Contextual determinants of participation in cervical cancer screening in France, 2010

Mélanie Araujo, Jeanna-Eve Franck, Emmanuelle Cadot, Arnaud Gautier, Pierre Chauvin, Laurent Rigal, Virginie Ringa, Gwenn Menvielle

Contextual determinants of participation in cervical cancer screening in France, 2010

Running title: Contextual determinants and cervical cancer screening

Mélanie Araujo[1], Jeanna-eve Franck[1], Emmanuelle Cadot[2], Arnaud Gautier[3], Pierre Chauvin[1], Laurent Rigal[4 5 6], Virginie Ringa[4 5 6], Gwenn Menvielle[1]

1 Sorbonne Universités, UPMC Univ Paris 06, INSERM, Institut Pierre Louis d'Épidémiologie et de Santé Publique (IPLESP UMRS 1136), F75012, Paris, France

2 IRD, UMR 5569, HydroSciences, F-34394, Montpellier, France

3 French National Institute for Prevention and Health Education (INPES), F-93200 Saint-Denis, France

4 INSERM, Epidemiology and Population Health Research Centre (CESP), U1018, Gender, Sexuality and Health Team, F-94276, Le Kremlin-Bicêtre, France

5 Univ Paris-Sud, UMRS 1018, F-94276, Le Kremlin-Bicêtre, France

6 INED, F-75012, Paris, France

Corresponding author: Gwenn Menvielle

Contact details

Emmanuelle Cadot : emmanuelle.cadot@ird.fr

IRD

911, avenue Agropolis

BP 64501

F-34394 Montpellier cedex 5, France

Arnaud Gautier : Arnaud.GAUTIER@santepubliquefrance.fr

Santé publique France

12, rue du Val d'Osne

94 415 Saint-Maurice cedex, France

Laurent Rigal : laurent.rigal@inserm.fr

Virginie Ringa : virginie.ringa@inserm.fr

CESP UMR Inserm 1018

Equipe 7 Genre, Sexualité, Santé

Hôpital de Bicêtre, 82 av du Général Leclerc

94276 Le Kremlin Bicêtre cedex, France

Mélanie Araujo: melanie.araujo78@gmail.com

Jeanne-eve Franck : jeanna-eve.franck@inserm.fr

Pierre Chauvin : pierre.chauvin@inserm.fr

Gwenn Menvielle : gwenn.menvielle@inserm.fr

ERES – Inserm U1136

27 rue Chaligny

75012 Paris Cedex, France

Keywords: Cervical cancer screening, contextual factors, marginal Poisson regression model, potential spatial accessibility to care, socioeconomic level

ABSTRACT

Background: A number of contextual factors associated with participation in cervical cancer screening are reported in the literature, but few studies have examined their combined effect. The objective was to assess the role of contextual characteristics, separately and in combination, in participation in cervical cancer screening in France.

Methods: Marginal Poisson regression models taking into account the correlation between women in a given commune were conducted using data from the *Baromètre Santé 2010* survey. The characteristics of the commune of residence of the women studied were the potential spatial accessibility to general practitioners (GP) and gynecologists, the agglomeration category, and the socioeconomic level.

Results: The analyses were performed in 3380 women, 88.2% of whom were up to date with their cervical cancer screening. Once the individual characteristics were taken into account, the screening participation rate was similar in all the communes, with the exception of those with low gynecologist and high GP accessibility, where the rate was 6% lower (95% CI: 0.5%-11%) than in the communes with high GP and gynecologist accessibility. The same association with accessibility was observed in small agglomerations. In relation to women living in the more advantaged communes, the screening participation rate was 8% (2%-12%) lower in those living in the more disadvantaged ones, except when accessibility to both types of physicians was high.

Discussion: We observed an association between potential spatial accessibility to care in women's commune of residence and their cervical cancer screening practices, in particular in small agglomerations, rural communes, and more disadvantaged communes.

INTRODUCTION

In France, there are approximately 3000 new cases of cervical cancer and close to 1000 deaths due to it every year (1). The incidence and mortality rates have declined over time thanks to the Pap test, but this decrease still falls short of the potential that this screening offers. A Pap test is recommended every 3 years between the ages of 25 and 65 years. Ninety percent of the procedures are performed by gynecologists (2).

Andersen's conceptual model (3), the behavioral model of health services use, highlights the concomitant influence of women's individual characteristics and characteristics both of the social and physical environment of their area of residence on health care utilization. This dual influence is observed for cervical cancer screening. Thus, women under the age of 50, those living in a couple, those with a favourable social situation, those with supplemental health insurance, those who are not obese, and those who do not engage in risky behaviours, such as alcohol or tobacco use, participate in screening to a greater degree (4, 5). At the same time, studies have shown a relationship between screening participation and the characteristics of the area of residence, namely agglomeration category, socioeconomic level and accessibility to care, after taking individual characteristics into account. Studies have found overall that women living in urban or socially advantaged areas are more up to date with their screening in France (6-8) as elsewhere (9-13). Most studies have found a higher screening rate in areas with a higher health care accessibility in France (numerous medical and paramedical facilities (8)) and elsewhere (high medical density (9, 10), short distances to physicians (14, 15)).

While the literature suggests that different individual and contextual dimensions influence screening participation, these different dimensions may interact with one another. Studies that have taken them into account simultaneously are rare (9, 10, 16), yet evaluating their combined effect in addition to their individual effect provides a better understanding of the mechanisms underlying

screening participation. To our knowledge, only one analysis has documented the combined effect of contextual variables. It revealed an interaction between the primary care supply and the agglomeration category of the women's area of residence. Of the women living in areas with a low medical density, those residing in rural or periurban areas were less likely to have had a Pap test than those living in urban areas. On the other hand, screening participation did not differ according to the agglomeration category in the areas with a high medical density (10). However, the analysis was conducted in the United States, and the results are probably not extrapolatable to the situation in France, given the significant differences in territorial organization and the health care systems between these two countries.

The objective of this study is to provide new results on this topic by studying the relationship between being up to date with cervical cancer screening and a number of contextual characteristics of the commune of residence, separately and in combination, using data from a national survey conducted in France in 2010.

MATERIAL AND METHODS

The *Baromètre Santé 2010* was a cross-sectional national health survey representative of the population conducted from October 2009 to July 2010. This telephone survey collected information about health behaviors and attitudes among the French-speaking population aged 15 to 85 years. Because of the growing percentage of households that were abandoning their landline phones for cell phones, the sampling base included a landline telephone sample and a cell phone-only sample. In all, 27,653 people were interviewed. The response rate was approximately 60%. In order to approach the optimal amount of time for the telephone survey while covering the various health dimensions, three subsamples of approximately 9000 respondents each were drawn randomly and asked a different set of questions. Our analysis is based on the subsample that was asked questions about

cancer screening participation (n=9761). The survey data were supplemented with information about the women's commune of residence (or district of residence in the case of Paris)

Participation in cervical cancer screening was measured according to the French recommendations: having had a Pap test during the previous 3 years for women aged 25 to 65 years (yes/no).

We studied the following characteristics: age (in 10-year age groups), living in a couple (yes/no), place of birth (France/Europe/other), smoking (never/current/ex-smoker), alcohol consumption (categorized using the Alcohol Use Disorder Identification Test: no alcohol problem/alcohol abuser/alcohol-dependent), self-reported body mass index (using the WHO standard categories: underweight/normal weight/overweight/obesity), health insurance (private/free health care for low-income individuals/none), having forgone health care for financial reasons during the past year (yes/no), and gynecological follow-up (none/by a gynecologist/by another health professional, a GP 90% of the time). Women with missing information (n=15) were grouped with those without a gynecological follow-up (n=19). Socioeconomic status was characterized using the attained level of education (lower/equal to/higher than high school), the employment status (employed/unemployed/retired/inactive, students being classified as inactive), and the current or last occupational category (self-employed and entrepreneurs/higher-level professionals or manager/lower-level professionals/clerical, sales and service/laborers and factory worker/other). Women who never worked were assigned their head of the household's occupational category. In addition, the number of adverse economic conditions met (0/1/≥2) was computed on the basis of the following three situations: being in the first quintile of the monthly household equivalent income (<840 €), sometimes or often lacking food, and perceiving financial difficulties (managing, but with difficulty, or unable to manage without incurring debts) (5).

The 4 following characteristics of the women's commune of residence were studied:

- The potential spatial accessibility to GPs and the potential spatial accessibility to gynecologists. It was measured by means of an indicator that takes into account both the health care supply and demand in the surrounding communes, the population's health care needs differentiated by age, and the physician activity level (potential spatial accessibility) (17). The indicator was calculated for the year 2010 and was categorized into quartiles based on its distribution in all French municipalities.
- The socioeconomic level. It was assessed using a social deprivation index developed for the French context (18). This variable was calculated for the year 2009 and was categorized into quartiles based on its distribution in all French municipalities.
- The agglomeration category (rural, <20,000 inhabitants, 20,000-100,000 inhabitants, ≥100,000 inhabitants, Paris area) in 2007.

Statistical methods

Of women aged 25 to 65 years, we excluded those who reported having had a hysterectomy and those who reported never having had sexual intercourse (n=358, 9.4%). Women with missing data on cancer screening participation (n=27), the independent variables (n=19) or the commune of residence (n=46) were excluded. In the end, the analyses concerned 3380 women in 2299 municipalities, including 16 administrative districts of Paris.

Screening rates were calculated for all the individual and contextual characteristics. The association between screening participation and the contextual characteristics of the women's commune of residence was quantified using marginal Poisson regressions (19-21) and adjusting for the women's age and all individual characteristics as they were all significant at the 20% threshold in the univariate analyses. Prevalence ratios (PRs) were first calculated for each contextual variable separately. Next, since there was a high correlation between the four contextual variables, variables combining these different dimensions were created by focusing on care accessibility. We first created a variable combining care accessibility, taking into account the accessibility to GPs and gynecologists in the

following manner: low GP and gynecologist accessibility (accessibility < median calculated for all of France's communes), low GP accessibility only, low gynecologist accessibility only, and high gynecologist and GP accessibility (accessibility > median). We then determined if the relationship between this variable and screening participation was modified by the socioeconomic level or the agglomeration category of the women's commune of residence. To do so, we created two 8-modality variables by combining the four categories of the care accessibility variable with a binary variable characterizing the socioeconomic level of the communes (living in the 75% more advantaged communes or living in the 25% more disadvantaged communes) or with a binary variable characterizing the agglomeration category (large agglomeration (≥20,000 inhabitants or the Paris area) or small agglomerations (<20,000 inhabitants or rural)). Lastly, the association between care accessibility and the health professional involved in the women's gynecological follow-up was studied using an 8-modality variable crossing these two parameters, after excluding women without gynaecological follow-up. In addition, to compare our results with the literature, we performed logistic regression models. The results are not presented.

Sampling weights to account for the survey's sampling design and the overall nonresponse were applied. Two-sided significance tests were used, and a *p*-value of 0.05 was considered significant. All the analyses were performed with SAS® 9.4 software.

RESULTS

In all, 88.2% of the women were up to date with their cervical cancer screening. The screening rates were lower among the women living alone, those engaging in risky alcohol use, those who reported a gynecological follow-up by a health professional other than a gynecologist or no gynaecological follow-up, laborers and factory workers, and women who had experienced at least one economic difficulty (Table S.1). About 71% of the women lived in a commune with high care accessibility (to GPs and gynecologists). About 12% of the women lived in a commune with low gynecologist and high

GP accessibility. These were rural communes or communes with fewer than 20,000 inhabitants. Lastly, 6% of the women lived in a commune with low care accessibility. These were almost exclusively rural communes. For the four care accessibility profiles, the socioeconomic situation in the communes varied (Table 1).

Screening participation according to the characteristics of the communes of residence is very similar with and without adjusting for the individual characteristics (Table 2). The screening participation rate was lower in the women living in communes with low gynecologist accessibility and higher in those living in communes with an intermediate level of GP accessibility. When GP accessibility and gynecologist accessibility are taken into account together, the screening participation rate was similar in all the communes, with the exception of those with low gynecologist and high GP accessibility, where the rate was 6% lower (95% CI: 0.5%-11%) than in the communes with high GP and gynecologist accessibility. The same pattern was found among the women who reported a gynecological follow-up by a gynecologist. On the other hand, those who reported that they were being followed by another health professional seemed to be less up to date with their screening if they lived in a commune with high GP accessibility (Figure 1).

The screening participation rate was lower among the women living in the most disadvantaged communes than in those living in the most advantaged ones (PR=0.93; 95% CI: 0.89-0.98) (Table 2). As regards care accessibility in the 25% most disadvantaged communes, the women living in those with low gynecologist and high GP accessibility were significantly less up to date with their screening (PR=0.89; 95% CI: 0.80-0.98). Similar results, although nonsignificant and based on small numbers, were found for the women living in the communes with low gynecologist or GP accessibility. However, women living in communes with high care accessibility were not less up to date with their screening. By contrast, care accessibility did not influence screening participation among women living in the 75% more advantaged communes.

The screening participation rate varied little according to the agglomeration category of the women's commune of residence, with the exception of those living in the Paris area (RP=1.09; 95% CI: 1.04-1.14) (Table 2). As regards care accessibility in the smaller agglomerations, the screening participation rate was lower only among the women living in communes with low gynecologist and high GP accessibility (RP=0.93; 95% CI: 0.88-0.98).

DISCUSSION

We used data from a large national health survey representative of the population. The survey's methodology had been validated, the interviews were conducted by trained interviewers, and the response rate was satisfactory for such a health survey. However, selection bias cannot be ruled out, and some populations, especially the most disadvantaged ones, were probably underrepresented. Although weights were used to correct for nonresponse bias, the associations may be underestimated. In addition, since all our data are self-reported, our results may be tainted by classification or desirability biases. Self-reported data on cancer screening participation are thought to overestimate actual participation in cervical cancer screening, but the accuracy of self-reporting does not seem to be associated with socioeconomic factors (22). The cervical cancer screening rates observed in our study are similar to those found in the other population surveys in France (23).

One of the strengths of our work is the fact that it considers the individual and combined effects of three contextual characteristics, namely, the agglomeration category, the socioeconomic level and care accessibility in the women's commune of residence, on participation in cervical cancer screening. Furthermore, we used a care accessibility indicator, recently developed in France, that is based on the two-step floating catchment area method (24). This indicator of potential spatial accessibility is more informative than those usually used (distance to access or medical density), since it takes potential care supply and demand imbalances into account (17).

The contextual variables considered were characteristics pertaining to the commune, the smallest available scale. Although the same trend between screening participation and the four care accessibility profiles was observed regardless of the category of agglomeration, we were probably therefore not able to specifically take context effects into account, in particular, in large cities, in which there is significant intra-urban care supply heterogeneity. Furthermore, it is possible that the area of residence alone is not a relevant datum and that it should be analyzed in conjunction with other characteristics, such as women's mobility, which has been shown to be a determining factor in cervical cancer screening participation in the Paris area (16). As well, an increasing number of studies point to the importance of no longer considering only the area of residence alone, but also individuals' places of activity, in particular, occupational activity (25).

We conducted analyses for the whole country but there may be differences between macro-areas. To test for the variability between regions, we conducted sensitivity analyses using a multilevel regression model (level 1 women, level 2 commune, level 3 NUTS 1 region). We did not find significant variability between regions.

The main contextual determinant of participation in cancer screening is accessibility to care, whether this is to GPs or gynecologists. A comparison of our results with the literature is not straightforward because of different methodologies. Most studies used logistic regression and none applied Poisson regression. However, after accounting for the differences in methodology, although the variables used to assess care accessibility differed between studies, the magnitude of the associations in our analyses was similar to that observed in the literature (8-10, 14). Several hypotheses could explain this finding, such as easier access to health professionals (distance and wait times) or Pap tests performed more frequently by health professionals to keep their patients in areas where there is strong competition between physicians.

Contrary to other countries where the role of gynaecologists in primary care is limited, gynecologists play an important role in cervical cancer screening in France. In 2010, even if the Pap test can be performed by a GP, 90% of these procedures were performed by gynecologists (2). Also, the lowest screening rates in GP practices were observed in women who consulted gynecologists the least (26, 27). Our results confirm the importance of gynecologists in cervical cancer screening. The screening participation rate was higher in the women who reported a gynecological follow-up by a gynecologist (90.1%) than by another health professional (82.4%). Furthermore, the screening rates increased with gynecologist accessibility, and when gynecologist accessibility was high, GP accessibility did not influence the screening rate.

The association between accessibility to care and participation in cancer screening is complex. First, the communes with low care accessibility were not characterized by lower screening rates. They were almost exclusively rural communes. Perhaps this is due to the fact that in rural areas in France, especially agricultural areas, many women have paying jobs in town. In addition, in France, problems accessing care in areas with a low medical density have been shown but are limited to the elderly, mainly because of their reduced mobility (28), and therefore most certainly do not, or only slightly, concern women targeted by cervical cancer screening. However, significant heterogeneity in care accessibility is observed in rural communes, both in the literature (29) and in our data. As well, we observe, among women living in rural communes, less screening among those living in communes with low gynecologist and high GP accessibility. The most important determinant for participation in cancer screening may not be whether the commune is rural but the accessibility to health care. Finally, the literature consistently reports higher screening rates in urban areas when compared with rural areas (9, 10, 12, 13). Although this is observed in French data when grouping all urban areas (6), we found that the higher participation in urban areas was limited to the Paris region. This contrasts with a Spanish study that observed increased screening participation both in medium and large-sized urban areas when compared with small-sized municipalities (less than 20000 inhabitants) (12).

Second, when gynecologist accessibility was low, GP accessibility influenced screening participation, with fewer Pap tests only in the women residing in communes with high GP accessibility. This counterintuitive finding may be partly due to a specific behaviour on the part of women, which might be influenced by the supply of medical services. Women might travel more easily for their gynecological follow-up when they already have to travel for primary care than when accessibility to primary care is high in their commune of residence, even when they report a gynecological follow-up by a gynecologist. Other characteristics of the commune not included in this analysis may also partly account for this finding.

The socioeconomic level of the commune was strongly associated with screening participation. As in most other studies, our results showed less screening participation among women living in more socially disadvantaged areas (7, 8, 11, 30). After accounting for the differences in methodology, the magnitude of the associations in our study was similar to that observed in the international literature but was smaller than what was reported in a French study conducted in the metropolitan Greater Paris area (7). The latter study, though, investigated inequalities at a much smaller geographical lever (sub-municipal division including about 2000 inhabitants). In our data, the lower level of participation in more socially disadvantaged areas was not found in disadvantaged communes with the highest care accessibility though, suggesting a cumulative effect of health care accessibility and contextual deprivation. Interestingly, health care accessibility was associated with participation in cancer screening only in the more socially disadvantaged communes. Although we carefully adjusted for women's socioeconomic characteristics, residual confounding due to compositional effects cannot be ruled out. In addition, contextual effects may occur, such as social capital or social interactions among residents through exchange of health behaviour norms and experience in health care utilization.

In conclusion, accessibility to care, whether this is to GPs or gynecologists, is an important contextual determining factor of cervical cancer screening practice. Our analysis points to a profile of communes where accessibility to care is especially relevant for cancer screening: small agglomerations and rural communes, as well as more disadvantaged communes. Studies using a smaller geographical scale would be needed to specifically investigate contextual determinants of cancer screening in large agglomerations.

ACKNOWLEDGEMENTS

This project was funded by the French Research Institute in Public Health (IReSP).

Table 1: Cross distribution of social situation and agglomeration category of the women's communes of residence by accessibility to care, France 2010, n=3380

	Low GYN and GP accessibility[a] N	Low GYN and high GP accessibility[a] N	High GYN and low GP accessibility[a] N	High GYN and GP accessibility[a] N
Social situation				
Quartile 1 (most advantaged)	40	59	150	933
Quartile 2	47	77	79	621
Quartile 3	71	137	70	417
Quartile 4 (least advantaged)	45	168	35	431
Agglomeration category				
Rural	165	199	189	277
< 20,000 inhabitants	16	191	33	395
≥ 20,000 inhabitants	22	51	46	1291
Paris area	0	0	66	439
Total (%)	203 (6.0)	441 (12.4)	334 (9.9)	2402 (71.7)

GYN: gynaecologist; GP: general practitioner; Percentages weighted

[a]Low accessibility corresponds to the two lowest quartiles, High accessibility corresponds to the two highest quartiles

Table 2: Screening rates, prevalence ratios (PRs) and 95% confidence intervals (CIs) for cervical cancer screening participation by characteristics of the women's communes of residence, France 2010, n=3380

Characteristic of the women's communes of residence	n (%)	Screening rate	Analysis adjusted for age		Analysis adjusted for individual characteristics[a]	
			PR (CI)	*P*-value	PR (CI)	*P*-value
ACCESSIBILITY TO CARE						
PSA to GPs				**0.039**		0.37
Quartile 1 (lowest accessibility)	186 (5.5)	87.1	1.01 (0.93-1.08)		1.01 (0.95-1.08)	
Quartile 2	351 (10.4)	91.8	**1.06 (1.02-1.10)**		1.03 (0.99-1.07)	
Quartile 3	1025 (30.9)	89.6	1.03 (1.00-1.07)		1.02 (0.99-1.06)	
Quartile 4 (highest accessibility)	1818 (53.2)	86.8	Ref.		Ref.	
PSA to gynecologists				**0.022**		**0.039**
Quartile 1 (lowest accessibility)	272 (7.5)	80.5	**0.90 (0.83-0.97)**		**0.92 (0.86-0.98)**	
Quartile 2	372 (10.8)	87.6	0.98 (0.93-1.03)		0.98 (0.94-1.03)	
Quartile 3	606 (17.1)	86.6	0.97 (0.93-1.01)		0.97 (0.93-1.00)	
Quartile 4 (highest accessibility)	2130 (64.6)	89.6	Ref.		Ref.	
Accessibility to GPs and gynecologists[b]				**0.034**		0.14
Low GYN and GP accessibility	203 (5.9)	88.3	1.00 (0.94-1.06)		1.01 (0.95-1.07)	
Low GYN and high GP accessibility	441 (12.4)	82.9	**0.94 (0.89-0.99)**		**0.94 (0.90-1.00)***	
High GYN and low GP accessibility	334 (10.0)	91.2	1.03 (0.99-1.07)		1.01 (0.97-1.05)	
High GYN and GP accessibility	2402 (71.7)	88.6	Ref.		Ref.	
SOCIAL SITUATION						
Social situation				**<0.001**		**0.032**
Quartile 1 (most advantaged)	1182 (34.8)	91.2	Ref.		Ref.	
Quartile 2	824 (23.3)	89.5	0.98 (0.95-1.01)		0.99 (0.95-1.02)	
Quartile 3	695 (20.4)	88.5	0.97 (0.93-1.01)		0.98 (0.95-1.02)	
Quartile 4 (least advantaged)	679 (21.6)	81.5	**0.89 (0.85-0.94)**		**0.93 (0.89-0.98)**	
Social situation and accessibility to GP and GYN[c]				**<0.001**		**0.038**
Least advantaged with low GYN and GP accessibility	45 (1.5)	78.9	0.88 (0.74-1.04)		0.93 (0.80-1.09)	
Least advantaged with low GYN and high GP accessibility	168 (4.8)	77.1	**0.86 (0.77-0.95)**		**0.89 (0.80-0.98)**	
Least advantaged with high GYN and low GP accessibility	35 (1.3)	76.1	0.85 (0.67-1.07)		0.86 (0.69-1.07)	
Least advantaged with high GYN and GP accessibility	431 (13.9)	83.8	**0.93 (0.88-0.99)**		0.97 (0.91-1.02)	
More advantaged with low GYN and GP accessibility	158 (4.4)	91.5	1.02 (0.96-1.09)		1.02 (0.97-1.08)	
More advantaged with low GYN and high GP accessibility	273 (7.6)	86.7	0.97 (0.91-1.02)		0.97 (0.92-1.02)	
More advantaged with high GYN and low GP accessibility	299 (8.6)	93.5	**1.04 (1.01-1.08)**		1.02 (0.99-1.06)	
More advantaged with high GYN and GP accessibility	1971 (57.8)	89.8	Ref.		Ref.	
AGGLOMERATION CATEGORY						
Agglomeration category				**0.006**		**0.01**
Rural	830 (23.2)	87.3	1.02 (0.98-1.08)		1.02 (0.97-1.06)	
< 20,000 inhabitants	635 (18.0)	85.2	Ref.		Ref.	
20,000 to 100,000 inhabitants	450 (13.0)	88.7	1.04 (0.98-1.10)		1.03 (0.98-1.09)	
≥ 100,000 inhabitants	960 (29.5)	87.9	1.03 (0.99-1.08)		1.03 (0.98-1.08)	
Paris area	505 (16.4)	92.7	**1.09 (1.04-1.14)**		**1.09 (1.04-1.14)**	
Agglomeration category and accessibility to GP and GYN[d]				**<0.001**		**0.01**
Small agglomerations with low GYN and GP accessibility	181 (5.4)	87.1	0.98 (0.91-1.05)		0.99 (0.93-1.05)	
Small agglomerations with low GYN and high GP accessibility	390 (11.0)	82.7	**0.93 (0.88-0.98)**		**0.93 (0.88-0.98)**	
Small agglomerations with high GYN and low GP accessibility	222 (6.4)	89.7	1.01 (0.95-1.07)		0.99 (0.94-1.04)	
Small agglomerations with high GYN and GP accessibility	672 (18.4)	87.3	0.98 (0.94-1.02)		0.97 (0.93-1.01)	
Large agglomerations with low GYN and GP accessibility	22 (0.5)	100.0	**1.12 (1.10-1.15)**		**1.11 (1.06-1.15)**	
Large agglomerations with low GYN and high GP accessibility	51 (1.4)	85.3	0.96 (0.82-1.12)		0.97 (0.83-1.14)	
Large agglomerations with high GYN and low GP accessibility	112 (3.6)	93.9	**1.05 (1.00-1.11)***		1.02 (0.97-1.07)	
Large agglomerations with high GYN and GP accessibility	1730 (53.3)	89.1	Ref.		Ref.	

GP: General Practitioner; GYN: Gynecologist; PSA: Potential spatial accessibility; Ref.: Reference.

Screening rates and prevalence ratios weighted.

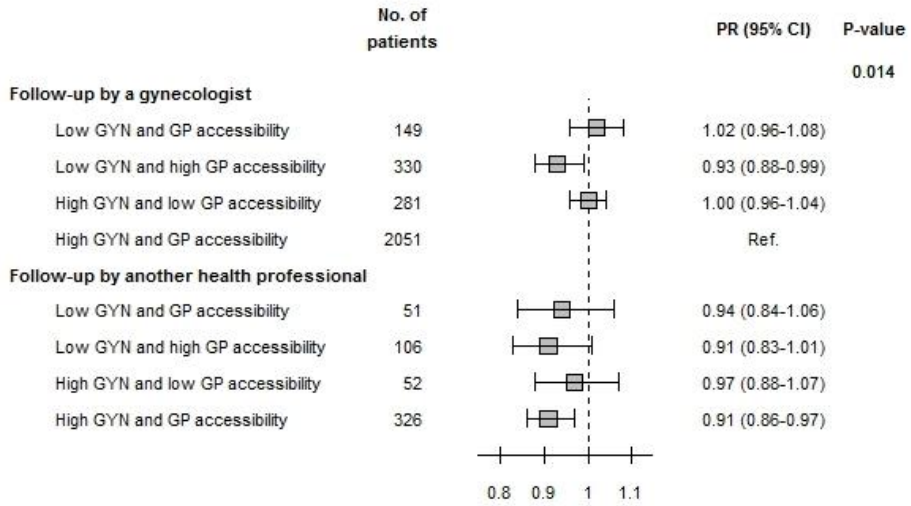
[a]PRs adjusted for all the characteristics listed in Table S.1.

[b]Low (resp. high) accessibility corresponds to the two lowest (resp. highest) quartiles of GYN or GP accessibility

[c]Least advantaged socially: quartile 1 (Q1) of the social deprivation index; more advantaged socially: Q2, Q3 and Q4.

[d]Small agglomerations: rural communes and <20,000 inhabitants; large agglomerations: ≥ 20,000 inhabitants and Paris area.
* 1 not included in the confidence interval

Figure 1: Prevalence ratios (PRs) and 95% confidence intervals (CIs) for cervical cancer screening participation by the women's gynecological follow-up and by accessibility to care in their communes of residence, France 2010, n=3346



Women who did not report any gynecological follow-up are excluded from the analysis (n=34).

Table S.1: Screening rates, prevalence ratios (PRs) and 95% confidence intervals (CIs) for cervical cancer screening participation by the women's sociodemographic, socioeconomic and lifestyle characteristics, France 2010, n= 3380

Characteristic	n (%)	Screening rate	Univariate analysis	Multivariate analysis[a]	
			PR (95% CI)	PR (95% CI)	*P*-value
Age					0.31
[25-34]	778 (25.1)	90.0	Ref.	Ref.	
[35-44]	971 (27.9)	89.3	0.99 (0.95-1.03)	0.98 (0.95-1.02)	
[45-54]	810 (25.5)	88.5	0.98 (0.94-1.02)	0.98 (0.94-1.02)	
[55-65]	821 (21.6)	84.2	**0.94 (0.90-0.98)**	0.95 (0.90-1.00)	
Living in a couple					**0.049**
No	1226 (27.8)	83.6	Ref.	Ref.	
Yes	2154 (72.2)	89.9	**1.08 (1.04-1.12)**	1.04 (1.00-1.08)	
Place of birth					0.43
France	3063 (88.7)	88.8	Ref.	Ref.	
Europe	112 (3.3)	82.0	0.92 (0.83-1.02)	0.94 (0.85-1.04)	
Other	205 (7.9)	83.5	0.94 (0.87-1.01)	0.98 (0.90-1.06)	
Risky alcohol use					**0.018**
No	3138 (93.4)	88.7	Ref.	Ref.	
Yes	242 (6.6)	80.2	**0.90 (0.84-0.97)**	**0.92 (0.85-0.99)**	
Smoking status					0.33
Smoker	1121 (34.7)	86.5	0.98 (0.95-1.02)	0.99 (0.95-1.02)	
Ex-smoker	980 (27.4)	90.5	1.03 (0.99-1.06)	1.01 (0.98-1.05)	
Never-smoker	1279 (37.9)	88.0	Ref.	Ref.	
Body Mass Index class					0.28
Underweight	197 (5.8)	88.0	0.98 (0.92-1.04)	1.00 (0.94-1.06)	
Normal weight	2103 (60.4)	90.2	Ref.	Ref.	
Overweight	726 (22.3)	85.5	**0.95 (0.91-0.99)**	0.97 (0.93-1.01)	
Obesity	354 (11.5)	82.8	**0.92 (0.87-0.97)**	0.96 (0.91-1.02)	
Level of education					0.09
<High school	1447 (52.8)	85.0	Ref.	Ref.	
High school	650 (19.3)	92.3	**1.09 (1.05-1.12)**	1.03 (1.00-1.07)	
> High school	1283 (27.9)	91.5	**1.08 (1.04-1.11)**	1.00 (0.96-1.04)	
Occupational status					0.23
Working	2414 (69.2)	90.6	Ref.	Ref.	
Unemployed	244 (8.2)	83.3	**0.92 (0.86-0.99)**	0.99 (0.92-1.07)	
Retired	357 (9.2)	83.0	**0.92 (0.87-0.97)**	0.96 (0.90-1.03)	
Inactive	365 (13.4)	81.9	**0.90 (0.86-0.96)**	0.95 (0.89-1.00)	
Socio-occupational category					**<0.001**
Self-employed and entrepreneurs	115 (3.4)	95.5	1.04 (0.99-1.09)	**1.11 (1.05-1.17)**	
Higher level professionals and managers	522 (11.8)	91.9	Ref.	Ref.	
Lower level professionals	1008 (26.0)	90.6	0.99 (0.95-1.02)	0.98 (0.95-1.02)	
Clerical, sales and service	1340 (43.7)	88.4	**0.96 (0.93-1.00)***	0.99 (0.95-1.03)	
Labourers and factory workers	346 (13.4)	79.7	**0.87 (0.81-0.93)**	**0.93 (0.87-1.00)***	
Others	49 (1.7)	71.8	**0.78 (0.63-0.97)**	0.86 (0.70-1.05)	
Supplemental health insurance					0.38
Free coverage for low income	258 (9.6)	78.8	**0.88 (0.82-0.95)**	0.94 (0.87-1.03)	
None	205 (7.4)	84.3	0.94 (0.88-1.01)	0.98 (0.91-1.05)	
Private	2917 (82.9)	89.6	Ref.	Ref.	
Number of economic difficulties					**0.036**
0	2459 (68.9)	91.3	Ref.	Ref.	
1	538 (17.7)	83.1	**0.91 (0.87-0.96)**	**0.95 (0.91-0.99)**	
≥2	383 (13.4)	79.0	**0.87 (0.81-0.92)**	0.94 (0.88-1.01)	
Had foregone care for financial reasons					0.81
Yes	428 (13.7)	83.5	**0.94 (0.89-0.99)**	0.99 (0.94-1.05)	
No	2952 (86.3)	88.9	Ref.	Ref.	
Gynecological follow-up					**<0.001**
None	34 (1.4)	38.1	**0.42 (0.25-0.75)**	**0.46 (0.28-0.75)**	
By a gynecologist	2811 (82.5)	90.1	Ref.	Ref.	
By another physician	535 (16.2)	82.4	**0.91 (0.87-0.96)**	**0.93 (0.89-0.97)**	

Screening rates and prevalence ratios weighted.

[a] PRs adjusted for all the variables listed in this table.

* 1 not included in the confidence interval

REFERENCES

References

1. Belot A, Grosclaude P, Bossard N, Jougla E, Benhamou E, Delafosse P, et al. Cancer incidence and mortality in France over the period 1980-2005. Rev Epidemiol Sante Publique. 2008. doi 10.1016/j.respe.2008.03.117.
2. Haute Autorité de Santé. [Overview and guidelines for cervical cancer screening in France]. Saint-Denis: Haute Autorité de Santé, 2010.
3. Andersen RM. National health surveys and the behavioral model of health services use. Med Care. 2008;46(7):647-53. doi 10.1097/MLR.0b013e31817a835d
4. Damiani G, Federico B, Basso D, Ronconi A, Bianchi CB, Anzellotti GM, et al. Socioeconomic disparities in the uptake of breast and cervical cancer screening in Italy: a cross sectional study. BMC Public Health. 2012;12:99. doi 10.1186/1471-2458-12-99
5. Menvielle G, Richard JB, Ringa V, Dray-Spira R, Beck F. To what extent is women's economic situation associated with cancer screening uptake when nationwide screening exists? A study of breast and cervical cancer screening in France in 2010. Cancer Causes Control. 2014;25(8):977-83. doi 10.1007/s10552-014-0397-z
6. Duport N, Serra D, Goulard H, Bloch J. [Which factors influence screening practices for female cancer in France?]. Revue d'épidémiologie et de santé publique. 2008;56(5):303-13. doi 10.1016/j.respe.2008.07.086
7. Grillo F, Vallee J, Chauvin P. Inequalities in cervical cancer screening for women with or without a regular consulting in primary care for gynaecological health, in Paris, France. Prev Med. 2012;54(3-4):259-65. doi 10.1016/j.ypmed.2012.01.013
8. Challier B, Meslans Y, Viel JF. Deprived areas and attendance to screening of cervix uteri cancer in a French region. Cancer Causes Control. 2000;11(2):157-62. doi
9. Benjamins MR, Kirby JB, Bond Huie SA. County characteristics and racial and ethnic disparities in the use of preventive services. Prev Med. 2004;39(4):704-12. doi 10.1016/j.ypmed.2004.02.039
10. Coughlin SS, Leadbetter S, Richards T, Sabatino SA. Contextual analysis of breast and cervical cancer screening and factors associated with health care access among United States women, 2002. Soc Sci Med. 2008;66(2):260-75. doi 10.1016/j.socscimed.2007.09.009
11. Coughlin SS, King J, Richards TB, Ekwueme DU. Cervical cancer screening among women in metropolitan areas of the United States by individual-level and area-based measures of socioeconomic status, 2000 to 2002. Cancer Epidemiol Biomarkers Prev. 2006;15(11):2154-9. doi 10.1158/1055-9965.epi-05-0914
12. Bermedo-Carrasco S, Pena-Sanchez JN, Lepnurm R, Szafron M, Waldner C. Inequities in cervical cancer screening among Colombian women: a multilevel analysis of a nationwide survey. Cancer Epidemiol. 2015;39(2):229-36. doi 10.1016/j.canep.2015.01.011
13. Ricardo-Rodrigues I, Jimenez-Garcia R, Hernandez-Barrera V, Carrasco-Garrido P, Jimenez-Trujillo I, Lopez de Andres A. Social disparities in access to breast and cervical cancer screening by women living in Spain. Public Health. 2015;129(7):881-8. doi 10.1016/j.puhe.2015.02.021
14. Vogt V, Siegel M, Sundmacher L. Examining regional variation in the use of cancer screening in Germany. Soc Sci Med. 2014;110:74-80. doi 10.1016/j.socscimed.2014.03.033
15. Kangmennaang J, Thogarapalli N, Mkandawire P, Luginaah I. Investigating the disparities in cervical cancer screening among Namibian women. Gynecol Oncol. 2015;138(2):411-6. doi 10.1016/j.ygyno.2015.05.036

16. Vallee J, Cadot E, Grillo F, Parizot I, Chauvin P. The combined effects of activity space and neighbourhood of residence on participation in preventive health-care activities: The case of cervical screening in the Paris metropolitan area (France). Health Place. 2010;16(5):838-52. doi 10.1016/j.healthplace.2010.04.009
17. Barlet M, Coldefy M, Collin C, Lucas-Gabrielli V. [Potential Spatial Accessibility: a new tool to assess care accessibility. The example of accessibility to General Practitioners in France]. Document de travail, Série Etudes et recherche Drees. 2012;124. doi
18. Rey G, Jougla E, Fouillet A, Hemon 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. doi 10.1186/1471-2458-9-33
19. Zou GY, Donner A. Extension of the modified Poisson regression model to prospective studies with correlated binary data. Stat Methods Med Res. 2013;22(6):661-70. doi 10.1177/0962280211427759
20. Zou G. A modified poisson regression approach to prospective studies with binary data. American journal of epidemiology. 2004;159(7):702-6. doi
21. Hubbard AE, Ahern J, Fleischer NL, Van der Laan M, Lippman SA, Jewell N, et al. To GEE or not to GEE: comparing population average and mixed models for estimating the associations between neighborhood risk factors and health. Epidemiology (Cambridge, Mass). 2010;21(4):467-74. doi 10.1097/EDE.0b013e3181caeb90
22. Howard M, Agarwal G, Lytwyn A. Accuracy of self-reports of Pap and mammography screening compared to medical record: a meta-analysis. Cancer Causes Control. 2009;20(1):1-13. doi 10.1007/s10552-008-9228-4
23. Constantinou P, Dray-Spira R, Menvielle G. Cervical and breast cancer screening participation for women with chronic conditions in France: results from a national health survey. BMC Cancer. 2016;16(1):255. doi 10.1186/s12885-016-2295-0
24. Luo W, Qi Y. An enhanced two-step floating catchment area (E2SFCA) method for measuring spatial accessibility to primary care physicians. Health Place. 2009;15(4):1100-7. doi 10.1016/j.healthplace.2009.06.002
25. Brondeel R, Weill A, Thomas F, Chaix B. Use of healthcare services in the residence and workplace neighbourhood: the effect of spatial accessibility to healthcare services. Health Place. 2014;30:127-33. doi 10.1016/j.healthplace.2014.09.004
26. Oussaid N, Lutringer-Magnin D, Barone G, Haesebaert J, Lasset C. Factors associated with Pap smear screening among French women visiting a general practitioner in the Rhone-Alpes region. Rev Epidemiol Sante Publique. 2013;61(5):437-45. doi 10.1016/j.respe.2013.04.009
27. Rigal L, Saurel-Cubizolles MJ, Falcoff H, Bouyer J, Ringa V. Do social inequalities in cervical cancer screening persist among patients who use primary care? The Paris Prevention in General Practice survey. Prev Med. 2011;53(3):199-202. doi 10.1016/j.ypmed.2011.06.016
28. Chaix B, Veugelers PJ, Boelle PY, Chauvin P. Access to general practitioner services: the disabled elderly lag behind in underserved areas. Eur J Public Health. 2005;15(3):282-7. doi 10.1093/eurpub/cki082
29. McGrail MR, Humphreys JS. Spatial access disparities to primary health care in rural and remote Australia. Geospat Health. 2015;10(2):358. doi 10.4081/gh.2015.358
30. Schootman M, Jeffe DB, Baker EA, Walker MS. Effect of area poverty rate on cancer screening across US communities. J Epidemiol Community Health. 2006;60(3):202-7. doi 10.1136/jech.2005.041020