Sociogeographical factors associated with participation in colorectal cancer screening

Analyse socioterritoriale des facteurs associés à la participation au dépistage organisé du cancer colorectal

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Summary

\textit{Background/aim.} — Sociodemographic factors associated with colorectal cancer screening participation have been extensively analysed although few, if any, studies have focused on regional/geographical factors as determinants of non-participation rates. The purpose of this study was to investigate the effects of individual and geographical determinants on the variable participation rates seen for colorectal cancer screening.

\textit{Methods.} — The study population comprised 183,978 individuals in the first round of screening and 175,596 in the second round, all of whom were residents of the city of Marseille in France. The influence of age, gender and regional/geographical characteristics, such as proportion of migrants and property prices per square meter, on participation rates was assessed by multilevel analysis.

\textit{Results.} — The participation rate was lower for men (0.85; 95\% CI: 0.83—0.86), and higher for those aged 65—69 years. Univariate analysis showed that participation rates were significantly different across the 16 municipal districts of Marseille (range: 22.8—36.7\%; OR: 1.97; 95\% CI: 1.86—2.08). On multivariate analysis, having a higher proportion of migrants in the district population was still associated with lower participation (OR: 0.96; 95\% CI: 0.95—0.97).

\textit{Conclusion.} — In addition to individual factors, regional/geographical factors appear to be relevant determinants of participation rates in urban colorectal cancer screening programs.

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Introduction

Colorectal cancer is a major public health problem. In France, colorectal cancer is diagnosed in 37,000 new patients each year and is the cause of death of 16,500 people annually [1]. It is the third leading cancer in the male population, after prostate and lung cancers, and the second leading cancer in the female population, after breast cancer. Colorectal cancer is second to lung cancer as the most common cause of cancer death [2].

The efficacy of screening with the Hemoccult II® fecal occult blood test has been demonstrated by several large-scale randomized trials. Experiments conducted in the United Kingdom, Denmark and France have shown that mortality due to colorectal cancer can be decreased by 15–18% if 50% of the target population participates in the program [3–5].

Given these observations, the Paris 1998 consensus conference on the screening and management of colorectal cancer recommended systematic screening, every two years, for average-risk persons aged 50–74 years [6]. A pilot screening program was started in 2002 in 12 administrative districts (départements) in France, and the screening program has now been extended to cover the entire country.

Yet, despite the recognized effectiveness of fecal occult blood screening with Hemoccult II® and the increase in the incidence of colorectal cancer, many people still fail to participate in the screening program. The participation rate in the administrative district of Bouches-du-Rhône was 41.8% for the first round of screening (2003–2004) and 35.7% for the second (2005–2006).

Several studies have focused on the factors associated with non-participation in screening for colorectal and breast cancer. These studies have included age, gender, family situation, social and occupational category, educational level and screening organization [7–13]. A few studies have shown that the place of residence influences participation or non-participation in screening for breast cancer, as well as the incidence of breast cancer [14–17].

For this reason, the present study of geographical factors associated with participation in a screening program for colorectal cancer was carried out in the city of Marseille, which is divided into 16 municipal districts (arrondissements) and 111 residential areas (quartiers), each with a distinctive history and characteristics. Marseille has a surface area twice that of Paris, and the geographical, economic and social differences across its municipal districts are enormous [18,19]. Three districts have the poorest populations with low occupational qualifications and the highest percentages of people on welfare. As such factors could have an impact on the rate of participation in colorectal screening programs, the present study was designed to test this hypothesis.

The study aimed to analyse participation in the 16 municipal districts of Marseille by gender, age and medical coverage in the district. It also took into consideration the medical density, percentage of physicians specially trained for colorectal screening, property prices, percentage of migrants in the population and rate of unemployment. The main objective was to determine whether the place of residence was predictive of participation (or not) in a colorectal screening program.

Material and methods

Population

The study was designed to determine the rate of participation in the colorectal screening program organized for the 16 municipal districts of the city of Marseille during two rounds of screening. The database for the target population was established from the databases maintained by the different administrations of the French healthcare fund. The target population for the screening campaigns included all individuals residing in Marseille, aged 50–74 years. The screening program covered those with an average risk of colorectal cancer, as individual colonoscopy screening was proposed for those with a high or very high risk of colorectal cancer.

Invitation to participate and study procedures

In compliance with the national schedule [20], a letter was sent to all individuals in the target population inviting them to consult their general practitioner for colorectal screening. An information brochure was enclosed with the letter of invitation. All general practitioners in the Bouches-du-Rhône district had already been informed of the screening campaign for colorectal cancer (in addition to attending evening meetings, general practitioners have, since 2005, also been informed by a medical delegate visiting their offices). At present, 80% of the general practitioners in Bouches-du-Rhône have received training related to the colorectal screening program.

People who responded to the letter of invitation received the Hemoccult II® test from their general practitioner free of charge. Those who failed to respond received a recall letter three months later, again advising them to consult their general practitioner to receive the screening test. After this so-called ‘medical’ phase, individuals who still had not responded were sent the test kit by mail (six months after receiving the initial invitation). A prestamped envelope was included for returning the test. During this so-called ‘postal’ phase, a reason for not participating could be given. In all cases, the test was delivered free of charge.

There are several indicators of screening quality:

- rate of positive tests (which should be around 2%);
- rate of non-analysable tests (which should be < 3%);
- rate of colonoscopy after a positive test (which should be > 90%);
- rate of adenomatous polyps and early-stage cancers found at colonoscopy after a positive test [20].

In the first two rounds in Bouches-du-Rhône, the rate of adenomas found at colonoscopy was about 25% and the rate of cancers was around 15%, including 70% at an early stage. This indicates that good qualitative results can be obtained with organized screening for colorectal cancer.

The study database was compiled from the Arcades database and included, from the city of Marseille, 183,978 people in the first round and 175,596 in the second.
Parameters analysed in the study

Participation was determined for the eligible population by considering only those specifically targeted for screening, and excluding those whose non-participation was the result of a medical indication. Thus, participation was defined as returning the test. The age and gender of each participant were known.

The following data were also known for each municipal district:

- unemployment rate (source: 1999, Institut national de la statistique et des études économiques [Insee] census data);
- property price per square meter (source: La Vie Immobilière on the Internet, notary data for Paris–Île-de-France and France on December 31, 2007, and L’Internaute indicators for 2006);
- medical density (number of physicians per 1000 inhabitants);
- percentage of general practitioners with screening training.

It should be noted that, for the purposes of this study, a migrant was defined as a person residing in France, but who is not a French national, either because of having another nationality exclusively or having no nationality. In Marseille, which has a total population of 797,500, there were 57,500 people who had acquired French nationality and 54,355 migrants, of whom 60% had come from three of the five Maghreb countries of North Africa. Also, the largest community in the world of people from the Comoros Islands was living in Marseille at the time of the study [18].

Statistical analysis

SPSS version 15 software was used for statistical analysis. The chi-square test was used to determine participation rates by gender and municipal district. The t test was used, after testing the variance hypothesis, to assess the participation rates within each municipal district by age, medical density, percentage of physicians with screening training, unemployment rate, property prices and proportion of migrants. These analyses were performed for both the first and second rounds of screening.

A multilevel logistic-regression model was used for the multivariate analysis. This method of analysis was originally developed in the field of educational sciences [21], but has since been applied more generally and, in particular, for studies in the fields of demographics and health [22]. Multilevel analysis is used specifically to identify correlations between, on one hand, individual-related variables and, on the other, socioeconomic variables, while considering several factors simultaneously (for example, individuals and region). This allows the way the socioeconomic environment of a given individual affects the statistical associations observed on the individual level to be investigated. Multilevel, or cluster, analysis can also be adapted to account for a geographical dimension in a model designed on an individual level, thereby allowing the identification of regional effects.

### Table 1: Participation rates in the first and the second rounds of colorectal cancer screening.

<table>
<thead>
<tr>
<th></th>
<th>Participation rate in the first round</th>
<th>Participation rate in the second round</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>22.8%</td>
<td>21.9%</td>
</tr>
<tr>
<td>Maximum</td>
<td>36.7%</td>
<td>35.7%</td>
</tr>
<tr>
<td>Odds ratio</td>
<td>1.97 (95% CI: 1.86–2.08)</td>
<td>1.98 (95% CI: 1.87–2.07)</td>
</tr>
</tbody>
</table>

Multilevel logistic regression was applied using the GLIMMIX procedure of SAS version 9.1 software. This is a two-level model: 183,978 people in the first round and 175,596 in the second round constituted level 1; and they were grouped according to which of the 16 municipal districts of Marseille they lived in, which constituted level 2.

The dependent variable was binary (participation vs non-participation). Reasons for exclusion, as mentioned above, were also taken into consideration. The multivariate analysis took into account the factors related to the individual and those related to the district of residence.

Multilevel analyses were applied for age and gender as explanatory variables, and then for each municipal district of Marseille, property prices and proportion of migrants. The explanatory variables of medical density and proportion of screening-trained general practitioners, as well as the unemployment rate per district were not retained for the multivariate model, as they were too strongly correlated with other variables. However, property prices and migrant proportions were retained because of the wide disparities observed for these variables across the Marseille municipal districts. The age range of 70–74 years was taken as the reference.

The pseudo-likelihood of residuals method was used to estimate model parameters. Odds ratios (OR) were calculated with 95% confidence intervals (CI). Results were considered significant for \( p < 0.005 \).

Results

### Characteristics of the study population: univariate analysis

#### General data

The participation rate in each municipal district was statistically significantly different from the others (\( p < 0.001 \)) in both the first and second screening rounds (Fig. 1). The overall participation rate for the entire city was 30.6% in the first round and 30% in the second, with a minimum of 22.8% in the first round in the first district and a maximum of 36.7% in the eighth district, giving an OR of 1.97 (95% CI: 1.86–2.08). These figures were similar in the second round (Table 1).

#### Individual data: age and gender

Women participated significantly more than men in both rounds (\( p < 0.001 \); Table 2). Screening for colorectal cancer was higher in those aged superior to 60 years, and reached a peak in the 65–69 age range (Fig. 2).
Geographical factors in colorectal cancer screening

Figure 1  Participation rate in colorectal cancer screening in Marseille areas for the two rounds.

Table 2  Participation rates (%) and odds ratios (OR) for colorectal cancer screening according to gender.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Participation in the first round</th>
<th>Participation in the second round</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>29.3% (OR: 0.85; 95% CI: 0.83–0.86)</td>
<td>28.7% (OR: 0.81; 95% CI: 0.80–0.83)</td>
</tr>
<tr>
<td>Females</td>
<td>33.3% (OR: 1)</td>
<td>33.6% (OR: 1)</td>
</tr>
</tbody>
</table>

OR: odds ratio; CI: confidence interval.

Figure 2  Participation rate in colorectal cancer screening according to age for the two rounds.

Other data
The results of univariate analysis showed the impact of age, medical density, proportion of trained physicians, unemployment rate, property prices and proportion of migrants on performance of the test. In fact, all these variables were significantly associated with the performance (or not) of the fecal occult blood test ($p < 0.001$). Univariate analysis also showed that the proportions of migrants and unemployed persons were significantly higher, and that property prices, on average, were significantly lower, among non-participants. As for migrants in Marseille, the mean proportion was 6.28% among participants and 7.02% among non-participants.

Medical density per 1000 inhabitants appeared to have little influence on participation in the screening program. In contrast, the percentage of physicians trained in organized screening for colorectal cancer was significantly higher in the populations that performed the test (Table 3).

Factors associated with participation in screening: multivariate analysis

The results of multivariate analysis are summarized in Tables 4 and 5, where the data are presented as OR, CI and degree of significance ($p$ values). The multivariate model applying the GLIMMIX procedure used a two-by-two comparison of participation rates (first district vs second district, and so on up to the 16th district; second district vs the third district, and so on up to the 16th district; Table 6). As in the univariate analysis, there were significant differences in participation rates across the municipal districts in both screening rounds. The differences in the first round are summarized in Table 6.

The proportion of migrants had a significant impact on participation in the screening program in both rounds.

Table 3  Results of univariate analysis of both rounds of colorectal cancer screening.

<table>
<thead>
<tr>
<th></th>
<th>First round</th>
<th>Second round</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test performed</td>
<td>Test not performed</td>
</tr>
<tr>
<td>Medical density (%)</td>
<td>1.979</td>
<td>1.973</td>
</tr>
<tr>
<td>Trained physicians (%)</td>
<td>34.42</td>
<td>34.17</td>
</tr>
<tr>
<td>Unemployment rate (%)</td>
<td>22.43</td>
<td>23.69</td>
</tr>
<tr>
<td>Property prices per square meter (in thousands of euros)</td>
<td>2525</td>
<td>2471</td>
</tr>
<tr>
<td>Migrants (%)</td>
<td>6.28</td>
<td>7.02</td>
</tr>
</tbody>
</table>
were included in the model as quantitative variables. It should be noted that the proportion of migrants and property prices per square meter were higher proportions of migrants. It was also observed that the population participating in the screening program for colorectal cancer was significantly different in terms of age and gender: women participated more than men ($p < 0.001$); and more people in the 60—69 age range participated than those who were younger and those aged 70—74 years.

### Discussion

The present study identified several readily available sociogeographical factors that can be associated with participation in two rounds of a colorectal cancer screening program. Multilevel analysis demonstrated two factors related to the individual (age, gender) and two that were related to the district of residence (proportion of migrants in the population, property prices per square meter).

In both rounds of screening, gender and age distributions were different in participants compared with non-participants. Several studies have shown that women participate significantly more than men [23,24], particularly women who have had experience with mammography or Pap-smear screening programs [25,26]. In the literature, screening for colorectal cancer has focused on subjects aged 55—69 years, with lower participation rates observed in the younger (50—54 years) and older (70—74 years) age ranges [12]. However, the results of the present study are not in complete agreement with the literature, as the Marseille participation rate was highest in those aged 60—74 years.

Several studies, conducted with the use of questionnaires, have shown the influence of certain sociodemographic or psychological factors on the intention to participate (or not) in screening programs [7—11]. Indeed, age, gender, marital status, level of social education and family history of cancer are recognized factors associated with participation in screening [27]. In contrast, few studies have reported data obtained directly from organized screening programs [24,28].

As for the impact of ethnic background on cancer screening, the question has not been specifically examined for either cancer or screening in migrants residing in France. Most of the studies reported have been carried out in the United States, where the healthcare system is totally different from that in France. In addition, most of the studies involved screening for breast or cervical cancer, and few studies have involved colorectal cancer. The available reports show a difference in participation according to ethnic background, but the differences observed may be more readily explained by socioeconomic factors [29—32]. In the present study, the percentage of migrants was a measurable factor that was statistically linked to the participation rate in an organized screening program for colorectal cancer. It would, however, be unlikely that this factor has a causal effect. Instead, it is more likely an indirect marker of underlying associated socioeconomic factors. Concerning the impact of geographical factors on participation in screening, two Swedish studies [15,16] have shown that residential area appears to be a determining factor for participation or non-participation in breast cancer screening independent of individual factors, with a highly variable participation rate for different residential areas in the same city. However, there are no data available on the effect of residential area on participation in colorectal cancer screening.

### Table 4: Results of multivariate analysis of the first round of screening.

<table>
<thead>
<tr>
<th>Municipal district (arrondissement)</th>
<th>OR</th>
<th>CI−</th>
<th>CI+</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st vs 9th</td>
<td>0.83</td>
<td>0.71</td>
<td>0.98</td>
<td>0.02</td>
</tr>
<tr>
<td>2nd vs 9th</td>
<td>0.82</td>
<td>0.70</td>
<td>0.97</td>
<td>0.02</td>
</tr>
<tr>
<td>3rd vs 9th</td>
<td>0.82</td>
<td>0.72</td>
<td>0.95</td>
<td>0.007</td>
</tr>
<tr>
<td>4th vs 8th</td>
<td>0.83</td>
<td>0.73</td>
<td>0.95</td>
<td>0.008</td>
</tr>
<tr>
<td>5th vs 9th</td>
<td>0.77</td>
<td>0.72</td>
<td>0.82</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>6th vs 9th</td>
<td>0.89</td>
<td>0.84</td>
<td>0.94</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>7th vs 16th</td>
<td>1.18</td>
<td>1.03</td>
<td>1.35</td>
<td>0.017</td>
</tr>
<tr>
<td>8th vs 12th</td>
<td>1.29</td>
<td>1.16</td>
<td>1.43</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>9th vs 16th</td>
<td>1.40</td>
<td>1.28</td>
<td>1.52</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>10th vs 12th</td>
<td>1.20</td>
<td>1.12</td>
<td>1.27</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>11th vs 16th</td>
<td>1.29</td>
<td>1.20</td>
<td>1.39</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>12th vs 13th</td>
<td>0.81</td>
<td>0.75</td>
<td>0.88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>13th vs 16th</td>
<td>1.28</td>
<td>1.19</td>
<td>1.37</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>14th vs 16th</td>
<td>1.31</td>
<td>1.20</td>
<td>1.44</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>15th vs 16th</td>
<td>1.35</td>
<td>1.22</td>
<td>1.49</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

OR: odds ratio; CI: confidence interval.

### Table 5: Results of multivariate analysis of the second round of screening.

<table>
<thead>
<tr>
<th>Municipal district (arrondissement)</th>
<th>OR</th>
<th>CI−</th>
<th>CI+</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st vs 9th</td>
<td>0.74</td>
<td>0.71</td>
<td>0.76</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2nd vs 9th</td>
<td>0.78</td>
<td>0.76</td>
<td>0.81</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3rd vs 9th</td>
<td>0.98</td>
<td>0.95</td>
<td>1.01</td>
<td>0.17</td>
</tr>
<tr>
<td>4th vs 8th</td>
<td>1.14</td>
<td>1.1</td>
<td>1.18</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>5th vs 9th</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>6th vs 9th</td>
<td>0.81</td>
<td>0.8</td>
<td>0.83</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>7th vs 16th</td>
<td>0.96</td>
<td>0.95</td>
<td>0.97</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>8th vs 12th</td>
<td>1.000042</td>
<td>0.99</td>
<td>1.0002</td>
<td>0.56</td>
</tr>
</tbody>
</table>

OR: odds ratio; CI: confidence interval.
Thus, the main contribution of the present study is demonstration of a regional/geographical effect on participation (or not) in organized screening for colorectal cancer. However, such an effect is most likely a reflection of underlying socioeconomic factors. The participation rates were lowest in the first, second and third municipal districts of Marseille, which are in the heart of the city, and in the 14th, 15th and 16th municipal districts, which are in the northern parts of the city. These districts have the poorest residential populations and also have the highest proportions of foreign residents (Fig. 3).

It should be noted that, in the 1960’s, in response to the population growth resulting from the repatriation of expatriates returning from North Africa, the northern part of Marseille, where land prices were lower, became the site of large-scale social housing programs. Within a decade, tens of thousands of social housing units were constructed without adequate links to the city center. After rapid degradation, these areas now house a marginal population bordering on exclusion. The area’s inhabitants are much younger than the rest of the city’s population, have low occupational qualifications and are unemployable for the sort of jobs being offered by new companies; 80% of this population have no occupational skills, 76% do not pay income taxes and 11% of those aged inferior to 25 years are on welfare [18].

The present study was restricted to the corporation limits of the city of Marseille, but it could be usefully extended to include the remainder of the Bouches-du-Rhône district, taking into consideration the size of the urban communities and the more rural areas.

Conclusion

In addition to individual determinants, the geographical place of residence, characterized by socioeconomic variables, appears to be an important determinant of the rate of participation in an organized screening program for colorectal cancer. This suggests that targeted communication measures, designed specifically for residential areas where such participation is known to be low, need to be developed and evaluated. It would also be helpful to undertake an educational campaign targeting general practitioners, who are key agents in organized screening programs.

Conflict of interest

None.

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References


