0.94 to 1.82)   | 1.19 (0.82 to 1.74) | 0.57 (0.17 to 1.96) |
| 60–74          | 0.76 (0.62 to 0.93)   | 1.81 (1.43 to 2.29) | 1.89 (1.11 to 3.23) |
| ≥75            | 1.12 (0.83 to 1.52)   | 1.42 (1.01 to 1.99) | 1.01 (0.43 to 2.36) |

**Socioprofessional category**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| Farmer, craftsman, shopkeeper, business owner | 0.87 (0.59 to 1.29) | 1.12 (0.74 to 1.71) | 1.75 (0.67 to 4.58) |
| Executive, intellectual profession | Ref              | Ref            | Ref     |
| Intermediate profession | 1.33 (0.94 to 1.88) | 0.84 (0.57 to 1.23) | 0.83 (0.32 to 2.11) |
| Office worker   | 1.20 (0.92 to 1.58)   | 0.87 (0.65 to 1.18) | 1.12 (0.56 to 2.25) |
| Manual worker   | 1.21 (0.79 to 1.85)   | 1.07 (0.68 to 1.68) | 0.36 (0.05 to 2.91) |
| Retired         | 1.00 (0.75 to 1.34)   | 0.80 (0.58 to 1.10) | 0.84 (0.41 to 1.74) |
| Unemployed      | 0.92 (0.68 to 1.23)   | 0.76 (0.55 to 1.05) | 0.95 (0.44 to 2.06) |

**Exemption from medical fees for low income**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| No             | Ref                  | Ref            | Ref     |
| Yes            | 0.92 (0.69 to 1.23)   | 0.65 (0.41 to 1.03) | 1.34 (0.55 to 3.26) |

**Exemption from medical fees for a serious chronic disease**

|                | Clinical examination | Laboratory test | Imaging |
|----------------|----------------------|----------------|---------|
| No             | Ref                  | Ref            | Ref     |
| Yes            | 0.68 (0.57 to 0.81)   | 0.90 (0.74 to 1.09) | 0.78 (0.48 to 1.27) |

**No of health problems managed**

Continued
No inversed interaction was observed in favour of male GPs for any of the top 20 health problems, which accounted for almost half the health problems managed.

Given concerns about increasing expenditures for medical tests, studies of the appropriateness of diagnostic procedures have focused mainly on their overuse. GPs in the USA and the UK acknowledge that they regularly prescribe unnecessary tests. Nonetheless, underuse accounts for a substantial portion of inappropriate test use. Both errors expose patients to adverse events: underuse of both clinical examinations and laboratory tests can result in missed or delayed diagnosis, while their inappropriate use in asymptomatic adults can lead to overtreatment and overdiagnosis without reducing patient mortality. A few studies have found that female GPs prescribe slightly more recommended tests than males for the follow-up of chronic conditions such as diabetes and hypertension. These findings tend to favour the underuse of diagnostic procedures by male GPs, although this conclusion depends on the frequency thresholds used. A few studies have found that female GPs prescribe slightly more recommended tests than males for the follow-up of chronic conditions such as diabetes and hypertension. These findings tend to favour the underuse of diagnostic procedures by male GPs, although this conclusion depends on the frequency thresholds used. Since female GPs are more reluctant to deal with uncertainty than male GPs, they might also overuse diagnostic procedures to reassure themselves about the risk of diagnostic oversights.

In this study, GP gender had no influence on the frequency per health problem of imaging investigation orders. This finding is consistent with the results of an Australian study. Previous studies have found, however, that female GPs order more imaging investigations per encounter than male GPs, perhaps because their patients report a higher number of health problems per visit. Moreover, screening mammograms ordered for female patients may explain this higher rate of imaging orders. The likelihood of this interpretation is supported by the finding of a US study that patient gender did not influence imaging orders when screening mammograms were excluded.

### Implications for research and practice

Given that these analyses were adjusted for various patient and health problem characteristics, it is likely that the differences in clinical examination and laboratory test use observed between male and female GPs are due to their inappropriate use by male and/or female GPs. Further research is required to determine the extent to which these differences may be related to underuse or overuse of these procedures, for few studies have explored their appropriateness by doctors’ gender.

Recommendations about the use of diagnostic procedures are frequently imprecise, inapplicable or lack evidence, for example, about follow-up intervals. Since appraisals of procedure overuse or underuse are usually based on clinical practice guidelines, improving guideline quality should optimise the appropriateness of procedures and reduce their differential use by female and male GPs.

As training in test-ordering can lead to long-term improvement in the use and cost of laboratory tests, developing programmes for initial and continuing medical education is another way to reduce these differences. Multifaceted interventions aimed at both GPs and patients, including reminders and audit/feedback, may help reduce use of low-value diagnostic procedures.

### Strengths and limitations

Because the participating GPs all trained and supervised GP interns, they were likely to be different from other GPs. Nonetheless, they were representative of French GPs for gender, mean age (although not for age class), mean annual number of consultations, practice location and type of fees authorised. Another French study has reported that their patients can be considered globally similar to those of GPs who do not train interns.

---

**Table 4** Continued

|   | Clinical examination | Laboratory test | Imaging |
|---|----------------------|-----------------|---------|
| 1 | 3480/6224 (55.9%) OR (95% CI) | 1011/6224 (16.2%) OR (95% CI) | 144/6224 (2.3%) OR (95% CI) |
| 2 | 4.87 (3.32 to 7.15) | 0.92 (0.60 to 1.40) | 1.58 (0.63 to 3.95) |
| 3 | 2.18 (1.55 to 3.07) | 0.75 (0.53 to 1.07) | 0.68 (0.30 to 1.55) |
| 4 | 1.60 (1.14 to 2.25) | 0.77 (0.55 to 1.10) | 0.86 (0.39 to 1.89) |
| 5 | 1.24 (0.88 to 1.76) | 1.22 (0.86 to 1.74) | 0.83 (0.37 to 1.88) |
| 6 | 1.22 (0.84 to 1.76) | 0.91 (0.62 to 1.33) | 1.36 (0.60 to 3.09) |
| ≥7 | 0.98 (0.65 to 1.48) | 1.61 (1.07 to 2.40) | 0.87 (0.32 to 2.38) |

GPs, general practitioners.
### Table 5  Characteristics of GPs, consultations and health problems associated with the three types of diagnostic procedures used (clinical examinations, laboratory tests, imaging) per health problem managed, restricted to those of diagnostic or follow-up purposes, in the multivariable analyses (France, 2011–2012)

| Characteristics of GPs, consultations | Clinical examination | Laboratory test | Imaging |
|---------------------------------------|----------------------|----------------|--------|
|                                       | 25 740/39 358 (65.4%) | 4755/39 358 (12.1%) | 2138/39 358 (5.4%) |
|                                       | OR (95% CI)           | OR (95% CI)     | OR (95% CI)     |
| **GPs' characteristics**              |                      |                |                 |
| Gender                                |                      |                |                 |
| Male                                  | Ref                   | Ref            | Ref             |
| Female                                | 1.41 (1.08 to 1.84)   | 1.21 (1.03 to 1.43) | 1.13 (0.94 to 1.35) |
| Age (years)                           |                      |                |                 |
| 32–49                                  | Ref                   | Ref            | Ref             |
| 50–54                                  | 1.02 (0.73 to 1.41)   | 1.03 (0.83 to 1.27) | 0.92 (0.73 to 1.16) |
| 55–59                                  | 1.10 (0.80 to 1.53)   | 0.92 (0.74 to 1.14) | 0.82 (0.65 to 1.04) |
| 60+                                    | 1.36 (0.93 to 2.00)   | 1.07 (0.83 to 1.36) | 0.86 (0.65 to 1.13) |
| Practice location                      |                      |                |                 |
| Rural                                  | 1.33 (0.92 to 1.91)   | 1.00 (0.79 to 1.27) | 0.94 (0.72 to 1.23) |
| Urban                                  | 1.49 (1.12 to 1.96)   | 1.04 (0.87 to 1.25) | 0.91 (0.74 to 1.11) |
| Fees                                   |                      |                |                 |
| Set by health authorities              | Ref                   | Ref            | Ref             |
| Set by GP                              | 0.60 (0.38 to 0.95)   | 0.93 (0.69 to 1.25) | 1.05 (0.76 to 1.46) |
| **Characteristics of consultations**   |                      |                |                 |
| Patient gender                         |                      |                |                 |
| Male                                   | Ref                   | Ref            | Ref             |
| Female                                 | 0.95 (0.90 to 1.00)   | 0.98 (0.91 to 1.04) | 1.07 (0.98 to 1.18) |
| Patient age (years)                    |                      |                |                 |
| 0–4                                    | 2.41 (1.96 to 2.96)   | 0.39 (0.30 to 0.51) | 0.21 (0.14 to 0.32) |
| 5–14                                   | 2.58 (2.13 to 3.12)   | 0.86 (0.69 to 1.06) | 0.73 (0.56 to 0.95) |
| 15–29                                  | 1.27 (1.14 to 1.42)   | 1.31 (1.15 to 1.49) | 0.75 (0.63 to 0.90) |
| 30–44                                  | Ref                   | Ref            | Ref             |
| 45–59                                  | 1.01 (0.88 to 1.15)   | 0.97 (0.81 to 1.16) | 1.09 (0.87 to 1.35) |
| 60–74                                  | 1.10 (1.01 to 1.19)   | 1.06 (0.95 to 1.19) | 1.10 (0.95 to 1.27) |
| ≥75                                    | 1.18 (1.06 to 1.31)   | 0.95 (0.82 to 1.10) | 0.82 (0.66 to 1.01) |
| Socioprofessional category             |                      |                |                 |
| Farmer, craftsman, shopkeeper, business owner | 1.01 (0.84 to 1.21) | 0.98 (0.79 to 1.22) | 0.88 (0.65 to 1.17) |
| Executive, intellectual profession     | Ref                   | Ref            | Ref             |
| Intermediate profession                | 0.98 (0.84 to 1.15)   | 0.78 (0.64 to 0.95) | 0.81 (0.63 to 1.03) |
| Office worker                          | 0.98 (0.86 to 1.11)   | 0.76 (0.64 to 0.89) | 0.74 (0.60 to 0.90) |
| Manual worker                          | 0.94 (0.79 to 1.12)   | 0.68 (0.54 to 0.86) | 0.81 (0.61 to 1.08) |
| Retired                                | 1.00 (0.88 to 1.14)   | 0.83 (0.70 to 0.98) | 0.83 (0.67 to 1.03) |
| Unemployed                             | 0.84 (0.74 to 0.96)   | 0.69 (0.58 to 0.81) | 0.75 (0.60 to 0.93) |
| Exemption from medical fees for a serious chronic disease | | | |
| No                                     | Ref                   | Ref            | Ref             |
| Yes                                    | 1.08 (1.02 to 1.15)   | 1.38 (1.28 to 1.49) | 0.79 (0.70 to 0.89) |
| Exemption from medical fees for a workplace accident or occupational disease | | | |
| No                                     | Ref                   | Ref            | Ref             |
| Yes                                    | 0.62 (0.53 to 0.73)   | 0.36 (0.26 to 0.51) | 0.74 (0.55 to 0.99) |
We could not adjust analyses for a possible influence of the interns, as it would have introduced a level of collinearity with GP characteristics into the multivariable models. However, the standardised process used for data collection and the observing role of the interns during the study limited the risk of confounding bias due to this factor.

The study data were collected in 2011–2012. In the recent years, the sex ratio female/male of the GPs practicing in France has still substantially increased (from 0.64 in 2010 to 1.02 in 2020). The diagnostic practices of GPs may have also evolved as observed in Australia (with an increase in the number of pathology tests and of imaging investigations from 6.0 to 7.1 per 100 problems managed between 2006–2007 and 2015–16). However, it is unlikely that the gaps observed between female and male GPs in this study have much changed in the meantime, since the medical education does not differ by gender and no incentive specific to GP gender has been provided in France.

The higher use of diagnostic procedures by female compared with male GPs may be due to a lower frequency of visits for chronic diseases. No such finding has been reported, however, and female GPs tend to ask patients to come back for follow-up visits at shorter intervals than male GPs.

We could not include consultation length in our analyses, although it may be a confounding factor, given that consultations with female GPs are usually longer than those of males. However, the statistical models were adjusted for the number of health problems managed.

**CONCLUSIONS**

The results of this study indicate that female GPs perform clinical examinations and order laboratory
Table 6  Search for interactions between the top 20 health problems managed and GP gender for clinical examinations and laboratory tests in multivariable analyses†

| Health maintenance/preventive medicine (n=5000) | Clinical examination | Laboratory test |
|-----------------------------------------------|----------------------|-----------------|
| OR (95% CI)                                   | OR (95% CI)          |
| Female vs male (Health maintenance/preventive medicine) | 2.62 (2.02 to 3.41)  | 1.06 (0.86 to 1.31) |
| Female vs male (All other health problems)     | 1.28 (1.02 to 1.62)  | 1.21 (1.04 to 1.42) |
| Interaction, p value                           | <0.001               | 0.11            |

Hypertension, uncomplicated (n=3189)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Hypertension, uncomplicated)  | 1.82 (1.22 to 2.70)  | 1.33 (1.02 to 1.74) |
| Female vs male (All other health problems)    | 1.41 (1.11 to 1.79)  | 1.19 (1.02 to 1.39) |
| Interaction, p value                           | 0.13                 | 0.34            |

Upper respiratory infection, acute (n=1969)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Upper respiratory infection, acute) | 1.69 (0.80 to 3.60)  | 1.03 (0.59 to 1.80) |
| Female vs male (All other health problems)     | 1.38 (1.10 to 1.75)  | 1.20 (1.03 to 1.40) |
| Interaction, p value                           | 0.58                 | 0.59            |

Lipid disorder (n=1691)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Lipid disorder)               | 1.38 (1.00 to 1.90)  | 1.67 (1.26 to 2.21) |
| Female vs male (All other health problems)    | 1.37 (1.09 to 1.73)  | 1.19 (1.02 to 1.39) |
| Interaction, p value                           | 0.97                 | 0.01            |

No disease (n=1235)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (No disease)                   | 1.38 (0.98 to 1.93)  | 1.65 (1.03 to 2.64) |
| Female vs male (All other health problems)    | 1.38 (1.09 to 1.73)  | 1.19 (1.02 to 1.39) |
| Interaction, p value                           | 1.0                  | 0.16            |

Depressive disorder (n=1216)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Depressive disorder)          | 0.95 (0.67 to 1.35)  | 0.45 (0.14 to 1.39) |
| Female vs male (All other health problems)    | 1.40 (1.11 to 1.77)  | 1.21 (1.03 to 1.41) |
| Interaction, p value                           | 0.01                 | 0.08            |

Diabetes, non-insulin dependent (n=1093)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Diabetes, non-insulin dependent) | 1.44 (0.99 to 2.08)  | 1.23 (0.91 to 1.66) |
| Female vs male (All other health problems)    | 1.38 (1.09 to 1.73)  | 1.20 (1.02 to 1.41) |
| Interaction, p value                           | 0.78                 | 0.86            |

Acute bronchitis/bronchiolitis (n=697)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Acute bronchitis/bronchiolitis) | 1.43 (0.57 to 3.57)  | 1.20 (1.03 to 1.40) |
| Female vs male (All other health problems)    | 1.20 (1.03 to 1.40)  |                 |
| Interaction, p value                           | 0.70                 |                 |

Sleep disturbance (n=669)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Sleep disturbance)            | 0.70 (0.40 to 1.22)  | 0.61 (0.06 to 5.97) |
| Female vs male (All other health problems)    | 1.39 (1.10 to 1.75)  | 1.20 (1.03 to 1.40) |
| Interaction, p value                           | 0.01                 | 0.56            |

Hypothyroidism/thyrotoxicosis (n=647)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Hypothyroidism/thyrotoxicosis) | 2.10 (1.38 to 3.19)  | 2.02 (1.40 to 2.93) |
| Female vs male (All other health problems)    | 1.37 (1.09 to 1.72)  | 1.19 (1.02 to 1.39) |
| Interaction, p value                           | 0.02                 | <0.01           |

Osteoarthrosis, other (n=576)

| OR (95% CI)                                   | OR (95% CI)          |
|-----------------------------------------------|----------------------|-----------------|
| Female vs male (Osteoarthrosis, other)        | 1.62 (1.06 to 2.49)  | 0.84 (0.23 to 3.06) |

Continued
### Table 6  Continued

|                          | Clinical examination 29220/45582 (64.1%) | Laboratory test 5766/45582 (12.7%) |
|--------------------------|------------------------------------------|-------------------------------------|
|                          | OR (95% CI)                              | OR (95% CI)                         |
| Female vs male           |                                          |                                     |
| (All other health problems) | 1.38 (1.09 to 1.73)                      | 1.20 (1.03 to 1.40)                 |
| Interaction, p value     | 0.38                                    | 0.59                                |
| Back syndrome without radiating pain (n=482) |                          |                                     |
| Female vs male (Back syndrome without radiating pain) | 2.70 (1.55 to 4.70)                      | 0.63 (0.20 to 2.04)                 |
| Female vs male (All other health problems) | 1.37 (1.09 to 1.72)                      | 1.20 (1.03 to 1.40)                 |
| Interaction, p value     | 0.01                                    | 0.28                                |
| Anxiety disorder/anxiety state (n=474) |                          |                                     |
| Female vs male (Anxiety disorder/anxiety state) | 1.16 (0.71 to 1.90)                      |                                     |
| Female vs male (All other health problems) | 1.38 (1.09 to 1.73)                      |                                     |
| Interaction, p value     | 0.45                                    | *                                   |
| Constipation (n=451)     |                                          |                                     |
| Female vs male (Constipation) | 2.15 (1.34 to 3.45)                      | 2.29 (0.71 to 7.44)                 |
| Female vs male (All other health problems) | 1.37 (1.09 to 1.72)                      | 1.20 (1.03 to 1.40)                 |
| Interaction, p value     | 0.04                                    | 0.27                                |
| Bursitis/tendinitis/synovitis NOS (n=435) |                          |                                     |
| Female vs male (Bursitis/tendinitis/synovitis NOS) | 1.32 (0.75 to 2.34)                      | 0.46 (0.05 to 4.01)                 |
| Female vs male (All other health problems) | 1.38 (1.10 to 1.73)                      | 1.20 (1.03 to 1.40)                 |
| Interaction, p value     | 0.87                                    | 0.38                                |
| Back syndrome with radiating pain (n=429) |                          |                                     |
| Female vs male (Back syndrome with radiating pain) | 1.63 (0.92 to 2.89)                      | 0.73 (0.19 to 2.84)                 |
| Female vs male (All other health problems) | 1.38 (1.09 to 1.73)                      | 1.20 (1.03 to 1.40)                 |
| Interaction, p value     | 0.52                                    | 0.47                                |
| Atrial fibrillation/flutter (n=408) |                          |                                     |
| Female vs male (Atrial fibrillation/flutter) | 0.90 (0.50 to 1.61)                      | 1.03 (0.63 to 1.67)                 |
| Female vs male (All other health problems) | 1.38 (1.10 to 1.74)                      | 1.21 (1.03 to 1.41)                 |
| Interaction, p value     | 0.12                                    | 0.50                                |
| Oesophagus disease (n=388) |                          |                                     |
| Female vs male (Oesophagus disease) | 2.13 (1.28 to 3.54)                      | 1.60 (0.31 to 8.10)                 |
| Female vs male (All other health problems) | 1.37 (1.09 to 1.72)                      | 1.20 (1.03 to 1.40)                 |
| Interaction, p value     | 0.06                                    | 0.73                                |
| Osteoporosis (n=379)     |                                          |                                     |
| Female vs male (Osteoporosis) | 1.60 (0.85 to 3.04)                      | 5.79 (2.15 to 15.58)                |
| Female vs male (All other health problems) | 1.38 (1.10 to 1.74)                      | 1.19 (1.02 to 1.39)                 |
| Interaction, p value     | 0.63                                    | <0.01                               |
| Vitamin/nutritional deficiency (n=370) |                          |                                     |
| Female vs male (Vitamin/nutritional deficiency) | 0.81 (0.28 to 2.33)                      | 1.17 (0.59 to 2.33)                 |
| Female vs male (All other health problems) | 1.39 (1.10 to 1.74)                      | 1.20 (1.03 to 1.40)                 |
| Interaction, p value     | 0.31                                    | 0.94                                |

<sup>1</sup>The top 20 health problems accounted for 21 798 (47.8%) out of 45 582 health problems managed.

<sup>2</sup>The test for interaction could not be processed when the proportion of GPs performing clinical examination or ordering a laboratory test was 0% or 100%.

<sup>3</sup>These 20 multivariable analyses were performed using multilevel models adjusted for all the variables included in the models presented in table 3.

NOS, not otherwise specified.
Acknowledgements We acknowledge the ECOCEN study group, including the Steering Committee, the 54 residents and the 128 GP supervisors. The members of the Steering Committee were: Laurent Letrilliart, Alain Mercier, Irene Supper, Matthieu Schuers, David Darmon, Pascal Boulet, Dominique Ambros, Madeleine Favre, Gil Mury, Bernard Gay, Denis Pouchain, Eric Van Ganse, Philippe Amelie, Anne-Marie Schott, Angelique Denis. The interns (trainees) were: Céline Alexanian, Clement Barletta, Solene Baron de Previle, Muriel Baudoin-Bion, Naima Belbari, Clarisse Bertrand, Anne-Sophie Billet, Emilie Boulard, Emilie Breilliat, Claire Brunet, Claire Camilleri, Hélène Carrier, Matthieu Carron, Nelly Cordeiro, Clément Coutarel, Sophie Dargent, Sarah Darriau, Hubert de Lary, Karen Denis, Yohana Dery, Isabelle Duquenne, Guillaume Farcis-Morgat, Charlotte Favier, Sarah Filoche, Mohamed Hamade, Marie Helly, Laura Hsiung, Thibault Lelong, Nathalie Levernier, Julia Marquant, Priska Martin, Caroline Martin-Bouyer, Ryma Metahsi, Lesley-Ann Montigneanu, Noémie Morel, David Nakache, Claire Parker, Eric Pernollet, Solène Petitclerc, Alicia Pillot, Henri Plancke, Fanny Pironot, Thomas Prouboeuf, Sophie Quien, Marie-Camille Rault-Tandonnet, Charlotte Regnier, Yohan Saynac, Sapahanie Son, Damien Steciuk, Aurélie Urena-Dores, Yannick Vacher, Maxime Veques, Lucile Wies, Elodie Youssel. The GP supervisors were: Ahmed Adjourj, Isabelle Aubin-Auger, Ghislaïne Audran, Nadine Ayme, Catherine Bageot, Jérôme Bard, Bruno Beauchamps, Olivier Bisch, Paul Blanchet, Jean-Michel Blondel, Pierre Bobey, Jean-Yves Borgeaud, Jean-Yves Bouten, Agnès Bruno, Martin Buisson, Marine Cabanas, Gérard Catsando, Maxime Cauchin, Nicole Caunes, Ceriser-Cornillot, Patrick Charbit, Pascal Clerc, Laurent Convent, François Corriou, Therié Corinou, Alain Coularnac'h, Claude Danner, Jean-Claude Darrieux, Alain Dasse, François de Golmard, Gilles de Lorenzo, Anto de Pavljasevic, Pierre-François Delzanno, Nicole Derain, Pierre Deveche, Vincent Diou, Bénédicte Chevreau, Christian Larcheron, Elise Dubreuil, Pierre Dupont, Charline Dupont, Richard Dymny, Catherine Elsass, Pierre Eterstein, Gilles Faivre, Eric Fanjeaux, Emmanuelle Farci, Claudine Fity, Vasantha Flohy, Anne Girard, Christophe Girault, Sabine Grutter, Murielle Guillier, Thérèse Guyenne-Chamburu, Christophe Haguenet, Jean-Yves Hascoet, Sophie Haudidier, Sylvain Hirsch, Gaëtan Houdard, Hélène Huball, André Kastelik, Sylvain Kichelewski, Xavier Lainé, Valérie Lapouge, David Laurent, Laurent Lavall, Serge Lavaure, Mireille Lavigne, Yves Leborgne, Odile Lion, Viviane Manney, Jean-Michel Mathieu, LaureEmmanuelle Mavraganis, Denis Perrot, Yvon Petroux, Christophe Pigache, Maurice Pochant, Véronique Poupet, Daniel Reynolds, Emmanuel Robin, Marie-Hélène Robinne, Jean-Loup Roblot, Larissa Savan, Pierre Sebbag, Patrick Serery, Michel Serraille, Corinne Simonneau, François Tahon, Jean Louis Teruel, Audrey Tordoir, Christian Verot, Valérie Zéline. We thank Jo Ann Cahn for help in manuscript preparation.

Contributors LL and VR conceived the study. LL, LR and HP designed the analyses. HP performed the statistical analyses. AB and ML wrote the first draft, with the help of LL. All authors revised the first draft and approved the final version of the manuscript. LL is responsible for the overall content as guarantor.

Funding The ECOCEN study was supported by the French National College of teachers in general practice via a grant from Pfizer laboratories (grant number not applicable).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Ethics Committee Sud-Est N (No.L11-149). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

REFERENCES

1 Phillips SP, Austin EB. The feminization of medicine and population health. JAMA 2009;301:1363-4.
2 Hedden L, Barer ML, Cardiff K, et al. The implications of the feminization of the primary care physician workforce on service supply: a systematic review. Hum Resour Health 2014;12:32.
3 Harrison CM, Britt HC, Charles J. Sex of the GP—20 years on. Med J Aust 2011;195:190-6.
4 Delpech R, Bloy G, Panjo H, et al. Physicians’ preventive practices: more frequently performed for male patients and by female physicians. BMC Health Serv Res 2020;20:331.
5 Diehl K, Ganaefort D, Herr RM, et al. Physician gender and lifestyle counselling to prevent cardiovascular disease: a nationwide representative study. J Public Health Res 2015;4:534.
6 Lofters AK, Nq R, Lobb R. Primary care physician characteristics associated with cancer screening: a retrospective cohort study in Ontario, Canada. Cancer Med 2015;4:212-23.
7 Ramírez AG, Wildes K, Nápoles-Springer A, et al. Physician gender differences in general and cancer-specific prevention attitudes and practices. J Cancer Educ 2009;24:85-93.
8 Roter DL, Hall JA. Physician gender and patient-centered communication: a critical review of empirical research. Ann Rev Public Health 2004;25:497-519.
9 Dahrouge S, Seale E, Hogg W, et al. A comprehensive assessment of family physician gender and quality of care: a cross-sectional analysis in Ontario, Canada. Med Care 2016;54:277-86.
10 Kovács N, Varga O, Hóta I, et al. The impact of general practitioners’ gender on process indicators in Hungarian primary healthcare: a nation-wide cross-sectional study. BMJ Open 2019;9:e027296.
11 Wallace E, Fehery T. Use of tests in UK primary care. BMJ 2012;345:e6910.
12 Medical test, 2020. Available: https://en.wikipedia.org/wiki/index.php?title=Medical_test&oldid=989665380 [Accessed 20 May 2021].
13 Franks P, Bertakis KD. Physician gender, patient gender, and primary care. J Menomena Health 2003;12:73-80.
14 Vinker S, Kvint I, Erez R, et al. Effect of the characteristics of family physicians on their utilisation of laboratory tests. Br J Gen Pract 2007;57:377-82.
15 Keane D, Woodward CA, Ferrier BM, et al. Female and male physicians: different practice profiles: will increasing numbers of female GPs affect practice patterns of the future? Can Fam Physician 1991;37:72-81.
16 Rosen MP, Davis RB, Lesky LG. Utilization of outpatient diagnostic imaging. J Gen Intern Med 1997;12:407-11.
17 Letrilliart L, Supper I, Schuers M. ECOCEN : étude des Eléments de la COnsultation en médecine GENérale. Exercer 2014;25:148-57.
18 WHO. International classification of primary care. Second edition (ICPC-2), 2021. http://www.who.int/classifications/icd/adaptations/icpc2/en/
19 Prometheus. Available: http://www.promethe.org/ [Accessed 20 May 2021].
20 Snijders TAB, Bosker RJ. Multilevel analysis: an introduction to basic and advanced multilevel modeling. SAGE, 2011.
21 Nakagawa S, Schielzeth H. A general and simple method for obtaining R² from generalized linear mixed-effects models. Methods Ecol Evol 2013;4:133-42.
22 Hosmer Jr DW, Lemoshow S, Sturdivant RX. Applied logistic regression. 91. 3rd edn. Hoboken, NJ: John Wiley & Sons, 2013.
23 StataCorp. Stata statistical software: release 16. College Station, TX: StataCorp LLC, 2019: 2019.
24 Bertakis KD. The influence of gender on the doctor-patient interaction. Patient Educ Couns 2009;76:356-60.
25 Sutharaman KN, Marcolini EG, McCunn M, et al. Gender specific issues in traumatic injury and resuscitation: consensus-based recommendations for future research. Acad Emerg Med 2014;21:1386-94.
26 Safdar B, Heins A, Hornel P, et al. Impact of physician and patient gender on pain management in the emergency department—a multicenter study. *Pain Med* 2009;10:364–72.

27 Bensing JM, van den Brink-Muinen A, de Bakker DH. Gender differences in practice style: a Dutch study of general practitioners. *Med Care* 1993;31:219–29.

28 Cassard SD, Weisman CS, Plitcha SB, et al. Physician gender and women’s preventive services. *J Womens Health* 1997;6:199–207.

29 Markova A, Weinstock MA, Risica P, et al. The role of gender in examination and counseling for melanoma in primary care. *Arch Intern Med* 2011;171:2061–3.

30 Fullen BM, Baxter GD, O’Donovan BGG, et al. Factors impacting on doctors’ management of acute low back pain: a systematic review. *Eur J Pain* 2009;13:908–14.

31 Kovács N, Varga O, Nagy A, et al. The impact of general practitioners’ gender on process indicators in Hungarian primary healthcare: a nation-wide cross-sectional study. *BMJ Open* 2019;9:e027296.

32 Weiss TW, Siris ES, Barrett-Connor E, et al. Osteoporosis practice patterns in 2006 among primary care physicians participating in the NORA study. *Osteoporos Int* 2007;18:1473–80.

33 O’Sullivan JW, Albasri A, Nicholson BD, et al. Overtesting and undertesting in primary care: a systematic review and meta-analysis. *BMJ Open* 2018;8:e018557.

34 McCarthy M. US doctors say unnecessary tests and procedures are a serious concern. *BMJ* 2014;348:g3098.

35 Zhi M, Ding EL, Theisen-Toupal J, et al. The landscape of inappropriate laboratory testing: a 15-year meta-analysis. *PLoS One* 2013;8:e79962.

36 Verghese A, Charlton B, Kassirer JP, et al. Inadequacies of physical examination as a cause of medical errors and adverse events: a collection of Vignettes. *Am J Med* 2015;128:1322–4.

37 Roethberg MB. The $50,000 physical. *JAMA* 2020;323:1682–3.

38 Bouck Z, Calzavara AJ, Ivers NM, et al. Association of low-value testing with subsequent health care use and clinical outcomes among low-risk primary care outpatients undergoing an annual health examination. *JAMA Intern Med* 2020;180:973.

39 Krogsbøll LT, Jørgensen KJ, Gatzsche PC. General health checks in adults for reducing morbidity and mortality from disease. *Cochrane Database Syst Rev* 2019;1:CD009009.

40 Bovier PA, Perneve TV. Stress from uncertainty from graduation to retirement—a population-based study of Swiss physicians. *J Gen Intern Med* 2007;22:632–8.

41 Elwenspoek MMC, Patel R, Watson JC, et al. Are guidelines for monitoring chronic disease in primary care evidence based? *BMJ* 2019;365:l2319.

42 Oosterhuis WP, Bruns DE, Watine J, et al. Evidence-based guidelines in laboratory medicine: principles and methods. *Clin Chem* 2004;50:806–18.

43 Mindemark M, Larsson A. Long-term effects of an education programme on the optimal use of clinical chemistry testing in primary health care. *Scand J Clin Lab Invest* 2009;69:481–6.

44 Pahwa AK, Eaton K, Apfel A, et al. Effect of a high value care curriculum on standardized patient exam in the core clerkship in internal medicine. *BMC Med Educ* 2020;20:365.

45 Takada T, Heus P, van Doorn S, et al. Strategies to reduce the use of low-value medical tests in primary care: a systematic review. *Br J Gen Pract* 2020;70:e858–65.

46 Letrilliart L, Rigault-Fossier P, Fossier B, et al. Comparison of French training and non-training general practices: a cross-sectional study. *BMC Med Educ* 2016;16:126.

47 Conseil national de l’Ordre des médecins. Atlas de la démographie médicale en France : situation au 1er janvier, 2020. Available: https://www.conseil-national.medecin.fr/sites/default/files/external-package_analyse_etude/1grhel2/cnom_atlas_demographie_medecale_2020_tome1.pdf

48 Britt H, Miller GC, Henderson J. General practice activity in Australia 2015–16. *general practice series No. 40*. Sydney: Sydney University Press, 2016.

49 Roos NP, Carrière KC, Friesen D. Factors influencing the frequency of visits by hypertensive patients to primary care physicians in Winnipeg. *CMAJ* 1998;159:777–83.

50 Breuil-Genier P, Goffette C. La durée des séances des médecins généralistes. *Etudes et Résultats* 2006;481:1–8.