RESEARCH ARTICLE

Does mammogram attendance influence participation in cervical and colorectal cancer screening? A prospective study among 1856 French women

Aurélie Bertaut1 *, Julien Coudert2, Leila Bengrine2, Vincent Dancourt3, Christine Binquet4,5, Serge Douvier6

1 Methodology and Biostatistics Unit, Centre Georges François Leclerc, Dijon, France, 2 Medical Oncology Unit, Centre Georges François Leclerc, Dijon, France, 3 ADECA 21-58, « Association pour le dépistage des cancers Côte-d’Or », Dijon, France, 4 INSERM U1231-EPICAD Team, Burgundy-Franche Comte University, Dijon, France, 5 INSERM CIC143, University Hospital, Dijon, France, 6 Department of Gynecologic and Oncologic Surgery, University Hospital, Dijon, France

* abertaut@cgfl.fr

Abstract

Background

We aimed to determine participation rates and factors associated with participation in colorectal (fecal occult blood test) and cervical cancer (Pap-smear) screening among a population of women participating in breast cancer screening.

Methods

From August to October 2015, a self-administered questionnaire was sent by post to 2 900 women aged 50–65, living in Côte-d’Or, France, and who were up to date with mammogram screening. Polytomic logistic regression was used to identify correlates of participation in both cervical and colorectal cancer screenings. Participation in all 3 screenings was chosen as the reference.

Results

Study participation rate was 66.3% (n = 1856). Besides being compliant with mammogram, respectively 78.3% and 56.6% of respondents were up to date for cervical and colorectal cancer screenings, while 46.2% were compliant with the 3 screenings. Consultation with a gynecologist in the past year was associated with higher chance of undergoing the 3 screenings or female cancer screenings (p < 10–4), when consultation with a GP was associated with higher chance of undergoing the 3 screenings or organized cancer screenings (p < 0.05). Unemployment, obesity, age >59 and yearly flu vaccine were associated with a lower involvement in cervical cancer screening. Women from high socio-economic classes were more likely to attend only female cancer screenings (p = 0.009). Finally, a low level of physical activity and tobacco use were associated with higher risk of no additional screening participation (p < 10–3 and p = 0.027).
Conclusions

Among women participating in breast screening, colorectal and cervical cancer screening rates could be improved. Including communication about these 2 cancer screenings in the mammogram invitation could be worth to explore.

Introduction

Cancer is the leading cause of death among women. In 2012, 48,753 new cases of breast cancer, 18,926 colorectal cancers and 3,028 cervical cancers were diagnosed among women in France. These three cancer sites account for 44.4% of cancer deaths each year, despite the existence of screening programs [1–3].

In France, women aged 50–65 years are eligible for breast and cervical cancer screening [female cancer screenings], and also for colorectal cancer screening. Both breast and colorectal cancer, as part of organized cancer screening programs, are covered by national health prevention policies. Costs of the exams are supported by social security system. The Breast cancer screening program target women in the 50–74-year age group, who receive an invitation to have a mammogram free of charge every 2 years. This program has been implemented nationwide since 2004 with a quality policy ensuring a free double reading of the images. Over the period 2015–2016, the participation rate in organized breast cancer screening was around 51%, to which should be added around 10% who participate on their own individual initiative outside the organized program (in particular women younger than 50 with family history of breast cancer) [4]. This mammogram participation rate which has been quite stable since 2008 hides disparities between areas mainly in relation with healthcare access [5–7]. In addition to geographical determinants, socio-demographical determinants of breast cancer screening participation are well known. Many studies have shown that being married [8], moderate or high use of health services, employment and socio economic level are all associated with higher screening participation rates [6] [9–10].

Cervical cancer screening shows similar participation rates, 61% between 2010 and 2014 in France, but it is not organized at a national level [11]. French guidelines recommend performing cervical cancer screening (by means of a Pap smear test) every three years after two normal Pap-smears at one-year intervals. Screening is opportunistic, i.e. during a consultation for other purposes, and proposed mostly by gynecologists and some general practitioners (GPs). Conversely, colorectal cancer screening is much less widely implemented, with only 30.8% of French women performing the fecal occult blood test (FOBT) in 2015–2016 [12]. Colorectal cancer screening was implemented in all of France in 2009 after an experimental phase in 22 French geographical administrative areas, and is now available for men and women aged 50 to 74 years.

Younger age, good health status, participation in mammogram screening and regular gynecological follow-up are known predictors of a higher cervical cancer screening participation [9] [13–16]. Regarding colorectal cancer screening, factors shown to be associated with increased participation include younger age, having complementary health insurance, non-smoking status, and participation in other screening programs [17–21]. Most studies that focused on the determinants of participation in colorectal or cervical cancer screening mixed two kinds of populations, namely women who already have a general prevention attitude and participate in breast cancer screening; and women who do not participate. Little is known about colorectal and cervical cancer screening behavior among women who already performed
mammogram. However, a better knowledge of these women supposed to feel concerned about their health, would allow reaching specific factors that can constitute some leverage to increase participation to either colorectal or cervical cancers screenings.

We aimed to determine participation rates and factors associated with participation in both organized colorectal and individual cervical cancer screenings among a population of women participating in organized breast cancer screening.

**Methods**

**Population**

This cross-sectional study was conducted between June and August 2015 in women aged between 50 and 65 years old, resident in Côte-d’Or and participating in breast screening. Côte-d’Or is a French Department located in Burgundy, with a population of 524,144 inhabitants, of whom 270,930 are women, and nearly 54,000 of those women are aged between 50 and 65. To be eligible for inclusion in the present study, the women had to meet the following criteria: 1) having been invited to participate in organized breast and colorectal cancer screenings between 1 January 2011 and 31 December 2014, and 2) having participated in breast screening.

**Sampling strategy and sample size calculation**

The eligible source population, comprising 21,136 women, was obtained from the local screening structure (ADECA) that sends mammograms invitation letters to every woman living in the administrative area. Overall, 2,900 women were randomly selected, from the ADECA database, to participate in the study. The sample size was determined assuming that 50% of women would be up-to-date for both colorectal and cervical cancer screening, with a precision of 2.5% and a response rate of 55%.

**Main outcomes**

**Cervical cancer screening.** Patients were considered up to date for cervical cancer screening if they had undergone a Pap-smear test within the previous 3 years. Cervical cancer screening in France was an individual initiative at the time of the study.

**Colorectal screening.** Patients were considered up to date for colorectal cancer screening if they had undergone a FOBT test within the previous 2 years. FOBT was used in France for colorectal screening at the time of the study. The ADECA send an invitation letter and the test is then given by the GP during a specific consultation. FOBTs are the analyzed in private practices and results are systematically transmitted to the ADECA.

**Study procedures**

The study was approved by the French Data Protection Authority (Commission Nationale de l’Informatique et des Libertés). A self-administered questionnaire was delivered by post to each participant. A reminder letter was sent one month after the first mailing. Besides clinical and demographical questions (age, height, weight, highest level of diploma, current occupation, complementary health insurance underwriting), women were asked about their family history regarding breast, colorectal and cervical cancer, and their medical follow-up (last consultation with a GP, gynecologist or gastroenterologist, last influenza vaccination). Data about their health behavior (consumption of fruit and vegetables, level of physical activity, consumption of alcohol and smoking status) were also recorded. Data on cervical cancer screening were self-reported, since no academic or governmental organization currently takes a census of the
number of women participating in cervical cancer testing. Self-reported data on colorectal cancer screening were cross validated using the ADECA database.

**Statistical analysis**

Categorical variables are presented as number (percentage) and continuous variables as mean ± standard deviation (SD). Categorical variables were compared using the Chi square test. When appropriate, continuous variable were dichotomized using the median as a cut-off. Polytomic logistic regression was used to identify variables independently associated with adequate cervical and colorectal cancer screening participation. Participation in all 3 screenings was chosen as the reference. Correlations between eligible variables were tested. The following covariates were considered: age, marital status, BMI, social and occupational group (4 classes), family history of breast, colorectal or cervical cancer, influenza vaccination, gynecologist consultation in the past 12 months, physical activity, level of education, health insurance coverage, smoking status, consumption of fruit and vegetables, and finally alcohol consumption. All covariates with a p value less than 0.20 in univariate analyses were entered into the multivariate model. A backward selection procedure was then applied to identify the factors associated with the outcome, with a significance level of 0.15 or less. Analyses were performed on complete data. Some variables were grouped due to the low number of subjects in certain response classes. All analyses were performed using SAS version 9.3 software (SAS Institute Inc., Cary, NC, USA). A p-value less than 0.05 was considered statistically significant.

**Results**

**Study sample**

Among the 2 900 selected women, 1 856 agreed to participate, giving a participation rate of 66.3%. The mean age of participants was 58.8 (SD = 3.8) years, range 50 to 65 years. Half the population (n = 917) had a family history of cancer, including breast (n = 604, 32.9%), colorectal (n = 327, 17.8%) and cervical (n = 211, 11.4%) cancer. The characteristics of the study population are shown in Table 1.

Our sample reported having a relatively healthy lifestyle, with half the population consuming fruit and vegetables several times per day, and 80% reporting engaging in physical activity at least once a week. More than 85% of women were non-smokers and reported that they consumed alcohol once a week or less (Table 2). Patients with a family history of colorectal cancer had better gastroenterological follow-up (16.9% declared having consulted a gastroenterologist in the previous year vs 9.3% for women without a history of colorectal cancer, p<10−4).

**Screening participation rates**

The information about screening participation was available for 1749 (94.2%), 1804 (97.2%) and 1720 (92.7%) women for cervical cancer alone, colorectal cancer alone, and both cervical and colorectal cancer, respectively. Participation rates are presented in Table 3.

Considering each cancer independently, more than of the responders (n = 1369, 78.3%) were up to date for cervical cancer screening and more than half (n = 1021, 56.6%) for colorectal cancer screening. Only 3.1% (n = 54) had never performed a Pap-smear test and 19.1% (n = 345) had never performed a FOBT test. Regarding the combination of all cancer screenings, 795 (46.2%) were up to date for the 3 cancer types, while 192 (11.2%) were up to date for breast cancer screening only, including 21 women who had never undergone either colorectal or cervical cancer tests. Five hundred and fifty two women (32.1%) were up to date for female
Table 1. Socio-demographic characteristics of the population.

|                          | n   | %     |
|--------------------------|-----|-------|
| **Age**                  |     |       |
| n                        | 1851|       |
| mean [STD]               | 58.8[3.8]|       |
| median [min-max]         | 59[50–65]|       |
| missing                  | 5   |       |
| **BMI**                  |     |       |
| n                        | 1833|       |
| mean [STD]               | 25.0[4.8]|       |
| median [min-max]         | 24.2[15.1–45.8]|       |
| missing                  | 21  |       |
| **Marital status**       |     |       |
| Alone                    | 461 | 25.0% |
| In couple                | 1382| 75.0% |
| missing                  | 13  |       |
| **Diploma**              |     |       |
| Junior high school degree| 279 | 15.8% |
| Vocational occupation    | 581 | 32.8% |
| High-School diploma      | 353 | 19.9% |
| High-School diploma + 2 years | 245 | 13.8% |
| ≥ University degree or higher | 312 | 17.6% |
| missing                  | 86  |       |
| **Social and occupational group** | | |
| Farmer                   | 23  | 1.3%  |
| Self-employed, traders   | 46  | 2.5%  |
| Senior manager           | 184 | 10.0% |
| Junior manager           | 131 | 7.1%  |
| Employee                 | 556 | 30.3% |
| Manual worker            | 42  | 2.3%  |
| Unemployed               | 203 | 11.1% |
| Retired                  | 650 | 35.4% |
| missing                  | 21  |       |
| **Supplementary health insurance** | | |
| No                       | 42  | 2.3%  |
| Yes                      | 1806| 97.7% |
| missing                  | 8   |       |
| **Family history of breast cancer** | | |
| No                       | 1176| 64.0% |
| Yes                      | 604 | 32.9% |
| Unknown                  | 58  | 3.2%  |
| missing                  | 18  |       |
| **Family history of cervical cancer** | | |
| No                       | 1494| 81.1% |
| Yes                      | 211 | 11.4% |
| Unknown                  | 138 | 7.5%  |
| missing                  | 13  |       |
| **Family history of colorectal cancer** | | |
| No                       | 1342| 72.9% |

(Continued)
cancer screenings only, (i.e. breast and cervical cancers) and 181 (10.5%) for organized cancer screenings only, (i.e. breast and colorectal cancers).

The highest rates of all screening participation were observed among women who had consulted a gynecologist in the past 12 months (55.7%), followed by women with normal BMI, retired women (50.9%) and women aged between 59 and 65 (50.3%).

On the contrary, women who underwent neither cervical nor colorectal cancer screening had not consulted a gynecologist in the past year (24.0%), were mostly unemployed (19.1%) and had a low level of physical activity (less than once a week, 17.4%).

The highest rates of female cancer screenings only were observed among senior managers, the self-employed or traders (46.2%), or women aged less than 59 (40.5%), and those who had not consulted a GP in the past year (40.4%).

Participation rates for organized cancer screening only tended to be systematically lower compared to others modalities (i.e. breast and cervical cancers screening, only breast cancer screening and the 3 screenings compliance).

Regular medical follow up was associated with better screening compliance. Among women who had consulted a GP in the past year or who received the flu vaccine each year, respectively 46.8% and 50% attended the 3 screenings, and only 11.0% and 10.4% underwent mammogram alone. Note that women with regular follow up by a GP were 78.1% to perform cervical cancer screening and 57.7% to perform colorectal screening. Women with regular gynecological follow up either attended all 3 screenings (55.7%) or breast and cervical cancer screening only, as stated above. Only 1.6% of them had mammogram alone and 2.9% were not up to date for cervical cancer screening. On the whole, 95.5% of women who visit a gynecologist in the past year were compliant with cervical cancer screening.

**Polytomic regression**

Given their low association with the outcome of interest, family history of cervical cancer (p = 0.262), gastroenterologist consultation in the past 12 months (p = 0.263) and alcohol consumption (p = 0.248) were not considered for multivariate analysis.

After adjustment for confounding factors and compared to women attending all 3 screenings, consultation with a gynecologist in the past year was associated with a higher chance of undergoing the 3 screenings or breast and cervical cancer screenings (lower risk of performing only breast screening (OR = 0.05, p<0.001) or breast and colorectal cancer screenings (OR = 0.09, p<0.001)). In the same time, women who had a GP consultation in the past year were more likely to perform the 3 screenings or breast and colorectal screenings (lower risk of performing only breast cancer screening (OR = 0.52, p = 0.044) or breast and cervical cancer screenings (OR = 0.65, p = 0.034). Women who were unemployed and those who suffer from obesity were more likely to attend no additional screening besides breast cancer screening (OR = 2.75, p = 0.004 and OR = 2.84, p<10–3, respectively) or to be compliant with breast plus colorectal cancer screenings (OR = 1.80, p = 0.061, and OR = 2.22, p = 0.004, respectively). This reflects a lower involvement in cervical cancer screening. For their part, women older

| n   | %   |
|-----|-----|
| Yes | 327 |
| Unknown | 171 |
| missing | 16  |

https://doi.org/10.1371/journal.pone.0198939.t001
Table 2. Health behaviors characteristics of the population.

|                                   | n   | %     |
|-----------------------------------|-----|-------|
| **Alcohol consumption**           |     |       |
| Every days                        | 68  | 3.7%  |
| Several times a week              | 240 | 13.2% |
| Once a week                       | 458 | 25.1% |
| Less often                        | 671 | 36.8% |
| Never                             | 387 | 21.2% |
| missing                           | 32  |       |
| **Tobacco smoking**               |     |       |
| No                                | 1565| 85.1% |
| Yes                               | 275 | 14.9% |
| missing                           | 16  |       |
| **Fruit consumption**             |     |       |
| Several times per day             | 914 | 49.8% |
| Once a day                        | 628 | 34.2% |
| At least once a week              | 270 | 14.7% |
| Never                             | 22  | 1.2%  |
| missing                           | 22  |       |
| **Vegetable consumption**         |     |       |
| Several times per day             | 909 | 49.4% |
| Once a day                        | 747 | 40.6% |
| At least once a week              | 180 | 9.8%  |
| Never                             | 4   | 0.2%  |
| missing                           | 16  |       |
| **Physical activity practice**    |     |       |
| Every days                        | 350 | 19.1% |
| Several times a week              | 727 | 39.7% |
| Once a week                       | 382 | 20.9% |
| Less often                        | 239 | 13.1% |
| Never                             | 132 | 7.2%  |
| missing                           | 26  |       |
| **Influenza vaccine**             |     |       |
| Each year                         | 315 | 17.2% |
| Every second year                 | 40  | 2.2%  |
| Less often                        | 137 | 7.5%  |
| Never                             | 1343| 73.2% |
| missing                           | 21  |       |
| **GP consultation in the past 12 months** | | |
| No                                | 163 | 8.9%  |
| Yes                               | 1675| 91.1% |
| missing                           | 18  |       |
| **Gynecologist consultation in the past 12 months** | | |
| No                                | 792 | 43.2% |
| Yes                               | 1042| 56.8% |
| missing                           | 22  |       |
| **Gastroenterologist consultation in the past 12 months** | | |
| No                                | 1638| 88.8% |
| Yes                               | 206 | 11.2% |
| missing                           | 12  |       |

https://doi.org/10.1371/journal.pone.0198939.t002
|                                | only breast cancer screening compliance | breast and cervical cancers screening compliance | breast and colorectal cancers screening compliance | 3 screenings compliance | Total |
|--------------------------------|----------------------------------------|------------------------------------------------|------------------------------------------------|-------------------------|-------|
|                                | n  | %  | n  | %  | n  | %  | n  | %  | p  | n  | %  |
| Overall population             | 192| 11.2| 552| 32.1| 181| 10.5| 795| 46.2| 1720| 100 |     |
| Age                            |    |     |    |     |    |     |    |     | <0.001 |    |     |
| [50–59]                        | 78 | 9.3 | 340| 40.5| 69 | 8.2 | 352| 42  | 839| 100 |     |
| [59–65]                        | 113| 12.9| 212| 24.1| 112| 12.7| 443| 50.3| 880| 100 |     |
| BMI                            | <0.001 |     |    |     |    |     |    |     |     |     |     |
| < 25                           | 78 | 7.9 | 321| 32.8| 82 | 8.4 | 499| 50.9| 980| 100 |     |
| [25–30]                        | 58 | 12.2| 164| 34.6| 50 | 10.6| 202| 42.6| 474| 100 |     |
| ≥ 30                           | 53 | 21.3| 61 | 24.5| 47 | 18.9| 88 | 35.3| 249| 100 |     |
| Marital status                 | 0.043 |     |    |     |    |     |    |     |     |     |     |
| Alone                          | 57 | 13.3| 139| 32.6| 54 | 12.6| 177| 41.5| 427| 100 |     |
| In couple                      | 132| 10.3| 411| 32  | 126| 9.8 | 616| 47.9| 1285| 100 |     |
| Social and occupational group  | <0.001 |     |    |     |    |     |    |     |     |     |     |
| Employee, manual worker, farmer, junior manager | 62 | 8.8 | 251| 35.4| 72 | 10.2| 323| 45.6| 708| 100 |     |
| Senior manager, self-employed, traders | 13 | 6.1 | 99 | 46.2| 13 | 6.1 | 89 | 41.6| 214| 100 |     |
| Unemployed                     | 36 | 19.1| 55 | 29.1| 25 | 13.2| 73 | 38.6| 189| 100 |     |
| Retired                        | 76 | 12.8| 144| 24.3| 71 | 12  | 302| 50.9| 593| 100 |     |
| Diploma                        | <0.001 |     |    |     |    |     |    |     |     |     |     |
| Junior high school             | 33 | 12.8| 59 | 22.9| 46 | 17.8| 120| 46.5| 258| 100 |     |
| Vocational qualification       | 69 | 12.9| 171| 31.9| 52 | 9.7 | 244| 45.5| 536| 100 |     |
| High-School diploma            | 33 | 10.1| 108| 32.9| 30 | 9.1 | 157| 47.9| 328| 100 |     |
| High-School diploma + 2 years  | 18 | 7.7 | 91 | 39.1| 17 | 7.3 | 107| 45.9| 233| 100 |     |
| University degree or higher    | 21 | 7.1 | 106| 35.7| 29 | 9.8 | 141| 47.4| 297| 100 |     |
| Family history of breast cancer| 0.079 |     |    |     |    |     |    |     |     |     |     |
| No                             | 122| 11.1| 341| 31  | 113| 10.3| 524| 47.6| 1100| 100 |     |
| Yes                            | 61 | 11  | 193| 34.8| 55 | 9.9 | 246| 44.3| 555| 100 |     |
| Unknown                        | 9  | 16.7| 16 | 29.6| 11 | 20.4| 18 | 33.3| 54 | 100 |     |
| Family history of cervical cancer| 0.262 |     |    |     |    |     |    |     |     |     |     |
| No                             | 148| 10.6| 455| 32.7| 145| 10.4| 645| 46.3| 1393| 100 |     |
| Yes                            | 22 | 11.3| 62 | 31.8| 19 | 9.7 | 92 | 47.2| 195| 100 |     |
| Unknown                        | 22 | 17.6| 32 | 25.6| 16 | 12.8| 55 | 44  | 125| 100 |     |
| Family history of colorectal cancer| 0.022 |     |    |     |    |     |    |     |     |     |     |
| No                             | 140| 11.1| 389| 30.8| 135| 10.7| 598| 47.4| 1262| 100 |     |
| Yes                            | 28 | 9.6 | 117| 40   | 23 | 7.9 | 124| 42.5| 292| 100 |     |
| Unknown                        | 23 | 14.7| 42 | 26.9| 21 | 13.5| 70 | 44.9| 156|     |     |
| Influenza vaccine              | 0.003 |     |    |     |    |     |    |     |     |     |     |
| Never                          | 142| 11.4| 430| 34.5| 117| 9.4 | 557| 44.7| 1246| 100 |     |
| Each year or less often        | 48 | 10.4| 121| 26.3| 61 | 13.3| 230| 50  | 460| 100 |     |
| GP consultation in the past 12 months| 0.063 |     |    |     |    |     |    |     |     |     |     |
| No                             | 20 | 13.2| 61 | 40.4| 12 | 8   | 58 | 38.4| 151| 100 |     |
| Yes                            | 171| 11  | 488| 31.3| 169| 10.9| 728| 46.8| 1556| 100|     |
| Gynecologist consultation in the past 12 months| <0.001 |     |    |     |    |     |    |     |     |     |     |
| No                             | 175| 24  | 159| 21.8| 152| 20.9| 242| 33.3| 728| 100 |     |
| Yes                            | 16 | 1.6 | 388| 39.8| 28 | 2.9 | 544| 55.7| 976| 100 |     |

(Continued)
than 59 and those who got a yearly flu vaccine were less likely to participate in gynecological cancer screenings only (OR = 0.57, p < 0.001 and OR = 0.68, p = 0.008, respectively).

On the contrary, senior managers, self-employed, traders and women with a family history of colorectal cancer were more likely to attend only female cancer screenings, compared to all 3 screenings (OR = 1.65, p = 0.009 and OR = 1.48, p = 0.013, respectively). This reflects a lower involvement in organized colorectal cancer screening.

A low level of physical activity (less than once a week) tend to be associated with worse screening habits, i.e. only female cancer screenings participation (OR = 1.33, p = 0.076), only organized screenings participation (OR = 1.47, p = 0.105) or only breast cancer screening participation (OR = 1.88, p < 0.001), even if statistical significance is reach only for the last modality. The same trend is observed among women living alone without achieving statistical significance. Finally, tobacco use was associated with higher risk of no additional screening participation besides breast screening (OR = 1.77, p = 0.027). Results are compiled in Table 4.

Noticed that no impact of the level of education (p = 0.214), or supplementary health insurance (p = 0.621) or a family history of breast cancer (p = 0.409) on screening habits was observed.
Discussion

We observed high participation rates in cervical cancer screening (78.3%) and colon cancer screening (56.6%) in this population of women compliant with breast cancer screening. Indeed, in 2011–2012, the participation rates in France for all ages are estimated to be 34% for colorectal cancer and 57% for cervical cancer [13–14] [22–23]. For cervical cancer screening, rates are even lower in the age group included in the present study, reaching about 47% among women aged 60–65 [24]. These higher levels of participation among our population may reflect a better health attitude of women still participating in breast cancer screening compared to the general population. This better health attitude is suggested by a lower rate of tobacco and alcohol use, a higher level of physical activity and a healthier diet compared to the general population [25]. Besides, it has previously been shown that participating in any cancer screening increases the participation rate in other cancer screening types [6] [9] [18]. In terms of public health policy this must be highlighted as promoting one screening may increase participation in the others.

Despite satisfying levels of participation, our population seem more aware of female cancer screenings, suggesting that women feel less concerned by colorectal cancer [21] or that they have a better gynecological follow-up. The types of screening tests are also quite different, which can explain the different participation levels. Mammogram is non-invasive and based

Table 4. Multivariate polytomic regression.

|                          | only breast screening compliance | breast and cervical cancers screening compliance | breast and CR cancers screening compliance |
|--------------------------|---------------------------------|-----------------------------------------------|------------------------------------------|
|                         | OR 95%CI p                      | OR 95%CI p                                    | OR 95%CI p                               |
| Age                     |                                 |                                               |                                          |
| [59–65] vs [50–59]      | 1.10 0.61 1.62 0.995 0.57 0.42 0.78 <10–3 | 1.13 0.71 1.82 0.601                          |
| BMI                     |                                 |                                               |                                          |
| [25–30] vs < 25         | 1.54 0.98 2.40 0.67 1.28 0.97 1.681 0.263 | 1.20 0.77 1.87 0.316                          |
| ≥ 30 vs < 25            | 2.84 1.67 4.77 <10–3             | 1.17 0.79 1.729 0.872                         | 2.22 1.34 3.70 0.004                      |
| Marital status          |                                 |                                               |                                          |
| Alone vs in couple       | 1.49 0.97 2.29 0.07 1.25 0.95 1.651 0.114 | 1.49 0.98 2.26 0.062                          |
| Social and occupational group |                                 |                                               |                                          |
| Senior manager, self-employed, shop-keeper vs ref | 1.06 0.52 2.18 0.216 1.65 1.16 2.344 0.009 | 0.92 0.46 1.84 0.336                          |
| Unemployed vs ref       | 2.75 1.52 5.00 0.004             | 1.11 0.72 1.705 0.758                         | 1.80 0.98 3.31 0.061                      |
| Retired vs ref          | 1.60 0.94 2.73 0.657 1.00 0.71 1.422 0.257 | 1.17 0.700 1.95 0.955                           |
| Family history of colorectal cancer |                   |                                               |                                          |
| Yes vs no               | 1.12 0.66 1.89 0.717 1.48 1.10 2.007 0.013 | 0.92 0.54 1.59 0.380                          |
| Unknown vs no           | 1.54 0.81 2.93 0.261 0.91 0.59 1.414 0.203 | 1.44 0.77 2.66 0.218                          |
| Influenza vaccine       |                                 |                                               |                                          |
| Each year or less often vs never | 0.75 0.48 1.17 0.204 0.69 0.53 0.910 0.008 | 1.19 0.79 1.78 0.400                          |
| GP consultation in the past 12 months |                  |                                               |                                          |
| Yes vs no               | 0.52 0.28 0.98 0.044             | 0.65 0.44 0.967 0.034                         | 1.02 0.50 2.09 0.962                      |
| Gynecologist consultation in the past 12 months |                      |                                               |                                          |
| Yes vs no               | 0.05 0.03 0.09 <10–4            | 1.16 0.89 1.497 0.275                         | 0.09 0.05 0.14 <10–4                      |
| Physical activity practice |                           |                                               |                                          |
| Less often or never vs once a week or more | 1.88 1.20 2.95 <10–3 | 1.33 0.97 1.818 0.076                         | 1.47 0.92 2.33 0.105                      |
| Tobacco smoking         |                                 |                                               |                                          |
| Yes vs no               | 1.77 1.07 2.95 0.027           | 1.33 0.94 1.87 0.103                         | 1.37 0.82 2.30 0.234                      |

OR: odds ratio, CR: colorectal, ref = employee, manual worker, farmer, junior manag

https://doi.org/10.1371/journal.pone.0198939.t004
on radiologic exam performed by a health care provider. On the contrary, the FOBT is proposed by the GP, but remains a self-administered test. Moreover, many people may feel reluctant to perform the test, which involves fecal manipulation [21] [26]. The new faecal immunobiological test (iFOBT), requiring only one stool sample versus six for the previous test, might be more convenient to use, yielding better screening participation [27–28]. In addition, randomized trails reported that sigmoidoscopy screening reduced colorectal cancer incidence suggesting that FOBT may become of marginal interest in the future [29–31]. Anyway, qualitative studies may be useful to provide explanations and insights into the women’s individual perceptions, thus exploring our results in greater depth. Indeed, this study presents the quantitative results of a larger project that includes both quantitative and qualitative approaches. The next step will be to analyze the psycho-social aspects of screening participation in a specific study consisting in semi-structured qualitative interviews. This will enable us to understand why women who have a preventive approach for one type of cancer failed to participate in specific screenings for other types of cancer (is it a financial concern? The nature of the exam? The representation of the disease? Why breast cancer, and not the other screening exams? Why 2 screenings and not all 3).

Regular follow up by a gynecologist was associated with higher chance of being compliant with all screenings or only female screening. As the same regular follow up by a GP was associated with higher chance of being compliant with all screenings or only organized screenings. This confirms the key-role of these health professionals in cancer prevention [18] [32–33]. In the light of these results, we postulate that encouraging gynecologists to promote colorectal cancers screening, and GPs to encourage cervical cancer prevention, may improve screening coverage even further.

Not surprisingly older women were less likely to participate in cervical cancer screening as stated in many studies [34–36]. Unemployed women compliant with mammogram were more likely to performed no additional screening or only colorectal screening. This impact of socio-economic conditions on cervical screening participation is well known [36–40]. Adherence to organized colorectal cancer screening may be explained as it is free of charge in France. This is a strong argument in favor of the implementation of organized cervical cancer screening as planned in 2018 by the French government [41–42]. The same trend of undergoing no additional screening or only colorectal screening is observed among obese women with less clear explanation as the determinants of obesity are complex. However, in France a significant association between overweight and socio economic level exists [43–44]. Senior managers, self-employed, traders and women with a family history of colorectal cancer were more likely to attend female cancer screenings, compared to all 3 screenings. They are then less involved in colorectal cancer screening. A family history of colorectal cancer is often associated with a better gastroenterological follow-up, explaining lower participation in organized colorectal cancer screening, since these women likely undergo regular colonoscopy outside the context of organized colorectal cancer screening [45]. The same explanation may apply to high socio occupational classes which are more prone to benefit from individual screening as suggested by their high level of Pap smear compliance [40]. A low level of physical activity and tobacco use which may reflect unhealthy habits were associated with higher risk of being compliant with no additional screening, as previously highlighted [36] [46].

Our study found no association between educational level and screening compliance when several other studies did [36–39] [47]. This may be related to the characteristics of our population including women still compliant with breast screening. Noticed that our population had quite similar level of education to French women with 19.9% of high-school degree in our sample versus 17.0% in France and 31.4% of women with university degree versus 28% [48].
This study presents some limitations that deserve to be underlined. One limitation is the use of self-reported data, which could be affected by biases related to the accuracy of data about screening history. This concerns only cervical cancer screening, since data from the ADECA database of confirmed test results were used to identify colorectal participation and should therefore not impact the results. Furthermore, many studies have concluded that self-reporting is fairly accurate, showing good agreement with administrative health data [49–50]. Self-reported data are also subject to “social desirability” response bias. However this might be limited as our questionnaire was anonymous.

To conclude, colorectal and cervical cancer screening participation rates among women already undergoing breast cancer screening are satisfactory, but leave margin for improvement, especially for colorectal cancer. There still is a need to increase public awareness about the benefit of cancer screening. Encouraging gynecologists to promote colorectal cancer screening and GP to promote cervical cancer screening should be considered with a view to increasing participation rates in cancer screening. In the current context of low medical density in France, including midwives in the prevention offer is also an area that worth exploring to broaden the target audience.

Acknowledgments
We thank Dr Bruno Coudert for reviewing the manuscript, Fiona Caulfield for correcting the English, Johan Adnet and Adèle Cueff for sending the questionnaires.

Author Contributions

Conceptualization: Aurélie Bertaut, Vincent Dancourt.
Data curation: Aurélie Bertaut.
Formal analysis: Aurélie Bertaut.
Investigation: Aurélie Bertaut, Julien Coudert.
Methodology: Aurélie Bertaut.
Project administration: Aurélie Bertaut.
Resources: Aurélie Bertaut, Vincent Dancourt.
Software: Aurélie Bertaut.
Supervision: Aurélie Bertaut, Serge Douvier.
Validation: Aurélie Bertaut.
Visualization: Aurélie Bertaut.
Writing – original draft: Aurélie Bertaut, Julien Coudert.
Writing – review & editing: Aurélie Bertaut, Leila Bengrine, Christine Binquet, Serge Douvier.

References
1. Binder-Foucard F, Rasamimanana Cerf N, Belot A, Bossard N. Estimation nationale de l’incidence et de la mortalité par cancer en France entre 1980 et 2012. Étude à partir des registres des cancers du réseau Francim. Partie 1 – Tumeurs solides. Synthèse. Saint-Maurice [Fra]: Institut de veille sanitaire; 2013. 6 p. http://www.invs.sante.fr. Accessed 10 Oct 2017.
2. Hill C. [Cancer prevention and screening]. Bull Cancer [Paris]. Jun 2013; 100[6]:547–54.
3. Dynamique d’évolution des taux de mortalité des principaux cancers en France—Institut National Du Cancer. http://www.e-cancer.fr/Expertises-et-publications/Catalogue-des-publications/Dynamique-d-evolution-des-taux-de-mortalite-des-principaux-cancers-en-France. Accessed 15 Oct 2017.

4. InVS. Taux de participation au programme de dépistage organisé du cancer du sein 2015–2016. Disponible sur: http://invs.santepubliquefrance.fr. Accessed 10 Oct 2017.

5. Dialla PO, Arveux P, Ouedraogo S, Pernet C, Bertaut A, Roignot P, et al. Age-related socio-economic and geographic disparities in breast cancer stage at diagnosis: a population-based study. Eur J Public Health. Dec 2015; 25[6]:966–72.

6. Duport N, Ancelle-Park R, Bousac-Zarebska M, Uhry Z, Bloch J. Are breast cancer screening practices associated with sociodemographic status and healthcare access? Analysis of a French cross-sectional study. Eur J Cancer Prev Off J Eur Cancer Prev Organ ECP. Jun 2008; 17[3]:218–24.

7. Padoan M, Ferrante D, Pretti G, Magnani C. Study of socio-economic characteristics, diagnosis and outcome of women participating or not participating in mammogram screening. Ann Ig. Dec 2014; 26[6]:518–26. PMID: 25524076

8. Hanske J, Meyer CP, Sammon JD, Choueiri TK, Menon M, Lipsitz SR, et al. The influence of marital status on the use of breast, cervical, and colorectal cancer screening. Prev Med. Aug 2016; 89:140–5.

9. Duport N, Serra D, Gouard H, Bloch J. [Which factors influence screening practices for female cancer in France?]. Rev Epidemiol Sante Publique. Oct 2008; 56[5]:303–13. https://doi.org/10.1016/j.respe.2008.07.086 PMID: 18951740

10. Edgar L, Glackin M, Hughes C, Rogers KMA. Factors influencing participation in breast cancer screening. Br J Nurs Mark Allen Publ. 12 Sep 2013; 22[17]:1021–6.

11. Participation au dépistage du col de l’utérus. http://lesdonneess.e-cancer.fr/index.php/Themes/Depistage/Le-depistage-du-cancer-du-col-de-l-uterus#ind6916. Accessed 10 Oct 2017.

12. Taux de participation au programme de dépistage organisé du cancer colorectal 2015–2016. http://invs.santepubliquefrance.fr/Dossiers-thematiques/Maladies-chroniques-et-traumatismes/Cancers/Evaluation-des-programmes-de-depistage-des-cancers/Evaluation-du-programme-de-depistage-du-cancer-colorectal/Indicateurs-d-evaluation/Taux-de-participation-au-programme-de-depistage-organise-du-cancer-colorectal-2015-2016. Accessed 15 Oct 2017.

13. Bernard E, Saint-Lary O, Haboubi L, Le Breton J. [Cervical cancer screening: women’s knowledge and participation]. Sante Publique Vandoeuvre—Nancy Fr. Jun 2013; 25[3]:255–62.

14. Jezewski-Serra D, Salines E. Évaluation épidémiologique du programme de dépistage organisé du cancer colorectal en France, 2013. http://invs.santepubliquefrance.fr/Publications-et-outils/Rapports-et-syntheses/Maladies-chroniques-et-traumatismes/2013/Evaluation-epidemiologique-du-programme-de-depistage-organise-du-cancer-colorectal-en-France. Accessed 9 Oct 2017.

15. Olesen SC, Butterworth P, Jacomb P, Tait RJ. Personal factors influence use of cervical cancer screening services: epidemiological survey and linked administrative data address the limitations of previous research. BMC Health Serv Res. 14 Feb 2012; 12:34. https://doi.org/10.1186/1472-6963-12-34 PMID: 22333932

16. Schoofs J, Krijger K, Van de Voorde J, Rossem IV, Devroey D. Health-related factors associated with the participation in cervical cancer screening. J Res Health Sci. 2015; 15[1]:11–6. PMID: 25821019

17. El-Haddad B, Dong F, Kallail KJ, Hines RB, Abrah E. Association of marital status and colorectal cancer screening participation in the USA. Colorectal Dis. May 2015; 17[5]:O108–114.

18. Fon Sing M, Leuraud K, Duport N. Characteristics of French people using organised colorectal cancer screening. Analysis of the 2010 French Health, Healthcare and Insurance Survey. Prev Med. Jul 2013; 57[1]:65–8. https://doi.org/10.1016/j.ypmed.2013.03.008 PMID: 23541516

19. Poncet F, Delafosse P, Seigneuri A, Exbrayat C, Colonna M. Determinants of participation in organized colorectal cancer screening in Isère [France], Clin Res Hepatol Gastroenterol. Apr 2013; 37[2]:193–9. https://doi.org/10.1016/j.clinre.2012.04.011 PMID: 22704817

20. Pernet C, Dejean D, Miralles F, Bouvier V, Launoy G. Socioeconomic determinants for compliance to colorectal cancer screening. A multilevel analysis. J Epidemiol Community Health. Apr 2010; 64[4]:318–24. https://doi.org/10.1136/jech.2008.081117 PMID: 19740776

21. Lo SH, Waller J, Wardle J, von Wagner C. Comparing barriers to colorectal cancer screening with barriers to breast and cervical screening: a population-based survey of screening-age women in Great Britain. J Med Screen. June 2013; 20[2]:73–9.

22. Duport N. INVS. Données épidémiologiques sur le cancer du col de l’utérus–Etat des connaissances–Actualisation 2008. http://invs.santepubliquefrance.fr/publications/2008/cancer_col_uterus_2008/index.html. Accessed 9 Oct 2017.
Tinmouth J, Lansdorp-Vogelaar I, Allison JE. Faecal immunochemical tests versus guaiac faecal occult blood tests: what clinicians and colorectal cancer screening programme organisers need to know. Gut. Aug 2015; 64(8):1327–37.

Holme Ø, Leberg M, Kalager M, Brethauer M, Hernán MA, Aas E, Eide TJ, Skovlund E, Schneede J, Tveit KM, Hoff G. Effect of flexible sigmoidoscopy screening on colorectal cancer incidence and mortality: a randomized clinical trial. JAMA. 2014; 312(6):606–15. https://doi.org/10.1001/jama.2014.8266 PMID: 25117129

Regge D, Iussich G, Senore C, Correale L, Hassan C, Bert A, Montenerozzi S, Segnan N. Population screening for colorectal cancer by flexible sigmoidoscopy or CT colonography: study protocol for a multicenter randomized trial. Trials. 2014 Mar 28; 15:97. https://doi.org/10.1186/1745-6215-15-97 PMID: 24678896

Brenner H, Stock C, Hoffmeister M. Effect of screening sigmoidoscopy and screening colonoscopy on colorectal cancer incidence and mortality: systematic review and meta-analysis of randomised controlled trials and observational studies. BMJ. 2014 Apr 9; 348:g2467. https://doi.org/10.1136/bmj.g2467 PMID: 24922745

Munro A, Pavicic H, Leung Y, Westoby V, Steel N, Semmens J, et al. The role of general practitioners in the continued success of the National Cervical Screening Program. Aust Fam Physician. May 2014; 43(5):293–6. PMID: 24791771

Pornet C, Denis B, Perrin P, Gendre I, Launoy G. Predictors of adherence to repeat fecal occult blood test in a population-based colorectal cancer screening program. Br J Cancer. 25 Nov 2014; 111(11):2152–5. https://doi.org/10.1038/bjc.2014.507 PMID: 25314056

Nelson W, Moser RP, Gaffey A, Waldron W. Adherence to cervical cancer screening guidelines for U.S. women aged 25–64: data from the 2005 Health Information National Trends Survey [HINTS]. J Womens Health 2002. Nov 2009; 18[11]:1759–68.

Park MJ, Park E-C, Choi KS, Jun JK, Lee H-Y. Sociodemographic gradients in breast and cervical cancer screening in Korea: the Korean National Cancer Screening Survey [KNCSS] 2005–2009. BMC Cancer. 17 Jun 2011; 11:257. https://doi.org/10.1186/1471-2407-11-257 PMID: 21682886

Martín-López R, Hernández-Barrera V, de Andres AL, Carrasco-Garrido P, de Miguel AG, Jimenez-Garcia R. Trend in cervical cancer screening in Spain [2003–2009] and predictors of adherence. Eur J Cancer Prev Off J Eur Cancer Prev Org ECP. May 2010; 19[3]:239–45.

Grillo F, Vallée J, Chauvin P. Inequalities in cervical screening for women with or without a regular consulting in primary care for gynaecological health, in Paris, France. Prev Med. Apr 2012; 54[3–4]:259–65. https://doi.org/10.1016/j.ypmed.2012.01.013 PMID: 22296836

Chen H-Y, Kessler CL, Mori N, Chauhan SP. Cervical cancer screening in the United States, 1993–2010: characteristics of women who are never screened. J Womens Health 2002. Nov 2012; 21[11]:1132–8.

Martín-López R, Hernández-Barrera V, De Andres AL, Garrido PC, De Miguel AG, García RJ. Breast and cervical cancer screening in Spain and predictors of adherence. Eur J Cancer Prev Off J Eur Cancer Prev Org ECP. May 2010; 19[3]:239–45.

Damiani G, Federico B, Basso D, Ronconi A, Bianchi CBNA, Anzellotti GM, et al. Socioeconomic disparities in the uptake of breast and cervical cancer screening in Italy: a cross sectional study. BMC Public Health. 3 Feb 2012; 12:99. https://doi.org/10.1186/1471-2458-12-99 PMID: 22305108
41. Duport N, Salines E, Grémy I. Premiers résultats de l’évaluation du programme expérimental de dépistage organisé du cancer du col de l’utérus, France, 2010–2012. Bull Epidémol Hebd 2014;[13-14-15]:228–34.
42. Duport N & Viguier J. Éditorial. Des études essentielles pour la généralisation du dépistage organisé du cancer du col de l’utérus. Bull Epidémol Hebd. 2014;[13-14-15]:218–9.
43. L’obésité en France: les écarts entre catégories sociales s’accroissent—INSEE. https://www.insee.fr/fr/statistiques/1280848. Accessed 15 Oct 2017.
44. L’état de santé de la population en France—RAPPORT 2017—L’état de santé de la population—Ministère des Solidarités et de la Santé. http://drees.solidarites-sante.gouv.fr/etudes-et-statistiques/publications/recueils-ouvrages-et-rapports/recueils-annuels/l-etat-de-sante-de-la-population/article/l-etat-de-sante-de-la-population-en-france-rapport-2017. Accessed 10 Oct 2017.
45. Haute Autorité de Santé—Cancer colorectal : modalités de dépistage et de prévention chez les sujets à risque élevé et très élevé. https://www.has-sante.fr/portail/jcms/c_2772744/fr/cancer-colorectal-modalites-de-depistage-et-de-prevention-chez-les-sujets-a-risque-eleve-et-tres-eleve. Accessed 10 Oct 2017.
46. Guiriguet C, Pera G, Castells A, Toran P, Grau J, Rivero I, et al. Impact of comorbid condition on participation in an organised colorectal cancer screening programme: a cross-sectional study. BMC Cancer. 7 Aug 2017; 17[1]:524. https://doi.org/10.1186/s12885-017-3516-x PMID: 28784093
47. Menvielle G, Luce D, Geoffroy-Perez B, Chastang J-F, Leclerc A. Social inequalities and cancer mortality in France, 1975–1990. Cancer Causes Control CCC. Jun 2005; 16[5]:501–13. https://doi.org/10.1007/s10552-004-7114-2 PMID: 15986105
48. Diplômes—Formation en 2014, Diplôme le plus élevé de la population non scolarisée de 15 ans ou plus selon le sexe en 2014—insee. https://www.insee.fr/fr/statistiques/2011101?geo=FRANCE-1#chiffre-cle-6. Accessed 15 Ap 2018.
49. Gentry-Maharaj A, Fourkala E-O, Burnell M, Ryan A, Apostolidou S, Habib M, et al. Concordance of National Cancer Registration with self-reported breast, bowel and lung cancer in England and Wales: a prospective cohort study within the UK Collaborative Trial of Ovarian Cancer Screening. Br J Cancer. 26 Nov 2013; 109[11]:2875–9. https://doi.org/10.1038/bjc.2013.626 PMID: 24129231
50. Zeig-Owens R, Kablianian A, Webber MP, Liu Y, Mayerson E, Schwartz T, et al. Agreement Between Self-Reported and Confirmed Cancer Diagnoses in New York City Firefighters and EMS Workers, 2001–2011. Public Health Rep Wash DC 1974. Feb 2016; 131[1]:153–9.