Factors associated with participation in the organized cervical cancer screening program in the greater Paris area (France): An analysis among more than 200,000 women

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Title

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Abstract

We aimed to identify the contextual factors associated with participation in the organized Cervical Cancer Screening (CCS) pilot program, which includes specific interventions to reach vulnerable women, in the Greater Paris region

Study population consisted of **231,712** women aged 25-65 years, who were not up to date to their smear test and had been invited to take part in the program from July 2014 to September 2017. Using a multilevel mixed logistic regression with random effects, we investigated the effect of grassroots interventions targeting vulnerable women, healthcare provider accessibility, social environment and municipal policy-related factors.

The CCS rate was two times higher in women who had received their first invitation to the program during the study period (32·9%) compared to those who were already invited before the study period (15·3%). In both populations, there were no significant trends in participation with regards to the type of grassroots interventions, level of accessibility of healthcare services or municipal commitment to healthcare. Among women invited previously and aged above 35 increased participation was seen in neighborhoods with low proportion of single women or in less deprived neighborhoods.

Our results identified groups of women who participated less in the organized CCS program and suggested that additional interventions targeting the barriers faced by vulnerable women, especially those aged 35-45 years old, are needed.

Abbreviations

CCS: cervical cancer screening

Key words

organized cervical cancer screening program, Greater Paris area, France, interventions to reach vulnerable women, healthcare accessibility.

Abbreviations

CC: cervical cancer

CCS: cervical cancer screening

GP: general practitioner

SEP: socio economic position

SMC: screening management center

VDM: Val-de-Marne

1. Introduction

Cervical smear tests have been shown to be an effective tool in fighting cervical cancer, decreasing both the incidence and mortality in several countries (Jansen et al., 2020; Peirson et al., 2013). There are large variations in the cervical cancer screening (CCS) policies implemented in different European countries, especially population-based organized programs versus opportunistic screening(Anttila et al., 2004). In France CCS was mainly opportunistic until 2020. However, an organized CCS pilot program was initiated in 2010 across 13 administrative geographical areas, before extending it to the whole country in 2020. One of these regions was the Val de Marne (VDM), an urban metropolitan area located in the Greater Paris region, where the implementation of the organized CCS pilot program was managed by the VDM screening management centre (SMC).

The expected benefits of an organized CCS program are decreases in the incidence of cervical cancer (Bucchi et al., 2019), increases in the population coverage of CCS (Minozzi et al., 2015) and fewer disparities surrounding participation. Women with a low socioeconomic position (SEP) are less likely to participate in CCS (Menvielle et al., 2014; Seidel et al., 2009). Therefore, the SMC devoted an in-depth reflection to better reach the vulnerable women. As the literature suggests the best intervention to decrease social inequalities in health is a progressive graded approach with scale and intensity proportionate to the level of disadvantage (Bradley et al., 2004; Frohlich and Potvin, 2008), the SMC developed two types of grassroots interventions, which were primarily, but not exclusively, implemented in deprived neighborhoods. However, due to limited finances and human resources, not all deprived neighborhoods benefitted from these interventions. First, temporary large-scale CCS information events were set up (e.g.

market stalls). Secondly, empowerment interventions were developed in close collaboration with local associations working with vulnerable populations. These interventions were evidence-based; the literature attests that health promotion interventions involving the targeted community, mediated by people coming from the community and promoting empowerment are the most efficient in reducing health inequalities (Liu et al., 2012; Salmi et al., 2017). The aim for these empowerment interventions was to train women to act as "CCS relays" in their communities with the end goal of empowering women locally. In addition to this deep and proactive approach, other contextual factors may also influence the rate of CCS participation. This includes municipal commitment to healthcare (Haynes et al., 2014; Trompette et al., 2020)and healthcare accessibility-related factors (Akinyemiju et al., 2015; Ferdous et al., 2018; Vallée and Chauvin, 2012)such as lack of healthcare providers, heavy workloads among healthcare staff(Donnelly, 2006), delays in appointments (Black et al., 2011) and geographical distance (Akinyemiju et al., 2015). In other words, an intervention can be seen 'an event in a system'(Cambon et al., 2019; Hawe et al., 2009) and its effectiveness depends on mechanisms at play within a given context (Pawson R, Tilley N, 1997)

Using a unique high-quality database with eight years of follow-up, this study aims to identify how the type of grassroots interventions, healthcare, social and municipal policy-related factors were associated with participation in the organized CCS program in the VDM.

1. Materials and methods

In France, the official recommendations are to perform a cervical smear test every 3 years, after two normal tests one year apart, from 25 to 65 years old. The organized CCS program targeted women who had not had a cervical smear test in the past three years. Women were invited by post to perform a cervical smear test. Upon receiving their letter of invitation, women had to book an appointment with a medical professional of their choice. To help them, the letter specified the different healthcare providers performing cervical smear tests: gynaecologists (who perform 90% of cervical smear tests in France), general practitioners (GPs) and midwives. Most of the time, women are required to pay the cost of the medical consultation and test before being refunded by health insurance providers. Nevertheless, it is important to keep in mind that in the VDM as everywhere in France, most gynaecologists charge out-of-pocket fees.

2.1 Population

The Val de Marne is an urban metropolitan area, comprised of 47 towns, located in the South-East of the Greater Paris region (1,378,151 inhabitants in 2016, population density of 5,624 per km^2). In the VDM, the organized CCS program was initiated in 2010 with an interruption during 2013. Once every three months, a list of all 25–65-year-old, female residents of the VDM, and the date of their previous smear test, was sent to the SMC by the VDM health insurance fund. The SMC then identified women who had not been screened over the past three years and sent them a personal invitation for screening by post. Recipients (or their next-of-kin) could then respond with the date of their most recent smear test or any reasons for non-participation (e.g. hysterectomy, history of CC, disability which rendered the test impossible, personal objection, death).

We selected data from all the women invited for screening by the organized CCS program from 1st July 2014 to 30th of September 2017 (N=302,339). Exclusion criteria were the following: medical exemption (death, hysterectomy, history of CC, disability) (N=2918), letters returned to sender (N=20,328) and women's address not being geocoded (N=8124).

2.2 Variables

For each woman, their address, age, date of CCS invitation, and date of their subsequent cervical smear test (if any) were recorded from the health insurance database. Addresses were geolocalized and assigned to an IRIS (a municipal sub-division including about 2000 people).

A detailed description of all contextual variables is available in the supplementary material. Briefly, for each IRIS, called neighbourhood hereafter, we calculated the proportion of single women. When this proportion is low, it may serve as a proxy for marital status, a major determinant of participation in CCS with higher participation in partnered women (Luque et al., 2018). In addition, we developed an indicator for healthcare provider accessibility based on the geographical distribution of healthcare providers performing smear tests (gynaecologists, general practitioners, midwives) in each neighborhood and its adjacent neighborhoods.

For each IRIS and town, we obtained a social deprivation indicator based on the French deprivation index (Schuurman et al., 2007).

For every town, we also created a healthcare provider accessibility indicator by combining the potential spatial accessibility to gynaecologists and midwifes. The potential spatial accessibility

is comprised of information on medical density, average distance between healthcare providers and patients and average number of patients seen by the healthcare providers each month. We also defined the type of grassroots interventions performed by the SMC by scanning their annual activity reports and categorised as either temporary large-scale CCS information events (e.g. market stalls, information related to CCS set up in local associations working with vulnerable women) and empowerment interventions (intervention in small committees developed in close collaboration with the local associations working with vulnerable women such as training women to act as relays in the community for CCS promotion). In sensitivity analyses, we refined this indicator by splitting temporary large-scale screening information events into sporadic or regular and by distinguishing empowerment interventions without or with a long cooperation with the associations. Finally, political context can also impact the efficiency of a public health intervention (Trompette et al., 2020). As no validated scale for municipal commitment to healthcare exists in France, we developed an ad-hoc indicator encompassing the dimensions identified as relevant from both the literature and discussions with experts such as density of health associations and specific arrangements around health policy.

Our outcome was having a cervical smear test in the year following the invitation, according to the official governmental guidelines (Barré et al., 2017). Therefore, women who had lived for less than one year in the VDM after the invitation for screening was sent were excluded from analyses (N 39,257).

To assess the stability of our results, we also conducted a sensitivity analysis without excluding these participants. We used a conservative approach assuming that women had not been screened when no data on CCS were available (these women may nevertheless have been screened in another region after leaving the VDM). In the rest of the paper, we will refer to women who were screened as having participated in the organized CCS program.

We identified three populations: long-term residents of the VDM who had already been invited to the organized CCS program before the study period (N=48,644), long-term residents of the VDM who received the first invitation to the organized CCS program during the study period (N=117,990) and newly arrived residents to the VDM (N=65,078). Long-term residents were identified as those who had any previous invitation or cervical smear test before the invitation for screening sent during our study period. Newly arrived residents were identified as women for whom the invitation during our study period was their very first record in the screening

187 management centre database. Women who had just turned 25 years-old were also included in
188 the latter population.

189 Details on the data selection process are displayed in Figure 1.

190 **2.3 Analysis**

191 To account for the hierarchical structure of our data, we conducted a multilevel mixed logistic
192 regression with random effects. We included individual characteristics as level one,
193 neighbourhood characteristics as level two, and town characteristics as level three. The
194 healthcare provider accessibility indicator was introduced at the town level in the main model
195 and at the neighbourhood level in the sensitivity analysis because the town indicator included
196 more detailed information (e.g. number of patients monthly seen).

197 Analyses were conducted in the three populations defined above.

198 New arrivals to the VDM were analysed as a specific group. As the health insurance fund is
199 organized into administrative areas which do not share their information, the SMC has no
200 visibility regarding newly-arrived women's screening or medical history. Thus, when a woman
201 moves to the VDM, she systematically receives a personal invitation for screening. Therefore,
202 this group includes women who performed a Pap smear less than three years ago and should
203 not have been invited. Results are difficult to interpret and no stratified analysis was performed
204 in this group.

205 As the determinants of CCS participation are likely to differ by age (Seidel et al., 2009), we
206 carried out a stratified analysis by age among long-term residents. In addition, if any grassroots
207 interventions were efficient (in particular empowerment interventions), their effects are likely
208 to be accentuated among populations that would normally lack the resources (economic,
209 psychological, cultural) to participate in CCS(Grillo et al., 2012). We therefore conducted
210 analyses restricted to the most disadvantaged women, i.e. women living in the most deprived
211 neighborhoods (lowest quintile) in the most deprived towns (lowest tertile).

212 All statistical analyses were performed with R (version 3.1).

213

214 **2. Results**

215 Women who had arrived recently to the VDM were younger and lived in neighborhoods with a
216 higher proportion of single women than long-term residents (Table 1). Among long-term
217 residents, women who had already been invited to take part in the organized CCS program
218 generally lived in the most deprived neighborhoods, as opposed to women for whom this was

their first invitation. The CCS rate was two times higher for women receiving a first invitation (32·9%) compared to women invited previously (15·3%).

Participation increased as neighborhood deprivation decreased in all three populations and increased with decreasing age amongst newly arrived residents and long-term residents who had already been invited (Table 2). On the contrary, participation did not strongly differ by age amongst long-term residents who received their first invitation during the study period.

Overall, participation was not significantly associated with the type of grassroots interventions (in three or five categories (Suppl Table 1)), the level of municipal commitment to healthcare or the healthcare providers' accessibility (measured at the town or neighbourhood level (Suppl Table 2)). Nevertheless, among women who received their first invitation during the study period, a reduced participation was seen when temporary large-scale CCS information events were set up and in neighborhoods with high healthcare accessibility. We also noticed a tendency towards increased participation when there were healthcare professionals performing smear tests in the neighbourhood or its adjacent neighborhoods (Suppl Table 2). Similar results were found in analyses that included women who lived less than 12 months in the VDM (Suppl Table 3).

Among women invited previously, women over 35 years old showed increased participation in neighborhoods with a lower proportion of single women or in most advantaged neighborhoods. However, for the latter, this association was weakened amongst older participants (Table 3). Medium healthcare accessibility was also associated with increased participation within the older age group. Among women who received their first invitation during the study period, those aged 35-45 years old again showed increased participation when living in neighborhoods with a lower proportion of single women or in most advantaged neighborhoods.

Among women living in the most deprived neighborhoods in the most deprived towns, no significant associations were observed between CCS participation and healthcare accessibility (both at the town and neighbourhood level) nor with municipal commitment to healthcare or the type of grassroots interventions (Suppl. Tables 4-5)

3. Discussion

We investigated the factors associated with participation in an organized CCS program that included specific interventions to reach vulnerable women and to promote women's empowerment. Our results provide detail on the real-life effectiveness of these interventions at

252 population level, over a long period of time, and add to the literature previously assessing the
253 efficacy of interventions through randomised controlled trials (Smith et al., 2017).

254

255 Before discussing the results, several methodological limits should be mentioned. Our analysis
256 was based on a large population-based sample comprising about 93% of the inhabitants of the
257 VDM with exhaustive information on CCS participation. Some deprived groups could not be
258 included in our database such as women without health insurance or residence permits.
259 Nevertheless, we believe this limitation would not strongly affect our conclusions due to the
260 very low proportion of the population it accounts for (<1%)**.** In addition, our results were
261 obtained in a very urban environment and therefore cannot be extrapolated to the entire French
262 population. Finally, SEP was assessed using an ecological index. Although we cannot rule out
263 any ecological bias, this index was available for a small geographical unit. The bias is hence
264 likely to be minimized and this index partly reflects women's SEP (Schuurman et al., 2007).

265

266 One of the characteristics of the organized CCS program was to include grassroots interventions
267 targeting vulnerable women: large-scale CCS information events or empowerment
268 interventions. Surprisingly, we did not observe any association between any type of grassroots
269 interventions and participation in CCS, except a negative association for temporary large-scale
270 CCS information events. This negative association might be partly explained by a saturation of
271 information that decreased the likelihood of participation among women more exposed to CCS
272 prevention messages.

273 Several factors may explain the lack of association between participation and the intervention
274 provided. The grassroots interventions indicator was built at the town level, with interventions
275 almost exclusively reported in the SCM activities report at the town level whereas interventions
276 took place in specific neighborhoods. In addition, it was impossible to account for territorial
277 dynamics, quality of the relationship between stakeholders and stakeholder's involvement in a
278 precise way (Cambon et al., 2019). However, no association was observed either when
279 categorizing this indicator in a more refined way (into five categories), nor when restricting
280 analyses to the population, which was the most likely to benefit from these interventions (most
281 deprived neighborhoods in the most deprived towns). Even empowerment interventions had no
282 effect on participation contrary to the previous findings (Nickel and von dem Knesebeck, 2020).
283 This type of intervention is likely to take time before becoming efficient. However, our analyses

were based on data collected almost 8 years from the beginning of the pilot program. Our results thus suggest that, if existent, the impact of the grassroots interventions on participation was modest and present only at a very local level. We can also not rule out that these interventions did not overcome the financial barriers to CCS.

Similarly, level of municipal commitment to healthcare did not have any impact on participation in the organized CCS program. Although we used an ad-hoc indicator, this was based on both previous literature (Trompette et al., 2020) and discussions with experts, therefore providing a solid scientific basis. Nevertheless, a qualitative study may have provided a better understanding of the relationship between the different stakeholders, especially their involvement in public health politics(Cambon et al., 2019), in turn helping to refine the accuracy of this indicator.

In our study, accessibility to healthcare services had little influence on participation in the organized CCS program. We obtained similar results with both healthcare provider accessibility indicators at the neighbourhood and town level. However, we observed a positive association between high midwife/low gynaecological accessibility and participation in the organized CCS program among women aged over 55 who had been invited previously. The letter may have incited these women to go for a last smear test, leading them to look for a new healthcare professional, the midwife. In France, more and more gynaecologists are retiring, and most are not being replaced due to low medical demography. The recent role of midwives in gynaecological check-ups (since 2009) is often unknown to the general population, therefore women may have only discovered it when reading their invitation. In addition, we found that among the most deprived population, age was the single predictor for screening regardless of the healthcare provider accessibility indicator used, highlighting the need for targeting older women to increase CCS participation.

To better understand the role of healthcare on participation in the organized CCS program, it would be of interest to explore CCS care pathways (who performed the smear test and where). However, this information was unavailable. We may nevertheless presume that depending on their SEP(Lorant et al., 2002; van Ballegooijen et al., 2000) and mobility(Traoré et al., 2020; Vallée and Chauvin, 2012), women visit different type of health professionals in various places. More precisely, socioeconomically privileged women are more likely to have a smear test

performed by a gynecologist outside their place of residence whereas vulnerable women more often use municipal center close to their place of residence(Vallée and Chauvin, 2012).

The groups that were less likely to participate in opportunistic CCS, and therefore the most likely to be invited to the organized CCS program (older, single and women with low SEP)(Luque et al., 2018; Menvielle et al., 2014; Seidel et al., 2009), were also the least likely to participate in the program. This pattern was clear among women who had already been invited to the organized CCS program before our study period. These women had received at least two invitations since the beginning of the program in 2010 meaning that they had not been screened for a long time. Evidently, they do not participate in opportunistic CCS and the organized CCS program does not seem to empower them despite the implementation of empowerment interventions targeting vulnerable women.

However, the situation was different among women who received their first invitation to the organized CCS program during the study period. In this group no factors were associated with participation except in the 35-45-year age group where we observed a social gradient for CCS participation and higher rates of participation among women living in neighborhoods with lower proportions of single women. Both associations most probably reflected the combined effect of family commitments and economic barriers, which are likely to be greater in this age group for several reasons: the presence of more women with young dependent children and more single mothers, leading to increased financial barriers and more difficulties in finding someone to look after babies or toddlers during gynecological appointments. In addition, this first invitation to the organized CCS program may have acted as a reminder in particular for the youngest and the wealthiest women. In fact, these sexually active and socio-economically privileged women do not face financial barriers and are more likely to have regular gynecological check-ups.

Overall, our results provide valuable information on factors limiting participation in the organized CCS program. In our study conducted in an urban context, low healthcare accessibility did not appear to be a barrier for participation. Hence, the obstacles may lie elsewhere, such as a lack of knowledge about which healthcare providers perform smear tests in one’s neighborhood. Financial barriers may also exist, as users are often required to pay the cost of medical consultations and tests before being refunded by their health insurance, with

possible out-of-pocket fees. In almost all cities in the VDM, there are places where women could get CCS free of charge and this information was communicated to women during the interventions led by the SMC, but it is often difficult to get an appointment. In addition, other barriers to CCS may exist such as limited health literacy(Kobayashi et al., 2014), cultural factors and the burden of daily life(Grillo et al., 2012). We may also presume from the SMC's experience that organisational problems regarding transport or childcare may be another important barrier, which was not addressed by empowerment interventions. All these barriers among vulnerable women are likely to limit the effectiveness of grassroots interventions. Methods directly bringing CCS to these women may help improve access to CCS (Arbyn et al., 2018). Developing mobile smear test facilities may be efficient. Indeed, a study conducted in France showed that mobile mammography units targeting underserved remote communities, could increase participation and decrease social and geographical inequalities in participation(Guillaume et al., 2017). HPV self-sampling (through vaginal swabs (Madzima et al., 2017)or urinary samples(Arbyn et al., 2018)) could also be considered as an additional strategy to increase CCS participation for hard-to-reach and vulnerable women(Des Marais et al., 2018; Lefeuvre et al., 2020). For women who are out of touch with the healthcare system, appropriate follow-ups in the instance of pathological results would nevertheless be a challenge without the extremely active involvement of healthcare professionals(Ducancelle et al., 2015) .

4. Conclusion

Overall, our study identified groups of women that participated less in the CCS organized program. Interventions targeting vulnerable women aged 35-45 years old should be developed to maintain these women in the CCS process, paying special attention on both the financial (e.g. removal of fees associated with screening) and logistic (e.g. medical visits outside working hours; medical visits accepting young children; performing CCS close to participants' place of residence) aspects of the care pathway. Moreover, HPV self-sampling strategies directed towards the most vulnerable population should be considered, as the majority of women testing negative would be given 5 years of reassurance.

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Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki.

Consent to publish

No individual person's data are used in this manuscript in any form, so no consent for publication was required.

Data availability

All data and material are available in this study.

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Contributions

CA and GM conceived the present idea and designed the plan of analysis.

MD, AK, CP organized and supervised data collection.

TB performed the data management. CA and TB carried out the analysis. AB supervised the analyses related to the geographical variables.

CA interpreted the results and wrote the manuscript. GM supervised the statistical analysis, the interpretation of the data and the writing of the manuscript.

All authors revised the manuscript and approved the final version of the manuscript.

Supplementary material: Description of the contextual variables introduced in the analyses

Title

Factors associated with participation in the organized cervical cancer screening program in the Greater Paris area (France): an analysis among more than 200000 women.

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Abbreviations

CCS : cervical cancer screening

SMC : Screening management center

VDM: Val de Marne

Neighbourhood level

Proportion of single women

Using data from the 2013 census, we obtained the proportion of single women that we categorized into three groups according to the tertiles of the VDM distribution.

The categorization identified neighbourhoods with a low proportion of single women. Indeed women living in the first group (proportion of single women < 6.2%) are very likely to live with a partner. This indicator can thus be considered as a proxy of the marital status, an important determinant of participation in CCS with higher participation among partnered women (Luque et al., 2018).

Social deprivation

We obtained a social deprivation indicator based on the 2013 census data, the French deprivation index. The index was classified into five categories according to the quintiles of the distribution in the whole Paris area.

Healthcare provider accessibility

We collected the name of all healthcare providers working in the VDM who performed at least one Pap smear test during the year 2017 from the health insurance fund. The number of Pap smear tests monthly performed by each healthcare provider is unknown. We geolocated all healthcare providers and we attached them to a neighbourhood.

For each neighbourhood, we calculated the number of healthcare providers working in this neighbourhood and who performed at least one Pap smear during the year 2017. We then developed an ad-hoc indicator for healthcare provider accessibility in 4 categories:

- no healthcare provider inside the neighbourhood and its adjacent neighbourhoods
- no healthcare provider inside the neighbourhood but at least one in at least one adjacent neighbourhood
- one healthcare provider inside the neighbourhood
- more than one healthcare provider inside the neighbourhood.

Town level

Social deprivation

We obtained a social deprivation indicator based on the 2013 census data, the French deprivation index. The index was classified into three categories according to the tertiles of the distribution in the whole Paris area.

Healthcare provider accessibility

Our healthcare provider accessibility indicator was based on a potential spatial accessibility indicator(Luo and Qi, 2009; Luo and Wang, 2003) built by a French governmental institution for various medical specialties and that accounts for several dimensions (medical density, average distance between healthcare providers and patients and average number of patients seen by the healthcare providers each month)(Barlet, n.d.). We selected the potential spatial accessibility indicator for two medical specialities which were relevant for CCS, namely gynaecologists and midwives.

For each town, we created two dummy variables indicating if the potential spatial accessibility for gynaecologists (resp. midwives) was below or above the VDM mean. We then combined these two dummy variables to define our healthcare provider accessibility indicator in three categories:

- Low: Below the VDM mean regarding the midwives and the gynaecologists potential spatial accessibility
- Medium: Above the VDM mean regarding midwives potential spatial accessibility and below the VDM regarding the gynaecologist potential spatial accessibility
- High: Above the VDM mean regarding the gynaecologist potential spatial accessibility whatever midwives potential spatial accessibility

The definition of this indicator was based on two observations. First, 90% of Pap smear test are performed by a gynaecologist in France. Second, in the VDM, if the potential spatial accessibility to gynaecologist is high in a town, the potential spatial accessibility to midwives is also high.

Municipal commitment to healthcare

We developed an ad-hoc synthetic indicator to characterize the municipal commitment to healthcare. This indicator accounted for the following characteristics, that were selected based on the literature findings and discussions with experts. (Trompette et al., 2020)

- Density of health associations above the VDM mean. The associations are important local relay points and allow to spread CCS information more efficiently through the population.
- Municipal healthcare centre where women can get CCS free of charge.
- Local health agreement between the government and the town aiming at reducing health inequalities at local level. This agreement reflects the involvement of the town in health promotion.
- Organisation of workshops to apply the local health agreement. This reflects the political will to apply the agreement.
- Elected member in the municipal council in charge of health.
- Position of the elected member in charge of health in the municipal organisational chart

All these components were scored 0 if absent or 1 if present, except the position of the elected member in charge of health in the municipal organisation chart (0: no specific role, 1: advisor, 2: deputy). We then computed a score by summing these six characteristics. Our indicator was then defined by categorising the score into 3 categories according to the VDM distribution: low(scored 0), medium (scored 1-3), high (scored 4-6).

We wanted to integrate the position of the elected member in charge of health in the municipal organisation chart, because there are driving forces in the decision-making process. The higher this position in the municipal organisation chart, the greater the power of this elected member will be: this person will be able to mobilise more money and human resources for this public health issue.

However, we were concerned about the weight of the elected member in charge of health in our indicator as it was taken into account twice (first for the presence of an elected member, second for the position in the municipal organisational chart). We therefore conducted a sensitivity analysis by scoring similarly towns without elected member in the municipal council in charge of health and towns with an elected member in the municipal council in charge of health but with no specific role. We found similar results.

Grassroots interventions

The SCM implemented various grassroots interventions to reach the vulnerable women. These interventions were primarily organized in the most deprived neighbourhoods. First, the SCM organized temporary large-scale CCS information event such as stalls at the market. In addition, the SCM developed interventions which integrated communities and aimed at empowering women. More specifically, the SCM trained relay women to spread CCS information inside their communities.

These empowerment interventions were evidence-based. The literature indeed suggests that interventions involving communities and promoting women empowerment are the most efficient in reducing health inequalities (Liu et al., 2012; Nickel and von dem Knesebeck, 2020; Salmi et al., 2017)

We defined an indicator for the type of grassroots interventions conducted by the VDM SMC in three categories:

- No intervention
- Temporary large-scale CCS information events (stalls at a market, information related to CCS set up in local associations working with vulnerable women)
- Empowerment interventions (intervention in small committees in close collaboration with the local associations working with vulnerable women such as training women to act as relays in the neighbourhood for CCS promotion)

We also defined a more refined indicator for the type grassroots interventions conducted by the VDM SMC in five categories:

- No intervention
- Temporary sporadic large-scale CCS information events (maximum one per year)
- Temporary regular large-scale CCS information events (more than one per year)
- Empowerment interventions without a long cooperation with the associations working with vulnerable women (less than 18 months)
- Empowerment interventions with a long cooperation with the associations working with vulnerable women (more than 18 months)

This more refined indicator accounted for the frequency of large-scale CCS information events and the length of cooperation with the associations working with vulnerable women, as we supposed that these two criteria could have on impact on CCS participation.

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Highlights

- Low healthcare provider accessibility did not appear as a barrier to participation in the organized CCS program
- Municipal health commitment did not have any impact on CCS participation.
- Promoting women's empowerment was not sufficient to improve participation in the organized CCS program
- Interventions targeting vulnerable women aged 35-45 years old should be developed.

Conflicts of interest statement

Céline Audiger, Michel Deghaye, Aldis Kaufmanis, and Caroline Pelisson are working at the CRCDC-Ile de France

Table1: Characteristics of women aged 25-65 years old who were invited to the organized cervical cancer screening program of the VDM from the 1st July 2014 to the 1st October 2017 (n=231,712).

	Long-term residents				**Newly arrived residents**	
	First invitation during the study period		Invited before the study period			
	N(%)	Screening rate (%)1	N(%)	Screening rate (%)1	N(%)	Screening rate (%)1
	48,644 (21.0)	16,028 (32.9)	117,990(50.9)	18,111 (15.3)	65,078(28.1)	15,412(23.7)
INDIVIDUAL LEVEL						
Age group (years)						
[25-35]	10,361 (21.3)	3239 (31.3)	14,361 (12.2)	2677(18.6)	40,277(61.9)	9596(23.8)
[35-45]	13,830 (28.4)	4777 (34.6)	27,968(23.7)	4897(17.5)	12,354(19.0)	3353(27.0)
[45-55]	12,459 (25.6)	4109 (33.0)	35,081(29.7)	5695(16.2)	7639(11.7)	1634(21.4)
[55-65]	11,994 (24.6)	3903 (32.5)	40,580(34.4)	4842(11.9)	4808(7.4)	829(17.3)
Missing	0 (0.0)	0.0 (0.0)	0 (0.0)	0(0.0)	0 (0.0)	0(0.0)
NEIGHBOURHOOD LEVEL						
Proportion of single women (%) (in tertiles)2						
[0-6.2]	11,674 (24.0)	3911 (33.5)	29,740 (25.2)	4737(15.9)	13578(20.9)	3074(22.6)
[6.2-10.8]	25,270 (52.0)	8320 (32.9)	61,515(52.1)	9304(15.1)	33,924 (52.1)	7941(23.4)
[10.8-100]	11,686 (24.0)	3789 (32.4)	26,693(22.6)	4065(15.2)	17,548(27.0)	4390(25.0)
Missing	14 (0.0)	8 (57.1)	14 (0.0)	5(35.7)	28(0.0)	7(25.0)
Deprivation (in quintiles)4						
Q1(most deprived)	9946 (20.4)	3175 (31.9)	31,761(26.9)	4726(14.9)	14,490(22.3)	3185(21.9)
Q2	11,316 (23.3)	3716 (32.9)	29,361(24.9)	4473(15.3)	16,340(25.1)	3657(22.4)
Q3	11,702 (24.1)	3890 (33.2)	25,777(21.8)	4032(15.6)	14,510(22.3)	3515(24.2)
Q4	10,380 (21.3)	3498 (33.7)	20,909(17.7)	3296(15.8)	12,729(19.6)	3160(24.8)
Q5 (least deprived)	5261 (10.8)	1734 (32.9)	10,093(8.6)	1574(15.6)	6882(10.6)	1866(27.1)
Missing	39 (0.1)	15 (38.5)	89(0.1)	10(11.2)	127(0.2)	29(22.8)
Healthcare providers performing smear test 3						
None inside the neighborhood and in its adjacent neighborhoods	5631 (11.6)	1773 (31.5)	15,553(13.2)	2360(15.2)	7806(12.0)	1764(22.6)
None inside the neighborhood but at least one in at least one adjacent neighborhood	28,248 (58.1)	9417 (33.3)	68,828(58.3)	10546(15.3)	37,495(57.6)	8811(23.5)
One inside the neighborhood	6296 (12.9)	2056 (32.7)	14,076(11.9)	2140(15.2)	8053(12.4)	1941(24.1)
More than one inside the neighborhood	8469 (17.4)	2782 (32.8)	19,556(16.6)	3065(15.7)	11,724(18.0)	2896(24.7)
TOWN LEVEL						
Deprivation (in tertiles) 4						
Low	21,925 (45.1)	7140 (32.6)	59,795(50.7)	9106(15.2)	32,171(49.5)	7215(22.4)
Medium	13,519 (27.8)	4473 (33.1)	32,107(27.2)	4970(15.5)	17,402(26.7)	4229(24.3)

High	13,186 (27.1)	4407 (33.4)	26,046(22.1)	4019(15.4)	15,477(23.8)	3961(25.6)
Missing	14 (0.0)	8(57.1)	42(0.0)	5(11.9)	28(0.0)	7(25.0)
Healthcare provider accessibility 5						
Low	15,471 (31.8)	5196 (33.6)	37,565(31.8)	5746(15.3)	18,394(28.3)	4324(23.5)
Medium	13,815 (28.5)	4575(33.1)	35,769(30.4)	5602(15.7)	20,222(31.1)	4748(23.5)
High	19,266 (39.7)	6249(32.4)	44,614(37.8)	6758(15.1)	26,434(40.6)	6333(23.9)
Missing	14 (0.0)	8(57.1)	42(0.0)	5(11.9)	28(0.0)	7(28.0)
Municipal commitment to healthcare 6						
Low	6730 (13.8)	2300 (34.2)	14,327(12.1)	2222(15.5)	7103(10.9)	1711(24.1)
Medium	18,702 (38.4)	6149 (32.9)	41,634(35.3)	6388(15.3)	24,195(37.2)	6077(25.1)
High	23,198 (47.7)	7571 (32.6)	61,987(52.6)	9496(15.3)	33,752(51.9)	7617(22.6)
Missing	14 (0.0)	8 (57.1)	42(0.0)	5(11.9)	28(0.0)	7(25.0)
Type of grassroots interventions by the screening management centre						
No intervention	9732 (20.0)	3336 (34.3)	21,105 (17.9)	3273(15.5)	11,000(16.9)	2719(24.7)
Tempory sporadic large-scale CCS information events	9927 (20.4)	3268 (32.9)	21,976 (18.6)	3420(15.6)	13,835(21.3)	3591(26.0)
Tempory regular large-scale CCS information events	6862 (14.1)	2087 (30.4)	18,852 (16.0)	2750(14.6)	10,487(16.1)	2279(21.7)
Empowerment interventions without a long cooperation with the associations working with vulnerable women (less than 18 months)	11,985 (24.6)	3962 (33.1)	28,454(24.1)	4429(15.6)	15847(24.4)	3756(23.7)
Empowerment interventions with a long cooperation with the associations working with vulnerable women (more than 18 months)	10,124 (20.8)	3367 (33.3)	27,561(23.4)	4234(15.4)	13881(21.3)	3060(22.1)
Missing	14 (0.0)	8 (57.1)	42(0.0)	5(11.9)	28(0.0)	7(25.0)

VDM: Val de Marne CCS: cervical cancer screening

1 Calculated one year after the personnal invitation for screening was sent

2 Based on the VDM distribution

3 Healthcare professionals include gynecologists, general practionners, midwives.

4 Based on the distribution in the whole Paris area

5 Low: below the VDM mean regarding the midwives and gynaecologists potential spatial accessibility; Medium: above the VDM mean regarding the midwives potential spatial accessibility and below the VDM mean regarding the gynecologists potential spatial accessibility; High: above the VDM mean regarding the gynaecologists potential spatial accessibility whatever the midwives accessibility.

6 Adhoc synthetic indicator including the density of health associations and the existence of specific institutional arrangements around health policy (local health agreement, elected member in charge of health, municipal health care center)

Table 2: Individual, neighbourhood and town characteristics associated with participation in the organized cervical cancer screening program of the VDM among long term and newly arrived residents, multilevel logistic regression model, women invited from the 1st July 2014 to the 1st October 2017.

	Long-term residents		**Newly arrived residents**
	First invitation during the study period (n=48,644)	Invited before the study period (n=117,990)	(n=65,078)
	OR[95%CI]1	OR[95%CI]1	OR[95%CI]1
INDIVIDUAL LEVEL			
Age group (years)			
[25-35]	**0.95[0.89-1.00]**	**1.71[1.62-1.80]**	**1.51[1.39-1.63]**
[35-45]	**1.10[1.04-1.16]**	**1.57[1.51-1.64]**	**1.79[1.64-1.95]**
[45-55]	1.02[0.97-1.08]	**1.43[1.38-1.49]**	**1.31[1.19-1.44]**
[55-65]	1	1	1
NEIGHBOURHOOD LEVEL			
Proportion of single women (%) (in tertiles) 2			
[0-6.2]	1.04[0.97-1.11]	**1.10[1.04-1.16]**	0.94[0.88-1.01]
[6.2-10.8]	1.03[0.97-1.08]	1.02[0.97-1.07]	0.99[0.94-1.04]
[10.8-100]	1	1	1
Deprivation (in quintiles)3			
Q1(most deprived)	1	1	1
Q2	**1.06[1.00-1.13]**	**1.05[1.01-1.11]**	1.01[0.95-1.08]
Q3	**1.07[1.01-1.14]**	**1.12[1.06-1.18]**	**1.10[1.03-1.18]**
Q4	**1.09[1.02-1.17]**	**1.13[1.05-1.20]**	**1.10[1.02-1.18]**
Q5(least deprived)	1.08[0.99-1.17]	**1.13[1.05-1.22]**	**1.21[1.11-1.32]**
TOWN LEVEL			
Healthcare provider accessibility 4			
Low	1	1	1
Medium	0.99[0.93-1.06]	1.05[0.98-1.12]	0.98[0.91-1.05]
High	0.95[0.89-1.01]	0.99[0.93-1.05]	0.96[0.89-1.04]
Municipal commitment to healthcare 5			
Low	1	1	1
Medium	0.97[0.90-1.05]	1.01[0.93-1.08]	1.02[0.93-1.13]
High	0.96[0.89-1.04]	1.02[0.95-1.11]	0.97[0.87-1.07]
Type of grassroots interventions by the screening management centre			
No intervention	1	1	1
Tempory large-scale CCS information events	**0.92[0.85-0.99]**	0.99[0.92-1.07]	0.97[0.89-1.06]
Empowerment interventions	0.97[0.90-1.04]	1.00[0.93-1.07]	0.94[0.86-1.03]

VDM: Val de Marne OR: Odds ratio CI: Confidence interval CCS: cervical cancer screening

1 Adjusted ORs calculated one year after the personal invitation for screening was sent

2 Based on the VDM distribution

3 Based on the distribution in the whole Paris area

4 Low: below the VDM mean regarding the midwives and gynaecologists potential spatial accessibility; Medium: above the VDM mean regarding the midwives potential spatial accessibility and below the VDM mean regarding the gynecologists potential spatial accessibility; High: above the VDM mean regarding the gynaecologists potential spatial accessibility whatever the midwives potential accessibility.

5 Adhoc synthetic indicator including the density of health associations and the existence of specific institutional arrangements around health policy (local health agreement, elected member in charge of health, municipal health care center)

Table 3: Neighbourhood and town characteristics associated with participation in the organized cervical cancer screening program of the VDM by age group among long-term residents, multilevel logistic regression model, women invited from the 1st July 2014 to the 1st October 2017.

	First invitation during the study period (n=48,644)				Invited before the study period (n=117,990)			
	[25-35]	[35-45]	[45-55]	[55-65]	[25-35]	[35-45]	[45-55]	[55-65]
	OR[95% CI]1	OR[95% CI]1	OR[95% CI]1	OR[95% CI]1	OR[95% CI]1	OR[95% CI]1	OR[95% CI]1	OR[95% CI]1
NEIGHBOURGHOOD LEVEL								
Proportion of single women (%) (in tertiles) 2								
[0-6.2]	0.92[0.80-1.06]	**1.14[1.01-1.29]**	1.04[0.92-1.18]	1.01[0.89-1.15]	**0.87[0.75-1.00]**	**1.13[1.02-1.26]**	**1.18[1.07-1.31]**	**1.12[1.01-1.23]**
[6.2-10.8]	**0.89[0.79-1.00]**	1.08[0.98-1.19]	1.02[0.92-1.13]	1.08[0.98-1.20]	0.97[0.87-1.09]	1.03[0.95-1.13]	1.05[0.97-1.14]	0.98[0.90-1.06]
[10.8-100]	1	1	1	1	1	1	1	1
Deprivation (in quintiles)3								
Q1(most deprived)	1	1	1	1	1	1	1	1
Q2	1.11[0.97-1.26]	**1.16[1.03-1.30]**	1.01[0.90-1.30]	0.99[0.87-1.12]	1.01[0.89-1.14]	1.06[0.97-1.16]	1.08[0.99-1.18]	1.05[0.96-1.15]
Q3	1.02[0.89-1.17]	**1.18[1.05-1.32]**	1.02[0.90-1.15]	1.04[0.91-1.18]	1.05[0.92-1.20]	**1.13[1.03-1.25]**	**1.14[1.04-1.25]**	**1.10[1.00-1.20]**
Q4	1.04[0.89-1.21]	**1.29[1.14-1.47]**	0.99[0.87-1.12]	1.01[0.88-1.16]	1.02[0.87-1.19]	**1.16[1.04-1.29]**	**1.21[1.09-1.35]**	1.09[0.98-1.21]
Q5(least deprived)	1.07[0.88-1.31]	**1.38[1.18-1.62]**	1.00[0.86-1.17]	0.90[0.76-1.06]	1.16[0.94-1.43]	**1.27[1.10-1.45]**	1.12[0.97-1.28]	1.05[0.92-1.20]
TOWN LEVEL								
Healthcare provider accessibility 4								
Low	1	1	1	1	1	1	1	1
Medium	**0.83[0.72-0.94]**	0.99[0.89-1.09]	1.10[0.99-1.22]	1.02[0.91-1.13]	0.96[0.83-1.11]	1.02[0.92-1.12]	1.09[0.97-1.23]	**1.10[1.01-1.19]**
High	0.92[0.81-1.04]	0.90[0.82-0.99]	1.01[0.91-1.11]	0.97[0.87-1.07]	0.89[0.77-1.01]	1.01[0.92-1.10]	1.07[0.96-1.18]	1.00[0.93-1.09]
Municipal commitment to healthcare 5								
Low	1	1	1	1	1	1	1	1
Medium	0.88[0.75-1.03]	0.93[0.83-1.06]	1.01[0.89-1.14]	1.06[0.93-1.20]	0.93[0.78-1.11]	1.02[0.91-1.15]	0.99[0.87-1.12]	1.03[0.93-1.15]
High	0.88[0.74-1.04]	0.92[0.81-1.05]	1.00[0.88-1.15]	1.02[0.89-1.17]	0.87[0.73-1.05]	1.07[0.95-1.21]	0.99[0.87-1.13]	1.08[0.97-1.21]
Type of grassroots interventions by the screening management centre								
No intervention	1	1	1	1	1	1	1	1
Tempory large-scale CCS information events	**0.86[0.75-1.00]**	0.98[0.88-1.09]	**0.88[0.78-0.98]**	0.92[0.82-1.03]	0.92[0.78-1.08]	0.99[0.89-1.10]	0.99[0.87-1.12]	1.01[0.92-1.11]
Empowerment interventions	1.03[0.89-1.19]	0.99[0.89-1.10]	0.95[0.85-1.06]	0.93[0.83-1.05]	0.90[0.77-1.06]	1.09[0.98-1.20]	1.04[0.92-1.18]	0.95[0.86-1.04]

VDM: Val de Marne OR: Odds ratio CI: Confidence interval CCS: cervical cancer screening
1 Adjusted ORs calculated one year after the personal invitation for screening was sent

2 Based on the VDM distribution

3 Based on the distribution in the whole Paris area

4 Low: below the VDM mean regarding the midwives and gynaecologists potential spatial accessibility; Medium: above the VDM mean regarding the midwives potential spatial accessibility and below the VDM mean regarding the gynecologists potential spatial accessibility; High: above the VDM mean regarding the gynaecologists potential spatial accessibility whatever the midwives potential accessibility.

5 Adhoc synthetic indicator including the density of health associations and the existence of specific institutional arrangements around health policy (local health agreement, elected member in charge of health, municipal health care center)

Supplementary Table1: Individual, neighbourhood and town characteristics associated with participation in the organized cervical cancer screening program of the VDM among long-term residents with grassroots interventions by the screening management centre categorized in 5 categories, multilevel logistic regression model, women invited from the 1st July 2014 to the 1st October 2017.

	First invitation during the study period (n=48,644)	Invited before the study period (n=117,990)
	OR[95% CI]1	OR[95% CI]1
INDIVIDUAL LEVEL		
Age group (years)		
[25-35]	**0.95[0.89-1.00]**	**1.71[1.62-1.80]**
[35-45]	**1.10[1.04-1.16]**	**1.57[1.51-1.64]**
[45-55]	1.02[0.97-1.08]	**1.43[1.37-1.49]**
[55-65]	1	1
NEIGHBOURHOOD LEVEL		
Proportion of single women (%) (in tertiles) 2		
[0-6.2]	1.04[0.97-1.11]	**1.10[1.04-1.16]**
[6.2-10.8]	1.03[0.98-1.08]	1.02[0.97-1.07]
[10.8-100]	1	1
Deprivation (in quintiles) 3		
Q1(most deprived)	1	1
Q2	**1.07[1.00-1.13]**	**1.06[1.01-1.11]**
Q3	**1.07[1.01-1.14]**	**1.12[1.06-1.18]**
Q4	**1.09[1.02-1.17]**	**1.13[1.07-1.20]**
Q5(least deprived)	1.08[0.99-1.17]	**1.13[1.05-1.22]**
TOWN LEVEL		
Healthcare provider accessibility 4		
Low	1	1
Medium	0.99[0.93-1.05]	1.05[0.98-1.12]
High	**0.95[0.89-1.00]**	0.99[0.93-1.05]
Municipal commitment to healthcare 5		

Low	1	1
Medium	0.98[0.91-1.05]	1.01[0.94-1.09]
High	0.99[0.91-1.07]	1.04[0.96-1.13]
Type of grassroots actions by the screening management centre		
No intervention	1	1
Tempory sporadic large-scale CCS information events	0.95[0.89-1.02]	1.02[0.94-1.10]
Tempory regular large-scale CCS information events	**0.85[0.78-0.93]**	0.94[0.85-1.03]
Empowerment interventions without a long cooperation with the associations working with vulnerable women (less than 18 months)	0.96[0.89-1.03]	0.99[0.91-1.07]
Empowerment interventions with a long cooperation with the associations working with vulnerable women (more than 18 months)	0.96[0.89-1.04]	0.99[0.91-1.08]

VDM: Val de Marne OR: Odds ratio CI: Confidence interval CCS: cervical cancer screening

1 Adjusted ORs calculated one year after the personal invitation for screening was sent

2 Based on the VDM distribution

3 Based on the distribution in the whole Paris area

4 Low: below the VDM mean regarding the midwives and gynaecologists potential spatial accessibility; Medium: above the VDM mean regarding the midwives potential spatial accessibility and below the VDM mean regarding the gynecologists potential spatial accessibility; High: above the VDM mean regarding the gynaecologists potential spatial accessibility whatever the midwives potential accessibility.

5 Adhoc synthetic indicator including the density of health associations and the existence of specific institutional arrangements around health policy (local health agreement, elected member in charge of health, municipal health care center)

Supplementary Table2: Individual, neighbourhood and town characteristics associated with participation in the organized cervical cancer screening program of the VDM among long-term residents with assessment of the healthcare provider indicator at the neighbourhood level , multilevel logistic regression model, women invited from the 1st July 2014 to the 1st October 2017.

	First invitation during the study period (n=48,644)	Invited before the study period (n=117,990)
	OR[95% CI]1	OR[95% CI]1
INDIVIDUAL LEVEL		
Age group (years)		
[25-35]	**0.95[0.90-1.00]**	**1.71[1.62-1.80]**
[35-45]	**1.10[1.04-1.16]**	**1.57[1.51-1.64]**
[45-55]	**1.02[0.97-1.08]**	**1.43[1.38-1.49]**
[55-65]	1	1
NEIGHBORHOOD LEVEL		
Proportion of single women (%) (in tertiles) 2		
[0-6.2]	1.04[0.98-1.11]	**1.10[1.05-1.17]**
[6.2-10.8]	1.03[0.97-1.08]	1.03[0.98-1.07]
[10.8-100]	1	1
Deprivation (in quintiles) 3		
Q1(most deprived)	1	1
Q2	1.05[0.99-1.12]	**1.06[1.01-1.11]**
Q3	**1.07[1.00-1.14]**	**1.12[1.06-1.18]**
Q4	**1.10[1.02-1.18]**	**1.13[1.07-1.20]**
Q5(least deprived)	**1.07[0.98-1.16]**	**1.13[1.04-1.22]**
Healthcare providers performing smear test 4		
None inside the neighbourhood and in its adjacent neighbourhoods	1	1
None inside the neighbourhood but at least one in at least one adjacent neighbourghood	**1.07[1.01-1.15]**	1.00[0.95-1.06]
One inside the neighbourhood	1.04[0.96-1.13]	0.99[0.92-1.06]
More than one inside the neighbourhood	1.05[0.98-1.14]	1.03[0.97-1.10]
TOWN LEVEL		
Municipal commitment to healthcare 5		
Low	1	1
Medium	0.95[0.88-1.03]	1.01[0.93-1.09]
High	0.96[0.89-1.04]	1.03[0.95-1.12]
Type of grassroots interventions by the screening management centre		
No intervention	1	1
Tempory large-scale CCS information events	**0.91[0.84-0.98]**	1.00[0.93-1.08]
Empowerment interventions	0.95[0.88-1.03]	1.00[0.93-1.08]

VDM: Val de Marne OR: Odds ratio CI: Confidence interval CCS: cervical cancer screening
1 Adjusted ORs calculated one year after the personal invitation for screening was sent

2 Based on the VDM distribution
3 Based on the distribution in the whole Paris area
4 Healthcare providers include gynaecologists, general practioners, midwives.
5 Adhoc synthetic indicator including the density of health associations and the existence of specific institutional arrangements around health policy (local health agreement, elected member in charge of health, municipal health care center)

Supplementary Table 3 : Individual, neighbourhood and town characteristics associated with participation in the organized cervical cancer screening program of the VDM among long-term residents including women with a follow-up shorter than 12 months*, multilevel logistic regression model, women invited from the 1st July 2014 to the 1st October 2017(n=182,951).

	First invitation during the study period		Invited before the study period	
	N(%)	OR[95% CI]1	N(%)	OR[95% CI]1
	54,192(29.6)		128,759(70.4)	
INDIVIDUAL LEVEL				
Age group (years)				
[25-35]	12,463(23.0)	**0.88[0.83-0.93]**	16,978(13.2)	**1.62[1.55-1.71]**
[35-45]	16,115(29.7)	**1.06[1.00-1.11]**	32,013(24.9)	**1.52[1.46-1.59]**
[45-55]	13,218(24.4)	1.02[0.96-1.07]	37,063(28.8)	**1.44[1.38-1.50]**
[55-65]	12,396(22.9)	1	42,705(33.1)	1
NEIGHBOURHOOD LEVEL				
Proportion of single women (%) (in tertiles) 2				
[0-6.2]	12,875(23.8)	1.05[0.99-1.12]	32,202(25.0)	**1.10[1.04-1.16]**
[6.2-10.8]	28,199(52.0)	1.03[0.98-1.09]	67,187(52.2)	1.03[0.98-1.07]
[10.8-100]	13,101(24.2)	1	29,325(22.8)	1
Deprivation (in quintiles) 3				
Q1(most deprived)	11,079(20.4)	1	34,283(26.6)	1
Q2	12,623(23.3)	**1.06[1.00-1.12]**	32,079(24.9)	1.04[0.99-1.09]
Q3	13,019(24.0)	**1.07[1.01-1.14]**	28,181(21.9)	**1.10[1.05-1.16]**
Q4	11,534(21.3)	**1.08[1.01-1.16]**	22,946(17.8)	**1.10[1.04-1.16]**
Q5(least deprived)	5890(10.9)	1.05[0.96-1.14]	11,177(8.8)	**1.10[1.02-1.18]**
TOWN LEVEL				
Healthcare provider accessibility 4				
Low	17,306(32.0)	1	41,101(31.9)	1
Medium	15,404(28.5)	0.99[0.93-1.06]	38,967(30.3)	1.04[0.98-1.12]
High	21,373(39.5)	0.94[0.89-1.00]	48,535(37.7)	0.98[0.92-1.05]
Municipal commitment to healthcare 5				
Low	7450(13.8)	1	15,581(12.1)	1
Medium	20,914(38.6)	0.97[0.90-1.04]	45,567(35.4)	1.00[0.93-1.08]
High	25,811(47.6)	0.96[0.89-1.04]	67,566(52.5)	1.01[0.94-1.10]
Type of grassroots interventions by the screening management centre				
No intervention	10,765(19.9)	1	22,929(17.8)	1
Tempory large-scale CCS information events	18,842(34.8)	**0.92[0.85-0.98]**	44,834(34.8)	0.99[0.92-1.06]
Empowerment interventions	24,585(45.3)	0.97[0.90-1.04]	60951(47.4)	0.98[0.92-1.06]

VDM: Val de Marne OR: Odds ratio CI: Confidence interval CCS: cervical cancer screening

* we used a conservative approach and assumed that women did not screen when no data on CCS was available

1 Adjusted ORs calculated one year after the personal invitation for screening was sent

2 Based on the VDM distribution

3 Based on the distribution in the whole Paris area
4 Low: below the VDM mean regarding the midwives and gynaecologists potential spatial accessibility; Medium: above the VDM mean regarding the midwives potential spatial accessibility and below the VDM mean regarding the gynecologists potential spatial accessibility; High: above the VDM mean regarding the gynaecologists potential spatial accessibility whatever the midwives potential accessibility.
5 Adhoc synthetic indicator including the density of health associations and the existence of specific institutional arrangements around health policy (local health agreement, elected member in charge of health, municipal health care center)

Supplementary Table 4 : Individual, neighbourhood and town characteristics associated with participation in the organized cervical cancer screening program of the VDM among long-term residents living in the most deprived neighbourhoods and in the most deprived towns*, multilevel logistic regression model, women invited from the 1st July 2014 to the 1st October 2017(n=24,681).

	First invitation during the study period (n=5899)		Invited previously the study period (n=18,782)	
	N(%)	OR[95% CI]1	N(%)	OR[95% CI]1
INDIVIDUAL LEVEL				
Age group (years)				
[25-35]	1487(25.2)	0.83[0.71-0.97]	2559(13.6)	**1.68[1.48-1.91]**
[35-45]	1727(29.3)	0.90[0.77-1.05]	4631(24.6)	**1.51[1.35-1.68]**
[45-55]	1387(23.5)	0.97[0.83-1.14]	5652(30.1)	**1.41[1.27-1.57]**
[55-65]	1298(22.0)	1	5940(31.6)	1
NEIGHBOURHOOD LEVEL				
Proportion of single women (%) (in tertiles) 2				
[0-6.2]	402(6.8)	1.05[0.82-1.34]	7603(6.0)	1.07[0.89-1.29]
[6.2-10.8]	2308(39.2)	1.08[0.86-1.37]	1133(40.5)	1.02[0.85-1.21]
[10.8-100]	3189(54.0)	1	10,046(53.5)	1
TOWN LEVEL				
Healthcare provider accessibility 3				
Low	2924(49.6)	1	9234(49.2)	1
Medium	2026(34.4)	0.89[0.77-1.03]	6723(35.8)	0.98[0.88-1.09]
High	945(16.0)	1.04[0.87-1.24]	2815(15.0)	1.00[0.88-1.14]
Municipal commitment to healthcare 4				
Low	256(4.3)	1	766(4.0)	1
Medium	672(11.4)	0.63[0.38-1.05]	2493(13.4)	1.22[0.87-1.73]
High	4971(84.3)	0.70[0.44-1.12]	15,523(82.6)	1.24[0.90-1.73]
Type of grassroots interventions by the screening management centre				
No intervention	433(7.3)	1	1297(6.9)	1
Tempory large-scale CCS information events	1303(22.1)	0.76[0.45-1.28]	4118(21.9)	1.34[0.94-1.92]
Empowerment interventions	4163(70.6)	0.86[0.59-1.26]	13,367(71.2)	1.06[0.82-1.37]

VDM: Val de Marne OR: Odds ratio CI: Confidence interval CCS: cervical cancer screening

*This corresponds to the most deprived quintiles regarding the neighbourhood and the most deprived tertiles regarding the town

1 Adjusted ORs calculated one year after the personal invitation for screening was sent

2 Based on the VDM distribution

3 Low: below the VDM mean regarding the midwives and gynaecologists potential spatial accessibility; Medium: above the VDM mean regarding the midwives potential spatial accessibility and below the VDM mean regarding the gynecologists potential spatial accessibility; High: above the VDM mean regarding the gynaecologists potential spatial accessibility whatever the midwives potential accessibility.

4 Adhoc synthetic indicator including the density of health associations and the existence of specific institutional arrangements around health policy (local health agreement, elected member in charge of health, municipal health care center)

Supplementary Table 5: Individual, neighbourhood and town characteristics associated with participation in the organized cervical cancer screening program of the VDM among long-term residents living in the most deprived neighbourhoods in the most deprived towns*, with the assessment of the health care providers indicator at the neighbourghood level, multilevel logistic regression model, women invited from the 1st July 2014 to the 1st October 2017(n=24,681).

	First invitation during the study period (n=5899)		Invited before the study period (n=18,782)	
	N (%)	OR[95% CI]1	N (%)	OR[95% CI]1
INDIVIDUAL LEVEL				
Age group (years)				
[25-35]	1487(25.2)	0.83[0.71-0.97]	2559(13.6)	**1.68[1.48-1.91]**
[35-45]	1727(29.3)	0.90[0.77-1.04]	4631(24.6)	**1.51[1.35-1.68]**
[45-55]	1387(23.5)	0.96[0.82-1.13]	5652(30.1)	**1.41[1.27-1.57]**
[55-65]	1298(22.0)	1	5940(31.6)	1
NEIGHBOURHOOD LEVEL				
Proportion of single women (%) (in tertiles) 2				
[0-6.2]	402(6.8)	1.01[0.79-1.29]	7603(6.0)	1.05[0.88-1.26]
[6.2-10.8]	2308(39.2)	1.03[0.81-1.31]	1133(40.5)	0.98[0.82-1.17]
[10.8-100]	3189(54.0)	1	10,046(53.5)	1
Healthcare providers performing smear test 3				
None inside the neighbourhood and in its adjacent neighbourhoods	1216(20.6)	1	3958(21.1)	1
None inside the neighbourhood but at least one in at least one adjacent neighbourghood	3653(61.9)	1.08[0.93-1.26]	11,675(62.2)	1.06[0.96-1.18]
One inside the neighbourhood	401(6.8)	1.13[0.87-1.47]	1250(6.6)	1.15[0.96-1.39]
More than one inside the neighbourhood	629(10.7)	1.05[0.84-1.31]	1899(10.1)	1.12[0.96-1.32]
TOWN LEVEL				
Municipal commitment to healthcare 4				
Low	256(4.3)	1	766(4.0)	1
Medium	672(11.4)	0.69[0.42-1.14]	2493(13.4)	1.26[0.90-1.77]
High	4971(84.3)	0.86[0.55-1.34]	15,523(82.6)	1.33[0.98-1.81]
Type of grassroots interventions by the screening management centre				
No intervention	433(7.3)	1	1297(6.9)	1
Tempory large-scale CCS information events	1303(22.1)	0.71[0.44-1.16]	4118(21.9)	1.31[0.95-1.81]
Empowerment interventions	4163(70.6)	0.74[0.51-1.06]	13,367(71.2)	0.99[0.78-1.26]

VDM: Val de Marne OR: Odds ratio CI: Confidence interval CCS: cervical cancer screening

*This corresponds to the most deprived quintiles regarding the neighbourhood and the most deprived tertiles regarding the town

1 Adjusted ORs calculated one year after the personal invitation for screening was sent

2 Based on the VDM distribution

3 Healthcare providers include gynaecologists, general practioners, midwives.

4 Adhoc synthetic indicator including the density of health associations and the existence of specific institutional arrangements around health policy (local health agreement, elected member in charge of health, municipal health care center).

Title figure 1: Flow diagram to detail the selection of the 3 populations