BMJ Open

Social and territorial inequalities in gynaecological cancers screening uptake: a cross-sectional study in France

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-055363
Article Type:	Original research
Date Submitted by the Author:	13-Jul-2021
Complete List of Authors:	Ouanhnon, Lisa; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP Rougé Bugat, Marie-Eve ; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP LAMY, Sebastien; Institute Claudius Regaud; INSERM UMR_S 1027 Druel, Vladimir; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP Delpierre, Cyrille; INSERM UMR_S 1027; Université Toulouse III Paul Sabatier, Grosclaude, Pascale; INSERM UMR_S 1027; Institute Claudius Regaud
Keywords:	Gynaecological oncology < GYNAECOLOGY, GENERAL MEDICINE (see Internal Medicine), Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, SOCIAL MEDICINE, PREVENTIVE MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Title: Social and territorial inequalities in gynaecological cancers screening uptake: a cross-sectional study in France

Authors: Lisa Ouanhnon[1,2], Marie-Eve Rouge Bugat[1,2], Sébastien Lamy[2,4] Vladimir Druel[1,2], Cyrille Delpierre[2,3,*], Pascale Grosclaude [2,3,4,*]

Authors affiliations:

[1] DUMG (Département Universitaire de Médecine Générale), Université Toulouse 3 Paul Sabatier, France

[2] CERPOP, Université de Toulouse, Inserm, UPS, Toulouse, France

[3] Equipe Labellisée Ligue Contre le Cancer

[4] Institut Claudius Regaud, IUCT-O, Registre des cancers du Tarn, Toulouse, France

* these two authors have equally supervised the work

The research team is supported by the French association “La Ligue contre le cancer”.

Corresponding author: Lisa Ouanhnon, 87 rue du Faubourg Bonnefoy 31500 Toulouse, France, lisa.ouanhnon@gmail.com, +33661594978

Word counts of the main text: 3037 and abstract: 278 words

Number of tables, figures and appendixes: 3 tables, 2 figures and 6 appendixes (2 tables A, 4 tables B)

Abstract

Objective The objective of this cross-sectional study was to investigate the impact of socio-territorial characteristics on mammography and pap smear uptake in the recommended age groups, and secondly outside the recommended age groups.

Setting and participants We used an existing dataset of 1,027,039 women which combines data from the Health Insurance information systems, with census data from Midi-Pyrénées, France.

Primary and secondary outcome measures Our outcome was, for each woman, the uptake of the pap smear and the uptake of the mammography during the year.

Results A social gradient of gynaecological cancers screening uptake was found. This gradient was stronger in large urban areas:

- For mammography: decile 10 [the most deprived] vs 1 [the least deprived], adjusted OR= 0.777, 95%CI [0.748,0.808] in large urban area; adjusted OR= 0.808 for decile 1 to 0.726 for decile 10 in other areas vs decile 1 in urban areas ;
- For pap smear: decile 10 vs 1 adjusted OR= 0.66, 95%CI [0.642,0.679] in large urban areas; adjusted OR= 0.747 for decile 1 to 0.562 for decile 10 in other areas vs decile 1 in urban areas).

Screening rates were globally higher in large urban areas. For mammography, the social and territorial disparities were higher outside the recommended age group.

Conclusions Offering a universal approach to every woman, as it is often the case in nationally organised screening programmes, is likely to be insufficient to ensure real equity in access. Developing global dataset combining health data and diverse socioeconomic data, at individual and contextual levels, could enable a better understanding of the mechanisms involved in this

social gradient, and therefore the development of targeted territorial actions to improve equity of access to healthcare.

Keywords

Breast cancer screening; Cervical cancer screening; Screening programme participation; Women health; Socioeconomic inequalities; Geographic inequalities; Deprivation index.

Strengths and limitations of this study

- The use of health insurance data, merged with socio-territorial information, allowed for a very powerful and comprehensive study on social inequalities in health (database of 2.5 million of individuals or 88% of the region's total population).
- We used both individual and contextual variables to investigate the link between an ecological deprivation index and gynaecological cancers screening.
- We performed a sequential regression (variables were successively added in the multivariable model) to investigate the role of each variable in the link between the ecological deprivation index and screening and studied the interaction between EDI and the type of place of residence
- Our data covered only 1 year and we had a limited number of individual and contextual variables in our dataset.

Abbreviations:

CMU-C: Couverture Médicale Universelle-Comprélmentaire (Supplementary Universal Healthcare Coverage)

EDI: European deprivation Index

GP: General Practitioner

INSEE: Institut National de la Statistique et des Etudes Economiques (French National Institute of Statistics and Economic Studies)

IRIS: Ilots Regroupés pour l'Information statistique (aggregated units for statistical information)

OR: Odds-Ratio

PLA: Potential Localised Accessibility

SEP: Socioeconomic Position

1. Introduction

Breast and cervical cancers are the two most frequent gynaecological cancers in the world. They kill more than 600,000 and 300,000 women, respectively, every year (1).

For breast cancer in France, through the nationally organised screening programme, all women between 50 and 74 years old are offered a mammography every 2 years (2). For cervical cancer, a national screening programme is progressively being implemented (3). Before 2018, guidelines recommended a pap smear every 3 years between 25 and 65 years old.

In France, the participation rate is around 50% for breast cancer screening and 60% for cervical cancer (4). Despite an universal health coverage policy, mammography and pap smear uptake, and therefore breast and cervical cancer survival, vary considerably with factors like socioeconomic position (SEP) and place of residence (5–8). This raises the question of the determinants of universal access, in particular physical accessibility (availability, reasonable reach), financial affordability (healthcare cost, transportation, time away from work) and sociocultural accessibility (perceived effectiveness, social and cultural factors) (9,10). All these dimensions may be socially distributed and partly explain the inequalities of screening uptake.

Disentangling underlying mechanisms leading to these inequalities is a first step to address them. However, further studies on this topic have been made difficult by the lack of large and representative dataset combining socioeconomic, territorial, and healthcare data (11).

We used French healthcare insurance reimbursement data, merged with socio-territorial information, to assess and investigate the influence of deprivation, and of the place of residence, on mammography and pap smear uptake in the recommended age groups. We also explored the influence of these factors for women outside the recommended age groups.

2. Methods

Study design

We used a dataset combining data from health insurance information systems with census data, based on the address of residence. This dataset has been described in detail elsewhere (12). The health data was prospectively collected by the three main health insurance providers for 2012.

Population

This dataset included individuals who were beneficiaries of any of the three health insurance providers on the 31st of December 2012 in Midi-Pyrénées. The individuals with an incomplete address or with differences in the management of their data were excluded. We obtained a base of 2,574,310 subjects (88% of the region's total population).

For this study, we focused on women over 20 years old (1,027,039 women), as gynaecological cancers screening is rarely offered to women below that age.

Patient and public involvement

Patients or the public were not involved in the design of our study.

Collected variables

- Main outcomes

Our outcome was, for each woman, the uptake of the pap smear and the uptake of the mammography. It was categorised as a binary variable for each screening test to discriminate the women who had at least one mammography/pap smear during the year, and the other ones.

- Main explanatory variables

In the absence of individual social data, social condition of the participants was approached by an ecological deprivation index, the European Deprivation Index (13). The EDI approaches SEP by measuring social deprivation as defined by Townsend as “a state of observable and demonstrable disadvantage relative to the local community or the wider society to which an individual, family or group belongs”. To calculate the EDI, we used the aggregated unit for statistical information (‘IRIS’) corresponding to the person’s address. IRIS is the smallest geographical unit for which statistics are available in France, which represents about 2,000 inhabitants. Each IRIS was assigned an EDI value, calculated with census data. We used an EDI presentation in deciles, calculated from all the IRISs of the region: decile 1 corresponds to the least deprived zones, decile 10 to the most deprived zones.

- Covariates

We considered age as a potential confounder. As the association between this variable and the outcomes clearly appeared non-linear, we categorised it (into 5-year groups).

As an ecological index of deprivation, EDI is assumed to be capturing both intrinsic properties of the individuals in the area and contextual properties of the area (14). To explore the mechanisms involved in the link between EDI and screening uptake, we chose to study various factors, including one individual and one contextual:

- The Supplementary Universal Healthcare Coverage (CMU-C), is offered to individuals who earn less than a defined income threshold, to pay for their healthcare expenses. This characteristic was used as a proxy for individual financial precarity. Our hypothesis was that financial precarity, by limiting financial accessibility, was key in the link between deprivation and screening participation.
- Healthcare supply is a contextual property influencing deprivation. We assumed that this factor could partly explain the link between EDI and screening uptake by measuring

physical accessibility. Healthcare supply at IRIS level was approached by the Potential Localised Accessibility (PLA) to the GP. The PLA calculates the distance-weighted supply and the local demand, measured by the age-differentiated rate of access. It is interpreted as a medical density (number of full-time equivalents for 100 000 inhabitants) (15).

We assumed that the overall healthcare system adherence could also explain part of the association between deprivation and screening uptake. Therefore, we used a binary variable that discriminates between the patients who had no designated referring physician (in most cases a General Practitioner (GP)) and the ones who had one. This health-seeking behaviour is a property of individuals but is likely to be influenced by both individual and contextual factors (16).

Healthcare supply and transport facilities are very different in rural and urban areas (17–19). We assumed that the level of urbanisation of the place of residence could modify the social gradient of screening uptake. Based on the French National Institute of Statistics and Economic Studies (INSEE)'s 2010 zoning in urban areas, we built a variable to distinguish the large urban areas (more than 10 000 jobs) and their suburbs, from the rest of the region. In the descriptive analysis, we differentiated among large urban areas between Toulouse metropolis, the regional capital which covers almost a quarter of the region's population, and the other areas.

Our conceptual model showing how these variables interact is presented in Figure 1.

Statistical analysis

To describe the sample, we performed univariate analyses: we tested the association between the main explanatory variable and the outcomes, between each covariate and the outcomes, and between each covariate and the EDI.

We used a multivariable logistic regression model to analyse the association between EDI and the mammography and pap smear uptake, adjusted for all the previously identified confounders and intermediate variables. We performed a sequential regression. The variables were successively added to the model following a pre-defined order: the main explanatory variable alone first, then the confounder, and lastly the intermediate variables (at an individual then at a contextual level).

We studied the interaction between EDI and the type of place of residence (large urban/other areas) in the model through a new variable: a 20-modal indicator with ten modalities (corresponding to the EDI deciles) per type of geographical area.

We undertook some age groups analyses to study women outside the recommended age groups (younger and older). For younger women, we focused on women aged 20 to 25 for pap smear and 40 to 50 for mammography. Our hypothesis was that social and territorial inequalities were higher for women outside the recommended age groups.

Since we used data that are systematically recorded by health insurance providers, we expected very little missing data. This was therefore negligible in light of the global sample size (around 0.01%): a complete case analysis could be used.

Statistical analyses were performed with R software (R x64 3.0.2) (20).

3. Results

Selected population in the recommended age groups for mammography (50-74 years old) and pap smear (25-65 years old), were composed of 365 947 and 711 803 women respectively (Table 1). Among these women, 31% had had at least one mammography during the year, and 29% at least one pap smear. Almost two thirds of the population lived in large urban areas. A major part of the most disadvantaged women lived in the Toulouse metropolis (Supplementary material Appendix 1, Tables A). Around 8% of the 25-65 women and less than 4% of the 50-

74 had the CMU-C. 92% of the 25-65 women and 95% of the 50-74 had a designated referring physician.

The more deprived the area of residence, the lower the gynaecological cancers screening uptakes (p-value < 0.001) (Table 1). Regarding age, the mammography rate seemed rather constant throughout the recommended ages. Pap smear uptake decreased a lot after 55 years old (from 31% to 23% between the 45-50 and the 55–60-year-old groups). Women with CMU-C had a lower screening uptake rate. We noticed a slight territorial gradient: the higher the GP density, the higher the mammography and pap smear uptake, except for the last two deciles. The women living in large urban areas had a higher screening rate than the ones living in the rest of the region. Women who had a designated referring physician had a higher screening rate (32% vs 5% for mammography, 31% vs 8% for pap smear, p-value < 0.001).

Adding the interaction term between EDI and the type of place of residence (large urban/other areas) improved our models (better likelihood, p-value= 0.0048 for mammography uptake and 0.0040 for pap smear uptake). Tables 2 and 3 present the logistic regression of mammography and pap smear uptake in the recommended age groups: first the odds-ratios associated with the variable combining EDI and the type of place of residence (large urban/other areas), then the result of the sequential adjustments, and lastly the final multivariable regression model.

For mammography (Table 2), an effect of EDI on mammography uptake was observed, through a social gradient: the screening uptake regularly decreased with increasing deprivation. This social gradient was mostly observed in large urban areas (decile 10 vs 1 adjusted OR= 0.777, 95%CI [0.748,0.808]). There was no social gradient in the other areas, where mammography rate was globally lower than in urban areas. Influence of financial precarity was corroborated by CMU-C impact on screening uptake (adjusted OR= 0.644, 95%CI [0.618; 0.671]). The territorial gradient based on GP accessibility was confirmed. Adding this variable decreased only slightly the difference between large urban and other areas. The link between mammography and having a designated referring physician was confirmed as well (adjusted OR = 8.45, 95%CI [7.946; 8.996]). Age had a very limited effect on mammography uptake. Sequential inclusion of all these variables in the model modified only slightly the link between EDI and screening uptake.

For pap smear (Table 3), a strong social gradient was observed. This gradient was slightly stronger in large urban areas (decile 10 vs 1 adjusted OR= 0.66, 95%CI [0.642,0.679]) than in the rest of the region (adjusted OR= 0.747 for decile 1 to 0.562 for decile 10 in other areas vs decile 1 in urban areas). Influence of financial precarity was corroborated by CMU-C impact on screening uptake (adjusted OR= 0.669). The territorial gradient (based on GP accessibility) was confirmed but, as for mammography, adding this variable decreased only slightly the difference between large urban and other areas. The multivariable analysis confirmed the association between having a designated referring physician and pap smear uptake (adjusted OR = 5.39 95%CI [5.227; 5.557]). An effect of age on pap smear uptake was also found (adjusted OR= 0.59, 95% CI [0.574; 0.601] for 55-60 year-old women vs 25-30 women). Sequential inclusion of all these variables in the model modified only slightly the link between EDI and screening uptake.

We used the same approach for women outside the recommended age groups (Figure 2 & supplementary material Appendix 2, Tables B). Among younger women (40-50 years old for mammography and 20-25 for pap smear), both mammography and pap smear uptakes in the year were around 21%. Among women older than the recommended age, participation rates were around 6% for both breast and cervical cancers. Figure 2 shows that the social gradient in mammography uptake was substantially stronger in women between the ages of 40 and 50, and more so in large urban areas. For pap smear uptake, social gradient seemed less strong in younger women. Regarding GP accessibility, we observed a stronger territorial gradient for older women, for both screening uptakes.

	Total 50-74 y.o N=365 947 N (%)	No mammography n (%) n= 253 354	≥ 1 mammography n (%) n= 112 593 (30.77)	Total 25-65 y.o N=711 803 N (%)	No pap smear n (%) n= 506 731 (71.19)	≥ 1 pap smear n (%) n= 205 072 (28.81)
EDI			*			*
1 (best)	31201 (8.53)	20675 (66.26)	10526 (33.74)	62238 (8.74)	40787 (65.53)	21451 (34.47)
2	34826 (9.52)	23263 (66.8)	11563 (33.2)	70952 (9.97)	47640 (67.14)	23312 (32.86)
3	30111 (8.23)	20414 (67.8)	9697 (32.2)	60763 (8.54)	41703 (68.63)	19060 (31.37)
4	31564 (8.63)	21596 (68.42)	9968 (31.58)	60572 (8.51)	42269 (69.78)	18303 (30.22)
5	32733 (8.94)	22750 (69.5)	9983 (30.5)	65031 (9.14)	46072 (70.85)	18959 (29.15)
6	39518 (10.8)	27130 (68.65)	12388 (31.35)	73464 (10.32)	53153 (72.35)	20311 (27.65)
7	38825 (10.61)	27107 (69.82)	11718 (30.18)	72276 (10.15)	52119 (72.11)	20157 (27.89)
8	37868 (10.35)	26309 (69.48)	11559 (30.52)	70412 (9.89)	51084 (72.55)	19328 (27.45)
9	42390 (11.58)	29998 (70.77)	12392 (29.23)	82232 (11.55)	60646 (73.75)	21586 (26.25)
10 (worst)	46911 (12.82)	34112 (72.72)	12799 (27.28)	93863 (13.19)	71258 (75.92)	22605 (24.08)
Age (/5years)			*			*
25-30 y.o.	-	-	-	82413 (11.58)	56617 (68.7)	25796 (31.3)
30-35 y.o.	-	-	-	88249 (12.4)	58932 (66.78)	29317 (33.22)
35-40 y.o.	-	-	-	85200 (11.97)	57150 (67.08)	28050 (32.92)
40-45 y.o.	-	-	-	92964 (13.06)	63042 (67.81)	29922 (32.19)
45-50 y.o.	-	-	-	94291 (13.25)	64872 (68.8)	29419 (31.2)
50-55 y.o.	88241 (24.11)	61449 (69.64)	26792 (30.36)	88241 (12.4)	64145 (72.69)	24096 (27.31)
55-60 y.o.	83126 (22.72)	57836 (69.58)	25290 (30.42)	83126 (11.68)	64120 (77.14)	19006 (22.86)
60-65 y.o.	81209 (22.19)	55168 (67.93)	26041 (32.07)	81209 (11.41)	64544 (79.48)	16665 (20.52)
65-70 y.o.	64794 (17.71)	44289 (68.35)	20505 (31.65)	16110 (2.26)[1]	13309 (82.61)	2801 (17.39)
70-75 y.o.	48577 (13.27)	34612 (71.25)	13965 (28.75)	-	-	-
CMU-C			*			*
No CMU-C	351872 (96.15)	242406 (68.89)	109466 (31.11)	655969 (92.16)	463517 (70.66)	192452 (29.34)
CMU-C	14075 (3.85)	10948 (77.78)	3127 (22.22)	55834 (7.84)	43214 (77.4)	12620 (22.6)
GP PLA			*			*
1 (worst)	11427 (3.12)	8212 (71.86)	3215 (28.14)	18607 (2.61)	13784 (74.08)	4823 (25.92)
2	13767 (3.76)	9738 (70.73)	4029 (29.27)	24385 (3.43)	17816 (73.06)	6569 (26.94)
3	14455 (3.95)	10195 (70.53)	4260 (29.47)	26121 (3.67)	18888 (72.31)	7233 (27.69)
4	20582 (5.62)	14258 (69.27)	6324 (30.73)	37307 (5.24)	26610 (71.33)	10697 (28.67)
5	26405 (7.22)	18029 (68.28)	8376 (31.72)	49815 (7)	35139 (70.54)	14676 (29.46)
6	32262 (8.82)	21930 (67.97)	10332 (32.03)	63615 (8.94)	44311 (69.65)	19304 (30.35)
7	50863 (13.9)	34371 (67.58)	16492 (32.42)	98949 (13.9)	68782 (69.51)	30167 (30.49)
8	62331 (17.03)	42592 (68.33)	19739 (31.67)	123460 (17.34)	86465 (70.03)	36995 (29.97)
9	64131 (17.52)	44615 (69.57)	19516 (30.43)	127253 (17.88)	90793 (71.35)	36460 (28.65)
10 (best)	69724 (19.05)	49414 (70.87)	20310 (29.13)	142291 (19.99)	104143 (73.19)	38148 (26.81)
Urbanisation			*			*
Toulouse	72919 (19.93)	49978 (68.54)	22941 (31.46)	180030 (25.59)	123038 (68.34)	56992 (31.66)
Large urban areas	150755 (41.2)	102663 (68.1)	48092 (31.9)	302563 (42.51)	211072 (69.76)	91491 (30.24)
Other areas	142273 (38.88)	100713 (70.79)	41560 (29.21)	229210 (32.2)	172621 (75.31)	56589 (24.69)
RP[2]			*			*
No	20032 (5.47)	18963 (94.66)	1069 (5.34)	57596 (8.09)	52948 (91.93)	4648 (8.07)
Yes	345915 (94.53)	234391 (67.76)	111524 (32.24)	654207 (91.91)	453783 (69.36)	200424 (30.64)

Table1: **Socio-demographic characteristics of women**

[1] Only 65 y.o. women
[2] RP : Designated referring physician
*: p-value <0.001

***Table 2*: Mammography uptake in recommended age group: multivariable logistic regression models (mammography uptake = 30.77%)**

		N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
		Tot= 365947	OR (95%CI)	-225465	OR (95%CI)	-225373	OR (95%CI)	-225160	OR (95%CI)	-225115	OR (95%CI)	-220891
Combined EDI and large urban/other areas	1[3]	2 719	1		1		1		1		1	
	2	5 896	0.981 (0.948,1.016)		0.982 (0.948,1.016)		0.983 (0.95,1.018)		0.983 (0.949,1.018)		0.976 (0.942,1.011)	
	3	10 112	0.967 (0.931,1.005)		0.968 (0.932,1.006)		0.971 (0.934,1.009)		0.968 (0.932,1.007)		0.962 (0.925,1)	
	4	13 232	0.933 (0.897,0.97)		0.934 (0.898,0.971)		0.939 (0.902,0.976)		0.934 (0.897,0.971)		0.927 (0.891,0.965)	
	5	12 730	0.889 (0.856,0.924)		0.89 (0.857,0.925)		0.897 (0.863,0.933)		0.9 (0.865,0.936)		0.897 (0.862,0.933)	
EDI (deciles) in large urban areas	6	19 906	0.928 (0.893,0.965)		0.929 (0.894,0.966)		0.936 (0.901,0.973)		0.932 (0.896,0.969)		0.927 (0.891,0.964)	
	7	20 092	0.849 (0.816,0.883)		0.85 (0.817,0.884)		0.858 (0.825,0.892)		0.861 (0.826,0.896)		0.864 (0.83,0.9)	
	8	20 741	0.872 (0.837,0.908)		0.873 (0.838,0.909)		0.885 (0.85,0.922)		0.893 (0.857,0.931)		0.895 (0.858,0.933)	
	9	20 679	0.838 (0.807,0.871)		0.84 (0.809,0.872)		0.855 (0.823,0.888)		0.86 (0.827,0.895)		0.867 (0.833,0.903)	
	10	16 166	0.733 (0.708,0.759)		0.734 (0.709,0.76)		0.763 (0.737,0.79)		0.771 (0.742,0.801)		0.777 (0.748,0.808)	
EDI (deciles) in other areas	1	28 482	0.782 (0.718,0.853)		0.783 (0.718,0.854)		0.784 (0.719,0.855)		0.811 (0.743,0.884)		0.808 (0.74,0.882)	
	2	28 930	0.841 (0.791,0.893)		0.842 (0.792,0.894)		0.845 (0.795,0.897)		0.861 (0.81,0.915)		0.855 (0.804,0.91)	
	3	19 999	0.814 (0.775,0.855)		0.814 (0.775,0.855)		0.817 (0.778,0.858)		0.838 (0.798,0.881)		0.834 (0.793,0.877)	
	4	18 332	0.829 (0.793,0.866)		0.829 (0.793,0.867)		0.833 (0.797,0.871)		0.845 (0.808,0.883)		0.84 (0.803,0.879)	
	5	20 003	0.777 (0.742,0.813)		0.777 (0.742,0.813)		0.78 (0.746,0.817)		0.797 (0.761,0.835)		0.794 (0.758,0.832)	
	6	19 612	0.831 (0.799,0.864)		0.832 (0.801,0.866)		0.838 (0.805,0.871)		0.847 (0.815,0.881)		0.846 (0.813,0.881)	
	7	18 733	0.816 (0.785,0.848)		0.817 (0.786,0.85)		0.824 (0.792,0.857)		0.834 (0.801,0.867)		0.829 (0.797,0.863)	
	8	17 127	0.824 (0.793,0.857)		0.825 (0.794,0.858)		0.833 (0.802,0.866)		0.846 (0.813,0.88)		0.842 (0.809,0.876)	
	9	21 711	0.751 (0.722,0.78)		0.751 (0.722,0.781)		0.762 (0.733,0.792)		0.767 (0.737,0.798)		0.767 (0.737,0.799)	
	10	30 745	0.702 (0.672,0.732)		0.703 (0.674,0.734)		0.718 (0.688,0.75)		0.729 (0.698,0.762)		0.726 (0.694,0.759)	
Age (y.o)	50-55[3]	88 241			1		1		1		1	
	55-60	83 126			1.006 (0.985; 1.027)		1.002 (0.982; 1.023)		1.002 (0.982; 1.023)		0.997 (0.977; 1.018)	
	60-65	81 209			1.088 (1.066; 1.111)		1.077 (1.055; 1.099)		1.077 (1.055; 1.1)		1.066 (1.044; 1.088)	
	65-70	64 794			1.07 (1.047; 1.094)		1.052 (1.029; 1.076)		1.052 (1.029; 1.076)		1.035 (1.012; 1.058)	
	70-75	48 577			0.938 (0.916; 0.961)		0.919 (0.897; 0.942)		0.919 (0.897; 0.942)		0.897 (0.875; 0.919)	
CMU-C	No[3]	351 872					1		1		1	
	Yes	14 075					0.659 (0.633; 0.686)		0.659 (0.633; 0.687)		0.644 (0.618; 0.671)	
GP PLA	1[3]	11 427							1		1	
	2	13 767							1.023 (0.968; 1.081)		1.013 (0.958; 1.072)	
	3	14 455							1.027 (0.972; 1.084)		1.018 (0.964; 1.076)	
	4	20 582							1.068 (1.015; 1.124)		1.054 (1.002; 1.11)	
	5	26 405							1.111 (1.058; 1.167)		1.102 (1.048; 1.158)	
	6	32 262							1.118 (1.066; 1.173)		1.103 (1.051; 1.158)	
	7	50 863							1.14 (1.089; 1.194)		1.126 (1.075; 1.18)	
	8	6 2331							1.143 (1.092; 1.195)		1.126 (1.076; 1.179)	
	9	64 131							1.106 (1.057; 1.157)		1.096 (1.047; 1.148)	
	10	69 724							1.081 (1.033; 1.132)		1.081 (1.032; 1.132)	
Referring physician	No[3]	20 032									1	
	Yes	345 915									8.45 (7.946; 8.996)	

[3] Reference category

***Table 3*: Pap smear uptake multivariable logistic regression models in recommended age group (Pap smear uptake = 28.81%)**

		N	**Model 1** LogLik	**Model 2** LogLik	**Model 3** LogLik	**Model 4** LogLik	**Model 5** LogLik
		Total= 711803	OR (95%CI) -424737	OR (95%CI) -420964	OR (95%CI) -420368	OR (95%CI) -420310	OR (95%CI) -411557
Combined EDI and large urban/other areas EDI (deciles) in large urban area	1[4]	4 741	1	1	1	1	1
	2	9 906	0.945 (0.923,0.968)	0.936 (0.914,0.959)	0.939 (0.917,0.962)	0.929 (0.907,0.952)	0.922 (0.899,0.945)
	3	16 889	0.918 (0.894,0.942)	0.902 (0.879,0.927)	0.908 (0.884,0.932)	0.897 (0.873,0.921)	0.889 (0.865,0.913)
	4	21 643	0.887 (0.863,0.912)	0.878 (0.854,0.902)	0.886 (0.862,0.91)	0.878 (0.854,0.903)	0.873 (0.849,0.898)
	5	20 561	0.833 (0.811,0.855)	0.816 (0.795,0.838)	0.826 (0.804,0.848)	0.817 (0.795,0.839)	0.816 (0.794,0.839)
	6	31 816	0.793 (0.772,0.815)	0.781 (0.76,0.803)	0.792 (0.771,0.814)	0.78 (0.759,0.802)	0.781 (0.759,0.803)
	7	31 628	0.801 (0.78,0.823)	0.788 (0.766,0.81)	0.8 (0.778,0.822)	0.791 (0.769,0.813)	0.805 (0.782,0.828)
	8	32 394	0.806 (0.784,0.829)	0.788 (0.766,0.81)	0.806 (0.783,0.828)	0.801 (0.778,0.824)	0.81 (0.787,0.834)
	9	33 163	0.735 (0.716,0.754)	0.716 (0.698,0.735)	0.738 (0.719,0.758)	0.729 (0.709,0.749)	0.748 (0.727,0.769)
	10	26 469	0.616 (0.601,0.631)	0.602 (0.588,0.618)	0.643 (0.627,0.659)	0.636 (0.619,0.653)	0.66 (0.642,0.679)
EDI (deciles) in other area	1	57 497	0.723 (0.678,0.773)	0.735 (0.688,0.785)	0.737 (0.69,0.787)	0.749 (0.701,0.801)	0.747 (0.699,0.799)
	2	61 046	0.703 (0.671,0.738)	0.72 (0.686,0.755)	0.724 (0.69,0.759)	0.731 (0.697,0.767)	0.732 (0.697,0.768)
	3	43 874	0.685 (0.659,0.711)	0.704 (0.677,0.731)	0.707 (0.681,0.735)	0.715 (0.688,0.744)	0.716 (0.689,0.745)
	4	38929	0.667 (0.644,0.69)	0.684 (0.661,0.709)	0.69 (0.666,0.714)	0.693 (0.669,0.718)	0.693 (0.669,0.718)
	5	44470	0.628 (0.606,0.651)	0.645 (0.623,0.669)	0.65 (0.627,0.674)	0.655 (0.631,0.679)	0.659 (0.635,0.683)
	6	41648	0.608 (0.59,0.627)	0.626 (0.607,0.645)	0.632 (0.613,0.652)	0.631 (0.611,0.651)	0.637 (0.617,0.657)
	7	40648	0.619 (0.6,0.638)	0.637 (0.618,0.657)	0.647 (0.628,0.668)	0.646 (0.626,0.666)	0.648 (0.628,0.669)
	8	38018	0.591 (0.574,0.61)	0.61 (0.591,0.629)	0.621 (0.602,0.641)	0.62 (0.601,0.64)	0.622 (0.603,0.642)
	9	49069	0.559 (0.542,0.577)	0.573 (0.556,0.591)	0.588 (0.57,0.607)	0.582 (0.564,0.601)	0.59 (0.571,0.609)
	10	67394	0.524 (0.506,0.542)	0.533 (0.516,0.552)	0.556 (0.537,0.575)	0.552 (0.533,0.572)	0.562 (0.542,0.582)
Age (y.o)	25-30[4]	82413		1	1	1	1
	30-35	88249		1.084 (1.062; 1.106)	1.08 (1.059; 1.103)	1.081 (1.059; 1.104)	1.06 (1.038; 1.082)
	35-40	85200		1.063 (1.042; 1.085)	1.056 (1.035; 1.078)	1.057 (1.035; 1.079)	1.021 (1; 1.043)
	40-45	92964		1.031 (1.01; 1.052)	1.021 (1; 1.042)	1.021 (1.001; 1.042)	0.963 (0.944; 0.984)
	45-50	94291		0.988 (0.968; 1.008)	0.975 (0.955; 0.995)	0.975 (0.956; 0.996)	0.906 (0.888; 0.925)
	50-55	88241		0.826 (0.809; 0.843)	0.811 (0.794; 0.828)	0.812 (0.795; 0.829)	0.749 (0.733; 0.765)
	55-60	83126		0.655 (0.64; 0.669)	0.641 (0.627; 0.655)	0.641 (0.627; 0.656)	0.587 (0.574; 0.601)
	60-65	81209		0.573 (0.56; 0.586)	0.558 (0.545; 0.57)	0.558 (0.546; 0.571)	0.507 (0.496; 0.519)
	65	16110		0.468 (0.448; 0.488)	0.454 (0.434; 0.474)	0.454 (0.435; 0.474)	0.413 (0.395; 0.431)
CMU-C	No[4]	655969			1	1	1
	Yes	55834			0.696 (0.681; 0.711)	0.695 (0.681; 0.71)	0.669 (0.655; 0.684)
GP PLA (deciles)	1[4]	18607				1	1
	2	24385				0.966 (0.925; 1.01)	0.951 (0.909; 0.994)
	3	26121				0.982 (0.941; 1.026)	0.97 (0.928; 1.013)
	4	37307				1.004 (0.965; 1.046)	0.989 (0.95; 1.031)
	5	49815				1.01 (0.971; 1.05)	0.991 (0.952; 1.03)
	6	63615				1.033 (0.994; 1.073)	1.017 (0.978; 1.056)
	7	98949				1.049 (1.011; 1.088)	1.031 (0.993; 1.069)
	8	123460				1.086 (1.048; 1.126)	1.068 (1.03; 1.108)
	9	127253				1.056 (1.018; 1.095)	1.046 (1.009; 1.086)
	10	142291				1.03 (0.993; 1.069)	1.049 (1.011; 1.088)
Referring physician	No[4]	57596					1
	Yes	654207					5.389 (5.227; 5.557)

[4] Reference category

4. Discussion

Our study highlighted a link between deprivation and gynaecological cancers screening uptake, in and outside the recommended age groups. This link follows a social gradient across all socioeconomic levels. The gradient was stronger in large urban areas. The successive inclusion of variables indicating financial precarity, healthcare accessibility, and adherence to the healthcare system decreased only very slightly the association, suggesting that these variables explain a very limited extent of the link between EDI and screening uptake. The social and territorial disparities in mammography uptake were lower in the recommended age group than outside.

The main strength of our study is its power and comprehensiveness, achieved by using health insurance data. Using both individual and contextual variables to investigate the link between an ecological deprivation index and screening uptake is original. Another original aspect is the exploration of screening uptake outside the recommended age groups and the observation of two different implementation modes for national recommendations (with and without a screening programme). Our study also has limitations. As our data covered only 1 year, we could not differentiate between women who had screening tests every year (more often than recommended) and the ones who had it every two and three years as recommended. It raises the question of excess screening and its link with SEP. The limited number of individual and contextual variables in our dataset restrained our capability to disentangle what could be explained by contextual and individual properties in the associations we observed with EDI. The same difficulty limited the exploration of financial, physical, and sociocultural accessibility mechanisms involved in the social gradient.

We complemented existing literature on social inequalities in access to mammography and pap smear. The link between deprivation and screening participation was found in numerous countries all over the word, irrespective of the local healthcare policy. In the United States, where no centrally organised cancer screening programme exists, this link was repeatedly reported at an individual and at an area levels (22–24). In most Western European countries, nationally organised screening programmes are in place. The studies conducted there also showed an impact of SEP (25–27). In France, the lack of individual socioeconomic variable in healthcare datasets has made it difficult to obtain large and representative evidence. A few cohort studies have been conducted, but were limited by the relatively small sample size (7,28,29). Using healthcare insurance reimbursement data merged with sociodemographic information made it possible to assess the impact of socioterritorial inequalities in larger studies, more representative of the French population (30).

Our study tried to identify some of the mechanisms involved in the link between deprivation and screening uptake. One of our hypotheses was that deprivation leads to limitations of the three dimensions of healthcare accessibility: financial, physical, and sociocultural. We used CMU-C to explore the effect of financial precarity in the link between deprivation and screening uptake and GP PLA, a proxy for healthcare supply, to reflect physical accessibility. Our result suggests that the association between deprivation and screening uptake is very slightly influenced by these variables. This could be due to the choice of variables used in our model. CMU-C may not be enough precise to measure financial accessibility. GP PLA is a good proxy for physical accessibility to primary care, but maybe not to specialty care. Regarding sociocultural accessibility, no truly relevant variable was available in our dataset. Our results showed that the overall adherence to the healthcare system, approached by having a referring physician, only modified slightly the link between EDI and screening uptake. However sociocultural accessibility covers several concepts. Using psychological models, R. Crockett explained that the most deprived people focus more on present time (31). They concentrate on the inconvenience of the screening rather than on the possible long-term benefits. A measure of this mechanism, the fear of the result, language barriers or cultural representations (32) could be better proxies for sociocultural accessibility.

However, our study suggests that having a referring physician has a substantial direct impact on pap smear and mammography uptake. This key role of primary care providers was observed in other countries, like the United States and Canada (33,34). The improvement in screening uptake in people with a referring physician could be due to the direct role of the physician in overcoming the barriers to screening. This result might also be explained by another phenomenon linked to healthcare access: the patient's understanding of and capacity to navigate the healthcare system.

We confirmed territorial disparities in screening access. Large urban areas had higher participation rates than the rest of the region. These rural/urban disparities were observed in several studies in Western Europe and North America (17–19,27,35,36). The social gradient also appeared generally stronger in large urban areas. This result corroborates the assumption that a social gradient exists only if the healthcare supply is sufficient.

We observed that the social and territorial disparities in mammography uptake were lower inside than outside the recommended age groups. We did not observe the same trend for pap smear uptake. This difference could be explained by the nationally organised screening programme in place for breast cancer at the time of data collection but not for cervical cancer. Some studies suggested that tools used in the breast cancer screening programme might help decrease inequalities of access (37,38), but other showed that a national programme, with the exact same actions for every women, while improving overall participation rates, could also increase the social gradient in uptake (39). Pap smear and mammography uptake also appeared very high in women younger than the recommended age. While the social gradient within the recommended age groups is likely to be explained by a low uptake in deprived populations, its existence among younger and older women may indicate an overuse of screening in high SEP populations (40).

Developing global dataset combining health data and diverse socioeconomic data, at individual and contextual levels, could enable a better understanding of the mechanisms involved in this social gradient, and therefore the development of targeted territorial actions to improve equity of access to healthcare.

Author contributions: LO: Conceptualisation, Methodology, Formal analysis, Funding acquisition, Writing – original draft and review & editing. CD: Conceptualisation, Methodology, Formal analysis, Supervision, Validation. PG: Conceptualisation, Data curation, Methodology, Formal analysis, Supervision, Validation. MERB: Conceptualisation, Funding acquisition, Validation. SL: Methodology, Formal analysis, Writing – review, Validation. VD: Writing – review, Validation.

All authors read, edited, and approved the final manuscript.

Acknowledgments:

We gratefully acknowledge Sarah Ouanhnon for her translation help and her many advice. Many thanks to Hervé Mainsonneuve for his careful reading and his precious advice. We wish to thank all the members of the research team: Marine Maurel for her skills with R-software, Camille Joanes for her advice, and all the other members. The research team is supported by the French association "La Ligue contre le cancer".

Data availability statements: This study is conformed to the principles embodied in the Declaration of Helsinki. The data we used in this study belongs to the French National Health Insurance. The procurement of such data necessitates the agreement of the French National Institute of Health Data (INDS) and the permission from the 'Commission Nationale Informatique et Liberte´s' (CNIL) which is the French Data Protection Authority in accordance with Law No 78/17 of 6 January 1978 on computing, files and personal information, article 54, paragraph I. Data cannot be diffused without these authorisations. A CNIL Authorisation (no. 1634837) was obtained for our study. In addition, data cannot be shared with anyone who does not have these authorisations. In our study, the Regional Health Agency of Occitanie completed the necessary formalities with the relevant authorities. If other authors want to obtain the data, they have to contact directly the French National Institute of Health Data and obtain the permission of the CNIL. It can be done on the INDS website (http://www.indsante.fr/). In addition, data regarding demographical characteristics of the whole inhabitants of the region can be freely obtained from the French national institute for statistics and economic studies (https://www.insee.fr/fr/statistiques/).

Ethics statement: According to French registration, the ethics Committee approval is not applicable for this study (on pre-existing dataset).

This study is conformed to the principles embodied in the Declaration of Helsinki. The authors obtained an agreement of the French National Institute of Health Data (INDS) and the permission from the 'Commission Nationale Informatique et Liberte´s' (CNIL) which is the French Data Protection Authority in accordance with Law No 78/17 of 6 January 1978 on computing, files and personal information, article 54, paragraph I. CNIL Authorisation: no. 1634837.

Funding Statement: This work was supported by Toulouse Hospital ("allocation jeune chercheur de la DRCI", Direction de la Recherche Clinique et de l'Innovation). There is no grant number: Toulouse Hospital allocates this grant to young doctors who wish to deepen their knowledge in research, after studying their research project.

Declaration of Competing Interest: The authors have declared that no competing interests exist.

References

1. International Agency for research on Cancer. Estimated number of deaths in 2020, breast, females, all ages: IARC Gobocan [Internet]. Disponible sur: https://gco.iarc.fr/today/online-analysis-table?v=2020&mode=population&mode_population=countries&population=900&populations=900&key=asr&sex=2&cancer=20&type=1&statistic=5&prevalence=0&population_group=0&ages_group%5B%5D=0&ages_group%5B%5D=17&group_cancer=1&include_nmsc=1&include_nmsc_other=1

2. Institut National du Cancer. Le programme de dépistage organisé - Dépistage du cancer du sein [Internet]. cancer.fr. 2019. Disponible sur: https://www.e-cancer.fr/Professionnels-de-sante/Depistage-et-detection-precoce/Depistage-du-cancer-du-sein/Le-programme-de-depistage-organise

3. INCA. Le programme de dépistage organisé du cancer du col de l'utérus - Dépistage du cancer du col de l'utérus [Internet]. Disponible sur: https://www.e-cancer.fr/Professionnels-de-sante/Depistage-et-detection-precoce/Depistage-du-cancer-du-col-de-l-uterus/Le-programme-de-depistage-organise

4. Santé publique France. Evaluation du programme de dépistage du cancer du col de l'utérus [Internet]. [cité 13 mai 2020]. Disponible sur: http://santepubliquefrance.fr/maladies-et-traumatismes/cancers/cancer-du-col-de-l-uterus/articles/evaluation-du-programme-de-depistage-du-cancer-du-col-de-l-uterus

5. Poiseuil M, Coureau G, Payet C, Savès M, Debled M, Mathoulin-Pelissier S, et al. Deprivation and mass screening: Survival of women diagnosed with breast cancer in France from 2008 to 2010. Cancer Epidemiol. 2019;60:149‑55.

6. Duport N, Serra D, Goulard H, Bloch J. Quels facteurs influencent la pratique du dépistage des cancers féminins en France ? Revue d'Épidémiologie et de Santé Publique. 1 oct 2008;56(5):303‑13.

7. Grillo F, Vallée J, Chauvin P. Inequalities in cervical cancer screening for women with or without a regular consulting in primary care for gynaecological health, in Paris, France. Prev Med. avr 2012;54(3‑4):259‑65.

8. Delpierre C, Fantin R, Chehoud H, Nicoules V, Bayle A, Souche A, et al. Inégalités sociales d'accès aux soins et à la prévention en Midi-Pyrénées, France, 2012. 2016; Disponible sur: http://invs.santepubliquefrance.fr//beh/2016/1/2016_1_1.html

9. Evans DB, Hsu J, Boerma T. Universal health coverage and universal access. Bull World Health Organ. août 2013;91:546-546A.

10. Thiede M, Akweongo P, McIntyre D. Exploring the dimensions of access. In: McIntyre D, Mooney G, éditeurs. The Economics of Health Equity [Internet]. Cambridge: Cambridge University Press; 2007 [cité 8 juin 2020]. p. 103‑23. Disponible sur: https://www.cambridge.org/core/books/economics-of-health-equity/exploring-the-dimensions-of-access/684DFDF7B640370D207C59FEAFC967E7

11. HCSP. Les systèmes d'information pour la santé publique [Internet]. Paris: Haut Conseil de la Santé Publique; 2009 nov [cité 10 mars 2019]. Disponible sur: https://www.hcsp.fr/explore.cgi/avisrapportsdomaine?clefr=175

12. Ducros D, Nicoules V, Chehoud H, Bayle A, Souche A, Tanguy M, et al. Les bases médico-administratives pour mesurer les inégalités sociales de santé. Sante Publique. 24 août 2015;Vol. 27(3):383‑94.

13. Pornet C, Delpierre C, Dejardin O, Grosclaude P, Launay L, Guittet L, et al. Construction of an adaptable European transnational ecological deprivation index: the French version. J Epidemiol Community Health. nov 2012;66(11):982‑9.

14. Yang XY, Hu A, Schieman S. Relative deprivation in context: How contextual status homogeneity shapes the relationship between disadvantaged social status and health. Social Science Research. 1 juill 2019;81:157‑69.

15. Muriel Barlet, Magali Coldefy, Clémentine Collin, Véronique Lucas-Gabrielli,. L'Accessibilité potentielle localisée (APL) : une nouvelle mesure de l'accessibilité aux soins appliquée aux médecins généralistes libéraux en France [Internet]. Drees; 2012. Disponible sur: https://drees.solidarites-sante.gouv.fr/etudes-et-statistiques/publications/documents-de-travail/serie-etudes-et-recherche/article/l-accessibilite-potentielle-localisee-apl-une-nouvelle-mesure-de-l

16. Short SE, Mollborn S. Social Determinants and Health Behaviors: Conceptual Frames and Empirical Advances. Curr Opin Psychol. oct 2015;5:78‑84.

17. Chandak A, Nayar P, Lin G. Rural-Urban Disparities in Access to Breast Cancer Screening: A Spatial Clustering Analysis. J Rural Health. 2019;35(2):229‑35.

18. Orwat J, Caputo N, Key W, De Sa J. Comparing Rural and Urban Cervical and Breast Cancer Screening Rates in a Privately Insured Population. Soc Work Public Health. 2017;32(5):311‑23.

19. Leung J, McKenzie S, Martin J, McLaughlin D. Effect of rurality on screening for breast cancer: a systematic review and meta-analysis comparing mammography. Rural Remote Health. 2014;14(2):2730.

20. R Core Team. R: A language and environment for statistical computing. [Internet]. 2013. Disponible sur: http://www.R-project.org/

21. Smith RA, Andrews KS, Brooks D, Fedewa SA, Manassaram-Baptiste D, Saslow D, et al. Cancer screening in the United States, 2019: A review of current American Cancer Society guidelines and current issues in cancer screening. CA: A Cancer Journal for Clinicians. 2019;69(3):184‑210.

22. Dailey AB, Kasl SV, Holford TR, Calvocoressi L, Jones BA. Neighborhood-Level Socioeconomic Predictors of Nonadherence to Mammography Screening Guidelines. Cancer Epidemiol Biomarkers Prev. 1 nov 2007;16(11):2293‑303.

23. Dailey AB, Brumback BA, Livingston MD, Jones BA, Curbow BA, Xu X. Area-Level Socioeconomic Position and Repeat Mammography Screening Use: Results from the 2005 National Health Interview Survey. Cancer Epidemiol Biomarkers Prev. 1 nov 2011;20(11):2331‑44.

24. Murfin J, Irvine F, Meechan-Rogers R, Swift A. Education, income and occupation and their influence on the uptake of cervical cancer prevention strategies: A systematic review. J Clin Nurs. févr 2020;29(3‑4):393‑415.

25. Borràs JM, Guillen M, Sanchez V, Juncà S, Vicente R. Educational level, voluntary private health insurance and opportunistic cancer screening among women in Catalonia (Spain): European Journal of Cancer Prevention. oct 1999;8(5):427‑34.

26. Douglas E, Waller J, Duffy SW, Wardle J. Socioeconomic inequalities in breast and cervical screening coverage in England: are we closing the gap? J Med Screen. 2016;23(2):98‑103.

27. Massat NJ, Douglas E, Waller J, Wardle J, Duffy SW. Variation in cervical and breast cancer screening coverage in England: a cross-sectional analysis to characterise districts with atypical behaviour. BMJ Open. 24 juill 2015;5(7):e007735.

28. Eisinger F, Viguier J, Touboul C, Coscas Y, Pivot X, Blay J-Y, et al. Social stratification, risk factor prevalence and cancer screening attendance. Eur J Cancer Prev. juin 2015;24 Suppl:S77-81.

29. Chauvin P, Parizot I. Les inégalités sociales et territoriales de santé dans l'agglomération parisienne. Une analyse de la cohorte Sirs (2005) [Internet]. Délégation interministérielle à la Ville; 2009 [cité 1 juin 2020]. Disponible sur: https://www.hal.inserm.fr/inserm-00415971

30. Deborde T, Chatignoux E, Quintin C, Beltzer N, Hamers FF, Rogel A. Breast cancer screening programme participation and socioeconomic deprivation in France. Prev Med. 2018;115:53‑60.

31. Crockett R, Wilkinson TM, Marteau TM. Social patterning of screening uptake and the impact of facilitating informed choices: psychological and ethical analyses. Health Care Anal. mars 2008;16(1):17‑30.

32. Szarewski A, Cadman L, Ashdown-Barr L, Waller J. Exploring the acceptability of two self-sampling devices for human papillomavirus testing in the cervical screening context: a qualitative study of Muslim women in London. J Med Screen. 2009;16(4):193‑8.

33. Schueler KM, Chu PW, Smith-Bindman R. Factors Associated with Mammography Utilization: A Systematic Quantitative Review of the Literature. Journal of Women's Health. 27 oct 2008;17(9):1477‑98.

34. Beaulieu MD, Béland F, Roy D, Falardeau M, Hébert G. Factors determining compliance with screening mammography. CMAJ. 1 mai 1996;154(9):1335‑43.

35. Ouédraogo S, Dabakuyo-Yonli TS, Roussot A, Dialla PO, Pornet C, Poillot M-L, et al. [Breast cancer screening in thirteen French departments]. Bull Cancer. févr 2015;102(2):126‑38.

36. Ouédraogo S, Dabakuyo-Yonli TS, Roussot A, Pornet C, Sarlin N, Lunaud P, et al. European transnational ecological deprivation index and participation in population-based breast cancer screening programmes in France. Prev Med. juin 2014;63:103‑8.

37. Cancer Care Ontario. Cancer Fact: Invitation letters improve breast screening behaviour [Internet]. 2016 [cité 13 mai 2020]. Disponible sur: https://www.cancercareontario.ca/en/cancer-facts/invitation-letters-improve-breast-screening-behaviour

38. Everett T, Bryant A, Griffin MF, Martin-Hirsch PP, Forbes CA, Jepson RG. Interventions targeted at women to encourage the uptake of cervical screening. Cochrane Database of Systematic Reviews [Internet]. 2011 [cité 16 oct 2019];(5). Disponible sur: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002834.pub2/full

39. Raginel T, de Mil R, Garnier A, Launoy G, Guittet L. National organization of uterine cervical cancer screening and social inequality in France. European Journal of Cancer Prevention [Internet]. 10 déc 2019 [cité 1 juin 2020];Publish Ahead of Print. Disponible sur: https://journals.lww.com/eurjcancerprev/Abstract/9000/National_organization_of_uterine_cervical_cancer.99158.aspx

40. Autier P. [Screening for breast cancer: worries about its effectiveness]. Rev Prat. déc 2013;63(10):1369‑77.

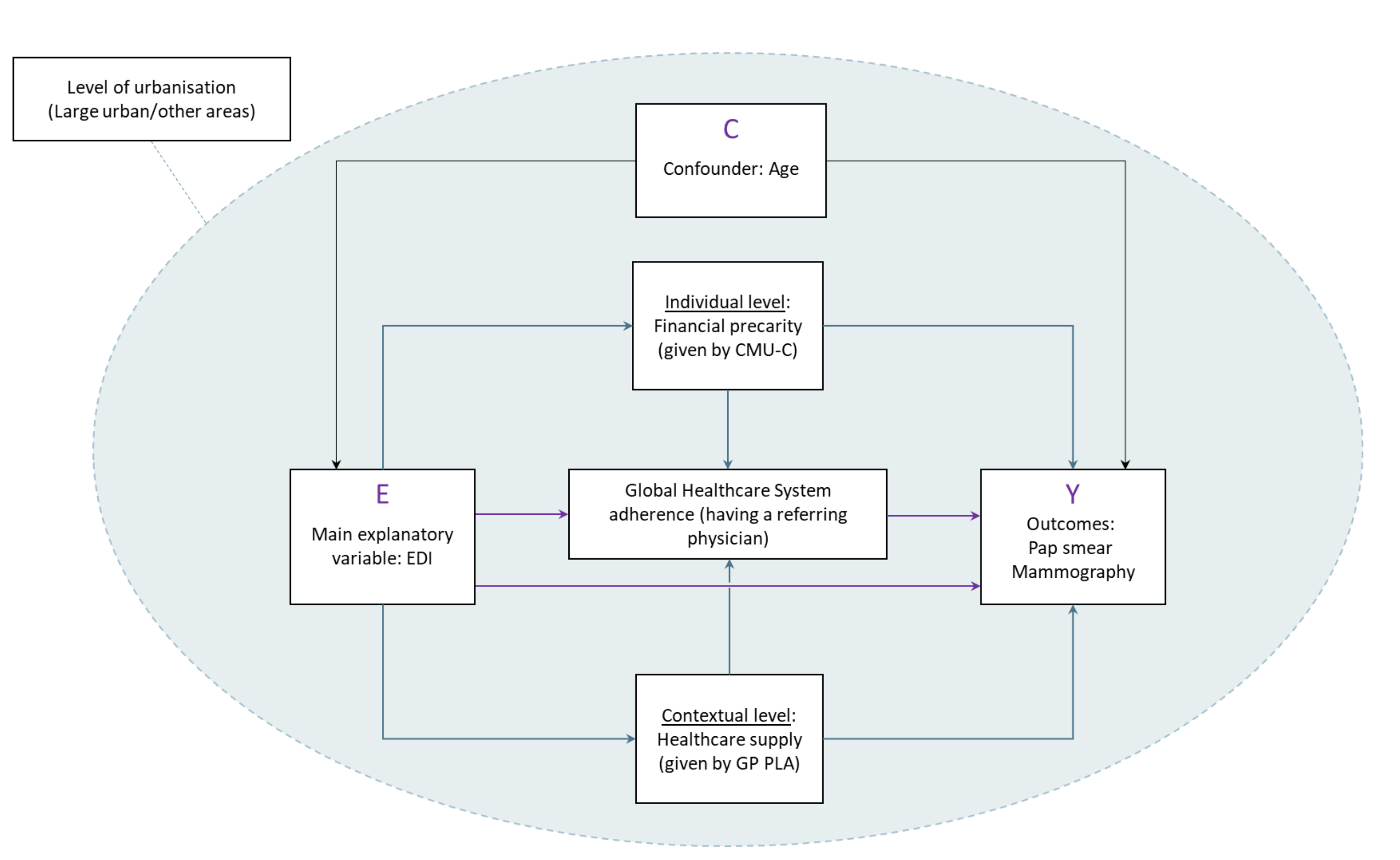
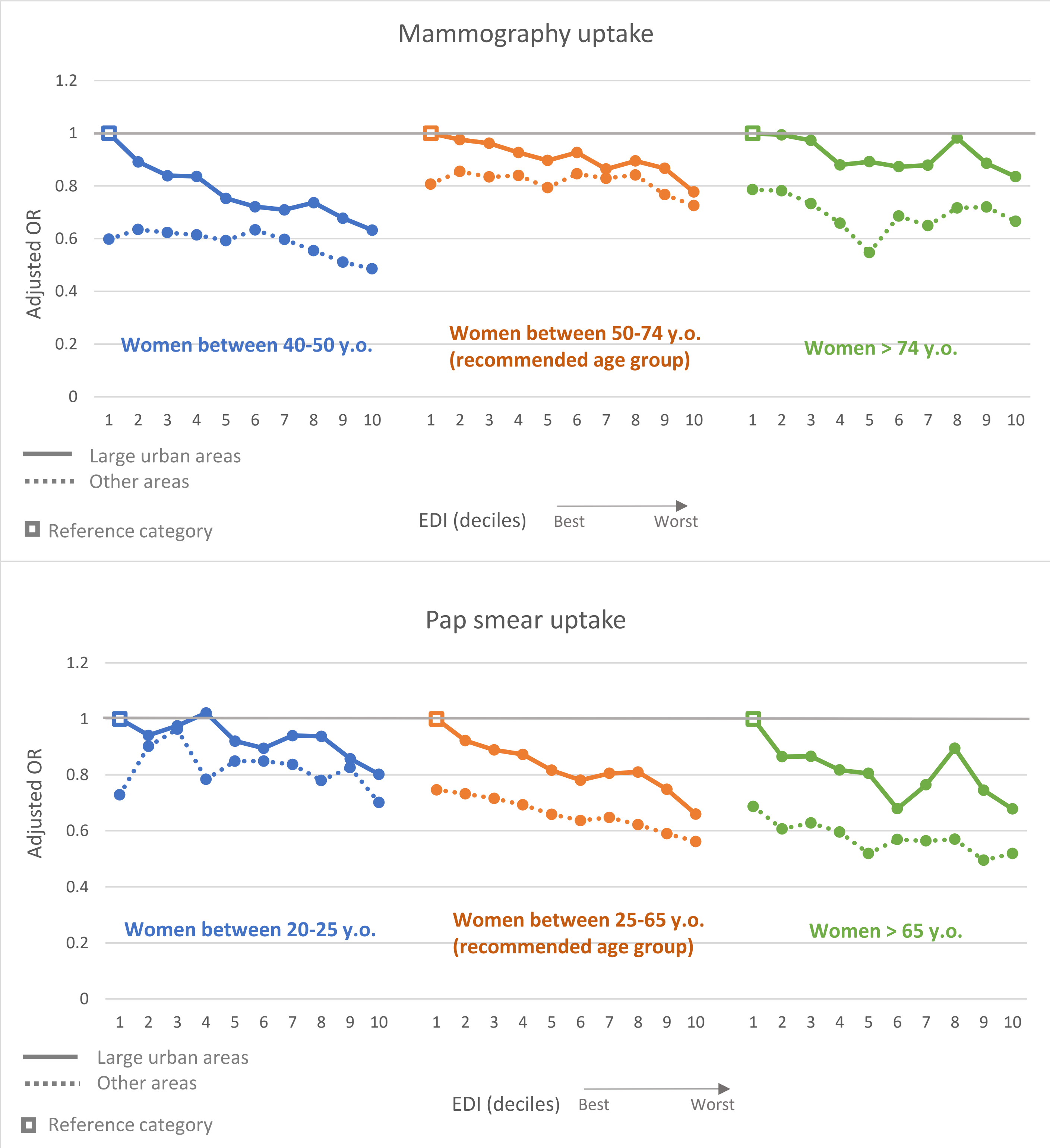


***Figure 1:* Conceptual model**

Links between the studied variables assumed to explain the impact of deprivation on screening uptake, depending on the level of urbanisation.

***Figure 2*: Mammography and pap smear uptake and combined variable EDI in large urban/other areas by age group, Midi Pyrenees region, 2012.**

Results from a logistic model adjusted for EDI by age, CMU-C, GP PLA, having an official referring physician.
Data from models 5 (Table 2 and 3) for the recommended age groups.



Supplementary material

Tables A: Characteristics of women in recommended age groups for gynaecological screening programmes in Midi Pyrénées

Characteristics of women between 50 and 74 y.o. (recommended age group for mammography)
N= 365 947

	Toulouse Metropolis	Other large urban area	Other area
	n= 72919 (19.93%)	n= 150755 (41.2%)	n= 142273 (38.88%)
	n (%)	n (%)	n (%)
Mammography			
No Mammography	49978 (68.54)	102663 (68.1)	100713 (70.79)
≥ 1 in the year	22941 (31.46)	48092 (31.9)	41560 (29.21)
Age			
Mean (SD)	60.7 (6.8)	60.9 (6.9)	61.6 (6.9)
Age (/5years)			
50-55 y.o	19112 (26.21)	37568 (24.92)	31561 (22.18)
55-60 y.o	17097 (23.45)	34985 (23.21)	31044 (21.82)
60-65 y.o	15774 (21.63)	33460 (22.19)	31975 (22.47)
65-70 y.o,	12305 (16.87)	25825 (17.13)	26664 (18.74)
70-75 y.o	8631 (11.84)	18917 (12.55)	21029 (14.78)
EDI (deciles: 1=best)			
1	7886 (10.81)	20596 (13.66)	2719 (1.91)
2	8615 (11.81)	20315 (13.48)	5896 (4.14)
3	4436 (6.08)	15563 (10.32)	10112 (7.11)
4	3484 (4.78)	14848 (9.85)	13232 (9.3)
5	8183 (11.22)	11820 (7.84)	12730 (8.95)
6	3368 (4.62)	16244 (10.78)	19906 (13.99)
7	6678 (9.16)	12055 (8)	20092 (14.12)
8	6367 (8.73)	10760 (7.14)	20741 (14.58)
9	9519 (13.05)	12192 (8.09)	20679 (14.53)
10	14383 (19.72)	16362 (10.85)	16166 (11.36)
CMU-C			
No CMU-C	68850 (94.42)	145641 (96.61)	137381 (96.56)
CMU-C	4069 (5.58)	5114 (3.39)	4892 (3.44)
GP PLA (deciles: 10= best)			
1	363 (0.5)	1744 (1.16)	9320 (6.55)
2	922 (1.26)	4887 (3.24)	7958 (5.59)
3	0 (0)	6290 (4.17)	8165 (5.74)
4	803 (1.1)	9625 (6.38)	10154 (7.14)
5	1409 (1.93)	14229 (9.44)	10767 (7.57)
6	2695 (3.7)	17381 (11.53)	12186 (8.57)
7	9531 (13.07)	25353 (16.82)	15979 (11.23)
8	14772 (20.26)	25147 (16.68)	22412 (15.75)
9	15456 (21.2)	27726 (18.39)	20949 (14.72)
10	26968 (36.98)	18373 (12.19)	24383 (17.14)
Referring physician			
No designated referring physician	4898 (6.72)	7428 (4.93)	7706 (5.42)
Official referring physician	68021 (93.28)	143327 (95.07)	134567 (94.58)

Characteristics of women between 25 and 65 y.o. (recommended age group for pap smear)
N= 711 803

	Toulouse Metropolis	**Other large urban areas**	**Other areas**
	n= 180030 (25.59%) n (%)	n= 302563 (42.61%) n (%)	n= 229210 (32.2%) n (%)
Pap smear			
No Pap smear	123038 (68.34)	211072 (69.76)	172621 (75.31)
≥ 1 in the year	56992 (31.66)	91491 (30.24)	56589 (24.69)
Age			
Mean (SD)	42.9 (11.8)	45.5 (11.4)	47.2 (11.4)
Age (/5years)	n= 180030	n= 302563	n= 229210
25-30 y.o	30798 (17.11)	32111 (10.61)	19504 (8.51)
30-35 y.o	28146 (15.63)	36721 (12.14)	23382 (10.2)
35-40 y.o	23292 (12.94)	37351 (12.34)	24557 (10.71)
40-45 y.o	21537 (11.96)	41983 (13.88)	29444 (12.85)
45-50 y.o	21259 (11.81)	41829 (13.82)	31203 (13.61)
50-55 y.o	19112 (10.62)	37568 (12.42)	31561 (13.77)
55-60 y.o	17097 (9.5)	34985 (11.56)	31044 (13.54)
60-65 y.o	15774 (8.76)	33460 (11.06)	31975 (13.95)
65-70 y.o,	3015 (1.67)	6555 (2.17)	6540 (2.85)
EDI (deciles: 1=best)			
1	14747 (8.19)	42750 (14.13)	4741 (2.07)
2	19389 (10.77)	41657 (13.77)	9906 (4.32)
3	10922 (6.07)	32952 (10.89)	16889 (7.37)
4	8239 (4.58)	30690 (10.14)	21643 (9.44)
5	21020 (11.68)	23450 (7.75)	20561 (8.97)
6	9173 (5.1)	32475 (10.73)	31816 (13.88)
7	17062 (9.48)	23586 (7.8)	31628 (13.8)
8	17051 (9.47)	20967 (6.93)	32394 (14.13)
9	26337 (14.63)	22732 (7.51)	33163 (14.47)
10	36090 (20.05)	31304 (10.35)	26469 (11.55)
CMU-C			
No CMU-C	161075 (89.47)	281794 (93.14)	213100 (92.97)
CMU-C	18955 (10.53)	20769 (6.86)	16110 (7.03)
GP PLA (deciles: 10= best)			
1	831 (0.46)	3162 (1.05)	14614 (6.38)
2	2273 (1.26)	9407 (3.11)	12705 (5.54)
3	0 (0%)	12683 (4.19)	13438 (5.86)
4	1815 (1.01)	18903 (6.25)	16589 (7.24)
5	3312 (1.84)	28690 (9.48)	17813 (7.77)
6	6666 (3.7)	36519 (12.07)	20430 (8.91)
7	20097 (11.16)	52821 (17.46)	26031 (11.36)
8	37194 (20.66)	51056 (16.87)	35210 (15.36)
9	38815 (21.56)	54907 (18.15)	33531 (14.63)
10	69027 (38.34)	34415 (11.37)	38849 (16.95)
Referring physician			
No designated	18754 (10.42)	20659 (6.83)	18183 (7.93)
Designated	161276 (89.58)	281904 (93.17)	211027 (92.07)

Tables B: Screening uptake multivariable logistic regression models outside the recommended age groups (sequential adjustment)

Mammography uptake multivariable logistic regression models (n= 187255): in 40-50 y.o. women (Mammography uptake = 20.77%)

			N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
			Tot= 187255	OR (95%CI)	-94934	OR (95%CI)	-94709	OR (95%CI)	-94508	OR (95%CI)	-94463	OR (95%CI)	-92837
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[1]	1284	1		1		1		1		1	
		2	2737	0.899 (0.857,0.944)		0.901 (0.859,0.946)		0.906 (0.863,0.951)		0.897 (0.855,0.942)		0.892 (0.849,0.937)	
		3	4550	0.845 (0.801,0.892)		0.847 (0.803,0.894)		0.855 (0.811,0.902)		0.843 (0.798,0.89)		0.839 (0.794,0.886)	
		4	5726	0.836 (0.791,0.884)		0.84 (0.794,0.888)		0.851 (0.805,0.9)		0.84 (0.794,0.888)		0.837 (0.791,0.885)	
		5	5472	0.745 (0.705,0.788)		0.748 (0.708,0.791)		0.761 (0.72,0.805)		0.751 (0.71,0.795)		0.753 (0.711,0.797)	
		6	8525	0.722 (0.682,0.764)		0.722 (0.682,0.765)		0.737 (0.696,0.78)		0.722 (0.682,0.766)		0.722 (0.681,0.766)	
		7	8283	0.688 (0.649,0.73)		0.69 (0.65,0.731)		0.705 (0.665,0.748)		0.699 (0.658,0.742)		0.71 (0.668,0.754)	
		8	8564	0.706 (0.665,0.75)		0.709 (0.668,0.753)		0.732 (0.689,0.777)		0.731 (0.687,0.778)		0.737 (0.693,0.784)	
		9	8629	0.639 (0.603,0.677)		0.64 (0.604,0.678)		0.67 (0.632,0.71)		0.665 (0.625,0.707)		0.678 (0.638,0.721)	
		10	6877	0.557 (0.528,0.587)		0.557 (0.528,0.587)		0.61 (0.578,0.644)		0.61 (0.575,0.647)		0.633 (0.596,0.671)	
	EDI (deciles) **in other areas**	1	16751	0.57 (0.492,0.66)		0.569 (0.491,0.66)		0.572 (0.494,0.663)		0.599 (0.516,0.694)		0.598 (0.515,0.694)	
		2	17342	0.616 (0.557,0.682)		0.615 (0.555,0.681)		0.619 (0.559,0.686)		0.634 (0.572,0.702)		0.635 (0.573,0.704)	
		3	12299	0.593 (0.546,0.644)		0.592 (0.545,0.643)		0.597 (0.549,0.648)		0.62 (0.571,0.674)		0.623 (0.573,0.678)	
		4	10802	0.596 (0.553,0.642)		0.595 (0.552,0.641)		0.602 (0.558,0.649)		0.613 (0.568,0.661)		0.614 (0.569,0.663)	
		5	11523	0.57 (0.528,0.616)		0.568 (0.526,0.614)		0.574 (0.531,0.62)		0.587 (0.543,0.635)		0.593 (0.548,0.641)	
		6	10898	0.613 (0.575,0.654)		0.612 (0.574,0.652)		0.621 (0.582,0.662)		0.624 (0.585,0.666)		0.633 (0.593,0.676)	
		7	10252	0.577 (0.54,0.616)		0.574 (0.538,0.613)		0.587 (0.55,0.627)		0.592 (0.554,0.633)		0.597 (0.558,0.638)	
		8	9432	0.53 (0.496,0.566)		0.528 (0.494,0.564)		0.543 (0.508,0.581)		0.55 (0.514,0.588)		0.555 (0.519,0.594)	
		9	11333	0.491 (0.459,0.525)		0.49 (0.458,0.524)		0.507 (0.474,0.543)		0.505 (0.471,0.541)		0.511 (0.477,0.548)	
		10	15976	0.452 (0.419,0.487)		0.45 (0.418,0.485)		0.476 (0.442,0.513)		0.479 (0.443,0.517)		0.486 (0.449,0.525)	
Age		40-45 y.o.[1]	92964			1		1		1		1	
		45-50 y.o.	94291			1.275 (1.247; 1.305)		1.27 (1.242; 1.299)		1.271 (1.242; 1.3)		1.258 (1.229; 1.286)	
CMU-C		No[1]	172456					1		1		1	
		Yes	14799					0.614 (0.584; 0.645)		0.613 (0.583; 0.645)		0.597 (0.567; 0.627)	
GP PLA (deciles)		1[1]	4959							1		1	
		2	6486							1.091 (0.99; 1.204)		1.078 (0.978; 1.19)	
		3	7123							1.064 (0.967; 1.172)		1.067 (0.969; 1.175)	
		4	10062							1.057 (0.966; 1.157)		1.044 (0.954; 1.144)	
		5	14074							1.159 (1.063; 1.264)		1.145 (1.05; 1.249)	
		6	17792							1.173 (1.078; 1.276)		1.158 (1.064; 1.261)	
		7	27034							1.217 (1.122; 1.321)		1.201 (1.107; 1.305)	
		8	33101							1.262 (1.165; 1.369)		1.247 (1.151; 1.354)	
		9	32681							1.193 (1.1; 1.295)		1.185 (1.092; 1.287)	
		10	33943							1.14 (1.05; 1.239)		1.161 (1.069; 1.262)	
Referring physician		No[1]	13378									1	
		Yes	173877									6.849 (6.275; 7.493)	

[1] Reference category

Mammography uptake multivariable logistic regression models (n= 154895): in > 74 y.o. women (Mammography uptake = 5.65%)								
			N	Model 1 LogLik	Model 2 LogLik	Model 3 LogLik	Model 4 LogLik	Model 5 LogLik
			Tot= 154895	OR (95%CI) -33537	OR (95%CI) -30948	OR (95%CI) -30936	OR (95%CI) -30890	OR (95%CI) -30674
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[2]	939	1	1	1	1	1
		2	2115	1.022 (0.904,1.154)	1.026 (0.906,1.162)	0.983 (0.95,1.018)	0.998 (0.88,1.131)	0.994 (0.877,1.127)
		3	3983	0.968 (0.849,1.104)	1.009 (0.883,1.154)	0.971 (0.934,1.009)	0.978 (0.855,1.119)	0.973 (0.85,1.114)
		4	6092	0.921 (0.803,1.055)	0.921 (0.802,1.058)	0.939 (0.902,0.976)	0.883 (0.769,1.015)	0.88 (0.765,1.011)
		5	5757	0.893 (0.784,1.017)	0.956 (0.838,1.092)	0.897 (0.863,0.933)	0.898 (0.785,1.027)	0.892 (0.779,1.02)
		6	9950	0.891 (0.784,1.013)	0.945 (0.829,1.077)	0.936 (0.901,0.973)	0.878 (0.769,1.002)	0.873 (0.765,0.997)
		7	10334	0.896 (0.789,1.019)	0.973 (0.854,1.108)	0.858 (0.825,0.892)	0.88 (0.77,1.006)	0.879 (0.769,1.005)
		8	10647	0.99 (0.873,1.123)	1.088 (0.957,1.238)	0.885 (0.85,0.922)	0.987 (0.865,1.127)	0.982 (0.86,1.121)
		9	10974	0.926 (0.821,1.044)	1.029 (0.911,1.163)	0.855 (0.823,0.888)	0.89 (0.782,1.012)	0.886 (0.779,1.008)
		10	9307	0.899 (0.802,1.007)	0.977 (0.87,1.097)	0.763 (0.737,0.79)	0.837 (0.74,0.948)	0.835 (0.738,0.946)
	EDI (deciles) **in other**	1	7482	0.77 (0.572,1.039)	0.765 (0.565,1.035)	0.784 (0.719,0.855)	0.793 (0.584,1.075)	0.786 (0.579,1.066)
		2	8759	0.78 (0.633,0.962)	0.767 (0.62,0.948)	0.845 (0.795,0.897)	0.791 (0.64,0.979)	0.782 (0.632,0.968)
		3	6862	0.701 (0.592,0.831)	0.708 (0.596,0.841)	0.817 (0.778,0.858)	0.742 (0.623,0.882)	0.733 (0.616,0.872)
		4	6193	0.645 (0.555,0.75)	0.671 (0.576,0.782)	0.833 (0.797,0.871)	0.662 (0.568,0.772)	0.659 (0.565,0.769)
		5	7566	0.539 (0.458,0.634)	0.552 (0.468,0.65)	0.78 (0.746,0.817)	0.55 (0.466,0.649)	0.547 (0.463,0.646)
		6	8023	0.696 (0.612,0.791)	0.726 (0.637,0.827)	0.838 (0.805,0.871)	0.692 (0.607,0.79)	0.686 (0.601,0.783)
		7	8076	0.65 (0.571,0.739)	0.696 (0.61,0.794)	0.824 (0.792,0.857)	0.657 (0.575,0.751)	0.65 (0.569,0.743)
		8	7774	0.728 (0.642,0.825)	0.774 (0.681,0.878)	0.833 (0.802,0.866)	0.727 (0.638,0.828)	0.717 (0.629,0.816)
		9	10269	0.706 (0.623,0.8)	0.776 (0.683,0.881)	0.762 (0.733,0.792)	0.728 (0.64,0.829)	0.72 (0.632,0.82)
		10	13793	0.693 (0.608,0.79)	0.757 (0.663,0.864)	0.718 (0.688,0.75)	0.675 (0.588,0.775)	0.666 (0.58,0.765)
Age		75-80 y.o.[2]	50815		1	1	1	1
		80-85 y.o.	48148		0.387 (0.368; 0.407)	0.387 (0.368; 0.407)	0.386 (0.367; 0.406)	0.385 (0.366; 0.405)
		85-90 y.o.	34698		0.152 (0.14; 0.165)	0.152 (0.14; 0.165)	0.151 (0.139; 0.164)	0.151 (0.139; 0.164)
		90-95 y.o.	16602		0.067 (0.057; 0.079)	0.067 (0.057; 0.079)	0.067 (0.056; 0.079)	0.067 (0.056; 0.079)
		95-100 y.o.	4632		0.024 (0.013; 0.038)	0.024 (0.013; 0.038)	0.023 (0.013; 0.038)	0.025 (0.014; 0.04)
CMU-C		No[2]	153807			1	1	1
		Yes	1088			0.443 (0.298; 0.63	0.443 (0.298; 0.63)	0.439 (0.295; 0.625)
GP PLA (deciles)		1[2]	4675				1	1
		2	5726				1.14 (0.94; 1.386)	1.138 (0.938; 1.383)
		3	5537				1.037 (0.851; 1.265)	1.035 (0.85; 1.263)
		4	7717				1.091 (0.909; 1.314)	1.085 (0.904; 1.306)
		5	9569				1.171 (0.983; 1.399)	1.17 (0.983; 1.399)
		6	11747				1.25 (1.056; 1.486)	1.25 (1.055; 1.486)
		7	18800				1.316 (1.12; 1.554)	1.312 (1.117; 1.549)
		8	25658				1.441 (1.231; 1.694)	1.44 (1.231; 1.695)
		9	30207				1.398 (1.195; 1.644)	1.403 (1.199; 1.65)
		10	35259				1.546 (1.322; 1.818)	1.555 (1.329; 1.829)
Referring physician		No[2]	5992					1
		Yes	148903					8.938 (6.66; 12.37)

[2] Reference category

Pap smear uptake multivariable logistic regression models (n= 63068) in 20-25 y.o. women (Pap smear uptake = 20.58 %)

			N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
			Tot= 63068	OR (95%CI)	-31988	OR (95%CI)	-31676	OR (95%CI)	-31675	OR (95%CI)	-31670	OR (95%CI)	-30989
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[3]	272	1		1		1		1		1	
		2	600	0.958 (0.864; 1.062)		0.951 (0.858; 1.056)		0.952 (0.859; 1.057)		0.956 (0.861; 1.062)		0.941 (0.846; 1.046)	
		3	1047	0.992 (0.888; 1.108)		0.985 (0.881; 1.101)		0.987 (0.882; 1.103)		0.987 (0.882; 1.105)		0.975 (0.87; 1.093)	
		4	1451	1.024 (0.914; 1.146)		1.021 (0.911; 1.143)		1.022 (0.913; 1.145)		1.029 (0.918; 1.154)		1.021 (0.91; 1.146)	
		5	1412	0.915 (0.823; 1.017)		0.905 (0.813; 1.007)		0.907 (0.815; 1.009)		0.922 (0.827; 1.028)		0.921 (0.825; 1.028)	
		6	2197	0.896 (0.803; 0.999)		0.889 (0.797; 0.992)		0.892 (0.799; 0.995)		0.903 (0.808; 1.009)		0.895 (0.8; 1.002)	
		7	2336	0.92 (0.828; 1.023)		0.901 (0.81; 1.002)		0.903 (0.812; 1.005)		0.923 (0.827; 1.03)		0.94 (0.841; 1.05)	
		8	2376	0.917 (0.824; 1.02)		0.895 (0.804; 0.997)		0.898 (0.806; 1)		0.925 (0.828; 1.033)		0.938 (0.838; 1.049)	
		9	2575	0.824 (0.746; 0.909)		0.801 (0.726; 0.885)		0.804 (0.728; 0.889)		0.834 (0.751; 0.927)		0.858 (0.771; 0.954)	
		10	2484	0.735 (0.67; 0.808)		0.733 (0.667; 0.805)		0.739 (0.672; 0.812)		0.772 (0.697; 0.856)		0.802 (0.722; 0.89)	
	EDI (deciles) **in other areas**	1	3700	0.696 (0.498; 0.953)		0.701 (0.501; 0.961)		0.701 (0.501; 0.962)		0.701 (0.5; 0.962)		0.729 (0.519; 1.005)	
		2	4599	0.895 (0.723; 1.101)		0.903 (0.729; 1.112)		0.903 (0.729; 1.113)		0.904 (0.729; 1.114)		0.902 (0.726; 1.114)	
		3	3387	0.938 (0.794; 1.105)		0.956 (0.809; 1.127)		0.957 (0.809; 1.128)		0.964 (0.814; 1.138)		0.963 (0.812; 1.139)	
		4	3098	0.779 (0.669; 0.906)		0.78 (0.669; 0.908)		0.781 (0.67; 0.909)		0.788 (0.675; 0.917)		0.784 (0.671; 0.914)	
		5	4188	0.846 (0.727; 0.983)		0.852 (0.731; 0.99)		0.853 (0.732; 0.992)		0.859 (0.736; 0.999)		0.849 (0.727; 0.989)	
		6	3814	0.839 (0.737; 0.955)		0.849 (0.745; 0.966)		0.85 (0.746; 0.967)		0.858 (0.752; 0.977)		0.849 (0.744; 0.969)	
		7	4205	0.835 (0.735; 0.948)		0.838 (0.737; 0.951)		0.84 (0.739; 0.954)		0.855 (0.751; 0.972)		0.837 (0.735; 0.954)	
		8	4074	0.77 (0.677; 0.875)		0.776 (0.682; 0.882)		0.778 (0.683; 0.885)		0.789 (0.692; 0.899)		0.78 (0.683; 0.89)	
		9	6237	0.797 (0.704; 0.902)		0.809 (0.713; 0.916)		0.812 (0.716; 0.919)		0.823 (0.725; 0.934)		0.826 (0.726; 0.939)	
		10	9016	0.655 (0.574; 0.746)		0.661 (0.579; 0.754)		0.665 (0.582; 0.758)		0.688 (0.6; 0.787)		0.701 (0.61; 0.803)	
Age		20-21y.o[3]	9827			1		1		1		1	
		21-22 y.o.	11080			1.234 (1.144; 1.33)		1.233 (1.144; 1.33)		1.234 (1.144; 1.33)		1.205 (1.117; 1.3)	
		22-23 y.o.	12631			1.516 (1.411; 1.628)		1.514 (1.41; 1.626)		1.516 (1.412; 1.628)		1.435 (1.335; 1.543)	
		23-24 y.o.	14064			1.709 (1.595; 1.832)		1.707 (1.593; 1.83)		1.711 (1.597; 1.834)		1.576 (1.47; 1.691)	
		24-25 y.o.	15466			2.102 (1.966; 2.249)		2.099 (1.963; 2.246)		2.104 (1.967; 2.25)		1.912 (1.787; 2.047)	
CMU-C		No[3]	54768					1		1		1	
		Yes	8300					0.968 (0.911; 1.028)		0.969 (0.912; 1.029)		0.899 (0.845; 0.955)	
GP PLA (deciles)		1[3]	1167							1		1	
		2	1569							1.057 (0.873; 1.281)		1.033 (0.851; 1.254)	
		3	1626							1.09 (0.903; 1.318)		1.069 (0.884; 1.295)	
		4	2498							1.096 (0.92; 1.307)		1.075 (0.902; 1.285)	
		5	3594							1.07 (0.906; 1.268)		1.055 (0.891; 1.252)	
		6	4813							1.026 (0.872; 1.21)		1.018 (0.864; 1.203)	
		7	7959							1.055 (0.902; 1.238)		1.039 (0.887; 1.222)	
		8	10982							1.074 (0.92; 1.257)		1.054 (0.902; 1.236)	
		9	12533							1.021 (0.875; 1.196)		1.011 (0.865; 1.186)	
		10	16327							0.986 (0.845; 1.155)		1.004 (0.859; 1.178)	
		No[3]	13716									1	
Referring physician		Yes	49352									2.859 (2.69; 3.042)	

[3] Reference category

Pap smear uptake multivariable logistic regression models (n= 252156) in > 65 y.o. women (Pap smear uptake = 5.69%)

			N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
			Tot= 252156	OR (95%CI)	-54676	OR (95%CI)	-48204	OR (95%CI)	-48196	OR (95%CI)	-48125	OR (95%CI)	-47675
Combined EDI and large urban/other areas	**EDI** (deciles) **in large urban areas**	1[4]	1669	1		1		1		1		1	
		2	3720	0.875 (0.805,0.951)		0.904 (0.83,0.985)		0.905 (0.83,0.985)		0.874 (0.801,0.953)		0.865 (0.793,0.944)	
		3	6672	0.822 (0.75,0.901)		0.903 (0.821,0.992)		0.903 (0.821,0.992)		0.874 (0.795,0.961)		0.866 (0.787,0.953)	
		4	9800	0.786 (0.714,0.865)		0.859 (0.779,0.948)		0.86 (0.78,0.949)		0.825 (0.748,0.911)		0.817 (0.74,0.902)	
		5	9294	0.743 (0.677,0.815)		0.858 (0.78,0.944)		0.859 (0.782,0.945)		0.809 (0.735,0.891)		0.805 (0.731,0.887)	
		6	15807	0.641 (0.584,0.705)		0.738 (0.669,0.813)		0.738 (0.67,0.813)		0.687 (0.622,0.758)		0.679 (0.615,0.749)	
		7	16336	0.69 (0.628,0.757)		0.833 (0.757,0.917)		0.834 (0.757,0.918)		0.763 (0.691,0.842)		0.764 (0.692,0.843)	
		8	16801	0.796 (0.727,0.872)		0.982 (0.894,1.079)		0.984 (0.895,1.081)		0.898 (0.815,0.99)		0.895 (0.812,0.987)	
		9	17022	0.685 (0.628,0.748)		0.855 (0.781,0.936)		0.858 (0.784,0.94)		0.748 (0.68,0.823)		0.745 (0.677,0.82)	
		10	14130	0.647 (0.596,0.702)		0.789 (0.725,0.858)		0.795 (0.73,0.865)		0.68 (0.621,0.745)		0.678 (0.619,0.743)	
	EDI (deciles) **in other areas**	1	14042	0.641 (0.517,0.795)		0.669 (0.537,0.834)		0.668 (0.536,0.833)		0.693 (0.555,0.865)		0.687 (0.55,0.858)	
		2	15838	0.571 (0.488,0.669)		0.6 (0.511,0.705)		0.6 (0.511,0.704)		0.616 (0.524,0.724)		0.607 (0.516,0.714)	
		3	11781	0.556 (0.49,0.63)		0.616 (0.542,0.7)		0.616 (0.542,0.7)		0.635 (0.558,0.723)		0.628 (0.551,0.715)	
		4	10633	0.522 (0.467,0.583)		0.61 (0.545,0.683)		0.61 (0.545,0.683)		0.603 (0.538,0.676)		0.596 (0.532,0.668)	
		5	12461	0.456 (0.405,0.513)		0.524 (0.464,0.591)		0.524 (0.464,0.591)		0.526 (0.466,0.594)		0.519 (0.459,0.586)	
		6	13160	0.5 (0.454,0.55)		0.598 (0.542,0.659)		0.598 (0.542,0.659)		0.577 (0.522,0.637)		0.569 (0.515,0.629)	
		7	12897	0.497 (0.452,0.547)		0.599 (0.544,0.66)		0.6 (0.544,0.661)		0.572 (0.518,0.631)		0.564 (0.511,0.623)	
		8	12297	0.508 (0.463,0.558)		0.612 (0.556,0.673)		0.612 (0.556,0.674)		0.579 (0.525,0.639)		0.57 (0.516,0.629)	
		9	15991	0.436 (0.396,0.481)		0.535 (0.484,0.591)		0.535 (0.485,0.591)		0.503 (0.454,0.556)		0.495 (0.447,0.548)	
		10	21805	0.461 (0.416,0.51)		0.587 (0.529,0.651)		0.589 (0.53,0.653)		0.528 (0.474,0.588)		0.519 (0.466,0.578)	
Age		65-70 y.o.[4]	48684			1		1		1		1	
		70-75 y.o.	48577			0.583 (0.56; 0.607)		0.582 (0.559; 0.606)		0.581 (0.558; 0.605)		0.578 (0.555; 0.601)	
		75-80 y.o.	50815			0.252 (0.24; 0.266)		0.252 (0.239; 0.265)		0.251 (0.238; 0.264)		0.247 (0.234; 0.26)	
		80-85 y.o.	48148			0.094 (0.087; 0.102)		0.094 (0.087; 0.101)		0.093 (0.086; 0.101)		0.092 (0.085; 0.099)	
		85-90 y.o.	34698			0.03 (0.026; 0.035)		0.03 (0.026; 0.035)		0.03 (0.026; 0.035)		0.029 (0.025; 0.034)	
		90-95 y.o.	16602			0.013 (0.01; 0.018)		0.013 (0.01; 0.018)		0.013 (0.009; 0.018)		0.013 (0.009; 0.018)	
		95-100 y.o.	4632			0.005 (0.002; 0.012)		0.005 (0.002; 0.012)		0.005 (0.002; 0.012)		0.005 (0.002; 0.012)	
CMU-C		No[4]	249945					1		1		1	
		Yes	2211					0.68 (0.558; 0.821)		0.676 (0.555; 0.816)		0.67 (0.55; 0.809)	
GP PLA (deciles)		1[4]	7805							1		1	
		2	9343							0.85 (0.731; 0.989)		0.842 (0.724; 0.98)	
		3	9254							0.885 (0.763; 1.028)		0.886 (0.763; 1.029)	
		4	12955							1.004 (0.877; 1.151)		0.995 (0.869; 1.141)	
		5	16421							1.054 (0.927; 1.202)		1.053 (0.926; 1.201)	
		6	19914							1.088 (0.96; 1.237)		1.08 (0.952; 1.227)	
		7	31912							1.147 (1.017; 1.296)		1.14 (1.011; 1.289)	
		8	42273							1.223 (1.087; 1.379)		1.214 (1.08; 1.37)	
		9	47761							1.282 (1.14; 1.446)		1.282 (1.14; 1.446)	
		10	54518							1.319 (1.173; 1.488)		1.327 (1.179; 1.497)	
Referring physician		No[4]	10487									1	
		Yes	241669									9.629 (7.764; 12.133)	

[4] Reference category

STROBE Statement—checklist of items included in the study "Social and territorial inequalities in gynaecological cancers screening uptake in France"

	Item No	Recommendation		Page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	X	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	X	2
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	X	5
Objectives	3	State specific objectives, including any prespecified hypotheses	X	5
Methods				
Study design	4	Present key elements of study design early in the paper	X	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	X	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	X	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	X	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	X	6-8
Bias	9	Describe any efforts to address potential sources of bias	X	6-9
Study size	10	Explain how the study size was arrived at	X	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	X	6-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	X	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	X	9
		(*c*) Explain how missing data were addressed	X	9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		

Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	X	7+10
		(b) Give reasons for non-participation at each stage	X	6+9
		(c) Consider use of a flow diagram	X	9 (no figure)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	X	9-10 + table 1 + suppl. Tables A
		(b) Indicate number of participants with missing data for each variable of interest	X	9
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	X	10-11 + Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	X	10-11+ Tables 2/3
		(*b*) Report category boundaries when continuous variables were categorized	X	8-10 + Tables 2/3
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	X	12-13 + Tables 2/3 + Suppl. Tables B
Discussion				
Key results	18	Summarise key results with reference to study objectives	X	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	X	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	X	16-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	X	16-19
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	X	21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at

http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Social and territorial inequalities in gynaecological cancers screening uptake: a cross-sectional study in France

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-055363.R1
Article Type:	Original research
Date Submitted by the Author:	14-Dec-2021
Complete List of Authors:	Ouanhnon, Lisa; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP Rougé Bugat, Marie-Eve ; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP LAMY, Sebastien; Institute Claudius Regaud; INSERM UMR_S 1027 Druel, Vladimir; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP Delpierre, Cyrille; INSERM UMR_S 1027; Université Toulouse III Paul Sabatier, Grosclaude, Pascale; INSERM UMR_S 1027; Institute Claudius Regaud
Primary Subject Heading:	Public health
Secondary Subject Heading:	Obstetrics and gynaecology, Sociology, Health policy, Epidemiology
Keywords:	Gynaecological oncology < GYNAECOLOGY, GENERAL MEDICINE (see Internal Medicine), Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, SOCIAL MEDICINE, PREVENTIVE MEDICINE

Title: Social and territorial inequalities in gynaecological cancers screening uptake: a cross-sectional study in France

Authors: Lisa Ouanhnon[1,2], Marie-Eve Rouge Bugat[1,2], Sébastien Lamy[2,4] Vladimir Druel[1,2], Cyrille Delpierre[2,3,*], Pascale Grosclaude [2,3,4,*]

Authors affiliations:

[1] DUMG (Département Universitaire de Médecine Générale), Université Toulouse 3 Paul Sabatier, France

[2] CERPOP, Université de Toulouse, Inserm, UPS, Toulouse, France

[3] Equipe Labellisée Ligue Contre le Cancer

[4] Institut Claudius Regaud, IUCT-O, Registre des cancers du Tarn, Toulouse, France

* these two authors have equally supervised the work

The research team is supported by the French association "La Ligue contre le cancer".

Corresponding author: Lisa Ouanhnon, 87 rue du Faubourg Bonnefoy 31500 Toulouse, France, lisa.ouanhnon@gmail.com, +33661594978

Word counts of the main text: 3176 and abstract: 287 words

Number of tables, figures and appendixes: 3 tables, 2 figures and 6 appendixes (2 tables A, 4 tables B)

Abstract

Objective The objective of this cross-sectional study was to investigate the impact of socio-territorial characteristics on mammography and pap smear uptake according to the place of residence in the recommended age groups, and secondly outside the recommended age groups.

Setting and participants We used an existing dataset of 1,027,039 women which combines data from the Health Insurance information systems, with census data from Midi-Pyrénées, France.

Primary and secondary outcome measures Our outcome was, for each woman, the uptake of the pap smear and the uptake of the mammography during the year.

Results A social gradient of screening uptake was found in the recommended age groups. This gradient was stronger in large urban areas:

- For mammography: decile 10 [the most deprived] vs 1 [the least deprived], adjusted OR= 0.777, 95%CI [0.748,0.808] in large urban area; adjusted OR= 0.808 for decile 1 to 0.726 for decile 10 in other areas vs decile 1 in urban areas ;
- For pap smear: decile 10 vs 1 adjusted OR= 0.66, 95%CI [0.642,0.679] in large urban areas; adjusted OR= 0.747 for decile 1 to 0.562 for decile 10 in other areas vs decile 1 in urban areas).

Screening rates were globally higher in large urban areas.

For mammography, the social and territorial disparities were higher outside the recommended age group.

Conclusions Offering a universal approach to every woman, as it is often the case in nationally organised screening programmes, is likely to be insufficient to ensure real equity in access. Developing global dataset combining health data and diverse socioeconomic data, at individual and contextual levels, could enable a better understanding of the mechanisms involved in this

social gradient, and therefore the development of targeted territorial actions to improve equity of access to healthcare.

Keywords

Breast cancer screening; Cervical cancer screening; Screening programme participation; Women health; Socioeconomic inequalities; Geographic inequalities; Deprivation index.

Strengths and limitations of this study

- The use of health insurance data, merged with socio-territorial information, allowed for a very powerful and comprehensive study on social inequalities in health (database of 2.5 million of individuals or 88% of the region's total population).
- We used both individual and contextual variables to investigate the link between an ecological deprivation index and breast and cervical cancers screening.
- We performed a sequential regression (variables were successively added in the multivariable model) to investigate the role of each variable in the link between the ecological deprivation index and screening and studied the interaction between EDI and the type of place of residence
- Our data covered only 1 year and we had a limited number of individual and contextual variables in our dataset.

Abbreviations:

CMU-C: Couverture Médicale Universelle-Comprélmentaire (Supplementary Universal Healthcare Coverage)

EDI: European deprivation Index

GP: General Practitioner

INSEE: Institut National de la Statistique et des Etudes Economiques (French National Institute of Statistics and Economic Studies)

IRIS: Ilots Regroupés pour l'Information statistique (aggregated units for statistical information)

OR: Odds-Ratio

PLA: Potential Localised Accessibility

SEP: Socioeconomic Position

1. Introduction

Breast and cervical cancers are the two most frequent cancersin women worldwide. They kill more than 600,000 and 300,000 women, respectively, every year (1).

For breast cancer in France, through the nationally organised screening programme, all women between 50 and 74 years old are offered a mammography every 2 years (2). For cervical cancer, a national screening programme is progressively being implemented (3). Before 2018, guidelines recommended a pap smear every 3 years between 25 and 65 years old.

In France, the participation rate is around 50% for breast cancer screening and 60% for cervical cancer (4). Despite an universal health coverage policy, mammography and pap smear uptake, and therefore breast and cervical cancer survival, vary considerably with factors like socioeconomic position (SEP) and place of residence (5–8). This raises the question of the determinants of universal access, in particular physical accessibility (availability, reasonable reach), financial affordability (healthcare cost, transportation, time away from work) and sociocultural accessibility (perceived effectiveness, social and cultural factors) (9,10). All these dimensions may be socially distributed and partly explain the inequalities of screening uptake.

Disentangling underlying mechanisms leading to these inequalities is a first step to address them. However, further studies on this topic have been made difficult by the lack of large and representative dataset combining socioeconomic, territorial, and healthcare data (11).

We used French healthcare insurance reimbursement data, merged with socio-territorial information, to assess and investigate the influence of deprivationon mammography and pap smear uptake,according to the place of residence, in the recommended age groups, and secondly outside the recommended age groups. To this end, we investigated the role of variables indicating financial precarity, healthcare accessibility, and adherence to the healthcare system.

2. Methods

Study design

We used a dataset combining data from health insurance information systems with census data, based on the address of residence. This dataset has been described in detail elsewhere (12).

The health data was prospectively collected by the three main health insurance providers for 2012.

Population

This dataset included individuals who were beneficiaries of any of the three health insurance providers on the 31st of December 2012 in Midi-Pyrénées. The individuals with an incomplete address or with differences in the management of their data were excluded. We obtained a base of 2,574,310 subjects (88% of the region's total population).

For this study, we focused on women over 20 years old (1,027,039 women), as cancers screening is rarely offered to women below that age.

Patient and public involvement

Patients or the public were not involved in the design of our study.

Collected variables

- Main outcomes

Our outcome was, for each woman, the uptake of the pap smear and the uptake of the mammography. It was categorised as a binary variable for each screening test to discriminate the women who had at least one mammography/pap smear during the year, and the other ones. Regarding mammography, we only included screening exams, but we could not differentiate between opportunistic and organised screening.

- Main explanatory variables

In the absence of individual social data, social condition of the participants was approached by an ecological deprivation index, the European Deprivation Index (13). The EDI approaches SEP by measuring social deprivation as defined by Townsend as "a state of observable and demonstrable disadvantage relative to the local community or the wider society to which an individual, family or group belongs". To calculate the EDI, we used the aggregated unit for statistical information ('IRIS') corresponding to the person's address. IRIS is the smallest geographical unit for which statistics are available in France, which represents about 2,000 inhabitants. Each IRIS was assigned an EDI value, calculated with census data. We used an EDI presentation in deciles, calculated from all the IRISs of the region: decile 1 corresponds to the least deprived zones, decile 10 to the most deprived zones.

- Covariates

We considered age as a potential confounder. As the association between this variable and the outcomes clearly appeared non-linear, we categorised it (into 5-year groups).

As an ecological index of deprivation, EDI is assumed to be capturing both intrinsic properties of the individuals in the area and contextual properties of the area (14). To explore the mechanisms involved in the link between EDI and screening uptake, we chose to study various factors, including one individual and one contextual:

- The Supplementary Universal Healthcare Coverage (CMU-C), is offered to individuals who earn less than a defined income threshold, to pay for their healthcare expenses. This characteristic was used as a proxy for individual financial precarity. Our hypothesis was that financial precarity, by limiting financial accessibility, was key in the link between deprivation and screening participation.

- Healthcare supply is a contextual property influencing deprivation. We assumed that this factor could partly explain the link between EDI and screening uptake by measuring physical accessibility. Healthcare supply at IRIS level was approached by the Potential Localised Accessibility (PLA) to the GP. The PLA calculates the distance-weighted supply and the local demand, measured by the age-differentiated rate of access. It is interpreted as a medical density (number of full-time equivalents for 100 000 inhabitants) (15).

We assumed that the overall healthcare system adherence could also explain part of the association between deprivation and screening uptake. Therefore, we used a binary variable that discriminates between the patients who had no designated referring physician (in most cases a General Practitioner (GP)) and the ones who had one. This health-seeking behaviour is a property of individuals but is likely to be influenced by both individual and contextual factors (16).

Healthcare supply and transport facilities are very different in rural and urban areas (17–19). We assumed that the level of urbanisation of the place of residence could modify the social gradient of screening uptake. Based on the French National Institute of Statistics and Economic Studies (INSEE)'s 2010 zoning in urban areas, we built a variable to distinguish the large urban centres (more than 10 000 jobs) and their suburbs (urban units in which at least 40% of the active residents work in the urban centre or in the towns attracted by it) (20), from the rest of the region. In the descriptive analysis, we differentiated among large urban areas between Toulouse metropolis, the regional capital which covers almost a quarter of the region's population, and the other areas.

Our conceptual model showing how these variables interact is presented in Figure 1.

Statistical analysis

To describe the sample, we performed univariate analyses: we tested the association between the main explanatory variable and the outcomes, between each covariate and the outcomes, and between each covariate and the EDI.

We used a multivariable logistic regression model to analyse the association between EDI and the mammography and pap smear uptake, adjusted for all the previously identified confounders and intermediate variables. We performed a sequential regression. The variables were successively added to the model following a pre-defined order: the main explanatory variable alone first, then the confounder, and lastly the intermediate variables (at an individual then at a contextual level).

We studied the interaction between EDI and the type of place of residence (large urban/other areas) in the model through a new variable: a 20-modal indicator with ten modalities (corresponding to the EDI deciles) per type of geographical area.

We undertook some age groups analyses to study women outside the recommended age groups (younger and older). For younger women, we focused on women aged 20 to 25 for pap smear and 40 to 50 for mammography. Our hypothesis was that social and territorial inequalities were higher for women outside the recommended age groups.

Since we used data that are systematically recorded by health insurance providers, we expected very little missing data. This was therefore negligible in light of the global sample size (around 0.01%): a complete case analysis could be used.

Statistical analyses were performed with R software (R x64 3.0.2) (21).

3. Results

Selected population in the recommended age groups for mammography (50-74 years old) and pap smear (25-65 years old), were composed of 365 947 and 711 803 women respectively

(Table 1). Among these women, 31% had had at least one mammography during the year, and 29% at least one pap smear. Almost two thirds of the population lived in large urban areas. A major part of the most disadvantaged women lived in the Toulouse metropolis (Supplementary material Appendix 1, Tables A). Around 8% of the 25-65 women and less than 4% of the 50-74 had the CMU-C. 92% of the 25-65 women and 95% of the 50-74 had a designated referring physician.

The more deprived the area of residence, the lower the breast and cervical cancers screening uptakes (p-value < 0.001) (Table 1). Regarding age, the mammography rate seemed rather constant throughout the recommended ages. Pap smear uptake decreased a lot after 55 years old (from 31% to 23% between the 45-50 and the 55–60-year-old groups). Women with CMU-C had a lower screening uptake rate. We noticed a slight territorial gradient: the higher the GP density, the higher the mammography and pap smear uptake, except for the last two deciles. The women living in large urban areas had a higher screening rate than the ones living in the rest of the region. Women who had a designated referring physician had a higher screening rate (32% vs 5% for mammography, 31% vs 8% for pap smear, p-value < 0.001).

Adding the interaction term between EDI and the type of place of residence (large urban/other areas) improved our models (better likelihood, p-value= 0.0048 for mammography uptake and 0.0040 for pap smear uptake). Tables 2 and 3 present the logistic regression of mammography and pap smear uptake in the recommended age groups: first the odds-ratios associated with the variable combining EDI and the type of place of residence (large urban/other areas), then the result of the sequential adjustments, and lastly the final multivariable regression model.

For mammography (Table 2), an effect of EDI on mammography uptake was observed, through a social gradient: the screening uptake regularly decreased with increasing deprivation. This social gradient was mostly observed in large urban areas (decile 10 vs 1 adjusted OR= 0.777, 95%CI [0.748,0.808]). Thesocial gradient was less strong in the other areas, where mammography rate was globally lower than in urban areas. Influence of financial precarity was corroborated by CMU-C impact on screening uptake (adjusted OR= 0.644, 95%CI [0.618; 0.671]). The territorial gradient based on GP accessibility was confirmed. Adding this variable decreased only slightly the difference between large urban and other areas. The link between mammography and having a designated referring physician was confirmed as well (adjusted OR = 8.45, 95%CI [7.946; 8.996]). Age had a very limited effect on mammography uptake. Sequential inclusion of all these variables in the model modified only slightly the link between EDI and screening uptake.

For pap smear (Table 3), a strong social gradient was observed. This gradient was slightly stronger in large urban areas (decile 10 vs 1 adjusted OR= 0.66, 95%CI [0.642,0.679]) than in the rest of the region (adjusted OR= 0.747 for decile 1 to 0.562 for decile 10 in other areas vs decile 1 in urban areas). Influence of financial precarity was corroborated by CMU-C impact on screening uptake (adjusted OR= 0.669). The territorial gradient (based on GP accessibility) was confirmed but, as for mammography, adding this variable decreased only slightly the difference between large urban and other areas. The multivariable analysis confirmed the association between having a designated referring physician and pap smear uptake (adjusted OR = 5.39 95%CI [5.227; 5.557]). An effect of age on pap smear uptake was also found (adjusted OR= 0.59, 95% CI [0.574; 0.601] for 55-60 year-old women vs 25-30 women). Sequential inclusion of all these variables in the model modified only slightly the link between EDI and screening uptake.

We used the same approach for women outside the recommended age groups (Figure 2 & supplementary material Appendix 2, Tables B). Among younger women (40-50 years old for mammography and 20-25 for pap smear), both mammography and pap smear uptakes in the year were around 21%. Among women older than the recommended age, participation rates were around 6% for both breast and cervical cancers. Figure 2 shows that the social gradient in mammography uptake was substantially stronger in women between the ages of 40 and 50, and more so in large urban areas. For pap smear uptake, social gradient seemed less strong in younger women. Regarding GP accessibility, we observed a stronger territorial gradient for older women, for both screening uptakes.

	Total 50-74 y.o N=365 947 N (%)	**No mammography** n (%) n= 253 354	**≥ 1 mammography** n (%) n= 112 593 (30.77)	**Total 25-65 y.o N=711 803 N (%)**	**No pap smear** n (%) n= 506 731 (71.19)	**≥ 1 pap smear** n (%) n= 205 072 (28.81)
EDI			*			*
1 (best)	31201 (8.53)	20675 (66.26)	10526 (33.74)	62238 (8.74)	40787 (65.53)	21451 (34.47)
2	34826 (9.52)	23263 (66.8)	11563 (33.2)	70952 (9.97)	47640 (67.14)	23312 (32.86)
3	30111 (8.23)	20414 (67.8)	9697 (32.2)	60763 (8.54)	41703 (68.63)	19060 (31.37)
4	31564 (8.63)	21596 (68.42)	9968 (31.58)	60572 (8.51)	42269 (69.78)	18303 (30.22)
5	32733 (8.94)	22750 (69.5)	9983 (30.5)	65031 (9.14)	46072 (70.85)	18959 (29.15)
6	39518 (10.8)	27130 (68.65)	12388 (31.35)	73464 (10.32)	53153 (72.35)	20311 (27.65)
7	38825 (10.61)	27107 (69.82)	11718 (30.18)	72276 (10.15)	52119 (72.11)	20157 (27.89)
8	37868 (10.35)	26309 (69.48)	11559 (30.52)	70412 (9.89)	51084 (72.55)	19328 (27.45)
9	42390 (11.58)	29998 (70.77)	12392 (29.23)	82232 (11.55)	60646 (73.75)	21586 (26.25)
10 (worst)	46911 (12.82)	34112 (72.72)	12799 (27.28)	93863 (13.19)	71258 (75.92)	22605 (24.08)
Age (/5years)			*			*
25-30 y.o.	-	-	-	82413 (11.58)	56617 (68.7)	25796 (31.3)
30-35 y.o.	-	-	-	88249 (12.4)	58932 (66.78)	29317 (33.22)
35-40 y.o.	-	-	-	85200 (11.97)	57150 (67.08)	28050 (32.92)
40-45 y.o.	-	-	-	92964 (13.06)	63042 (67.81)	29922 (32.19)
45-50 y.o.	-	-	-	94291 (13.25)	64872 (68.8)	29419 (31.2)
50-55 y.o.	88241 (24.11)	61449 (69.64)	26792 (30.36)	88241 (12.4)	64145 (72.69)	24096 (27.31)
55-60 y.o.	83126 (22.72)	57836 (69.58)	25290 (30.42)	83126 (11.68)	64120 (77.14)	19006 (22.86)
60-65 y.o.	81209 (22.19)	55168 (67.93)	26041 (32.07)	81209 (11.41)	64544 (79.48)	16665 (20.52)
65-70 y.o.	64794 (17.71)	44289 (68.35)	20505 (31.65)	16110 (2.26)[1]	13309 (82.61)	2801 (17.39)
70-75 y.o.	48577 (13.27)	34612 (71.25)	13965 (28.75)	-	-	-
CMU-C			*			*
No CMU-C	351872 (96.15)	242406 (68.89)	109466 (31.11)	655969 (92.16)	463517 (70.66)	192452 (29.34)
CMU-C	14075 (3.85)	10948 (77.78)	3127 (22.22)	55834 (7.84)	43214 (77.4)	12620 (22.6)
GP PLA			*			*
1 (worst)	11427 (3.12)	8212 (71.86)	3215 (28.14)	18607 (2.61)	13784 (74.08)	4823 (25.92)
2	13767 (3.76)	9738 (70.73)	4029 (29.27)	24385 (3.43)	17816 (73.06)	6569 (26.94)
3	14455 (3.95)	10195 (70.53)	4260 (29.47)	26121 (3.67)	18888 (72.31)	7233 (27.69)
4	20582 (5.62)	14258 (69.27)	6324 (30.73)	37307 (5.24)	26610 (71.33)	10697 (28.67)
5	26405 (7.22)	18029 (68.28)	8376 (31.72)	49815 (7)	35139 (70.54)	14676 (29.46)
6	32262 (8.82)	21930 (67.97)	10332 (32.03)	63615 (8.94)	44311 (69.65)	19304 (30.35)
7	50863 (13.9)	34371 (67.58)	16492 (32.42)	98949 (13.9)	68782 (69.51)	30167 (30.49)
8	62331 (17.03)	42592 (68.33)	19739 (31.67)	123460 (17.34)	86465 (70.03)	36995 (29.97)
9	64131 (17.52)	44615 (69.57)	19516 (30.43)	127253 (17.88)	90793 (71.35)	36460 (28.65)
10 (best)	69724 (19.05)	49414 (70.87)	20310 (29.13)	142291 (19.99)	104143 (73.19)	38148 (26.81)
Urbanisation			*			*
Toulouse	72919 (19.93)	49978 (68.54)	22941 (31.46)	180030 (25.59)	123038 (68.34)	56992 (31.66)
Large urban areas	150755 (41.2)	102663 (68.1)	48092 (31.9)	302563 (42.51)	211072 (69.76)	91491 (30.24)
Other areas	142273 (38.88)	100713 (70.79)	41560 (29.21)	229210 (32.2)	172621 (75.31)	56589 (24.69)
RP[2]			*			*
No	20032 (5.47)	18963 (94.66)	1069 (5.34)	57596 (8.09)	52948 (91.93)	4648 (8.07)
Yes	345915 (94.53)	234391 (67.76)	111524 (32.24)	654207 (91.91)	453783 (69.36)	200424 (30.64)

Table1: **Socio-demographic characteristics of women**

[1] Only 65 y.o. women
[2] RP : Designated referring physician
*: p-value <0.001

***Table 2*: Mammography uptake in recommended age group: multivariable logistic regression models (mammography uptake = 30.77%)**

		N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
		Tot= 365947	OR (95%CI)	-225465	OR (95%CI)	-225373	OR (95%CI)	-225160	OR (95%CI)	-225115	OR (95%CI)	-220891
Combined EDI and large urban/other areas	1[3]	2 719	1		1		1		1		1	
	2	5 896	0.981 (0.948,1.016)		0.982 (0.948,1.016)		0.983 (0.95,1.018)		0.983 (0.949,1.018)		0.976 (0.942,1.011)	
	3	10 112	0.967 (0.931,1.005)		0.968 (0.932,1.006)		0.971 (0.934,1.009)		0.968 (0.932,1.007)		0.962 (0.925,1)	
	4	13 232	0.933 (0.897,0.97)		0.934 (0.898,0.971)		0.939 (0.902,0.976)		0.934 (0.897,0.971)		0.927 (0.891,0.965)	
	5	12 730	0.889 (0.856,0.924)		0.89 (0.857,0.925)		0.897 (0.863,0.933)		0.9 (0.865,0.936)		0.897 (0.862,0.933)	
	6	19 906	0.928 (0.893,0.965)		0.929 (0.894,0.966)		0.936 (0.901,0.973)		0.932 (0.896,0.969)		0.927 (0.891,0.964)	
EDI (deciles) in large urban areas	7	20 092	0.849 (0.816,0.883)		0.85 (0.817,0.884)		0.858 (0.825,0.892)		0.861 (0.826,0.896)		0.864 (0.83,0.9)	
	8	20 741	0.872 (0.837,0.908)		0.873 (0.838,0.909)		0.885 (0.85,0.922)		0.893 (0.857,0.931)		0.895 (0.858,0.933)	
	9	20 679	0.838 (0.807,0.871)		0.84 (0.809,0.872)		0.855 (0.823,0.888)		0.86 (0.827,0.895)		0.867 (0.833,0.903)	
	10	16 166	0.733 (0.708,0.759)		0.734 (0.709,0.76)		0.763 (0.737,0.79)		0.771 (0.742,0.801)		0.777 (0.748,0.808)	
	1	28 482	0.782 (0.718,0.853)		0.783 (0.718,0.854)		0.784 (0.719,0.855)		0.811 (0.743,0.884)		0.808 (0.74,0.882)	
	2	28 930	0.841 (0.791,0.893)		0.842 (0.792,0.894)		0.845 (0.795,0.897)		0.861 (0.81,0.915)		0.855 (0.804,0.91)	
	3	19 999	0.814 (0.775,0.855)		0.814 (0.775,0.855)		0.817 (0.778,0.858)		0.838 (0.798,0.881)		0.834 (0.793,0.877)	
EDI (deciles) in other areas	4	18 332	0.829 (0.793,0.866)		0.829 (0.793,0.867)		0.833 (0.797,0.871)		0.845 (0.808,0.883)		0.84 (0.803,0.879)	
	5	20 003	0.777 (0.742,0.813)		0.777 (0.742,0.813)		0.78 (0.746,0.817)		0.797 (0.761,0.835)		0.794 (0.758,0.832)	
	6	19 612	0.831 (0.799,0.864)		0.832 (0.801,0.866)		0.838 (0.805,0.871)		0.847 (0.815,0.881)		0.846 (0.813,0.881)	
	7	18 733	0.816 (0.785,0.848)		0.817 (0.786,0.85)		0.824 (0.792,0.857)		0.834 (0.801,0.867)		0.829 (0.797,0.863)	
	8	17 127	0.824 (0.793,0.857)		0.825 (0.794,0.858)		0.833 (0.802,0.866)		0.846 (0.813,0.88)		0.842 (0.809,0.876)	
	9	21 711	0.751 (0.722,0.78)		0.751 (0.722,0.781)		0.762 (0.733,0.792)		0.767 (0.737,0.798)		0.767 (0.737,0.799)	
	10	30 745	0.702 (0.672,0.732)		0.703 (0.674,0.734)		0.718 (0.688,0.75)		0.729 (0.698,0.762)		0.726 (0.694,0.759)	
Age (y.o)	50-55[3]	88 241			1		1		1		1	
	55-60	83 126			1.006 (0.985; 1.027)		1.002 (0.982; 1.023)		1.002 (0.982; 1.023)		0.997 (0.977; 1.018)	
	60-65	81 209			1.088 (1.066; 1.111)		1.077 (1.055; 1.099)		1.077 (1.055; 1.1)		1.066 (1.044; 1.088)	
	65-70	64 794			1.07 (1.047; 1.094)		1.052 (1.029; 1.076)		1.052 (1.029; 1.076)		1.035 (1.012; 1.058)	
	70-75	48 577			0.938 (0.916; 0.961)		0.919 (0.897; 0.942)		0.919 (0.897; 0.942)		0.897 (0.875; 0.919)	
CMU-C	No[3]	351 872					1		1		1	
	Yes	14 075					0.659 (0.633; 0.686)		0.659 (0.633; 0.687)		0.644 (0.618; 0.671)	
GP PLA	1[3]	11 427							1		1	
	2	13 767							1.023 (0.968; 1.081)		1.013 (0.958; 1.072)	
	3	14 455							1.027 (0.972; 1.084)		1.018 (0.964; 1.076)	
	4	20 582							1.068 (1.015; 1.124)		1.054 (1.002; 1.11)	
	5	26 405							1.111 (1.058; 1.167)		1.102 (1.048; 1.158)	
	6	32 262							1.118 (1.066; 1.173)		1.103 (1.051; 1.158)	
	7	50 863							1.14 (1.089; 1.194)		1.126 (1.075; 1.18)	
	8	6 2331							1.143 (1.092; 1.195)		1.126 (1.076; 1.179)	
	9	64 131							1.106 (1.057; 1.157)		1.096 (1.047; 1.148)	
	10	69 724							1.081 (1.033; 1.132)		1.081 (1.032; 1.132)	
Referring physician	No[3]	20 032									1	
	Yes	345 915									8.45 (7.946; 8.996)	

[3] Reference category

Table 3: Pap smear uptake multivariable logistic regression models in recommended age group (Pap smear uptake = 28.81%)												
		N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
		Total= 711803	OR (95%CI)	-424737	OR (95%CI)	-420964	OR (95%CI)	-420368	OR (95%CI)	-420310	OR (95%CI)	-411557
Combined	1[4]	4 741	1		1		1		1		1	
EDI and large	2	9 906	0.945 (0.923,0.968)		0.936 (0.914,0.959)		0.939 (0.917,0.962)		0.929 (0.907,0.952)		0.922 (0.899,0.945)	
urban/other	3	16 889	0.918 (0.894,0.942)		0.902 (0.879,0.927)		0.908 (0.884,0.932)		0.897 (0.873,0.921)		0.889 (0.865,0.913)	
areas	4	21 643	0.887 (0.863,0.912)		0.878 (0.854,0.902)		0.886 (0.862,0.91)		0.878 (0.854,0.903)		0.873 (0.849,0.898)	
	5	20 561	0.833 (0.811,0.855)		0.816 (0.795,0.838)		0.826 (0.804,0.848)		0.817 (0.795,0.839)		0.816 (0.794,0.839)	
	6	31 816	0.793 (0.772,0.815)		0.781 (0.76,0.803)		0.792 (0.771,0.814)		0.78 (0.759,0.802)		0.781 (0.759,0.803)	
EDI (deciles)	7	31 628	0.801 (0.78,0.823)		0.788 (0.766,0.81)		0.8 (0.778,0.822)		0.791 (0.769,0.813)		0.805 (0.782,0.828)	
in large urban	8	32 394	0.806 (0.784,0.829)		0.788 (0.766,0.81)		0.806 (0.783,0.828)		0.801 (0.778,0.824)		0.81 (0.787,0.834)	
area	9	33 163	0.735 (0.716,0.754)		0.716 (0.698,0.735)		0.738 (0.719,0.758)		0.729 (0.709,0.749)		0.748 (0.727,0.769)	
	10	26 469	0.616 (0.601,0.631)		0.602 (0.588,0.618)		0.643 (0.627,0.659)		0.636 (0.619,0.653)		0.66 (0.642,0.679)	
	1	57 497	0.723 (0.678,0.773)		0.735 (0.688,0.785)		0.737 (0.69,0.787)		0.749 (0.701,0.801)		0.747 (0.699,0.799)	
	2	61 046	0.703 (0.671,0.738)		0.72 (0.686,0.755)		0.724 (0.69,0.759)		0.731 (0.697,0.767)		0.732 (0.697,0.768)	
	3	43 874	0.685 (0.659,0.711)		0.704 (0.677,0.731)		0.707 (0.681,0.735)		0.715 (0.688,0.744)		0.716 (0.689,0.745)	
EDI (deciles)	4	38929	0.667 (0.644,0.69)		0.684 (0.661,0.709)		0.69 (0.666,0.714)		0.693 (0.669,0.718)		0.693 (0.669,0.718)	
in other area	5	44470	0.628 (0.606,0.651)		0.645 (0.623,0.669)		0.65 (0.627,0.674)		0.655 (0.631,0.679)		0.659 (0.635,0.683)	
	6	41648	0.608 (0.59,0.627)		0.626 (0.607,0.645)		0.632 (0.613,0.652)		0.631 (0.611,0.651)		0.637 (0.617,0.657)	
	7	40648	0.619 (0.6,0.638)		0.637 (0.618,0.657)		0.647 (0.628,0.668)		0.646 (0.626,0.666)		0.648 (0.628,0.669)	
	8	38018	0.591 (0.574,0.61)		0.61 (0.591,0.629)		0.621 (0.602,0.641)		0.62 (0.601,0.64)		0.622 (0.603,0.642)	
	9	49069	0.559 (0.542,0.577)		0.573 (0.556,0.591)		0.588 (0.57,0.607)		0.582 (0.564,0.601)		0.59 (0.571,0.609)	
	10	67394	0.524 (0.506,0.542)		0.533 (0.516,0.552)		0.556 (0.537,0.575)		0.552 (0.533,0.572)		0.562 (0.542,0.582)	
Age (y.o)	25-30[4]	82413			1		1		1		1	
	30-35	88249			1.084 (1.062; 1.106)		1.08 (1.059; 1.103)		1.081 (1.059; 1.104)		1.06 (1.038; 1.082)	
	35-40	85200			1.063 (1.042; 1.085)		1.056 (1.035; 1.078)		1.057 (1.035; 1.079)		1.021 (1; 1.043)	
	40-45	92964			1.031 (1.01; 1.052)		1.021 (1; 1.042)		1.021 (1.001; 1.042)		0.963 (0.944; 0.984)	
	45-50	94291			0.988 (0.968; 1.008)		0.975 (0.955; 0.995)		0.975 (0.956; 0.996)		0.906 (0.888; 0.925)	
	50-55	88241			0.826 (0.809; 0.843)		0.811 (0.794; 0.828)		0.812 (0.795; 0.829)		0.749 (0.733; 0.765)	
	55-60	83126			0.655 (0.64; 0.669)		0.641 (0.627; 0.655)		0.641 (0.627; 0.656)		0.587 (0.574; 0.601)	
	60-65	81209			0.573 (0.56; 0.586)		0.558 (0.545; 0.57)		0.558 (0.546; 0.571)		0.507 (0.496; 0.519)	
	65	16110			0.468 (0.448; 0.488)		0.454 (0.434; 0.474)		0.454 (0.435; 0.474)		0.413 (0.395; 0.431)	
CMU-C	No[4]	655969					1		1		1	
	Yes	55834					0.696 (0.681; 0.711)		0.695 (0.681; 0.71)		0.669 (0.655; 0.684)	
GP PLA												
(deciles)	1[4]	18607							1		1	
	2	24385							0.966 (0.925; 1.01)		0.951 (0.909; 0.994)	
	3	26121							0.982 (0.941; 1.026)		0.97 (0.928; 1.013)	
	4	37307							1.004 (0.965; 1.046)		0.989 (0.95; 1.031)	
	5	49815							1.01 (0.971; 1.05)		0.991 (0.952; 1.03)	
	6	63615							1.033 (0.994; 1.073)		1.017 (0.978; 1.056)	
	7	98949							1.049 (1.011; 1.088)		1.031 (0.993; 1.069)	
	8	123460							1.086 (1.048; 1.126)		1.068 (1.03; 1.108)	
	9	127253							1.056 (1.018; 1.095)		1.046 (1.009; 1.086)	
	10	142291							1.03 (0.993; 1.069)		1.049 (1.011; 1.088)	
Referring	No[4]	57596									1	
physician	Yes	654207									5.389 (5.227; 5.557)	

[4] Reference category

4. Discussion

Our study highlighted a link between deprivation andbreast and cervical cancers screening uptake, in and outside the recommended age groups. This link follows a social gradient across all socioeconomic levels. The gradient was stronger in large urban areas. The successive inclusion of variables indicating financial precarity, healthcare accessibility, and adherence to the healthcare system decreased only very slightly the association, suggesting that these variables explain a very limited extent of the link between EDI and screening uptake. The social and territorial disparities in mammography uptake were lower in the recommended age group than outside.

The main strength of our study is its power and comprehensiveness, achieved by using health insurance data. Using both individual and contextual variables to investigate the link between an ecological deprivation index and screening uptake is original. Another original aspect is the exploration of screening uptake outside the recommended age groups and the observation of two different implementation modes for national recommendations (with and without a screening programme). Our study also has limitations. As our data covered only 1 year, we could not differentiate between women who had screening tests every year (more often than recommended) and the ones who had it every two and three years as recommended. It raises the question of excess screening and its link with SEP. In our dataset, pap smears prescribed for diagnostic purposes could not be distinguished from those performed in a screening context. The limited number of individual and contextual variables in our dataset restrained our capability to disentangle what could be explained by contextual and individual properties in the associations we observed with EDI. The same difficulty limited the exploration of financial, physical, and sociocultural accessibility mechanisms involved in the social gradient.

We complemented existing literature on social inequalities in access to mammography and pap smear. The link between deprivation and screening participation was found in numerous countries all over the word, irrespective of the local healthcare policy. In the United States, where no centrally organised cancer screening programme exists, this link was repeatedly reported at an individual and at an area levels (22–25). In most Western European countries, nationally organised screening programmes are in place. The studies conducted there also showed an impact of SEP (26–28). In France, the lack of individual socioeconomic variable in healthcare datasets has made it difficult to obtain large and representative evidence. A few cohort studies have been conducted, but were limited by the relatively small sample size (7,29,30). Using healthcare insurance reimbursement data merged with sociodemographic information made it possible to assess the impact of socioterritorial inequalities in larger studies, more representative of the French population (31).

Our study tried to identify some of the mechanisms involved in the link between deprivation and screening uptake. One of our hypotheses was that deprivation leads to limitations of the three dimensions of healthcare accessibility: financial, physical, and sociocultural. We used CMU-C to explore the effect of financial precarity in the link between deprivation and screening uptake and GP PLA, a proxy for healthcare supply, to reflect physical accessibility. Our result suggests that the association between deprivation and screening uptake is very slightly influenced by these variables. This could be due to the choice of variables used in our model. CMU-C may not be enough precise to measure financial accessibility. GP PLA is a good proxy for physical accessibility to primary care, but maybe not to specialty care. Regarding sociocultural accessibility, no truly relevant variable was available in our dataset. Our results showed that the overall adherence to the healthcare system, approached by having a referring physician, only modified slightly the link between EDI and screening uptake. However sociocultural accessibility covers several concepts. Using psychological models, R. Crockett explained that the most deprived people focus more on present time (32). They concentrate on the inconvenience of the screening rather than on the possible long-term benefits. A measure of this mechanism, the fear of the result, language barriers or cultural representations (33) could be better proxies for sociocultural accessibility.

However, our study suggests that having a referring physician has a substantial direct impact on pap smear and mammography uptake. This key role of primary care providers was observed in other countries, like the United States and Canada (34,35). The improvement in screening uptake in people with a referring physician could be due to the direct role of the physician in overcoming the barriers to screening. This result might also be explained by another phenomenon linked to healthcare access: the patient's understanding of and capacity to navigate the healthcare system.

We confirmed territorial disparities in screening access. Large urban areas had higher participation rates than the rest of the region. These rural/urban disparities were observed in several studies in Western Europe and North America (17–19,28,36,37). The social gradient also appeared generally stronger in large urban areas. But even in the other areas, the most deprived populations had a lower screening access. These results corroborate the assumption that the social gradient is stronger if the healthcare supply is sufficient, but access to care of the most deprived remains lower whatever the place

We observed that the social and territorial disparities in mammography uptake were lower inside the recommended age group than for younger women.. We did not observe the same trend for pap smear uptake. This difference could be explained by the nationally organised screening programme in place for breast cancer at the time of data collection but not for cervical cancer. Some studies suggested that tools used in the breast cancer screening programme might help decrease inequalities of access (38,39), but other showed that a national programme, with the exact same actions for every women, while improving overall participation rates, could also increase the social gradient in uptake (40). Pap smear and mammography uptake also appeared very high in women younger than the recommended age. While the social gradient within the recommended age groups is likely to be explained by a low uptake in deprived populations, its existence among younger and older women may indicate an overuse of screening in high SEP populations (41). Regarding women older than the recommended age, we observed a higher effect of territorial disparities on screening uptake (rural/urban disparities and effect of GP accessibility). This suggests that older women could have more difficulty adapting to territorial barriers.

Developing global dataset combining health data and diverse socioeconomic data, at individual and contextual levels, could enable a better understanding of the mechanisms involved in this social gradient, and therefore the development of targeted territorial actions to improve equity of access to healthcare.

Author contributions: LO: Conceptualisation, Methodology, Formal analysis, Funding acquisition, Writing – original draft and review & editing. CD: Conceptualisation, Methodology, Formal analysis, Supervision, Validation. PG: Conceptualisation, Data curation, Methodology, Formal analysis, Supervision, Validation. MERB: Conceptualisation, Funding acquisition, Validation. SL: Methodology, Formal analysis, Writing – review, Validation. VD: Writing – review, Validation.

All authors read, edited, and approved the final manuscript.

Acknowledgments:

We gratefully acknowledge Sarah Ouanhnon for her translation help and her many advice. Many thanks to Hervé Mainsonneuve for his careful reading and his precious advice. We wish to thank all the members of the research team: Marine Maurel for her skills with R-software, Camille Joanes for her advice, and all the other members. The research team is supported by the French association "La Ligue contre le cancer".

Data availability statements: This study is conformed to the principles embodied in the Declaration of Helsinki. The data we used in this study belongs to the French National Health Insurance. The procurement of such data necessitates the agreement of the French National Institute of Health Data (INDS) and the permission from the 'Commission Nationale Informatique et Liberte´s' (CNIL) which is the French Data Protection Authority in accordance with Law No 78/17 of 6 January 1978 on computing, files and personal information, article 54, paragraph I. Data cannot be diffused without these authorisations. A CNIL Authorisation (no. 1634837) was obtained for our study. In addition, data cannot be shared with anyone who does not have these authorisations. In our study, the Regional Health Agency of Occitanie completed the necessary formalities with the relevant authorities. If other authors want to obtain the data, they have to contact directly the French National Institute of Health Data and obtain the permission of the CNIL. It can be done on the INDS website (http://www.indsante.fr/). In addition, data regarding demographical characteristics of the whole inhabitants of the region can be freely obtained from the French national institute for statistics and economic studies (https://www.insee.fr/fr/statistiques/).

Ethics statement: According to French registration, the ethics Committee approval is not applicable for this study (on pre-existing dataset).

This study is conformed to the principles embodied in the Declaration of Helsinki. The authors obtained an agreement of the French National Institute of Health Data (INDS) and the permission from the 'Commission Nationale Informatique et Liberte´s' (CNIL) which is the French Data Protection Authority in accordance with Law No 78/17 of 6 January 1978 on computing, files and personal information, article 54, paragraph I. CNIL Authorisation: no. 1634837.

Funding Statement: This work was supported by Toulouse Hospital ("allocation jeune chercheur de la DRCI", Direction de la Recherche Clinique et de l'Innovation). There is no grant number: Toulouse Hospital allocates this grant to young doctors who wish to deepen their knowledge in research, after studying their research project.

Declaration of Competing Interest: The authors have declared that no competing interests exist.

References

1. International Agency for research on Cancer. Estimated number of deaths in 2020, breast, females, all ages: IARC Gobocan [Internet]. Available from: https://gco.iarc.fr/today/online-analysis-table?v=2020&mode=population&mode_population=countries&population=900&populations=900&key=asr&sex=2&cancer=20&type=1&statistic=5&prevalence=0&population_group=0&ages_group%5B%5D=0&ages_group%5B%5D=17&group_cancer=1&include_nmsc=1&include_nmsc_other=1

2. Institut National du Cancer. Le programme de dépistage organisé - Dépistage du cancer du sein [Internet]. cancer.fr. 2019. Available from: https://www.e-cancer.fr/Professionnels-de-sante/Depistage-et-detection-precoce/Depistage-du-cancer-du-sein/Le-programme-de-depistage-organise

3. INCA. Le programme de dépistage organisé du cancer du col de l'utérus - Dépistage du cancer du col de l'utérus [Internet]. Available from: https://www.e-cancer.fr/Professionnels-de-sante/Depistage-et-detection-precoce/Depistage-du-cancer-du-col-de-l-uterus/Le-programme-de-depistage-organise

4. Santé publique France. Evaluation du programme de dépistage du cancer du col de l'utérus [Internet]. [cited 2020 May 13]. Available from: http://santepubliquefrance.fr/maladies-et-traumatismes/cancers/cancer-du-col-de-l-uterus/articles/evaluation-du-programme-de-depistage-du-cancer-du-col-de-l-uterus

5. Poiseuil M, Coureau G, Payet C, Savès M, Debled M, Mathoulin-Pelissier S, et al. Deprivation and mass screening: Survival of women diagnosed with breast cancer in France from 2008 to 2010. Cancer Epidemiol. 2019;60:149–55.

6. Duport N, Serra D, Goulard H, Bloch J. Quels facteurs influencent la pratique du dépistage des cancers féminins en France ? Revue d'Épidémiologie et de Santé Publique. 2008 Oct 1;56(5):303–13.

7. Grillo F, Vallée J, Chauvin P. Inequalities in cervical cancer screening for women with or without a regular consulting in primary care for gynaecological health, in Paris, France. Prev Med. 2012 Apr;54(3–4):259–65.

8. Delpierre C, Fantin R, Chehoud H, Nicoules V, Bayle A, Souche A, et al. Inégalités sociales d'accès aux soins et à la prévention en Midi-Pyrénées, France, 2012. 2016; Available from: http://invs.santepubliquefrance.fr//beh/2016/1/2016_1_1.html

9. Evans DB, Hsu J, Boerma T. Universal health coverage and universal access. Bull World Health Organ. 2013 Aug;91:546-546A.

10. Thiede M, Akweongo P, McIntyre D. Exploring the dimensions of access. In: McIntyre D, Mooney G, editors. The Economics of Health Equity [Internet]. Cambridge: Cambridge University Press; 2007 [cited 2020 Jun 8]. p. 103–23. Available from: https://www.cambridge.org/core/books/economics-of-health-equity/exploring-the-dimensions-of-access/684DFDF7B640370D207C59FEAFC967E7

11. HCSP. Les systèmes d'information pour la santé publique [Internet]. Paris: Haut Conseil de la Santé Publique; 2009 Nov [cited 2019 Mar 10]. Available from: https://www.hcsp.fr/explore.cgi/avisrapportsdomaine?clefr=175

12. Ducros D, Nicoules V, Chehoud H, Bayle A, Souche A, Tanguy M, et al. Les bases médico-administratives pour mesurer les inégalités sociales de santé. Sante Publique. 2015 Aug 24;Vol. 27(3):383–94.

13. Pornet C, Delpierre C, Dejardin O, Grosclaude P, Launay L, Guittet L, et al. Construction of an adaptable European transnational ecological deprivation index: the French version. J Epidemiol Community Health. 2012 Nov;66(11):982–9.

14. Yang XY, Hu A, Schieman S. Relative deprivation in context: How contextual status homogeneity shapes the relationship between disadvantaged social status and health. Social Science Research. 2019 Jul 1;81:157–69.

15. Muriel Barlet, Magali Coldefy, Clémentine Collin, Véronique Lucas-Gabrielli,. L'Accessibilité potentielle localisée (APL) : une nouvelle mesure de l'accessibilité aux soins appliquée aux médecins généralistes libéraux en France [Internet]. Drees; 2012. Available from: https://drees.solidarites-sante.gouv.fr/etudes-et-statistiques/publications/documents-de-travail/serie-etudes-et-recherche/article/l-accessibilite-potentielle-localisee-apl-une-nouvelle-mesure-de-l

16. Short SE, Mollborn S. Social Determinants and Health Behaviors: Conceptual Frames and Empirical Advances. Curr Opin Psychol. 2015 Oct;5:78–84.

17. Chandak A, Nayar P, Lin G. Rural-Urban Disparities in Access to Breast Cancer Screening: A Spatial Clustering Analysis. J Rural Health. 2019;35(2):229–35.

18. Orwat J, Caputo N, Key W, De Sa J. Comparing Rural and Urban Cervical and Breast Cancer Screening Rates in a Privately Insured Population. Soc Work Public Health. 2017;32(5):311–23.

19. Leung J, McKenzie S, Martin J, McLaughlin D. Effect of rurality on screening for breast cancer: a systematic review and meta-analysis comparing mammography. Rural Remote Health. 2014;14(2):2730.

20. INSEE (Institut National de la Statistique et des Etudes Economiques). Le nouveau zonage en aires urbaines de 2010 - Insee Première - 1374 [Internet]. 2010 [cited 2021 Nov 26]. Available from: https://www.insee.fr/fr/statistiques/1281191

21. R Core Team. R: A language and environment for statistical computing. [Internet]. 2013. Available from: http://www.R-project.org/

22. Smith RA, Andrews KS, Brooks D, Fedewa SA, Manassaram-Baptiste D, Saslow D, et al. Cancer screening in the United States, 2019: A review of current American Cancer Society guidelines and current issues in cancer screening. CA: A Cancer Journal for Clinicians. 2019;69(3):184–210.

23. Dailey AB, Kasl SV, Holford TR, Calvocoressi L, Jones BA. Neighborhood-Level Socioeconomic Predictors of Nonadherence to Mammography Screening Guidelines. Cancer Epidemiol Biomarkers Prev. 2007 Nov 1;16(11):2293–303.

24. Dailey AB, Brumback BA, Livingston MD, Jones BA, Curbow BA, Xu X. Area-Level Socioeconomic Position and Repeat Mammography Screening Use: Results from the 2005 National Health Interview Survey. Cancer Epidemiol Biomarkers Prev. 2011 Nov 1;20(11):2331–44.

25. Murfin J, Irvine F, Meechan-Rogers R, Swift A. Education, income and occupation and their influence on the uptake of cervical cancer prevention strategies: A systematic review. J Clin Nurs. 2020 Feb;29(3–4):393–415.

26. Borràs JM, Guillen M, Sanchez V, Juncà S, Vicente R. Educational level, voluntary private health insurance and opportunistic cancer screening among women in Catalonia (Spain): European Journal of Cancer Prevention. 1999 Oct;8(5):427–34.

27. Douglas E, Waller J, Duffy SW, Wardle J. Socioeconomic inequalities in breast and cervical screening coverage in England: are we closing the gap? J Med Screen. 2016;23(2):98–103.

28. Massat NJ, Douglas E, Waller J, Wardle J, Duffy SW. Variation in cervical and breast cancer screening coverage in England: a cross-sectional analysis to characterise districts with atypical behaviour. BMJ Open. 2015 Jul 24;5(7):e007735.

29. Eisinger F, Viguier J, Touboul C, Coscas Y, Pivot X, Blay J-Y, et al. Social stratification, risk factor prevalence and cancer screening attendance. Eur J Cancer Prev. 2015 Jun;24 Suppl:S77-81.

30. Chauvin P, Parizot I. Les inégalités sociales et territoriales de santé dans l'agglomération parisienne. Une analyse de la cohorte Sirs (2005) [Internet]. Délégation interministérielle à la Ville; 2009 [cited 2020 Jun 1]. Available from: https://www.hal.inserm.fr/inserm-00415971

31. Deborde T, Chatignoux E, Quintin C, Beltzer N, Hamers FF, Rogel A. Breast cancer screening programme participation and socioeconomic deprivation in France. Prev Med. 2018;115:53–60.

32. Crockett R, Wilkinson TM, Marteau TM. Social patterning of screening uptake and the impact of facilitating informed choices: psychological and ethical analyses. Health Care Anal. 2008 Mar;16(1):17–30.

33. Szarewski A, Cadman L, Ashdown-Barr L, Waller J. Exploring the acceptability of two self-sampling devices for human papillomavirus testing in the cervical screening context: a qualitative study of Muslim women in London. J Med Screen. 2009;16(4):193–8.

34. Schueler KM, Chu PW, Smith-Bindman R. Factors Associated with Mammography Utilization: A Systematic Quantitative Review of the Literature. Journal of Women's Health. 2008 Oct 27;17(9):1477–98.

35. Beaulieu MD, Béland F, Roy D, Falardeau M, Hébert G. Factors determining compliance with screening mammography. CMAJ. 1996 May 1;154(9):1335–43.

36. Ouédraogo S, Dabakuyo-Yonli TS, Roussot A, Dialla PO, Pornet C, Poillot M-L, et al. [Breast cancer screening in thirteen French departments]. Bull Cancer. 2015 Feb;102(2):126–38.

37. Ouédraogo S, Dabakuyo-Yonli TS, Roussot A, Pornet C, Sarlin N, Lunaud P, et al. European transnational ecological deprivation index and participation in population-based breast cancer screening programmes in France. Prev Med. 2014 Jun;63:103–8.

38. Cancer Care Ontario. Cancer Fact: Invitation letters improve breast screening behaviour [Internet]. 2016 [cited 2020 May 13]. Available from: https://www.cancercareontario.ca/en/cancer-facts/invitation-letters-improve-breast-screening-behaviour

39. Everett T, Bryant A, Griffin MF, Martin-Hirsch PP, Forbes CA, Jepson RG. Interventions targeted at women to encourage the uptake of cervical screening. Cochrane Database of Systematic Reviews [Internet]. 2011 [cited 2019 Oct 16];(5). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002834.pub2/full

40. Raginel T, de Mil R, Garnier A, Launoy G, Guittet L. National organization of uterine cervical cancer screening and social inequality in France. European Journal of Cancer Prevention [Internet]. 2019 Dec 10 [cited 2020 Jun 1];Publish Ahead of Print. Available from:

https://journals.lww.com/eurjcancerprev/Abstract/9000/National_organization_of_uterine_cervical_cancer.99158.aspx

41. Autier P. [Screening for breast cancer: worries about its effectiveness]. Rev Prat. 2013 Dec;63(10):1369–77.

Figure 1: **Conceptual model**

Links between the studied variables assumed to explain the impact of deprivation on screening uptake, depending on the level of urbanisation.

***Figure 2*: Mammography and pap smear uptake and combined variable EDI in large urban/other areas by age group, Midi Pyrenees region, 2012.**

Results from a logistic model adjusted for EDI by age, CMU-C, GP PLA, having an official referring physician.
Data from models 5 (Table 2 and 3) for the recommended age groups.

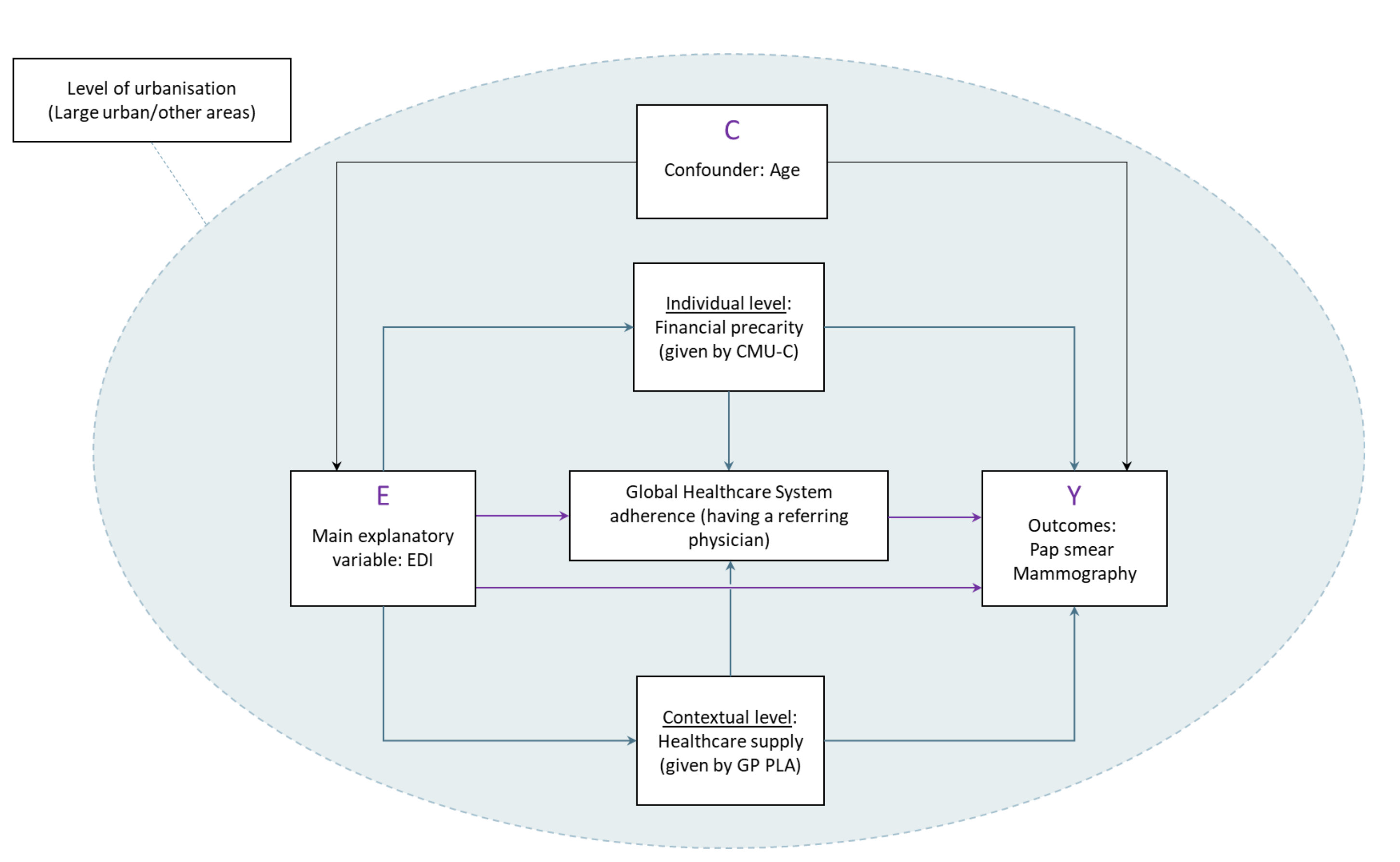
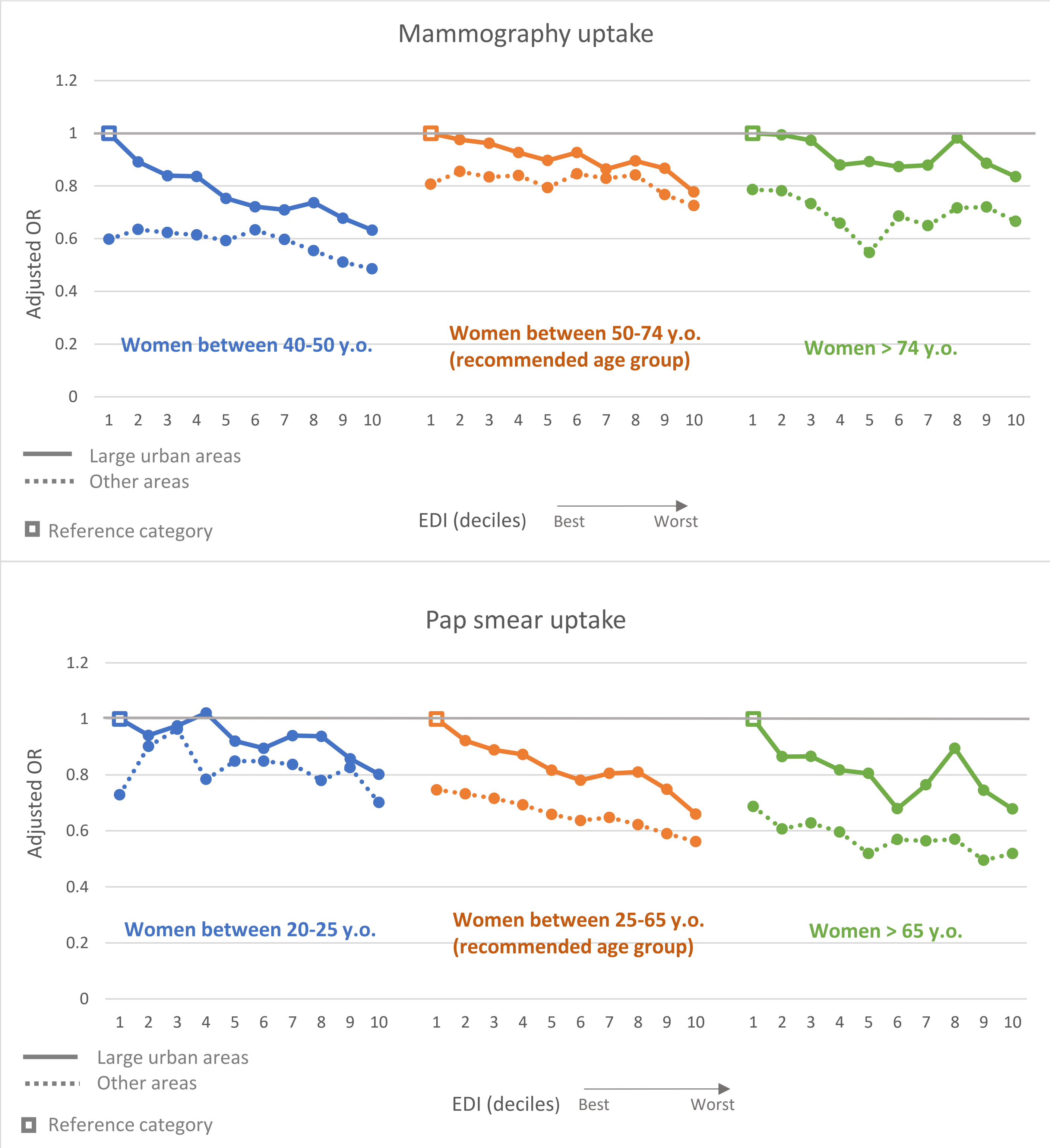


***Figure 1:* Conceptual model**

Links between the studied variables assumed to explain the impact of deprivation on screening uptake, depending on the level of urbanisation.

***Figure 2*: Mammography and pap smear uptake and combined variable EDI in large urban/other areas by age group, Midi Pyrenees region, 2012.**

Results from a logistic model adjusted for EDI by age, CMU-C, GP PLA, having an official referring physician.
Data from models 5 (Table 2 and 3) for the recommended age groups.



Supplementary material

Tables A: Characteristics of women in recommended age groups for gynaecological screening programmes in Midi Pyrénées

Characteristics of women between 50 and 74 y.o. (recommended age group for mammography) N= 365 947

	Toulouse Metropolis	Other large urban area	Other area
	n= 72919 (19.93%)	n= 150755 (41.2%)	n= 142273 (38.88%)
	n (%)	n (%)	n (%)
Mammography			
No Mammography	49978 (68.54)	102663 (68.1)	100713 (70.79)
≥ 1 in the year	22941 (31.46)	48092 (31.9)	41560 (29.21)
Age			
Mean (SD)	60.7 (6.8)	60.9 (6.9)	61.6 (6.9)
Age (/5years)			
50-55 y.o	19112 (26.21)	37568 (24.92)	31561 (22.18)
55-60 y.o	17097 (23.45)	34985 (23.21)	31044 (21.82)
60-65 y.o	15774 (21.63)	33460 (22.19)	31975 (22.47)
65-70 y.o,	12305 (16.87)	25825 (17.13)	26664 (18.74)
70-75 y.o	8631 (11.84)	18917 (12.55)	21029 (14.78)
EDI (deciles: 1=best)			
1	7886 (10.81)	20596 (13.66)	2719 (1.91)
2	8615 (11.81)	20315 (13.48)	5896 (4.14)
3	4436 (6.08)	15563 (10.32)	10112 (7.11)
4	3484 (4.78)	14848 (9.85)	13232 (9.3)
5	8183 (11.22)	11820 (7.84)	12730 (8.95)
6	3368 (4.62)	16244 (10.78)	19906 (13.99)
7	6678 (9.16)	12055 (8)	20092 (14.12)
8	6367 (8.73)	10760 (7.14)	20741 (14.58)
9	9519 (13.05)	12192 (8.09)	20679 (14.53)
10	14383 (19.72)	16362 (10.85)	16166 (11.36)
CMU-C			
No CMU-C	68850 (94.42)	145641 (96.61)	137381 (96.56)
CMU-C	4069 (5.58)	5114 (3.39)	4892 (3.44)
GP PLA (deciles: 10= best)			
1	363 (0.5)	1744 (1.16)	9320 (6.55)
2	922 (1.26)	4887 (3.24)	7958 (5.59)
3	0 (0)	6290 (4.17)	8165 (5.74)
4	803 (1.1)	9625 (6.38)	10154 (7.14)
5	1409 (1.93)	14229 (9.44)	10767 (7.57)
6	2695 (3.7)	17381 (11.53)	12186 (8.57)
7	9531 (13.07)	25353 (16.82)	15979 (11.23)
8	14772 (20.26)	25147 (16.68)	22412 (15.75)
9	15456 (21.2)	27726 (18.39)	20949 (14.72)
10	26968 (36.98)	18373 (12.19)	24383 (17.14)
Referring physician			
No designated referring physician	4898 (6.72)	7428 (4.93)	7706 (5.42)
Official referring physician	68021 (93.28)	143327 (95.07)	134567 (94.58)

Characteristics of women between 25 and 65 y.o. (recommended age group for pap smear)
N= 711 803

	Toulouse Metropolis	Other large urban areas	Other areas
	n= 180030 (25.59%) n (%)	n= 302563 (42.61%) n (%)	n= 229210 (32.2%) n (%)
Pap smear			
No Pap smear	123038 (68.34)	211072 (69.76)	172621 (75.31)
≥ 1 in the year	56992 (31.66)	91491 (30.24)	56589 (24.69)
Age			
Mean (SD)	42.9 (11.8)	45.5 (11.4)	47.2 (11.4)
Age (/5years)	n= 180030	n= 302563	n= 229210
25-30 y.o	30798 (17.11)	32111 (10.61)	19504 (8.51)
30-35 y.o	28146 (15.63)	36721 (12.14)	23382 (10.2)
35-40 y.o	23292 (12.94)	37351 (12.34)	24557 (10.71)
40-45 y.o	21537 (11.96)	41983 (13.88)	29444 (12.85)
45-50 y.o	21259 (11.81)	41829 (13.82)	31203 (13.61)
50-55 y.o	19112 (10.62)	37568 (12.42)	31561 (13.77)
55-60 y.o	17097 (9.5)	34985 (11.56)	31044 (13.54)
60-65 y.o	15774 (8.76)	33460 (11.06)	31975 (13.95)
65-70 y.o,	3015 (1.67)	6555 (2.17)	6540 (2.85)
EDI (deciles: 1=best)			
1	14747 (8.19)	42750 (14.13)	4741 (2.07)
2	19389 (10.77)	41657 (13.77)	9906 (4.32)
3	10922 (6.07)	32952 (10.89)	16889 (7.37)
4	8239 (4.58)	30690 (10.14)	21643 (9.44)
5	21020 (11.68)	23450 (7.75)	20561 (8.97)
6	9173 (5.1)	32475 (10.73)	31816 (13.88)
7	17062 (9.48)	23586 (7.8)	31628 (13.8)
8	17051 (9.47)	20967 (6.93)	32394 (14.13)
9	26337 (14.63)	22732 (7.51)	33163 (14.47)
10	36090 (20.05)	31304 (10.35)	26469 (11.55)
CMU-C			
No CMU-C	161075 (89.47)	281794 (93.14)	213100 (92.97)
CMU-C	18955 (10.53)	20769 (6.86)	16110 (7.03)
GP PLA (deciles: 10= best)			
1	831 (0.46)	3162 (1.05)	14614 (6.38)
2	2273 (1.26)	9407 (3.11)	12705 (5.54)
3	0 (0%)	12683 (4.19)	13438 (5.86)
4	1815 (1.01)	18903 (6.25)	16589 (7.24)
5	3312 (1.84)	28690 (9.48)	17813 (7.77)
6	6666 (3.7)	36519 (12.07)	20430 (8.91)
7	20097 (11.16)	52821 (17.46)	26031 (11.36)
8	37194 (20.66)	51056 (16.87)	35210 (15.36)
9	38815 (21.56)	54907 (18.15)	33531 (14.63)
10	69027 (38.34)	34415 (11.37)	38849 (16.95)
Referring physician			
No designated	18754 (10.42)	20659 (6.83)	18183 (7.93)
Designated	161276 (89.58)	281904 (93.17)	211027 (92.07)

Tables B: Screening uptake multivariable logistic regression models outside the recommended age groups (sequential adjustment)

Mammography uptake multivariable logistic regression models (n= 187255): in 40-50 y.o. women (Mammography uptake = 20.77%)

			N	Model 1	LogLik	Model 2	LogLik	Model 3	LogLik	Model 4	LogLik	Model 5	LogLik
			Tot= 187255	OR (95%CI)	-94934	OR (95%CI)	-94709	OR (95%CI)	-94508	OR (95%CI)	-94463	OR (95%CI)	-92837
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[1]	1284	1		1		1		1		1	
		2	2737	0.899 (0.857,0.944)		0.901 (0.859,0.946)		0.906 (0.863,0.951)		0.897 (0.855,0.942)		0.892 (0.849,0.937)	
		3	4550	0.845 (0.801,0.892)		0.847 (0.803,0.894)		0.855 (0.811,0.902)		0.843 (0.798,0.89)		0.839 (0.794,0.886)	
		4	5726	0.836 (0.791,0.884)		0.84 (0.794,0.888)		0.851 (0.805,0.9)		0.84 (0.794,0.888)		0.837 (0.791,0.885)	
		5	5472	0.745 (0.705,0.788)		0.748 (0.708,0.791)		0.761 (0.72,0.805)		0.751 (0.71,0.795)		0.753 (0.711,0.797)	
		6	8525	0.722 (0.682,0.764)		0.722 (0.682,0.765)		0.737 (0.696,0.78)		0.722 (0.682,0.766)		0.722 (0.681,0.766)	
		7	8283	0.688 (0.649,0.73)		0.69 (0.65,0.731)		0.705 (0.665,0.748)		0.699 (0.658,0.742)		0.71 (0.668,0.754)	
		8	8564	0.706 (0.665,0.75)		0.709 (0.668,0.753)		0.732 (0.689,0.777)		0.731 (0.687,0.778)		0.737 (0.693,0.784)	
		9	8629	0.639 (0.603,0.677)		0.64 (0.604,0.678)		0.67 (0.632,0.71)		0.665 (0.625,0.707)		0.678 (0.638,0.721)	
		10	6877	0.557 (0.528,0.587)		0.557 (0.528,0.587)		0.61 (0.578,0.644)		0.61 (0.575,0.647)		0.633 (0.596,0.671)	
	EDI (deciles) **in other areas**	1	16751	0.57 (0.492,0.66)		0.569 (0.491,0.66)		0.572 (0.494,0.663)		0.599 (0.516,0.694)		0.598 (0.515,0.694)	
		2	17342	0.616 (0.557,0.682)		0.615 (0.555,0.681)		0.619 (0.559,0.686)		0.634 (0.572,0.702)		0.635 (0.573,0.704)	
		3	12299	0.593 (0.546,0.644)		0.592 (0.545,0.643)		0.597 (0.549,0.648)		0.62 (0.571,0.674)		0.623 (0.573,0.678)	
		4	10802	0.596 (0.553,0.642)		0.595 (0.552,0.641)		0.602 (0.558,0.649)		0.613 (0.568,0.661)		0.614 (0.569,0.663)	
		5	11523	0.57 (0.528,0.616)		0.568 (0.526,0.614)		0.574 (0.531,0.62)		0.587 (0.543,0.635)		0.593 (0.548,0.641)	
		6	10898	0.613 (0.575,0.654)		0.612 (0.574,0.652)		0.621 (0.582,0.662)		0.624 (0.585,0.666)		0.633 (0.593,0.676)	
		7	10252	0.577 (0.54,0.616)		0.574 (0.538,0.613)		0.587 (0.55,0.627)		0.592 (0.554,0.633)		0.597 (0.558,0.638)	
		8	9432	0.53 (0.496,0.566)		0.528 (0.494,0.564)		0.543 (0.508,0.581)		0.55 (0.514,0.588)		0.555 (0.519,0.594)	
		9	11333	0.491 (0.459,0.525)		0.49 (0.458,0.524)		0.507 (0.474,0.543)		0.505 (0.471,0.541)		0.511 (0.477,0.548)	
		10	15976	0.452 (0.419,0.487)		0.45 (0.418,0.485)		0.476 (0.442,0.513)		0.479 (0.443,0.517)		0.486 (0.449,0.525)	
Age		40-45 y.o.[1]	92964			1		1		1		1	
		45-50 y.o.	94291			1.275 (1.247; 1.305)		1.27 (1.242; 1.299)		1.271 (1.242; 1.3)		1.258 (1.229; 1.286)	
CMU-C		No[1]	172456					1		1		1	
		Yes	14799					0.614 (0.584; 0.645)		0.613 (0.583; 0.645)		0.597 (0.567; 0.627)	
GP PLA (deciles)		1[1]	4959							1		1	
		2	6486							1.091 (0.99; 1.204)		1.078 (0.978; 1.19)	
		3	7123							1.064 (0.967; 1.172)		1.067 (0.969; 1.175)	
		4	10062							1.057 (0.966; 1.157)		1.044 (0.954; 1.144)	
		5	14074							1.159 (1.063; 1.264)		1.145 (1.05; 1.249)	
		6	17792							1.173 (1.078; 1.276)		1.158 (1.064; 1.261)	
		7	27034							1.217 (1.122; 1.321)		1.201 (1.107; 1.305)	
		8	33101							1.262 (1.165; 1.369)		1.247 (1.151; 1.354)	
		9	32681							1.193 (1.1; 1.295)		1.185 (1.092; 1.287)	
		10	33943							1.14 (1.05; 1.239)		1.161 (1.069; 1.262)	
Referring physician		No[1]	13378									1	
		Yes	173877									6.849 (6.275; 7.493)	

[1] Reference category

Mammography uptake multivariable logistic regression models (n= 154895): in > 74 y.o. women (Mammography uptake = 5.65%)														
			N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
			Tot= 154895	OR (95%CI)	-33537	OR (95%CI)	-30948	OR (95%CI)	-30936	OR (95%CI)	-30890	OR (95%CI)	-30674
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[2]	939	1		1		1		1		1	
		2	2115	1.022 (0.904,1.154)		1.026 (0.906,1.162)		0.983 (0.95,1.018)		0.998 (0.88,1.131)		0.994 (0.877,1.127)	
		3	3983	0.968 (0.849,1.104)		1.009 (0.883,1.154)		0.971 (0.934,1.009)		0.978 (0.855,1.119)		0.973 (0.85,1.114)	
		4	6092	0.921 (0.803,1.055)		0.921 (0.802,1.058)		0.939 (0.902,0.976)		0.883 (0.769,1.015)		0.88 (0.765,1.011)	
		5	5757	0.893 (0.784,1.017)		0.956 (0.838,1.092)		0.897 (0.863,0.933)		0.898 (0.785,1.027)		0.892 (0.779,1.02)	
		6	9950	0.891 (0.784,1.013)		0.945 (0.829,1.077)		0.936 (0.901,0.973)		0.878 (0.769,1.002)		0.873 (0.765,0.997)	
		7	10334	0.896 (0.789,1.019)		0.973 (0.854,1.108)		0.858 (0.825,0.892)		0.88 (0.77,1.006)		0.879 (0.769,1.005)	
		8	10647	0.99 (0.873,1.123)		1.088 (0.957,1.238)		0.885 (0.85,0.922)		0.987 (0.865,1.127)		0.982 (0.86,1.121)	
		9	10974	0.926 (0.821,1.044)		1.029 (0.911,1.163)		0.855 (0.823,0.888)		0.89 (0.782,1.012)		0.886 (0.779,1.008)	
		10	9307	0.899 (0.802,1.007)		0.977 (0.87,1.097)		0.763 (0.737,0.79)		0.837 (0.74,0.948)		0.835 (0.738,0.946)	
	EDI (deciles) **in other**	1	7482	0.77 (0.572,1.039)		0.765 (0.565,1.035)		0.784 (0.719,0.855)		0.793 (0.584,1.075)		0.786 (0.579,1.066)	
		2	8759	0.78 (0.633,0.962)		0.767 (0.62,0.948)		0.845 (0.795,0.897)		0.791 (0.64,0.979)		0.782 (0.632,0.968)	
		3	6862	0.701 (0.592,0.831)		0.708 (0.596,0.841)		0.817 (0.778,0.858)		0.742 (0.623,0.882)		0.733 (0.616,0.872)	
		4	6193	0.645 (0.555,0.75)		0.671 (0.576,0.782)		0.833 (0.797,0.871)		0.662 (0.568,0.772)		0.659 (0.565,0.769)	
		5	7566	0.539 (0.458,0.634)		0.552 (0.468,0.65)		0.78 (0.746,0.817)		0.55 (0.466,0.649)		0.547 (0.463,0.646)	
		6	8023	0.696 (0.612,0.791)		0.726 (0.637,0.827)		0.838 (0.805,0.871)		0.692 (0.607,0.79)		0.686 (0.601,0.783)	
		7	8076	0.65 (0.571,0.739)		0.696 (0.61,0.794)		0.824 (0.792,0.857)		0.657 (0.575,0.751)		0.65 (0.569,0.743)	
		8	7774	0.728 (0.642,0.825)		0.774 (0.681,0.878)		0.833 (0.802,0.866)		0.727 (0.638,0.828)		0.717 (0.629,0.816)	
		9	10269	0.706 (0.623,0.8)		0.776 (0.683,0.881)		0.762 (0.733,0.792)		0.728 (0.64,0.829)		0.72 (0.632,0.82)	
		10	13793	0.693 (0.608,0.79)		0.757 (0.663,0.864)		0.718 (0.688,0.75)		0.675 (0.588,0.775)		0.666 (0.58,0.765)	
Age		75-80 y.o.[2]	50815			1		1		1		1	
		80-85 y.o.	48148			0.387 (0.368; 0.407)		0.387 (0.368; 0.407)		0.386 (0.367; 0.406)		0.385 (0.366; 0.405)	
		85-90 y.o.	34698			0.152 (0.14; 0.165)		0.152 (0.14; 0.165)		0.151 (0.139; 0.164)		0.151 (0.139; 0.164)	
		90-95 y.o.	16602			0.067 (0.057; 0.079)		0.067 (0.057; 0.079)		0.067 (0.056; 0.079)		0.067 (0.056; 0.079)	
		95-100 y.o.	4632			0.024 (0.013; 0.038)		0.024 (0.013; 0.038)		0.023 (0.013; 0.038)		0.025 (0.014; 0.04)	
CMU-C		No[2]	153807					1		1		1	
		Yes	1088					0.443 (0.298; 0.63		0.443 (0.298; 0.63)		0.439 (0.295; 0.625)	
GP PLA (deciles)		1[2]	4675							1		1	
		2	5726							1.14 (0.94; 1.386)		1.138 (0.938; 1.383)	
		3	5537							1.037 (0.851; 1.265)		1.035 (0.85; 1.263)	
		4	7717							1.091 (0.909; 1.314)		1.085 (0.904; 1.306)	
		5	9569							1.171 (0.983; 1.399)		1.17 (0.983; 1.399)	
		6	11747							1.25 (1.056; 1.486)		1.25 (1.055; 1.486)	
		7	18800							1.316 (1.12; 1.554)		1.312 (1.117; 1.549)	
		8	25658							1.441 (1.231; 1.694)		1.44 (1.231; 1.695)	
		9	30207							1.398 (1.195; 1.644)		1.403 (1.199; 1.65)	
		10	35259							1.546 (1.322; 1.818)		1.555 (1.329; 1.829)	
Referring physician		No[2]	5992									1	
		Yes	148903									8.938 (6.66; 12.37)	

[2] Reference category

Pap smear uptake multivariable logistic regression models (n= 63068) in 20-25 y.o. women (Pap smear uptake = 20.58 %)

			N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
			Tot= 63068	OR (95%CI)	-31988	OR (95%CI)	-31676	OR (95%CI)	-31675	OR (95%CI)	-31670	OR (95%CI)	-30989
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[3]	272	1		1		1		1		1	
		2	600	0.958 (0.864; 1.062)		0.951 (0.858; 1.056)		0.952 (0.859; 1.057)		0.956 (0.861; 1.062)		0.941 (0.846; 1.046)	
		3	1047	0.992 (0.888; 1.108)		0.985 (0.881; 1.101)		0.987 (0.882; 1.103)		0.987 (0.882; 1.105)		0.975 (0.87; 1.093)	
		4	1451	1.024 (0.914; 1.146)		1.021 (0.911; 1.143)		1.022 (0.913; 1.145)		1.029 (0.918; 1.154)		1.021 (0.91; 1.146)	
		5	1412	0.915 (0.823; 1.017)		0.905 (0.813; 1.007)		0.907 (0.815; 1.009)		0.922 (0.827; 1.028)		0.921 (0.825; 1.028)	
		6	2197	0.896 (0.803; 0.999)		0.889 (0.797; 0.992)		0.892 (0.799; 0.995)		0.903 (0.808; 1.009)		0.895 (0.8; 1.002)	
		7	2336	0.92 (0.828; 1.023)		0.901 (0.81; 1.002)		0.903 (0.812; 1.005)		0.923 (0.827; 1.03)		0.94 (0.841; 1.05)	
		8	2376	0.917 (0.824; 1.02)		0.895 (0.804; 0.997)		0.898 (0.806; 1)		0.925 (0.828; 1.033)		0.938 (0.838; 1.049)	
		9	2575	0.824 (0.746; 0.909)		0.801 (0.726; 0.885)		0.804 (0.728; 0.889)		0.834 (0.751; 0.927)		0.858 (0.771; 0.954)	
		10	2484	0.735 (0.67; 0.808)		0.733 (0.667; 0.805)		0.739 (0.672; 0.812)		0.772 (0.697; 0.856)		0.802 (0.722; 0.89)	
	EDI (deciles) **in other areas**	1	3700	0.696 (0.498; 0.953)		0.701 (0.501; 0.961)		0.701 (0.501; 0.962)		0.701 (0.5; 0.962)		0.729 (0.519; 1.005)	
		2	4599	0.895 (0.723; 1.101)		0.903 (0.729; 1.112)		0.903 (0.729; 1.113)		0.904 (0.729; 1.114)		0.902 (0.726; 1.114)	
		3	3387	0.938 (0.794; 1.105)		0.956 (0.809; 1.127)		0.957 (0.809; 1.128)		0.964 (0.814; 1.138)		0.963 (0.812; 1.139)	
		4	3098	0.779 (0.669; 0.906)		0.78 (0.669; 0.908)		0.781 (0.67; 0.909)		0.788 (0.675; 0.917)		0.784 (0.671; 0.914)	
		5	4188	0.846 (0.727; 0.983)		0.852 (0.731; 0.99)		0.853 (0.732; 0.992)		0.859 (0.736; 0.999)		0.849 (0.727; 0.989)	
		6	3814	0.839 (0.737; 0.955)		0.849 (0.745; 0.966)		0.85 (0.746; 0.967)		0.858 (0.752; 0.977)		0.849 (0.744; 0.969)	
		7	4205	0.835 (0.735; 0.948)		0.838 (0.737; 0.951)		0.84 (0.739; 0.954)		0.855 (0.751; 0.972)		0.837 (0.735; 0.954)	
		8	4074	0.77 (0.677; 0.875)		0.776 (0.682; 0.882)		0.778 (0.683; 0.885)		0.789 (0.692; 0.899)		0.78 (0.683; 0.89)	
		9	6237	0.797 (0.704; 0.902)		0.809 (0.713; 0.916)		0.812 (0.716; 0.919)		0.823 (0.725; 0.934)		0.826 (0.726; 0.939)	
		10	9016	0.655 (0.574; 0.746)		0.661 (0.579; 0.754)		0.665 (0.582; 0.758)		0.688 (0.6; 0.787)		0.701 (0.61; 0.803)	
Age		20-21y.o[3]	9827			1		1		1		1	
		21-22 y.o.	11080			1.234 (1.144; 1.33)		1.233 (1.144; 1.33)		1.234 (1.144; 1.33)		1.205 (1.117; 1.3)	
		22-23 y.o.	12631			1.516 (1.411; 1.628)		1.514 (1.41; 1.626)		1.516 (1.412; 1.628)		1.435 (1.335; 1.543)	
		23-24 y.o.	14064			1.709 (1.595; 1.832)		1.707 (1.593; 1.83)		1.711 (1.597; 1.834)		1.576 (1.47; 1.691)	
		24-25 y.o.	15466			2.102 (1.966; 2.249)		2.099 (1.963; 2.246)		2.104 (1.967; 2.25)		1.912 (1.787; 2.047)	
CMU-C		No[3]	54768					1		1		1	
		Yes	8300					0.968 (0.911; 1.028)		0.969 (0.912; 1.029)		0.899 (0.845; 0.955)	
GP PLA (deciles)		1[3]	1167							1		1	
		2	1569							1.057 (0.873; 1.281)		1.033 (0.851; 1.254)	
		3	1626							1.09 (0.903; 1.318)		1.069 (0.884; 1.295)	
		4	2498							1.096 (0.92; 1.307)		1.075 (0.902; 1.285)	
		5	3594							1.07 (0.906; 1.268)		1.055 (0.891; 1.252)	
		6	4813							1.026 (0.872; 1.21)		1.018 (0.864; 1.203)	
		7	7959							1.055 (0.902; 1.238)		1.039 (0.887; 1.222)	
		8	10982							1.074 (0.92; 1.257)		1.054 (0.902; 1.236)	
		9	12533							1.021 (0.875; 1.196)		1.011 (0.865; 1.186)	
		10	16327							0.986 (0.845; 1.155)		1.004 (0.859; 1.178)	
		No[3]	13716									1	
Referring physician		Yes	49352									2.859 (2.69; 3.042)	

[3] Reference category

Pap smear uptake multivariable logistic regression models (n= 252156) in > 65 y.o. women (Pap smear uptake = 5.69%)

			N	Model 1	LogLik	Model 2	LogLik	Model 3	LogLik	Model 4	LogLik	Model 5	LogLik
			Tot= 252156	OR (95%CI)	-54676	OR (95%CI)	-48204	OR (95%CI)	-48196	OR (95%CI)	-48125	OR (95%CI)	-47675
Combined EDI and large urban/other areas	**EDI** (deciles) **in large urban areas**	1[4]	1669	1		1		1		1		1	
		2	3720	0.875 (0.805,0.951)		0.904 (0.83,0.985)		0.905 (0.83,0.985)		0.874 (0.801,0.953)		0.865 (0.793,0.944)	
		3	6672	0.822 (0.75,0.901)		0.903 (0.821,0.992)		0.903 (0.821,0.992)		0.874 (0.795,0.961)		0.866 (0.787,0.953)	
		4	9800	0.786 (0.714,0.865)		0.859 (0.779,0.948)		0.86 (0.78,0.949)		0.825 (0.748,0.911)		0.817 (0.74,0.902)	
		5	9294	0.743 (0.677,0.815)		0.858 (0.78,0.944)		0.859 (0.782,0.945)		0.809 (0.735,0.891)		0.805 (0.731,0.887)	
		6	15807	0.641 (0.584,0.705)		0.738 (0.669,0.813)		0.738 (0.67,0.813)		0.687 (0.622,0.758)		0.679 (0.615,0.749)	
		7	16336	0.69 (0.628,0.757)		0.833 (0.757,0.917)		0.834 (0.757,0.918)		0.763 (0.691,0.842)		0.764 (0.692,0.843)	
		8	16801	0.796 (0.727,0.872)		0.982 (0.894,1.079)		0.984 (0.895,1.081)		0.898 (0.815,0.99)		0.895 (0.812,0.987)	
		9	17022	0.685 (0.628,0.748)		0.855 (0.781,0.936)		0.858 (0.784,0.94)		0.748 (0.68,0.823)		0.745 (0.677,0.82)	
		10	14130	0.647 (0.596,0.702)		0.789 (0.725,0.858)		0.795 (0.73,0.865)		0.68 (0.621,0.745)		0.678 (0.619,0.743)	
	EDI (deciles) **in other areas**	1	14042	0.641 (0.517,0.795)		0.669 (0.537,0.834)		0.668 (0.536,0.833)		0.693 (0.555,0.865)		0.687 (0.55,0.858)	
		2	15838	0.571 (0.488,0.669)		0.6 (0.511,0.705)		0.6 (0.511,0.704)		0.616 (0.524,0.724)		0.607 (0.516,0.714)	
		3	11781	0.556 (0.49,0.63)		0.616 (0.542,0.7)		0.616 (0.542,0.7)		0.635 (0.558,0.723)		0.628 (0.551,0.715)	
		4	10633	0.522 (0.467,0.583)		0.61 (0.545,0.683)		0.61 (0.545,0.683)		0.603 (0.538,0.676)		0.596 (0.532,0.668)	
		5	12461	0.456 (0.405,0.513)		0.524 (0.464,0.591)		0.524 (0.464,0.591)		0.526 (0.466,0.594)		0.519 (0.459,0.586)	
		6	13160	0.5 (0.454,0.55)		0.598 (0.542,0.659)		0.598 (0.542,0.659)		0.577 (0.522,0.637)		0.569 (0.515,0.629)	
		7	12897	0.497 (0.452,0.547)		0.599 (0.544,0.66)		0.6 (0.544,0.661)		0.572 (0.518,0.631)		0.564 (0.511,0.623)	
		8	12297	0.508 (0.463,0.558)		0.612 (0.556,0.673)		0.612 (0.556,0.674)		0.579 (0.525,0.639)		0.57 (0.516,0.629)	
		9	15991	0.436 (0.396,0.481)		0.535 (0.484,0.591)		0.535 (0.485,0.591)		0.503 (0.454,0.556)		0.495 (0.447,0.548)	
		10	21805	0.461 (0.416,0.51)		0.587 (0.529,0.651)		0.589 (0.53,0.653)		0.528 (0.474,0.588)		0.519 (0.466,0.578)	
Age		65-70 y.o.[4]	48684			1		1		1		1	
		70-75 y.o.	48577			0.583 (0.56; 0.607)		0.582 (0.559; 0.606)		0.581 (0.558; 0.605)		0.578 (0.555; 0.601)	
		75-80 y.o.	50815			0.252 (0.24; 0.266)		0.252 (0.239; 0.265)		0.251 (0.238; 0.264)		0.247 (0.234; 0.26)	
		80-85 y.o.	48148			0.094 (0.087; 0.102)		0.094 (0.087; 0.101)		0.093 (0.086; 0.101)		0.092 (0.085; 0.099)	
		85-90 y.o.	34698			0.03 (0.026; 0.035)		0.03 (0.026; 0.035)		0.03 (0.026; 0.035)		0.029 (0.025; 0.034)	
		90-95 y.o.	16602			0.013 (0.01; 0.018)		0.013 (0.01; 0.018)		0.013 (0.009; 0.018)		0.013 (0.009; 0.018)	
		95-100 y.o.	4632			0.005 (0.002; 0.012)		0.005 (0.002; 0.012)		0.005 (0.002; 0.012)		0.005 (0.002; 0.012)	
CMU-C		No[4]	249945					1		1		1	
		Yes	2211					0.68 (0.558; 0.821)		0.676 (0.555; 0.816)		0.67 (0.55; 0.809)	
GP PLA (deciles)		1[4]	7805							1		1	
		2	9343							0.85 (0.731; 0.989)		0.842 (0.724; 0.98)	
		3	9254							0.885 (0.763; 1.028)		0.886 (0.763; 1.029)	
		4	12955							1.004 (0.877; 1.151)		0.995 (0.869; 1.141)	
		5	16421							1.054 (0.927; 1.202)		1.053 (0.926; 1.201)	
		6	19914							1.088 (0.96; 1.237)		1.08 (0.952; 1.227)	
		7	31912							1.147 (1.017; 1.296)		1.14 (1.011; 1.289)	
		8	42273							1.223 (1.087; 1.379)		1.214 (1.08; 1.37)	
		9	47761							1.282 (1.14; 1.446)		1.282 (1.14; 1.446)	
		10	54518							1.319 (1.173; 1.488)		1.327 (1.179; 1.497)	
Referring physician		No[4]	10487									1	
		Yes	241669									9.629 (7.764; 12.133)	

[4] Reference category

STROBE Statement—checklist of items included in the study "Social and territorial inequalities in gynaecological cancers screening uptake in France"

	Item No	Recommendation		Page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	X	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	X	2
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	X	5
Objectives	3	State specific objectives, including any prespecified hypotheses	X	5
Methods				
Study design	4	Present key elements of study design early in the paper	X	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	X	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	X	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	X	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	X	6-8
Bias	9	Describe any efforts to address potential sources of bias	X	6-9
Study size	10	Explain how the study size was arrived at	X	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	X	6-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	X	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	X	9
		(*c*) Explain how missing data were addressed	X	9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		

Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	X	7+10
		(b) Give reasons for non-participation at each stage	X	6+9
		(c) Consider use of a flow diagram	X	9 (no figure)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	X	9-10 + table 1 + suppl. Tables A
		(b) Indicate number of participants with missing data for each variable of interest	X	9
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	X	10-11 + Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	X	10-11+ Tables 2/3
		(*b*) Report category boundaries when continuous variables were categorized	X	8-10 + Tables 2/3
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	X	12-13 + Tables 2/3 + Suppl. Tables B
Discussion				
Key results	18	Summarise key results with reference to study objectives	X	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	X	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	X	16-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	X	16-19
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	X	21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at

http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Social and territorial inequalities in breast and cervical cancers screening uptake: a cross-sectional study in France

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-055363.R2
Article Type:	Original research
Date Submitted by the Author:	24-Dec-2021

Complete List of Authors:	Ouanhnon, Lisa; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP Rougé Bugat, Marie-Eve ; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP LAMY, Sebastien; Institute Claudius Regaud; INSERM UMR_S 1027, CERPOP Druel, Vladimir; Université Toulouse III Paul Sabatier, DUMG (Département Universitaire de Médecine Générale); INSERM UMR_S 1027, CERPOP Delpierre, Cyrille; INSERM UMR_S 1027, CERPOP; Université Toulouse III Paul Sabatier, Grosclaude, Pascale; INSERM UMR_S 1027, CERPOP; Institute Claudius Regaud

Primary Subject Heading:	Public health
Secondary Subject Heading:	Obstetrics and gynaecology, Sociology, Health policy, Epidemiology
Keywords:	Gynaecological oncology < GYNAECOLOGY, GENERAL MEDICINE (see Internal Medicine), Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, SOCIAL MEDICINE, PREVENTIVE MEDICINE

Title: Social and territorial inequalities in breast and cervical cancers screening uptake: a cross-sectional study in France

Authors: Lisa Ouanhnon[1,2], Marie-Eve Rouge Bugat[1,2], Sébastien Lamy[2,4] Vladimir Druel[1,2], Cyrille Delpierre[2,3,*], Pascale Grosclaude [2,3,4,*]

Authors affiliations:

[1] DUMG (Département Universitaire de Médecine Générale), Université Toulouse 3 Paul Sabatier, Toulouse, France

[2] CERPOP, UMR1295, Inserm, Université Toulouse 3 Paul Sabatier, Toulouse, France

[3] Equipe Labellisée Ligue Contre le Cancer

[4] Institut Claudius Regaud, IUCT-O, Registre des cancers du Tarn, Toulouse, France

* these two authors have equally supervised the work

The research team is supported by the French association "La Ligue contre le cancer".

Corresponding author: Lisa Ouanhnon, 87 rue du Faubourg Bonnefoy 31500 Toulouse, France, lisa.ouanhnon@gmail.com, +33661594978

Word counts of the main text: 3177 and abstract: 287 words

Number of tables, figures and appendixes: 3 tables, 2 figures and 6 appendixes (2 tables A, 4 tables B)

Abstract

Objective The objective of this cross-sectional study was to investigate the impact of socio-territorial characteristics on mammography and pap smear uptake according to the place of residence in the recommended age groups, and secondly outside the recommended age groups.

Setting and participants We used an existing dataset of 1,027,039 women which combines data from the Health Insurance information systems, with census data from Midi-Pyrénées, France.

Primary and secondary outcome measures Our outcome was, for each woman, the uptake of the pap smear and the uptake of the mammography during the year.

Results A social gradient of screening uptake was found in the recommended age groups. This gradient was stronger in large urban areas:

- For mammography: decile 10 [the most deprived] vs 1 [the least deprived], adjusted OR= 0.777, 95%CI [0.748,0.808] in large urban area; adjusted OR= 0.808 for decile 1 to 0.726 for decile 10 in other areas vs decile 1 in urban areas;
- For pap smear: decile 10 vs 1 adjusted OR= 0.66, 95%CI [0.642,0.679] in large urban areas; adjusted OR= 0.747 for decile 1 to 0.562 for decile 10 in other areas vs decile 1 in urban areas).

Screening rates were globally higher in large urban areas.

For mammography, the social and territorial disparities were higher outside the recommended age group.

Conclusions Offering a universal approach to every woman, as it is often the case in nationally organised screening programmes, is likely to be insufficient to ensure real equity in access. Developing global dataset combining health data and diverse socioeconomic data, at

individual and contextual levels, could enable a better understanding of the mechanisms involved in this social gradient, and therefore the development of targeted territorial actions to improve equity of access to healthcare.

Keywords

Breast cancer screening; Cervical cancer screening; Screening programme participation; Women health; Socioeconomic inequalities; Geographic inequalities; Deprivation index.

Strengths and limitations of this study

- The use of health insurance data, merged with socio-territorial information, allowed for a very powerful and comprehensive study on social inequalities in health (database of 2.5 million of individuals or 88% of the region's total population).
- We used both individual and contextual variables to investigate the link between an ecological deprivation index and breast and cervical cancers screening.
- We performed a sequential regression (variables were successively added in the multivariable model) to investigate the role of each variable in the link between the ecological deprivation index and screening and studied the interaction between EDI and the type of place of residence
- Our data covered only 1 year and we had a limited number of individual and contextual variables in our dataset.

Abbreviations:

CMU-C: Couverture Médicale Universelle-Comprélmentaire (Supplementary Universal Healthcare Coverage)

EDI: European deprivation Index

GP: General Practitioner

INSEE: Institut National de la Statistique et des Etudes Economiques (French National Institute of Statistics and Economic Studies)

IRIS: Ilots Regroupés pour l'Information statistique (aggregated units for statistical information)

OR: Odds-Ratio

PLA: Potential Localised Accessibility

SEP: Socioeconomic Position

1. Introduction

Breast and cervical cancers are among the most frequent cancers in women worldwide. They kill more than 600,000 and 300,000 women, respectively, every year (1).

For breast cancer in France, through the nationally organised screening programme, all women between 50 and 74 years old are offered a mammography every 2 years (2). For cervical cancer, a national screening programme is progressively being implemented (3). Before 2018, guidelines recommended a pap smear every 3 years between 25 and 65 years old.

In France, the participation rate is around 50% for breast cancer screening and 60% for cervical cancer (4). Despite an universal health coverage policy, mammography and pap smear uptake, and therefore breast and cervical cancer survival, vary considerably with factors like socioeconomic position (SEP) and place of residence (5–8). This raises the question of the determinants of universal access, in particular physical accessibility (availability, reasonable reach), financial affordability (healthcare cost, transportation, time away from work) and sociocultural accessibility (perceived effectiveness, social and cultural factors) (9,10). All these dimensions may be socially distributed and partly explain the inequalities of screening uptake.

Disentangling underlying mechanisms leading to these inequalities is a first step to address them. However, further studies on this topic have been made difficult by the lack of large and representative dataset combining socioeconomic, territorial, and healthcare data (11).

We used French healthcare insurance reimbursement data, merged with socio-territorial information, to assess and investigate the influence of deprivation on mammography and pap smear uptake, according to the place of residence, in the recommended age groups, and secondly outside the recommended age groups. To this end, we investigated the role of variables indicating financial precarity, healthcare accessibility, and adherence to the healthcare system.

2. Methods

Study design

We used a dataset combining data from health insurance information systems with census data, based on the address of residence. This dataset has been described in detail elsewhere (12).

The health data was prospectively collected by the three main health insurance providers for 2012.

Population

This dataset included individuals who were beneficiaries of any of the three health insurance providers on the 31st of December 2012 in Midi-Pyrénées. The individuals with an incomplete address or with differences in the management of their data were excluded. We obtained a base of 2,574,310 subjects (88% of the region's total population).

For this study, we focused on women over 20 years old (1,027,039 women), as cancers screening is rarely offered to women below that age.

Patient and public involvement

Patients or the public were not involved in the design of our study.

Collected variables

- Main outcomes

Our outcome was, for each woman, the uptake of the pap smear and the uptake of the mammography. It was categorised as a binary variable for each screening test to discriminate the women who had at least one mammography/pap smear during the year, and the other ones. Regarding mammography, we only included screening exams, but we could not differentiate between opportunistic and organised screening.

- Main explanatory variables

In the absence of individual social data, social condition of the participants was approached by an ecological deprivation index, the European Deprivation Index (13). The EDI approaches SEP by measuring social deprivation as defined by Townsend as "a state of observable and demonstrable disadvantage relative to the local community or the wider society to which an individual, family or group belongs". To calculate the EDI, we used the aggregated unit for statistical information ('IRIS') corresponding to the person's address. IRIS is the smallest geographical unit for which statistics are available in France, which represents about 2,000 inhabitants. Each IRIS was assigned an EDI value, calculated with census data. We used an EDI presentation in deciles, calculated from all the IRISs of the region: decile 1 corresponds to the least deprived zones, decile 10 to the most deprived zones.

- Covariates

We considered age as a potential confounder. As the association between this variable and the outcomes clearly appeared non-linear, we categorised it (into 5-year groups).

As an ecological index of deprivation, EDI is assumed to be capturing both intrinsic properties of the individuals in the area and contextual properties of the area (14). To explore the mechanisms involved in the link between EDI and screening uptake, we chose to study various factors, including one individual and one contextual:

- The Supplementary Universal Healthcare Coverage (CMU-C), is offered to individuals who earn less than a defined income threshold, to pay for their healthcare expenses. This characteristic was used as a proxy for individual financial precarity. Our hypothesis was that financial precarity, by limiting financial accessibility, was key in the link between deprivation and screening participation.
- Healthcare supply is a contextual property influencing deprivation. We assumed that this factor could partly explain the link between EDI and screening uptake by measuring physical accessibility. Healthcare supply at IRIS level was approached by the Potential Localised Accessibility (PLA) to the GP. The PLA calculates the distance-weighted supply and the local demand, measured by the age-differentiated rate of access. It is interpreted as a medical density (number of full-time equivalents for 100 000 inhabitants) (15).

We assumed that the overall healthcare system adherence could also explain part of the association between deprivation and screening uptake. Therefore, we used a binary variable that discriminates between the patients who had no designated referring physician (in most cases a General Practitioner (GP)) and the ones who had one. This health-seeking behaviour is a property of individuals but is likely to be influenced by both individual and contextual factors (16).

Healthcare supply and transport facilities are very different in rural and urban areas (17–19). We assumed that the level of urbanisation of the place of residence could modify the social gradient of screening uptake. Based on the French National Institute of Statistics and Economic Studies (INSEE)'s 2010 zoning in urban areas, we built a variable to distinguish the large urban centres (more than 10 000 jobs) and their suburbs (urban units in which at least 40% of the active residents work in the urban centre or in the towns attracted by it) (20), from the rest of the region. In the descriptive analysis, we differentiated among large urban areas between Toulouse metropolis, the regional capital which covers almost a quarter of the region's population, and the other areas.

Our conceptual model showing how these variables interact is presented in Figure 1.

Statistical analysis

To describe the sample, we performed univariate analyses: we tested the association between the main explanatory variable and the outcomes, between each covariate and the outcomes, and between each covariate and the EDI.

We used a multivariable logistic regression model to analyse the association between EDI and the mammography and pap smear uptake, adjusted for all the previously identified confounders and intermediate variables. We performed a sequential regression. The variables were successively added to the model following a pre-defined order: the main explanatory variable alone first, then the confounder, and lastly the intermediate variables (at an individual then at a contextual level).

We studied the interaction between EDI and the type of place of residence (large urban/other areas) in the model through a new variable: a 20-modal indicator with ten modalities (corresponding to the EDI deciles) per type of geographical area.

We undertook some age groups analyses to study women outside the recommended age groups (younger and older). For younger women, we focused on women aged 20 to 25 for pap smear and 40 to 50 for mammography. Our hypothesis was that social and territorial inequalities were higher for women outside the recommended age groups.

Since we used data that are systematically recorded by health insurance providers, we expected very little missing data. This was therefore negligible in light of the global sample size (around 0.01%): a complete case analysis could be used.

Statistical analyses were performed with R software (R x64 3.0.2) (21).

3. Results

Selected population in the recommended age groups for mammography (50-74 years old) and pap smear (25-65 years old), were composed of 365 947 and 711 803 women respectively (Table 1). Among these women, 31% had had at least one mammography during the year, and 29% at least one pap smear. Almost two thirds of the population lived in large urban areas. A major part of the most disadvantaged women lived in the Toulouse metropolis (Supplementary material Appendix 1, Tables A). Around 8% of the 25-65 women and less than 4% of the 50-74 had the CMU-C. 92% of the 25-65 women and 95% of the 50-74 had a designated referring physician.

The more deprived the area of residence, the lower the breast and cervical cancers screening uptakes (p-value < 0.001) (Table 1). Regarding age, the mammography rate seemed rather constant throughout the recommended ages. Pap smear uptake decreased a lot after 55 years old (from 31% to 23% between the 45-50 and the 55–60-year-old groups). Women with CMU-C had a lower screening uptake rate. We noticed a slight territorial gradient: the higher the GP density, the higher the mammography and pap smear uptake, except for the last two deciles. The women living in large urban areas had a higher screening rate than the ones living in the rest of the region. Women who had a designated referring physician had a higher screening rate (32% vs 5% for mammography, 31% vs 8% for pap smear, p-value < 0.001).

Adding the interaction term between EDI and the type of place of residence (large urban/other areas) improved our models (better likelihood, p-value= 0.0048 for mammography uptake and 0.0040 for pap smear uptake). Tables 2 and 3 present the logistic regression of mammography and pap smear uptake in the recommended age groups: first the odds-ratios associated with the variable combining EDI and the type of place of residence (large urban/other areas), then the result of the sequential adjustments, and lastly the final multivariable regression model.

For mammography (Table 2), an effect of EDI on mammography uptake was observed, through a social gradient: the screening uptake regularly decreased with increasing deprivation. This social gradient was mostly observed in large urban areas (decile 10 vs 1 adjusted OR= 0.777, 95%CI [0.748,0.808]). The social gradient was less strong in the other areas, where mammography rate was globally lower than in urban areas. Influence of financial precarity was corroborated by CMU-C impact on screening uptake (adjusted OR= 0.644, 95%CI [0.618; 0.671]). The territorial gradient based on GP accessibility was confirmed. Adding this variable decreased only slightly the difference between large urban and other areas. The link between mammography and having a designated referring physician was confirmed as well (adjusted OR = 8.45, 95%CI [7.946; 8.996]). Age had a very limited effect on mammography uptake. Sequential inclusion of all these variables in the model modified only slightly the link between EDI and screening uptake.

For pap smear (Table 3), a strong social gradient was observed. This gradient was slightly stronger in large urban areas (decile 10 vs 1 adjusted OR= 0.66, 95%CI [0.642,0.679]) than in the rest of the region (adjusted OR= 0.747 for decile 1 to 0.562 for decile 10 in other areas vs decile 1 in urban areas). Influence of financial precarity was corroborated by CMU-C impact on screening uptake (adjusted OR= 0.669). The territorial gradient (based on GP accessibility) was confirmed but, as for mammography, adding this variable decreased only slightly the difference between large urban and other areas. The multivariable analysis confirmed the association between having a designated referring physician and pap smear uptake (adjusted OR = 5.39 95%CI [5.227; 5.557]). An effect of age on pap smear uptake was also found (adjusted OR= 0.59, 95% CI [0.574; 0.601] for 55-60-year-old women vs 25-30 women).

Sequential inclusion of all these variables in the model modified only slightly the link between EDI and screening uptake.

We used the same approach for women outside the recommended age groups (Figure 2 & supplementary material Appendix 2, Tables B). Among younger women (40-50 years old for mammography and 20-25 for pap smear), both mammography and pap smear uptakes in the year were around 21%. Among women older than the recommended age, participation rates were around 6% for both breast and cervical cancers. Figure 2 shows that the social gradient in mammography uptake was substantially stronger in women between the ages of 40 and 50, and more so in large urban areas. For pap smear uptake, social gradient seemed less strong in younger women. Regarding GP accessibility, we observed a stronger territorial gradient for older women, for both screening uptakes.

	Total 50-74 y.o N=365 947 N (%)	No mammography n (%) n= 253 354	≥ 1 mammography n (%) n= 112 593 (30.77)	Total 25-65 y.o N=711 803 N (%)	No pap smear n (%) n= 506 731 (71.19)	≥ 1 pap smear n (%) n= 205 072 (28.81)
EDI			*			*
1 (best)	31201 (8.53)	20675 (66.26)	10526 (33.74)	62238 (8.74)	40787 (65.53)	21451 (34.47)
2	34826 (9.52)	23263 (66.8)	11563 (33.2)	70952 (9.97)	47640 (67.14)	23312 (32.86)
3	30111 (8.23)	20414 (67.8)	9697 (32.2)	60763 (8.54)	41703 (68.63)	19060 (31.37)
4	31564 (8.63)	21596 (68.42)	9968 (31.58)	60572 (8.51)	42269 (69.78)	18303 (30.22)
5	32733 (8.94)	22750 (69.5)	9983 (30.5)	65031 (9.14)	46072 (70.85)	18959 (29.15)
6	39518 (10.8)	27130 (68.65)	12388 (31.35)	73464 (10.32)	53153 (72.35)	20311 (27.65)
7	38825 (10.61)	27107 (69.82)	11718 (30.18)	72276 (10.15)	52119 (72.11)	20157 (27.89)
8	37868 (10.35)	26309 (69.48)	11559 (30.52)	70412 (9.89)	51084 (72.55)	19328 (27.45)
9	42390 (11.58)	29998 (70.77)	12392 (29.23)	82232 (11.55)	60646 (73.75)	21586 (26.25)
10 (worst)	46911 (12.82)	34112 (72.72)	12799 (27.28)	93863 (13.19)	71258 (75.92)	22605 (24.08)
Age (/5years)			*			*
25-30 y.o.	-	-	-	82413 (11.58)	56617 (68.7)	25796 (31.3)
30-35 y.o.	-	-	-	88249 (12.4)	58932 (66.78)	29317 (33.22)
35-40 y.o.	-	-	-	85200 (11.97)	57150 (67.08)	28050 (32.92)
40-45 y.o.	-	-	-	92964 (13.06)	63042 (67.81)	29922 (32.19)
45-50 y.o.	-	-	-	94291 (13.25)	64872 (68.8)	29419 (31.2)
50-55 y.o.	88241 (24.11)	61449 (69.64)	26792 (30.36)	88241 (12.4)	64145 (72.69)	24096 (27.31)
55-60 y.o.	83126 (22.72)	57836 (69.58)	25290 (30.42)	83126 (11.68)	64120 (77.14)	19006 (22.86)
60-65 y.o.	81209 (22.19)	55168 (67.93)	26041 (32.07)	81209 (11.41)	64544 (79.48)	16665 (20.52)
65-70 y.o.	64794 (17.71)	44289 (68.35)	20505 (31.65)	16110 (2.26)[1]	13309 (82.61)	2801 (17.39)
70-75 y.o.	48577 (13.27)	34612 (71.25)	13965 (28.75)	-	-	-
CMU-C			*			*
No CMU-C	351872 (96.15)	242406 (68.89)	109466 (31.11)	655969 (92.16)	463517 (70.66)	192452 (29.34)
CMU-C	14075 (3.85)	10948 (77.78)	3127 (22.22)	55834 (7.84)	43214 (77.4)	12620 (22.6)
GP PLA			*			*
1 (worst)	11427 (3.12)	8212 (71.86)	3215 (28.14)	18607 (2.61)	13784 (74.08)	4823 (25.92)
2	13767 (3.76)	9738 (70.73)	4029 (29.27)	24385 (3.43)	17816 (73.06)	6569 (26.94)
3	14455 (3.95)	10195 (70.53)	4260 (29.47)	26121 (3.67)	18888 (72.31)	7233 (27.69)
4	20582 (5.62)	14258 (69.27)	6324 (30.73)	37307 (5.24)	26610 (71.33)	10697 (28.67)
5	26405 (7.22)	18029 (68.28)	8376 (31.72)	49815 (7)	35139 (70.54)	14676 (29.46)
6	32262 (8.82)	21930 (67.97)	10332 (32.03)	63615 (8.94)	44311 (69.65)	19304 (30.35)
7	50863 (13.9)	34371 (67.58)	16492 (32.42)	98949 (13.9)	68782 (69.51)	30167 (30.49)
8	62331 (17.03)	42592 (68.33)	19739 (31.67)	123460 (17.34)	86465 (70.03)	36995 (29.97)
9	64131 (17.52)	44615 (69.57)	19516 (30.43)	127253 (17.88)	90793 (71.35)	36460 (28.65)
10 (best)	69724 (19.05)	49414 (70.87)	20310 (29.13)	142291 (19.99)	104143 (73.19)	38148 (26.81)
Urbanisation			*			*
Toulouse	72919 (19.93)	49978 (68.54)	22941 (31.46)	180030 (25.59)	123038 (68.34)	56992 (31.66)
Large urban areas	150755 (41.2)	102663 (68.1)	48092 (31.9)	302563 (42.51)	211072 (69.76)	91491 (30.24)
Other areas	142273 (38.88)	100713 (70.79)	41560 (29.21)	229210 (32.2)	172621 (75.31)	56589 (24.69)
RP[2]			*			*
No	20032 (5.47)	18963 (94.66)	1069 (5.34)	57596 (8.09)	52948 (91.93)	4648 (8.07)
Yes	345915 (94.53)	234391 (67.76)	111524 (32.24)	654207 (91.91)	453783 (69.36)	200424 (30.64)

Table1: **Socio-demographic characteristics of women**

[1] Only 65 y.o. women

[2] RP : Designated referring physician

*: p-value <0.001

Table 2: Mammography uptake in recommended age group: multivariable logistic regression models (mammography uptake = 30.77%)												
		N	**Model 1**	LogLik	**Model 2**	LogLik	**Model 3**	LogLik	**Model 4**	LogLik	**Model 5**	LogLik
		Tot= 365947	OR (95%CI)	-225465	OR (95%CI)	-225373	OR (95%CI)	-225160	OR (95%CI)	-225115	OR (95%CI)	-220891
Combined EDI and large urban/other areas												
EDI (deciles) in large urban areas	1[3]	2 719	1		1		1		1		1	
	2	5 896	0.981 (0.948,1.016)		0.982 (0.948,1.016)		0.983 (0.95,1.018)		0.983 (0.949,1.018)		0.976 (0.942,1.011)	
	3	10 112	0.967 (0.931,1.005)		0.968 (0.932,1.006)		0.971 (0.934,1.009)		0.968 (0.932,1.007)		0.962 (0.925,1)	
	4	13 232	0.933 (0.897,0.97)		0.934 (0.898,0.971)		0.939 (0.902,0.976)		0.934 (0.897,0.971)		0.927 (0.891,0.965)	
	5	12 730	0.889 (0.856,0.924)		0.89 (0.857,0.925)		0.897 (0.863,0.933)		0.9 (0.865,0.936)		0.897 (0.862,0.933)	
	6	19 906	0.928 (0.893,0.965)		0.929 (0.894,0.966)		0.936 (0.901,0.973)		0.932 (0.896,0.969)		0.927 (0.891,0.964)	
	7	20 092	0.849 (0.816,0.883)		0.85 (0.817,0.884)		0.858 (0.825,0.892)		0.861 (0.826,0.896)		0.864 (0.83,0.9)	
	8	20 741	0.872 (0.837,0.908)		0.873 (0.838,0.909)		0.885 (0.85,0.922)		0.893 (0.857,0.931)		0.895 (0.858,0.933)	
	9	20 679	0.838 (0.807,0.871)		0.84 (0.809,0.872)		0.855 (0.823,0.888)		0.86 (0.827,0.895)		0.867 (0.833,0.903)	
	10	16 166	0.733 (0.708,0.759)		0.734 (0.709,0.76)		0.763 (0.737,0.79)		0.771 (0.742,0.801)		0.777 (0.748,0.808)	
EDI (deciles) in other areas	1	28 482	0.782 (0.718,0.853)		0.783 (0.718,0.854)		0.784 (0.719,0.855)		0.811 (0.743,0.884)		0.808 (0.74,0.882)	
	2	28 930	0.841 (0.791,0.893)		0.842 (0.792,0.894)		0.845 (0.795,0.897)		0.861 (0.81,0.915)		0.855 (0.804,0.91)	
	3	19 999	0.814 (0.775,0.855)		0.814 (0.775,0.855)		0.817 (0.778,0.858)		0.838 (0.798,0.881)		0.834 (0.793,0.877)	
	4	18 332	0.829 (0.793,0.866)		0.829 (0.793,0.867)		0.833 (0.797,0.871)		0.845 (0.808,0.883)		0.84 (0.803,0.879)	
	5	20 003	0.777 (0.742,0.813)		0.777 (0.742,0.813)		0.78 (0.746,0.817)		0.797 (0.761,0.835)		0.794 (0.758,0.832)	
	6	19 612	0.831 (0.799,0.864)		0.832 (0.801,0.866)		0.838 (0.805,0.871)		0.847 (0.815,0.881)		0.846 (0.813,0.881)	
	7	18 733	0.816 (0.785,0.848)		0.817 (0.786,0.85)		0.824 (0.792,0.857)		0.834 (0.801,0.867)		0.829 (0.797,0.863)	
	8	17 127	0.824 (0.793,0.857)		0.825 (0.794,0.858)		0.833 (0.802,0.866)		0.846 (0.813,0.88)		0.842 (0.809,0.876)	
	9	21 711	0.751 (0.722,0.78)		0.751 (0.722,0.781)		0.762 (0.733,0.792)		0.767 (0.737,0.798)		0.767 (0.737,0.799)	
	10	30 745	0.702 (0.672,0.732)		0.703 (0.674,0.734)		0.718 (0.688,0.75)		0.729 (0.698,0.762)		0.726 (0.694,0.759)	
Age (y.o)	50-55[3]	88 241			1		1		1		1	
	55-60	83 126			1.006 (0.985; 1.027)		1.002 (0.982; 1.023)		1.002 (0.982; 1.023)		0.997 (0.977; 1.018)	
	60-65	81 209			1.088 (1.066; 1.111)		1.077 (1.055; 1.099)		1.077 (1.055; 1.1)		1.066 (1.044; 1.088)	
	65-70	64 794			1.07 (1.047; 1.094)		1.052 (1.029; 1.076)		1.052 (1.029; 1.076)		1.035 (1.012; 1.058)	
	70-75	48 577			0.938 (0.916; 0.961)		0.919 (0.897; 0.942)		0.919 (0.897; 0.942)		0.897 (0.875; 0.919)	
CMU-C	No[3]	351 872					1		1		1	
	Yes	14 075					0.659 (0.633; 0.686)		0.659 (0.633; 0.687)		0.644 (0.618; 0.671)	
GP PLA	1[3]	11 427							1		1	
	2	13 767							1.023 (0.968; 1.081)		1.013 (0.958; 1.072)	
	3	14 455							1.027 (0.972; 1.084)		1.018 (0.964; 1.076)	
	4	20 582							1.068 (1.015; 1.124)		1.054 (1.002; 1.11)	
	5	26 405							1.111 (1.058; 1.167)		1.102 (1.048; 1.158)	
	6	32 262							1.118 (1.066; 1.173)		1.103 (1.051; 1.158)	
	7	50 863							1.14 (1.089; 1.194)		1.126 (1.075; 1.18)	
	8	6 2331							1.143 (1.092; 1.195)		1.126 (1.076; 1.179)	
	9	64 131							1.106 (1.057; 1.157)		1.096 (1.047; 1.148)	
	10	69 724							1.081 (1.033; 1.132)		1.081 (1.032; 1.132)	
Referring physician	No[3]	20 032									1	
	Yes	345 915									8.45 (7.946; 8.996)	

[3] Reference category

***Table 3*: Pap smear uptake multivariable logistic regression models in recommended age group (Pap smear uptake = 28.81%)**

		N	**Model 1** LogLik	**Model 2** LogLik	**Model 3** LogLik	**Model 4** LogLik	**Model 5** LogLik
		Total= 711803	OR (95%CI) -424737	OR (95%CI) -420964	OR (95%CI) -420368	OR (95%CI) -420310	OR (95%CI) -411557
Combined EDI and large urban/other areas	1[4]	4 741	1	1	1	1	1
	2	9 906	0.945 (0.923,0.968)	0.936 (0.914,0.959)	0.939 (0.917,0.962)	0.929 (0.907,0.952)	0.922 (0.899,0.945)
	3	16 889	0.918 (0.894,0.942)	0.902 (0.879,0.927)	0.908 (0.884,0.932)	0.897 (0.873,0.921)	0.889 (0.865,0.913)
	4	21 643	0.887 (0.863,0.912)	0.878 (0.854,0.902)	0.886 (0.862,0.91)	0.878 (0.854,0.903)	0.873 (0.849,0.898)
	5	20 561	0.833 (0.811,0.855)	0.816 (0.795,0.838)	0.826 (0.804,0.848)	0.817 (0.795,0.839)	0.816 (0.794,0.839)
EDI (deciles) in large urban area	6	31 816	0.793 (0.772,0.815)	0.781 (0.76,0.803)	0.792 (0.771,0.814)	0.78 (0.759,0.802)	0.781 (0.759,0.803)
	7	31 628	0.801 (0.78,0.823)	0.788 (0.766,0.81)	0.8 (0.778,0.822)	0.791 (0.769,0.813)	0.805 (0.782,0.828)
	8	32 394	0.806 (0.784,0.829)	0.788 (0.766,0.81)	0.806 (0.783,0.828)	0.801 (0.778,0.824)	0.81 (0.787,0.834)
	9	33 163	0.735 (0.716,0.754)	0.716 (0.698,0.735)	0.738 (0.719,0.758)	0.729 (0.709,0.749)	0.748 (0.727,0.769)
	10	26 469	0.616 (0.601,0.631)	0.602 (0.588,0.618)	0.643 (0.627,0.659)	0.636 (0.619,0.653)	0.66 (0.642,0.679)
EDI (deciles) in other area	1	57 497	0.723 (0.678,0.773)	0.735 (0.688,0.785)	0.737 (0.69,0.787)	0.749 (0.701,0.801)	0.747 (0.699,0.799)
	2	61 046	0.703 (0.671,0.738)	0.72 (0.686,0.755)	0.724 (0.69,0.759)	0.731 (0.697,0.767)	0.732 (0.697,0.768)
	3	43 874	0.685 (0.659,0.711)	0.704 (0.677,0.731)	0.707 (0.681,0.735)	0.715 (0.688,0.744)	0.716 (0.689,0.745)
	4	38929	0.667 (0.644,0.69)	0.684 (0.661,0.709)	0.69 (0.666,0.714)	0.693 (0.669,0.718)	0.693 (0.669,0.718)
	5	44470	0.628 (0.606,0.651)	0.645 (0.623,0.669)	0.65 (0.627,0.674)	0.655 (0.631,0.679)	0.659 (0.635,0.683)
	6	41648	0.608 (0.59,0.627)	0.626 (0.607,0.645)	0.632 (0.613,0.652)	0.631 (0.611,0.651)	0.637 (0.617,0.657)
	7	40648	0.619 (0.6,0.638)	0.637 (0.618,0.657)	0.647 (0.628,0.668)	0.646 (0.626,0.666)	0.648 (0.628,0.669)
	8	38018	0.591 (0.574,0.61)	0.61 (0.591,0.629)	0.621 (0.602,0.641)	0.62 (0.601,0.64)	0.622 (0.603,0.642)
	9	49069	0.559 (0.542,0.577)	0.573 (0.556,0.591)	0.588 (0.57,0.607)	0.582 (0.564,0.601)	0.59 (0.571,0.609)
	10	67394	0.524 (0.506,0.542)	0.533 (0.516,0.552)	0.556 (0.537,0.575)	0.552 (0.533,0.572)	0.562 (0.542,0.582)
Age (y.o)	25-30[4]	82413		1	1	1	1
	30-35	88249		1.084 (1.062; 1.106)	1.08 (1.059; 1.103)	1.081 (1.059; 1.104)	1.06 (1.038; 1.082)
	35-40	85200		1.063 (1.042; 1.085)	1.056 (1.035; 1.078)	1.057 (1.035; 1.079)	1.021 (1; 1.043)
	40-45	92964		1.031 (1.01; 1.052)	1.021 (1; 1.042)	1.021 (1.001; 1.042)	0.963 (0.944; 0.984)
	45-50	94291		0.988 (0.968; 1.008)	0.975 (0.955; 0.995)	0.975 (0.956; 0.996)	0.906 (0.888; 0.925)
	50-55	88241		0.826 (0.809; 0.843)	0.811 (0.794; 0.828)	0.812 (0.795; 0.829)	0.749 (0.733; 0.765)
	55-60	83126		0.655 (0.64; 0.669)	0.641 (0.627; 0.655)	0.641 (0.627; 0.656)	0.587 (0.574; 0.601)
	60-65	81209		0.573 (0.56; 0.586)	0.558 (0.545; 0.57)	0.558 (0.546; 0.571)	0.507 (0.496; 0.519)
	65	16110		0.468 (0.448; 0.488)	0.454 (0.434; 0.474)	0.454 (0.435; 0.474)	0.413 (0.395; 0.431)
CMU-C	No[4]	655969			1	1	1
	Yes	55834			0.696 (0.681; 0.711)	0.695 (0.681; 0.71)	0.669 (0.655; 0.684)
GP PLA (deciles)	1[4]	18607				1	1
	2	24385				0.966 (0.925; 1.01)	0.951 (0.909; 0.994)
	3	26121				0.982 (0.941; 1.026)	0.97 (0.928; 1.013)
	4	37307				1.004 (0.965; 1.046)	0.989 (0.95; 1.031)
	5	49815				1.01 (0.971; 1.05)	0.991 (0.952; 1.03)
	6	63615				1.033 (0.994; 1.073)	1.017 (0.978; 1.056)
	7	98949				1.049 (1.011; 1.088)	1.031 (0.993; 1.069)
	8	123460				1.086 (1.048; 1.126)	1.068 (1.03; 1.108)
	9	127253				1.056 (1.018; 1.095)	1.046 (1.009; 1.086)
	10	142291				1.03 (0.993; 1.069)	1.049 (1.011; 1.088)
Referring physician	No[4]	57596					1
	Yes	654207					5.389 (5.227; 5.557)

[4] Reference category

4. Discussion

Our study highlighted a link between deprivation and breast and cervical cancers screening uptake, in and outside the recommended age groups. This link follows a social gradient across all socioeconomic levels. The gradient was stronger in large urban areas. The successive inclusion of variables indicating financial precarity, healthcare accessibility, and adherence to the healthcare system decreased only very slightly the association, suggesting that these variables explain a very limited extent of the link between EDI and screening uptake. The social and territorial disparities in mammography uptake were lower in the recommended age group than outside.

The main strength of our study is its power and comprehensiveness, achieved by using health insurance data. Using both individual and contextual variables to investigate the link between an ecological deprivation index and screening uptake is original. Another original aspect is the exploration of screening uptake outside the recommended age groups and the observation of two different implementation modes for national recommendations (with and without a screening programme). Our study also has limitations. As our data covered only 1 year, we could not differentiate between women who had screening tests every year (more often than recommended) and the ones who had it every two and three years as recommended. It raises the question of excess screening and its link with SEP. In our dataset, pap smears prescribed for diagnostic purposes could not be distinguished from those performed in a screening context. The limited number of individual and contextual variables in our dataset restrained our capability to disentangle what could be explained by contextual and individual properties in the associations we observed with EDI. The same difficulty limited the exploration of financial, physical, and sociocultural accessibility mechanisms involved in the social gradient.

We complemented existing literature on social inequalities in access to mammography and pap smear. The link between deprivation and screening participation was found in numerous countries all over the word, irrespective of the local healthcare policy. In the United States, where no centrally organised cancer screening programme exists, this link was repeatedly reported at an individual and at an area levels (22–25). In most Western European countries, nationally organised screening programmes are in place. The studies conducted there also showed an impact of SEP (26–28). In France, the lack of individual socioeconomic variable in healthcare datasets has made it difficult to obtain large and representative evidence. A few cohort studies have been conducted, but were limited by the relatively small sample size (7,29,30). Using healthcare insurance reimbursement data merged with sociodemographic information made it possible to assess the impact of socioterritorial inequalities in larger studies, more representative of the French population (31).

Our study tried to identify some of the mechanisms involved in the link between deprivation and screening uptake. One of our hypotheses was that deprivation leads to limitations of the three dimensions of healthcare accessibility: financial, physical, and sociocultural. We used CMU-C to explore the effect of financial precarity in the link between deprivation and screening uptake and GP PLA, a proxy for healthcare supply, to reflect physical accessibility. Our result suggests that the association between deprivation and screening uptake is very slightly influenced by these variables. This could be due to the choice of variables used in our model. CMU-C may not be enough precise to measure financial accessibility. GP PLA is a good proxy for physical accessibility to primary care, but maybe not to specialty care. Regarding sociocultural accessibility, no truly relevant variable was available in our dataset. Our results showed that the overall adherence to the healthcare system, approached by having a referring physician, only modified slightly the link between EDI and screening uptake. However sociocultural accessibility covers several concepts. Using psychological models, R.

Crockett explained that the most deprived people focus more on present time (32). They concentrate on the inconvenience of the screening rather than on the possible long-term benefits. A measure of this mechanism, the fear of the result, language barriers or cultural representations (33) could be better proxies for sociocultural accessibility.

However, our study suggests that having a referring physician has a substantial direct impact on pap smear and mammography uptake. This key role of primary care providers was observed in other countries, like the United States and Canada (34,35). The improvement in screening uptake in people with a referring physician could be due to the direct role of the physician in overcoming the barriers to screening. This result might also be explained by another phenomenon linked to healthcare access: the patient's understanding of and capacity to navigate the healthcare system.

We confirmed territorial disparities in screening access. Large urban areas had higher participation rates than the rest of the region. These rural/urban disparities were observed in several studies in Western Europe and North America (17–19,28,36,37). The social gradient also appeared generally stronger in large urban areas. But even in the other areas, the most deprived populations had a lower screening access. These results corroborate the assumption that the social gradient is stronger if the healthcare supply is sufficient, but access to care of the most deprived remains lower whatever the place.

We observed that the social and territorial disparities in mammography uptake were lower inside the recommended age group than for younger women. We did not observe the same trend for pap smear uptake. This difference could be explained by the nationally organised screening programme in place for breast cancer at the time of data collection but not for cervical cancer. Some studies suggested that tools used in the breast cancer screening programme might help decrease inequalities of access (38,39), but other showed that a national programme, with the exact same actions for every women, while improving overall participation rates, could also increase the social gradient in uptake (40). Pap smear and mammography uptake also appeared very high in women younger than the recommended age. While the social gradient within the recommended age groups is likely to be explained by a low uptake in deprived populations, its existence among younger and older women may indicate an overuse of screening in high SEP populations (41). Regarding women older than the recommended age, we observed a higher effect of territorial disparities on screening uptake (rural/urban disparities and effect of GP accessibility). This suggests that older women could have more difficulty adapting to territorial barriers.

Developing global dataset combining health data and diverse socioeconomic data, at individual and contextual levels, could enable a better understanding of the mechanisms involved in this social gradient, and therefore the development of targeted territorial actions to improve equity of access to healthcare.

Author contributions: LO: Conceptualisation, Methodology, Formal analysis, Funding acquisition, Writing – original draft and review & editing. CD: Conceptualisation, Methodology, Formal analysis, Supervision, Validation. PG: Conceptualisation, Data curation, Methodology, Formal analysis, Supervision, Validation. MERB: Conceptualisation, Funding acquisition, Validation. SL: Methodology, Formal analysis, Writing – review, Validation. VD: Writing – review, Validation.

All authors read, edited, and approved the final manuscript.

Acknowledgments:

We gratefully acknowledge Sarah Ouanhnon for her translation help and her many advice. Many thanks to Hervé Mainsonneuve for his careful reading and his precious advice. We wish to thank all the members of the research team: Marine Maurel for her skills with R-software, Camille Joanes for her advice, and all the other members. The research team is supported by the French association "La Ligue contre le cancer".

Data availability statements: This study is conformed to the principles embodied in the Declaration of Helsinki. The data we used in this study belongs to the French National Health Insurance. The procurement of such data necessitates the agreement of the French National Institute of Health Data (INDS) and the permission from the 'Commission Nationale Informatique et Liberte´s' (CNIL) which is the French Data Protection Authority in accordance with Law No 78/17 of 6 January 1978 on computing, files and personal information, article 54, paragraph I. Data cannot be diffused without these authorisations. A CNIL Authorisation (no. 1634837) was obtained for our study. In addition, data cannot be shared with anyone who does not have these authorisations. In our study, the Regional Health Agency of Occitanie completed the necessary formalities with the relevant authorities. If other authors want to obtain the data, they have to contact directly the French National Institute of Health Data and obtain the permission of the CNIL. It can be done on the INDS website (http://www.indsante.fr/). In addition, data regarding demographical characteristics of the whole inhabitants of the region can be freely obtained from the French national institute for statistics and economic studies (https://www.insee.fr/fr/statistiques/).

Ethics statement: According to French registration, the ethics Committee approval is not applicable for this study (on pre-existing dataset).

This study is conformed to the principles embodied in the Declaration of Helsinki. The authors obtained an agreement of the French National Institute of Health Data (INDS) and the permission from the 'Commission Nationale Informatique et Liberte´s' (CNIL) which is the French Data Protection Authority in accordance with Law No 78/17 of 6 January 1978 on computing, files and personal information, article 54, paragraph I. CNIL Authorisation: no. 1634837.

Funding Statement: This work was supported by Toulouse Hospital ("allocation jeune chercheur de la DRCI", Direction de la Recherche Clinique et de l'Innovation). There is no grant number: Toulouse Hospital allocates this grant to young doctors who wish to deepen their knowledge in research, after studying their research project.

Declaration of Competing Interest: The authors have declared that no competing interests exist.

References

1. International Agency for research on Cancer. Estimated number of deaths in 2020, breast, females, all ages: IARC Gobocan [Internet]. Available from: https://gco.iarc.fr/today/online-analysis-table?v=2020&mode=population&mode_population=countries&population=900&populations=900&key=asr&sex=2&cancer=20&type=1&statistic=5&prevalence=0&population_group=0&ages_group%5B%5D=0&ages_group%5B%5D=17&group_cancer=1&include_nmsc=1&include_nmsc_other=1

2. Institut National du Cancer. Le programme de dépistage organisé - Dépistage du cancer du sein [Internet]. cancer.fr. 2019. Available from: https://www.e-cancer.fr/Professionnels-de-sante/Depistage-et-detection-precoce/Depistage-du-cancer-du-sein/Le-programme-de-depistage-organise

3. INCA. Le programme de dépistage organisé du cancer du col de l'utérus - Dépistage du cancer du col de l'utérus [Internet]. Available from: https://www.e-cancer.fr/Professionnels-de-sante/Depistage-et-detection-precoce/Depistage-du-cancer-du-col-de-l-uterus/Le-programme-de-depistage-organise

4. Santé publique France. Evaluation du programme de dépistage du cancer du col de l'utérus [Internet]. [cited 2020 May 13]. Available from: http://santepubliquefrance.fr/maladies-et-traumatismes/cancers/cancer-du-col-de-l-uterus/articles/evaluation-du-programme-de-depistage-du-cancer-du-col-de-l-uterus

5. Poiseuil M, Coureau G, Payet C, Savès M, Debled M, Mathoulin-Pelissier S, et al. Deprivation and mass screening: Survival of women diagnosed with breast cancer in France from 2008 to 2010. Cancer Epidemiol. 2019;60:149–55.

6. Duport N, Serra D, Goulard H, Bloch J. Quels facteurs influencent la pratique du dépistage des cancers féminins en France ? Revue d'Épidémiologie et de Santé Publique. 2008 Oct 1;56(5):303–13.

7. Grillo F, Vallée J, Chauvin P. Inequalities in cervical cancer screening for women with or without a regular consulting in primary care for gynaecological health, in Paris, France. Prev Med. 2012 Apr;54(3–4):259–65.

8. Delpierre C, Fantin R, Chehoud H, Nicoules V, Bayle A, Souche A, et al. Inégalités sociales d'accès aux soins et à la prévention en Midi-Pyrénées, France, 2012. 2016; Available from: http://invs.santepubliquefrance.fr//beh/2016/1/2016_1_1.html

9. Evans DB, Hsu J, Boerma T. Universal health coverage and universal access. Bull World Health Organ. 2013 Aug;91:546-546A.

10. Thiede M, Akweongo P, McIntyre D. Exploring the dimensions of access. In: McIntyre D, Mooney G, editors. The Economics of Health Equity [Internet]. Cambridge: Cambridge University Press; 2007 [cited 2020 Jun 8]. p. 103–23. Available from: https://www.cambridge.org/core/books/economics-of-health-equity/exploring-the-dimensions-of-access/684DFDF7B640370D207C59FEAFC967E7

11. HCSP. Les systèmes d'information pour la santé publique [Internet]. Paris: Haut Conseil de la Santé Publique; 2009 Nov [cited 2019 Mar 10]. Available from: https://www.hcsp.fr/explore.cgi/avisrapportsdomaine?clefr=175

12. Ducros D, Nicoules V, Chehoud H, Bayle A, Souche A, Tanguy M, et al. Les bases médico-administratives pour mesurer les inégalités sociales de santé. Sante Publique. 2015 Aug 24;Vol. 27(3):383–94.

13. Pornet C, Delpierre C, Dejardin O, Grosclaude P, Launay L, Guittet L, et al. Construction of an adaptable European transnational ecological deprivation index: the French version. J Epidemiol Community Health. 2012 Nov;66(11):982–9.

14. Yang XY, Hu A, Schieman S. Relative deprivation in context: How contextual status homogeneity shapes the relationship between disadvantaged social status and health. Social Science Research. 2019 Jul 1;81:157–69.

15. Muriel Barlet, Magali Coldefy, Clémentine Collin, Véronique Lucas-Gabrielli,. L'Accessibilité potentielle localisée (APL) : une nouvelle mesure de l'accessibilité aux soins appliquée aux médecins généralistes libéraux en France [Internet]. Drees; 2012. Available from: https://drees.solidarites-sante.gouv.fr/etudes-et-statistiques/publications/documents-de-travail/serie-etudes-et-recherche/article/l-accessibilite-potentielle-localisee-apl-une-nouvelle-mesure-de-l

16. Short SE, Mollborn S. Social Determinants and Health Behaviors: Conceptual Frames and Empirical Advances. Curr Opin Psychol. 2015 Oct;5:78–84.

17. Chandak A, Nayar P, Lin G. Rural-Urban Disparities in Access to Breast Cancer Screening: A Spatial Clustering Analysis. J Rural Health. 2019;35(2):229–35.

18. Orwat J, Caputo N, Key W, De Sa J. Comparing Rural and Urban Cervical and Breast Cancer Screening Rates in a Privately Insured Population. Soc Work Public Health. 2017;32(5):311–23.

19. Leung J, McKenzie S, Martin J, McLaughlin D. Effect of rurality on screening for breast cancer: a systematic review and meta-analysis comparing mammography. Rural Remote Health. 2014;14(2):2730.

20. INSEE (Institut National de la Statistique et des Etudes Economiques). Le nouveau zonage en aires urbaines de 2010 - Insee Première - 1374 [Internet]. 2010 [cited 2021 Nov 26]. Available from: https://www.insee.fr/fr/statistiques/1281191

21. R Core Team. R: A language and environment for statistical computing. [Internet]. 2013. Available from: http://www.R-project.org/

22. Smith RA, Andrews KS, Brooks D, Fedewa SA, Manassaram-Baptiste D, Saslow D, et al. Cancer screening in the United States, 2019: A review of current American Cancer Society guidelines and current issues in cancer screening. CA: A Cancer Journal for Clinicians. 2019;69(3):184–210.

23. Dailey AB, Kasl SV, Holford TR, Calvocoressi L, Jones BA. Neighborhood-Level Socioeconomic Predictors of Nonadherence to Mammography Screening Guidelines. Cancer Epidemiol Biomarkers Prev. 2007 Nov 1;16(11):2293–303.

24. Dailey AB, Brumback BA, Livingston MD, Jones BA, Curbow BA, Xu X. Area-Level Socioeconomic Position and Repeat Mammography Screening Use: Results from the 2005 National Health Interview Survey. Cancer Epidemiol Biomarkers Prev. 2011 Nov 1;20(11):2331–44.

25. Murfin J, Irvine F, Meechan-Rogers R, Swift A. Education, income and occupation and their influence on the uptake of cervical cancer prevention strategies: A systematic review. J Clin Nurs. 2020 Feb;29(3–4):393–415.

26. Borràs JM, Guillen M, Sanchez V, Juncà S, Vicente R. Educational level, voluntary private health insurance and opportunistic cancer screening among women in Catalonia (Spain): European Journal of Cancer Prevention. 1999 Oct;8(5):427–34.

27. Douglas E, Waller J, Duffy SW, Wardle J. Socioeconomic inequalities in breast and cervical screening coverage in England: are we closing the gap? J Med Screen. 2016;23(2):98–103.

28. Massat NJ, Douglas E, Waller J, Wardle J, Duffy SW. Variation in cervical and breast cancer screening coverage in England: a cross-sectional analysis to characterise districts with atypical behaviour. BMJ Open. 2015 Jul 24;5(7):e007735.

29. Eisinger F, Viguier J, Touboul C, Coscas Y, Pivot X, Blay J-Y, et al. Social stratification, risk factor prevalence and cancer screening attendance. Eur J Cancer Prev. 2015 Jun;24 Suppl:S77-81.

30. Chauvin P, Parizot I. Les inégalités sociales et territoriales de santé dans l'agglomération parisienne. Une analyse de la cohorte Sirs (2005) [Internet]. Délégation interministérielle à la Ville; 2009 [cited 2020 Jun 1]. Available from: https://www.hal.inserm.fr/inserm-00415971

31. Deborde T, Chatignoux E, Quintin C, Beltzer N, Hamers FF, Rogel A. Breast cancer screening programme participation and socioeconomic deprivation in France. Prev Med. 2018;115:53–60.

32. Crockett R, Wilkinson TM, Marteau TM. Social patterning of screening uptake and the impact of facilitating informed choices: psychological and ethical analyses. Health Care Anal. 2008 Mar;16(1):17–30.

33. Szarewski A, Cadman L, Ashdown-Barr L, Waller J. Exploring the acceptability of two self-sampling devices for human papillomavirus testing in the cervical screening context: a qualitative study of Muslim women in London. J Med Screen. 2009;16(4):193–8.

34. Schueler KM, Chu PW, Smith-Bindman R. Factors Associated with Mammography Utilization: A Systematic Quantitative Review of the Literature. Journal of Women's Health. 2008 Oct 27;17(9):1477–98.

35. Beaulieu MD, Béland F, Roy D, Falardeau M, Hébert G. Factors determining compliance with screening mammography. CMAJ. 1996 May 1;154(9):1335–43.

36. Ouédraogo S, Dabakuyo-Yonli TS, Roussot A, Dialla PO, Pornet C, Poillot M-L, et al. [Breast cancer screening in thirteen French departments]. Bull Cancer. 2015 Feb;102(2):126–38.

37. Ouédraogo S, Dabakuyo-Yonli TS, Roussot A, Pornet C, Sarlin N, Lunaud P, et al. European transnational ecological deprivation index and participation in population-based breast cancer screening programmes in France. Prev Med. 2014 Jun;63:103–8.

38. Cancer Care Ontario. Cancer Fact: Invitation letters improve breast screening behaviour [Internet]. 2016 [cited 2020 May 13]. Available from: https://www.cancercareontario.ca/en/cancer-facts/invitation-letters-improve-breast-screening-behaviour

39. Everett T, Bryant A, Griffin MF, Martin-Hirsch PP, Forbes CA, Jepson RG. Interventions targeted at women to encourage the uptake of cervical screening. Cochrane Database of Systematic Reviews [Internet]. 2011 [cited 2019 Oct 16];(5). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002834.pub2/full

40. Raginel T, de Mil R, Garnier A, Launoy G, Guittet L. National organization of uterine cervical cancer screening and social inequality in France. European Journal of Cancer Prevention [Internet]. 2019 Dec 10 [cited 2020 Jun 1];Publish Ahead of Print. Available from:

https://journals.lww.com/eurjcancerprev/Abstract/9000/National_organization_of_uterine_cervical_cancer.99158.aspx

41. Autier P. [Screening for breast cancer: worries about its effectiveness]. Rev Prat. 2013 Dec;63(10):1369–77.

Figure 1: **Conceptual model**

Links between the studied variables assumed to explain the impact of deprivation on screening uptake, depending on the level of urbanisation.

Figure 2**: Mammography and pap smear uptake and combined variable EDI in large urban/other areas by age group, Midi Pyrenees region, 2012.**
Results from a logistic model adjusted for EDI by age, CMU-C, GP PLA, having an official referring physician.
Data from models 5 (Table 2 and 3) for the recommended age groups.

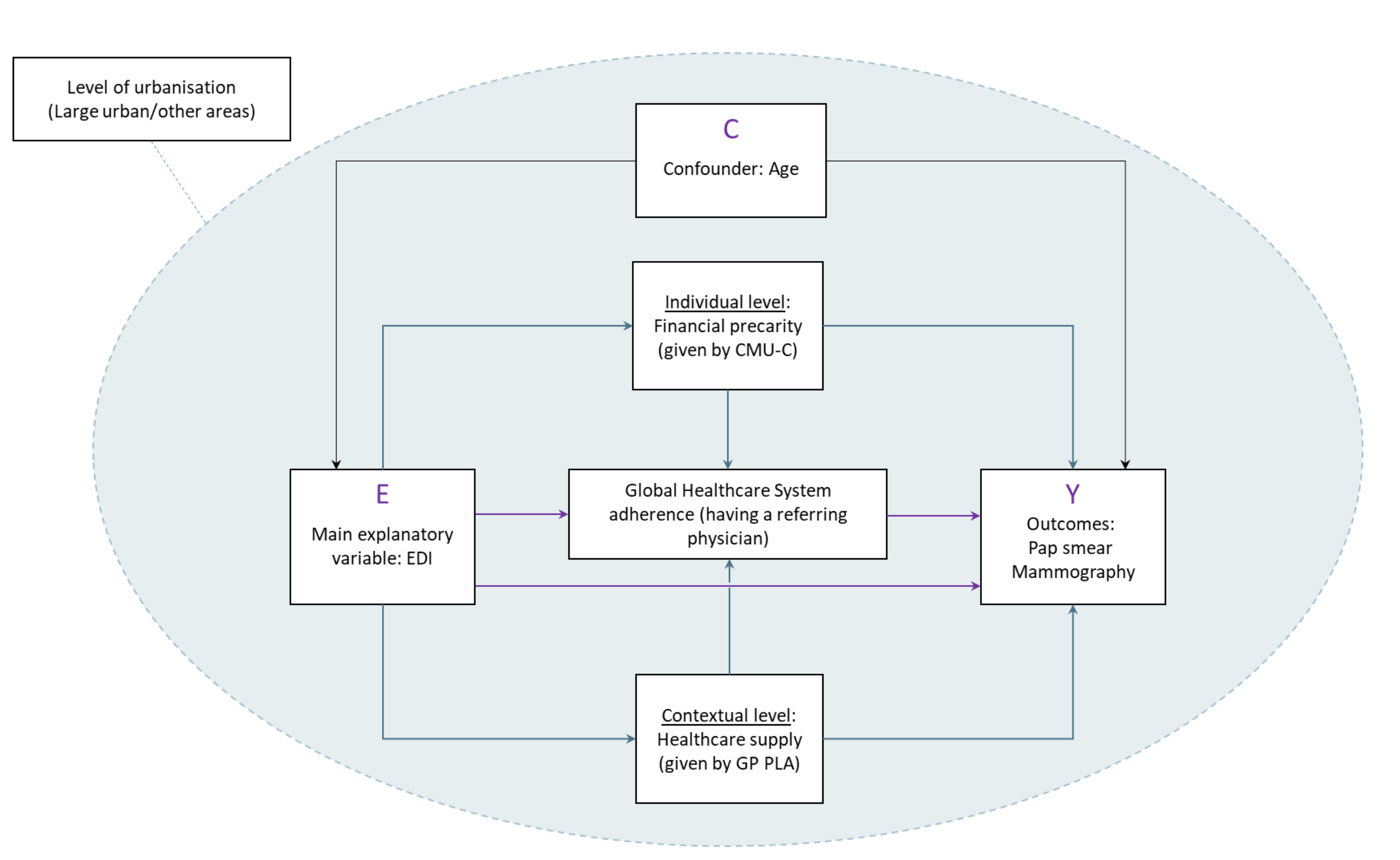
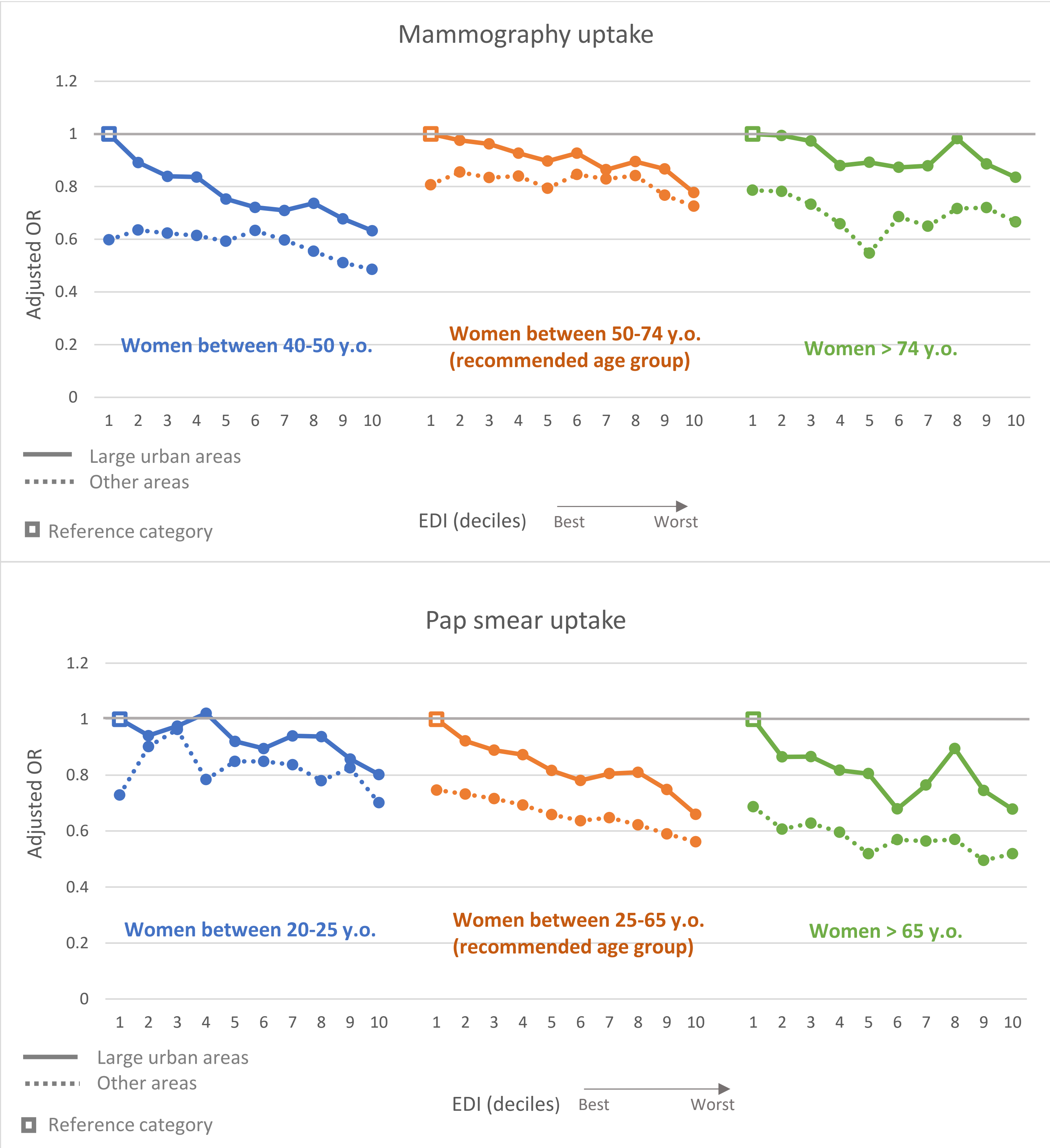


***Figure 1:* Conceptual model**

Links between the studied variables assumed to explain the impact of deprivation on screening uptake, depending on the level of urbanisation.

***Figure 2*: Mammography and pap smear uptake and combined variable EDI in large urban/other areas by age group, Midi Pyrenees region, 2012.**
Results from a logistic model adjusted for EDI by age, CMU-C, GP PLA, having an official referring physician.
Data from models 5 (Table 2 and 3) for the recommended age groups.



Supplementary material

Tables A: Characteristics of women in recommended age groups for gynaecological screening programmes in Midi Pyrénées

Characteristics of women between 50 and 74 y.o. (recommended age group for mammography) N= 365 947

	Toulouse Metropolis	Other large urban area	Other area
	n= 72919 (19.93%)	n= 150755 (41.2%)	n= 142273 (38.88%)
	n (%)	n (%)	n (%)
Mammography			
No Mammography	49978 (68.54)	102663 (68.1)	100713 (70.79)
≥ 1 in the year	22941 (31.46)	48092 (31.9)	41560 (29.21)
Age			
Mean (SD)	60.7 (6.8)	60.9 (6.9)	61.6 (6.9)
Age (/5years)			
50-55 y.o	19112 (26.21)	37568 (24.92)	31561 (22.18)
55-60 y.o	17097 (23.45)	34985 (23.21)	31044 (21.82)
60-65 y.o	15774 (21.63)	33460 (22.19)	31975 (22.47)
65-70 y.o,	12305 (16.87)	25825 (17.13)	26664 (18.74)
70-75 y.o	8631 (11.84)	18917 (12.55)	21029 (14.78)
EDI (deciles: 1=best)			
1	7886 (10.81)	20596 (13.66)	2719 (1.91)
2	8615 (11.81)	20315 (13.48)	5896 (4.14)
3	4436 (6.08)	15563 (10.32)	10112 (7.11)
4	3484 (4.78)	14848 (9.85)	13232 (9.3)
5	8183 (11.22)	11820 (7.84)	12730 (8.95)
6	3368 (4.62)	16244 (10.78)	19906 (13.99)
7	6678 (9.16)	12055 (8)	20092 (14.12)
8	6367 (8.73)	10760 (7.14)	20741 (14.58)
9	9519 (13.05)	12192 (8.09)	20679 (14.53)
10	14383 (19.72)	16362 (10.85)	16166 (11.36)
CMU-C			
No CMU-C	68850 (94.42)	145641 (96.61)	137381 (96.56)
CMU-C	4069 (5.58)	5114 (3.39)	4892 (3.44)
GP PLA (deciles: 10= best)			
1	363 (0.5)	1744 (1.16)	9320 (6.55)
2	922 (1.26)	4887 (3.24)	7958 (5.59)
3	0 (0)	6290 (4.17)	8165 (5.74)
4	803 (1.1)	9625 (6.38)	10154 (7.14)
5	1409 (1.93)	14229 (9.44)	10767 (7.57)
6	2695 (3.7)	17381 (11.53)	12186 (8.57)
7	9531 (13.07)	25353 (16.82)	15979 (11.23)
8	14772 (20.26)	25147 (16.68)	22412 (15.75)
9	15456 (21.2)	27726 (18.39)	20949 (14.72)
10	26968 (36.98)	18373 (12.19)	24383 (17.14)
Referring physician			
No designated referring physician	4898 (6.72)	7428 (4.93)	7706 (5.42)
Official referring physician	68021 (93.28)	143327 (95.07)	134567 (94.58)

Characteristics of women between 25 and 65 y.o. (recommended age group for pap smear)
N= 711 803

	Toulouse Metropolis	Other large urban areas	Other areas
	n= 180030 (25.59%) n (%)	n= 302563 (42.61%) n (%)	n= 229210 (32.2%) n (%)
Pap smear			
No Pap smear	123038 (68.34)	211072 (69.76)	172621 (75.31)
≥ 1 in the year	56992 (31.66)	91491 (30.24)	56589 (24.69)
Age			
Mean (SD)	42.9 (11.8)	45.5 (11.4)	47.2 (11.4)
Age (/5years)	n= 180030	n= 302563	n= 229210
25-30 y.o	30798 (17.11)	32111 (10.61)	19504 (8.51)
30-35 y.o	28146 (15.63)	36721 (12.14)	23382 (10.2)
35-40 y.o	23292 (12.94)	37351 (12.34)	24557 (10.71)
40-45 y.o	21537 (11.96)	41983 (13.88)	29444 (12.85)
45-50 y.o	21259 (11.81)	41829 (13.82)	31203 (13.61)
50-55 y.o	19112 (10.62)	37568 (12.42)	31561 (13.77)
55-60 y.o	17097 (9.5)	34985 (11.56)	31044 (13.54)
60-65 y.o	15774 (8.76)	33460 (11.06)	31975 (13.95)
65-70 y.o,	3015 (1.67)	6555 (2.17)	6540 (2.85)
EDI (deciles: 1=best)			
1	14747 (8.19)	42750 (14.13)	4741 (2.07)
2	19389 (10.77)	41657 (13.77)	9906 (4.32)
3	10922 (6.07)	32952 (10.89)	16889 (7.37)
4	8239 (4.58)	30690 (10.14)	21643 (9.44)
5	21020 (11.68)	23450 (7.75)	20561 (8.97)
6	9173 (5.1)	32475 (10.73)	31816 (13.88)
7	17062 (9.48)	23586 (7.8)	31628 (13.8)
8	17051 (9.47)	20967 (6.93)	32394 (14.13)
9	26337 (14.63)	22732 (7.51)	33163 (14.47)
10	36090 (20.05)	31304 (10.35)	26469 (11.55)
CMU-C			
No CMU-C	161075 (89.47)	281794 (93.14)	213100 (92.97)
CMU-C	18955 (10.53)	20769 (6.86)	16110 (7.03)
GP PLA (deciles: 10= best)			
1	831 (0.46)	3162 (1.05)	14614 (6.38)
2	2273 (1.26)	9407 (3.11)	12705 (5.54)
3	0 (0%)	12683 (4.19)	13438 (5.86)
4	1815 (1.01)	18903 (6.25)	16589 (7.24)
5	3312 (1.84)	28690 (9.48)	17813 (7.77)
6	6666 (3.7)	36519 (12.07)	20430 (8.91)
7	20097 (11.16)	52821 (17.46)	26031 (11.36)
8	37194 (20.66)	51056 (16.87)	35210 (15.36)
9	38815 (21.56)	54907 (18.15)	33531 (14.63)
10	69027 (38.34)	34415 (11.37)	38849 (16.95)
Referring physician			
No designated	18754 (10.42)	20659 (6.83)	18183 (7.93)
Designated	161276 (89.58)	281904 (93.17)	211027 (92.07)

Tables B: Screening uptake multivariable logistic regression models outside the recommended age groups (sequential adjustment)

Mammography uptake multivariable logistic regression models (n= 187255): in 40-50 y.o. women (Mammography uptake = 20.77%)

			N	Model 1	Model 2	Model 3	Model 4	Model 5
			Tot= 187255	OR (95%CI) — LogLik -94934	OR (95%CI) — LogLik -94709	OR (95%CI) — LogLik -94508	OR (95%CI) — LogLik -94463	OR (95%CI) — LogLik -92837
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[1]	1284	1	1	1	1	1
		2	2737	0.899 (0.857,0.944)	0.901 (0.859,0.946)	0.906 (0.863,0.951)	0.897 (0.855,0.942)	0.892 (0.849,0.937)
		3	4550	0.845 (0.801,0.892)	0.847 (0.803,0.894)	0.855 (0.811,0.902)	0.843 (0.798,0.89)	0.839 (0.794,0.886)
		4	5726	0.836 (0.791,0.884)	0.84 (0.794,0.888)	0.851 (0.805,0.9)	0.84 (0.794,0.888)	0.837 (0.791,0.885)
		5	5472	0.745 (0.705,0.788)	0.748 (0.708,0.791)	0.761 (0.72,0.805)	0.751 (0.71,0.795)	0.753 (0.711,0.797)
		6	8525	0.722 (0.682,0.764)	0.722 (0.682,0.765)	0.737 (0.696,0.78)	0.722 (0.682,0.766)	0.722 (0.681,0.766)
		7	8283	0.688 (0.649,0.73)	0.69 (0.65,0.731)	0.705 (0.665,0.748)	0.699 (0.658,0.742)	0.71 (0.668,0.754)
		8	8564	0.706 (0.665,0.75)	0.709 (0.668,0.753)	0.732 (0.689,0.777)	0.731 (0.687,0.778)	0.737 (0.693,0.784)
		9	8629	0.639 (0.603,0.677)	0.64 (0.604,0.678)	0.67 (0.632,0.71)	0.665 (0.625,0.707)	0.678 (0.638,0.721)
		10	6877	0.557 (0.528,0.587)	0.557 (0.528,0.587)	0.61 (0.578,0.644)	0.61 (0.575,0.647)	0.633 (0.596,0.671)
	EDI (deciles) **in other areas**	1	16751	0.57 (0.492,0.66)	0.569 (0.491,0.66)	0.572 (0.494,0.663)	0.599 (0.516,0.694)	0.598 (0.515,0.694)
		2	17342	0.616 (0.557,0.682)	0.615 (0.555,0.681)	0.619 (0.559,0.686)	0.634 (0.572,0.702)	0.635 (0.573,0.704)
		3	12299	0.593 (0.546,0.644)	0.592 (0.545,0.643)	0.597 (0.549,0.648)	0.62 (0.571,0.674)	0.623 (0.573,0.678)
		4	10802	0.596 (0.553,0.642)	0.595 (0.552,0.641)	0.602 (0.558,0.649)	0.613 (0.568,0.661)	0.614 (0.569,0.663)
		5	11523	0.57 (0.528,0.616)	0.568 (0.526,0.614)	0.574 (0.531,0.62)	0.587 (0.543,0.635)	0.593 (0.548,0.641)
		6	10898	0.613 (0.575,0.654)	0.612 (0.574,0.652)	0.621 (0.582,0.662)	0.624 (0.585,0.666)	0.633 (0.593,0.676)
		7	10252	0.577 (0.54,0.616)	0.574 (0.538,0.613)	0.587 (0.55,0.627)	0.592 (0.554,0.633)	0.597 (0.558,0.638)
		8	9432	0.53 (0.496,0.566)	0.528 (0.494,0.564)	0.543 (0.508,0.581)	0.55 (0.514,0.588)	0.555 (0.519,0.594)
		9	11333	0.491 (0.459,0.525)	0.49 (0.458,0.524)	0.507 (0.474,0.543)	0.505 (0.471,0.541)	0.511 (0.477,0.548)
		10	15976	0.452 (0.419,0.487)	0.45 (0.418,0.485)	0.476 (0.442,0.513)	0.479 (0.443,0.517)	0.486 (0.449,0.525)
Age		40-45 y.o.[1]	92964		1	1	1	1
		45-50 y.o.	94291		1.275 (1.247; 1.305)	1.27 (1.242; 1.299)	1.271 (1.242; 1.3)	1.258 (1.229; 1.286)
CMU-C		No[1]	172456			1	1	1
		Yes	14799			0.614 (0.584; 0.645)	0.613 (0.583; 0.645)	0.597 (0.567; 0.627)
GP PLA (deciles)		1[1]	4959				1	1
		2	6486				1.091 (0.99; 1.204)	1.078 (0.978; 1.19)
		3	7123				1.064 (0.967; 1.172)	1.067 (0.969; 1.175)
		4	10062				1.057 (0.966; 1.157)	1.044 (0.954; 1.144)
		5	14074				1.159 (1.063; 1.264)	1.145 (1.05; 1.249)
		6	17792				1.173 (1.078; 1.276)	1.158 (1.064; 1.261)
		7	27034				1.217 (1.122; 1.321)	1.201 (1.107; 1.305)
		8	33101				1.262 (1.165; 1.369)	1.247 (1.151; 1.354)
		9	32681				1.193 (1.1; 1.295)	1.185 (1.092; 1.287)
		10	33943				1.14 (1.05; 1.239)	1.161 (1.069; 1.262)
Referring physician		No[1]	13378					1
		Yes	173877					6.849 (6.275; 7.493)

[1] Reference category

Mammography uptake multivariable logistic regression models (n= 154895): in > 74 y.o. women (Mammography uptake = 5.65%)

			N	Model 1 LogLik	Model 2 LogLik	Model 3 LogLik	Model 4 LogLik	Model 5 LogLik
			Tot= 154895	OR (95%CI) -33537	OR (95%CI) -30948	OR (95%CI) -30936	OR (95%CI) -30890	OR (95%CI) -30674
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[2]	939	1	1	1	1	1
		2	2115	1.022 (0.904,1.154)	1.026 (0.906,1.162)	0.983 (0.95,1.018)	0.998 (0.88,1.131)	0.994 (0.877,1.127)
		3	3983	0.968 (0.849,1.104)	1.009 (0.883,1.154)	0.971 (0.934,1.009)	0.978 (0.855,1.119)	0.973 (0.85,1.114)
		4	6092	0.921 (0.803,1.055)	0.921 (0.802,1.058)	0.939 (0.902,0.976)	0.883 (0.769,1.015)	0.88 (0.765,1.011)
		5	5757	0.893 (0.784,1.017)	0.956 (0.838,1.092)	0.897 (0.863,0.933)	0.898 (0.785,1.027)	0.892 (0.779,1.02)
		6	9950	0.891 (0.784,1.013)	0.945 (0.829,1.077)	0.936 (0.901,0.973)	0.878 (0.769,1.002)	0.873 (0.765,0.997)
		7	10334	0.896 (0.789,1.019)	0.973 (0.854,1.108)	0.858 (0.825,0.892)	0.88 (0.77,1.006)	0.879 (0.769,1.005)
		8	10647	0.99 (0.873,1.123)	1.088 (0.957,1.238)	0.885 (0.85,0.922)	0.987 (0.865,1.127)	0.982 (0.86,1.121)
		9	10974	0.926 (0.821,1.044)	1.029 (0.911,1.163)	0.855 (0.823,0.888)	0.89 (0.782,1.012)	0.886 (0.779,1.008)
		10	9307	0.899 (0.802,1.007)	0.977 (0.87,1.097)	0.763 (0.737,0.79)	0.837 (0.74,0.948)	0.835 (0.738,0.946)
	EDI (deciles) **in other**	1	7482	0.77 (0.572,1.039)	0.765 (0.565,1.035)	0.784 (0.719,0.855)	0.793 (0.584,1.075)	0.786 (0.579,1.066)
		2	8759	0.78 (0.633,0.962)	0.767 (0.62,0.948)	0.845 (0.795,0.897)	0.791 (0.64,0.979)	0.782 (0.632,0.968)
		3	6862	0.701 (0.592,0.831)	0.708 (0.596,0.841)	0.817 (0.778,0.858)	0.742 (0.623,0.882)	0.733 (0.616,0.872)
		4	6193	0.645 (0.555,0.75)	0.671 (0.576,0.782)	0.833 (0.797,0.871)	0.662 (0.568,0.772)	0.659 (0.565,0.769)
		5	7566	0.539 (0.458,0.634)	0.552 (0.468,0.65)	0.78 (0.746,0.817)	0.55 (0.466,0.649)	0.547 (0.463,0.646)
		6	8023	0.696 (0.612,0.791)	0.726 (0.637,0.827)	0.838 (0.805,0.871)	0.692 (0.607,0.79)	0.686 (0.601,0.783)
		7	8076	0.65 (0.571,0.739)	0.696 (0.61,0.794)	0.824 (0.792,0.857)	0.657 (0.575,0.751)	0.65 (0.569,0.743)
		8	7774	0.728 (0.642,0.825)	0.774 (0.681,0.878)	0.833 (0.802,0.866)	0.727 (0.638,0.828)	0.717 (0.629,0.816)
		9	10269	0.706 (0.623,0.8)	0.776 (0.683,0.881)	0.762 (0.733,0.792)	0.728 (0.64,0.829)	0.72 (0.632,0.82)
		10	13793	0.693 (0.608,0.79)	0.757 (0.663,0.864)	0.718 (0.688,0.75)	0.675 (0.588,0.775)	0.666 (0.58,0.765)
Age		75-80 y.o.[2]	50815		1	1	1	1
		80-85 y.o.	48148		0.387 (0.368; 0.407)	0.387 (0.368; 0.407)	0.386 (0.367; 0.406)	0.385 (0.366; 0.405)
		85-90 y.o.	34698		0.152 (0.14; 0.165)	0.152 (0.14; 0.165)	0.151 (0.139; 0.164)	0.151 (0.139; 0.164)
		90-95 y.o.	16602		0.067 (0.057; 0.079)	0.067 (0.057; 0.079)	0.067 (0.056; 0.079)	0.067 (0.056; 0.079)
		95-100 y.o.	4632		0.024 (0.013; 0.038)	0.024 (0.013; 0.038)	0.023 (0.013; 0.038)	0.025 (0.014; 0.04)
CMU-C		No[2]	153807			1	1	1
		Yes	1088			0.443 (0.298; 0.63	0.443 (0.298; 0.63)	0.439 (0.295; 0.625)
GP PLA (deciles)		1[2]	4675				1	1
		2	5726				1.14 (0.94; 1.386)	1.138 (0.938; 1.383)
		3	5537				1.037 (0.851; 1.265)	1.035 (0.85; 1.263)
		4	7717				1.091 (0.909; 1.314)	1.085 (0.904; 1.306)
		5	9569				1.171 (0.983; 1.399)	1.17 (0.983; 1.399)
		6	11747				1.25 (1.056; 1.486)	1.25 (1.055; 1.486)
		7	18800				1.316 (1.12; 1.554)	1.312 (1.117; 1.549)
		8	25658				1.441 (1.231; 1.694)	1.44 (1.231; 1.695)
		9	30207				1.398 (1.195; 1.644)	1.403 (1.199; 1.65)
		10	35259				1.546 (1.322; 1.818)	1.555 (1.329; 1.829)
		No[2]	5992					1
Referring physician		Yes	148903					8.938 (6.66; 12.37)

[2] Reference category

Pap smear uptake multivariable logistic regression models (n= 63068) in 20-25 y.o. women (Pap smear uptake = 20.58 %)

			N	Model 1	LogLik	Model 2	LogLik	Model 3	LogLik	Model 4	LogLik	Model 5	LogLik
			Tot= 63068	OR (95%CI)	-31988	OR (95%CI)	-31676	OR (95%CI)	-31675	OR (95%CI)	-31670	OR (95%CI)	-30989
Combined EDI and large urban/other	**EDI** (deciles) **in large urban areas**	1[3]	272	1		1		1		1		1	
		2	600	0.958 (0.864; 1.062)		0.951 (0.858; 1.056)		0.952 (0.859; 1.057)		0.956 (0.861; 1.062)		0.941 (0.846; 1.046)	
		3	1047	0.992 (0.888; 1.108)		0.985 (0.881; 1.101)		0.987 (0.882; 1.103)		0.987 (0.882; 1.105)		0.975 (0.87; 1.093)	
		4	1451	1.024 (0.914; 1.146)		1.021 (0.911; 1.143)		1.022 (0.913; 1.145)		1.029 (0.918; 1.154)		1.021 (0.91; 1.146)	
		5	1412	0.915 (0.823; 1.017)		0.905 (0.813; 1.007)		0.907 (0.815; 1.009)		0.922 (0.827; 1.028)		0.921 (0.825; 1.028)	
		6	2197	0.896 (0.803; 0.999)		0.889 (0.797; 0.992)		0.892 (0.799; 0.995)		0.903 (0.808; 1.009)		0.895 (0.8; 1.002)	
		7	2336	0.92 (0.828; 1.023)		0.901 (0.81; 1.002)		0.903 (0.812; 1.005)		0.923 (0.827; 1.03)		0.94 (0.841; 1.05)	
		8	2376	0.917 (0.824; 1.02)		0.895 (0.804; 0.997)		0.898 (0.806; 1)		0.925 (0.828; 1.033)		0.938 (0.838; 1.049)	
		9	2575	0.824 (0.746; 0.909)		0.801 (0.726; 0.885)		0.804 (0.728; 0.889)		0.834 (0.751; 0.927)		0.858 (0.771; 0.954)	
		10	2484	0.735 (0.67; 0.808)		0.733 (0.667; 0.805)		0.739 (0.672; 0.812)		0.772 (0.697; 0.856)		0.802 (0.722; 0.89)	
	EDI (deciles) **in other areas**	1	3700	0.696 (0.498; 0.953)		0.701 (0.501; 0.961)		0.701 (0.501; 0.962)		0.701 (0.5; 0.962)		0.729 (0.519; 1.005)	
		2	4599	0.895 (0.723; 1.101)		0.903 (0.729; 1.112)		0.903 (0.729; 1.113)		0.904 (0.729; 1.114)		0.902 (0.726; 1.114)	
		3	3387	0.938 (0.794; 1.105)		0.956 (0.809; 1.127)		0.957 (0.809; 1.128)		0.964 (0.814; 1.138)		0.963 (0.812; 1.139)	
		4	3098	0.779 (0.669; 0.906)		0.78 (0.669; 0.908)		0.781 (0.67; 0.909)		0.788 (0.675; 0.917)		0.784 (0.671; 0.914)	
		5	4188	0.846 (0.727; 0.983)		0.852 (0.731; 0.99)		0.853 (0.732; 0.992)		0.859 (0.736; 0.999)		0.849 (0.727; 0.989)	
		6	3814	0.839 (0.737; 0.955)		0.849 (0.745; 0.966)		0.85 (0.746; 0.967)		0.858 (0.752; 0.977)		0.849 (0.744; 0.969)	
		7	4205	0.835 (0.735; 0.948)		0.838 (0.737; 0.951)		0.84 (0.739; 0.954)		0.855 (0.751; 0.972)		0.837 (0.735; 0.954)	
		8	4074	0.77 (0.677; 0.875)		0.776 (0.682; 0.882)		0.778 (0.683; 0.885)		0.789 (0.692; 0.899)		0.78 (0.683; 0.89)	
		9	6237	0.797 (0.704; 0.902)		0.809 (0.713; 0.916)		0.812 (0.716; 0.919)		0.823 (0.725; 0.934)		0.826 (0.726; 0.939)	
		10	9016	0.655 (0.574; 0.746)		0.661 (0.579; 0.754)		0.665 (0.582; 0.758)		0.688 (0.6; 0.787)		0.701 (0.61; 0.803)	
Age		20-21y.o[3]	9827			1		1		1		1	
		21-22 y.o.	11080			1.234 (1.144; 1.33)		1.233 (1.144; 1.33)		1.234 (1.144; 1.33)		1.205 (1.117; 1.3)	
		22-23 y.o.	12631			1.516 (1.411; 1.628)		1.514 (1.41; 1.626)		1.516 (1.412; 1.628)		1.435 (1.335; 1.543)	
		23-24 y.o.	14064			1.709 (1.595; 1.832)		1.707 (1.593; 1.83)		1.711 (1.597; 1.834)		1.576 (1.47; 1.691)	
		24-25 y.o.	15466			2.102 (1.966; 2.249)		2.099 (1.963; 2.246)		2.104 (1.967; 2.25)		1.912 (1.787; 2.047)	
CMU-C		No[3]	54768					1		1		1	
		Yes	8300					0.968 (0.911; 1.028)		0.969 (0.912; 1.029)		0.899 (0.845; 0.955)	
GP PLA (deciles)		1[3]	1167							1		1	
		2	1569							1.057 (0.873; 1.281)		1.033 (0.851; 1.254)	
		3	1626							1.09 (0.903; 1.318)		1.069 (0.884; 1.295)	
		4	2498							1.096 (0.92; 1.307)		1.075 (0.902; 1.285)	
		5	3594							1.07 (0.906; 1.268)		1.055 (0.891; 1.252)	
		6	4813							1.026 (0.872; 1.21)		1.018 (0.864; 1.203)	
		7	7959							1.055 (0.902; 1.238)		1.039 (0.887; 1.222)	
		8	10982							1.074 (0.92; 1.257)		1.054 (0.902; 1.236)	
		9	12533							1.021 (0.875; 1.196)		1.011 (0.865; 1.186)	
		10	16327							0.986 (0.845; 1.155)		1.004 (0.859; 1.178)	
Referring physician		No[3]	13716									1	
		Yes	49352									2.859 (2.69; 3.042)	

[3] Reference category

Pap smear uptake multivariable logistic regression models (n= 252156) in > 65 y.o. women (Pap smear uptake = 5.69%)

			N	Model 1	LogLik	Model 2	LogLik	Model 3	LogLik	Model 4	LogLik	Model 5	LogLik
			Tot= 252156	OR (95%CI)	-54676	OR (95%CI)	-48204	OR (95%CI)	-48196	OR (95%CI)	-48125	OR (95%CI)	-47675
Combined EDI and large urban/other areas	**EDI** (deciles) **in large urban areas**	1[4]	1669	1		1		1		1		1	
		2	3720	0.875 (0.805,0.951)		0.904 (0.83,0.985)		0.905 (0.83,0.985)		0.874 (0.801,0.953)		0.865 (0.793,0.944)	
		3	6672	0.822 (0.75,0.901)		0.903 (0.821,0.992)		0.903 (0.821,0.992)		0.874 (0.795,0.961)		0.866 (0.787,0.953)	
		4	9800	0.786 (0.714,0.865)		0.859 (0.779,0.948)		0.86 (0.78,0.949)		0.825 (0.748,0.911)		0.817 (0.74,0.902)	
		5	9294	0.743 (0.677,0.815)		0.858 (0.78,0.944)		0.859 (0.782,0.945)		0.809 (0.735,0.891)		0.805 (0.731,0.887)	
		6	15807	0.641 (0.584,0.705)		0.738 (0.669,0.813)		0.738 (0.67,0.813)		0.687 (0.622,0.758)		0.679 (0.615,0.749)	
		7	16336	0.69 (0.628,0.757)		0.833 (0.757,0.917)		0.834 (0.757,0.918)		0.763 (0.691,0.842)		0.764 (0.692,0.843)	
		8	16801	0.796 (0.727,0.872)		0.982 (0.894,1.079)		0.984 (0.895,1.081)		0.898 (0.815,0.99)		0.895 (0.812,0.987)	
		9	17022	0.685 (0.628,0.748)		0.855 (0.781,0.936)		0.858 (0.784,0.94)		0.748 (0.68,0.823)		0.745 (0.677,0.82)	
		10	14130	0.647 (0.596,0.702)		0.789 (0.725,0.858)		0.795 (0.73,0.865)		0.68 (0.621,0.745)		0.678 (0.619,0.743)	
	EDI (deciles) **in other areas**	1	14042	0.641 (0.517,0.795)		0.669 (0.537,0.834)		0.668 (0.536,0.833)		0.693 (0.555,0.865)		0.687 (0.55,0.858)	
		2	15838	0.571 (0.488,0.669)		0.6 (0.511,0.705)		0.6 (0.511,0.704)		0.616 (0.524,0.724)		0.607 (0.516,0.714)	
		3	11781	0.556 (0.49,0.63)		0.616 (0.542,0.7)		0.616 (0.542,0.7)		0.635 (0.558,0.723)		0.628 (0.551,0.715)	
		4	10633	0.522 (0.467,0.583)		0.61 (0.545,0.683)		0.61 (0.545,0.683)		0.603 (0.538,0.676)		0.596 (0.532,0.668)	
		5	12461	0.456 (0.405,0.513)		0.524 (0.464,0.591)		0.524 (0.464,0.591)		0.526 (0.466,0.594)		0.519 (0.459,0.586)	
		6	13160	0.5 (0.454,0.55)		0.598 (0.542,0.659)		0.598 (0.542,0.659)		0.577 (0.522,0.637)		0.569 (0.515,0.629)	
		7	12897	0.497 (0.452,0.547)		0.599 (0.544,0.66)		0.6 (0.544,0.661)		0.572 (0.518,0.631)		0.564 (0.511,0.623)	
		8	12297	0.508 (0.463,0.558)		0.612 (0.556,0.673)		0.612 (0.556,0.674)		0.579 (0.525,0.639)		0.57 (0.516,0.629)	
		9	15991	0.436 (0.396,0.481)		0.535 (0.484,0.591)		0.535 (0.485,0.591)		0.503 (0.454,0.556)		0.495 (0.447,0.548)	
		10	21805	0.461 (0.416,0.51)		0.587 (0.529,0.651)		0.589 (0.53,0.653)		0.528 (0.474,0.588)		0.519 (0.466,0.578)	
Age		65-70 y.o.[4]	48684			1		1		1		1	
		70-75 y.o.	48577			0.583 (0.56; 0.607)		0.582 (0.559; 0.606)		0.581 (0.558; 0.605)		0.578 (0.555; 0.601)	
		75-80 y.o.	50815			0.252 (0.24; 0.266)		0.252 (0.239; 0.265)		0.251 (0.238; 0.264)		0.247 (0.234; 0.26)	
		80-85 y.o.	48148			0.094 (0.087; 0.102)		0.094 (0.087; 0.101)		0.093 (0.086; 0.101)		0.092 (0.085; 0.099)	
		85-90 y.o.	34698			0.03 (0.026; 0.035)		0.03 (0.026; 0.035)		0.03 (0.026; 0.035)		0.029 (0.025; 0.034)	
		90-95 y.o.	16602			0.013 (0.01; 0.018)		0.013 (0.01; 0.018)		0.013 (0.009; 0.018)		0.013 (0.009; 0.018)	
		95-100 y.o.	4632			0.005 (0.002; 0.012)		0.005 (0.002; 0.012)		0.005 (0.002; 0.012)		0.005 (0.002; 0.012)	
CMU-C		No[4]	249945					1		1		1	
		Yes	2211					0.68 (0.558; 0.821)		0.676 (0.555; 0.816)		0.67 (0.55; 0.809)	
GP PLA (deciles)		1[4]	7805							1		1	
		2	9343							0.85 (0.731; 0.989)		0.842 (0.724; 0.98)	
		3	9254							0.885 (0.763; 1.028)		0.886 (0.763; 1.029)	
		4	12955							1.004 (0.877; 1.151)		0.995 (0.869; 1.141)	
		5	16421							1.054 (0.927; 1.202)		1.053 (0.926; 1.201)	
		6	19914							1.088 (0.96; 1.237)		1.08 (0.952; 1.227)	
		7	31912							1.147 (1.017; 1.296)		1.14 (1.011; 1.289)	
		8	42273							1.223 (1.087; 1.379)		1.214 (1.08; 1.37)	
		9	47761							1.282 (1.14; 1.446)		1.282 (1.14; 1.446)	
		10	54518							1.319 (1.173; 1.488)		1.327 (1.179; 1.497)	
Referring physician		No[4]	10487									1	
		Yes	241669									9.629 (7.764; 12.133)	

[4] Reference category

STROBE Statement—checklist of items included in the study "Social and territorial inequalities in gynaecological cancers screening uptake in France"

	Item No	Recommendation		Page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	X	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	X	2
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	X	5
Objectives	3	State specific objectives, including any prespecified hypotheses	X	5
Methods				
Study design	4	Present key elements of study design early in the paper	X	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	X	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	X	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	X	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	X	6-8
Bias	9	Describe any efforts to address potential sources of bias	X	6-9
Study size	10	Explain how the study size was arrived at	X	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	X	6-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	X	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	X	9
		(*c*) Explain how missing data were addressed	X	9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		

Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	X	7+10
		(b) Give reasons for non-participation at each stage	X	6+9
		(c) Consider use of a flow diagram	X	9 (no figure)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	X	9-10 + table 1 + suppl. Tables A
		(b) Indicate number of participants with missing data for each variable of interest	X	9
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	X	10-11 + Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	X	10-11+ Tables 2/3
		(*b*) Report category boundaries when continuous variables were categorized	X	8-10 + Tables 2/3
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	X	12-13 + Tables 2/3 + Suppl. Tables B
Discussion				
Key results	18	Summarise key results with reference to study objectives	X	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	X	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	X	16-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	X	16-19
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	X	21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at

http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.