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ORIGINAL ARTICLE

The education gradient in cancer screening participation: a consistent phenomenon across Europe?

Barbara Willems[1] · Piet Bracke[1]

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Abstract
Objectives To extend the literature on educational inequalities in cancer screening participation (1) by simultaneously focusing on participation in screening for cervical, breast and colorectal cancer across 27 European countries and (2) by statistically testing whether these educational inequalities vary according to country-specific screening strategies: organised or opportunistic.
Methods Self-reported data from Eurobarometer 66.2 (2006) on cancer screening participation in the preceding 12 months were used to outline cross-national variations in screening strategies, target populations and participation rates. Multilevel logistic regressions were applied.
Results Individuals with higher levels of education were more likely to participate in screening for cervical, breast and colorectal cancer than were those with less education. Educational inequalities were significantly smaller in countries with organised cervical cancer screening than they were in countries with opportunistic screening (OR = 0.716, 95% CI 0.549–0.935). The same interaction was observed for participation in screening for breast and colorectal cancer, albeit with marginal significance.
Conclusions This study clearly highlights the crucial role of educational level in the likelihood of participating in cancer screening. Countries can reduce educational inequalities by applying organised screening programmes.

Keywords Cancer screening participation · Cancer screening strategy · Educational inequalities · Comparative health research · Europe

✉ Barbara Willems
Barbara.Willems@UGent.be

[1] Ghent University, Ghent, Belgium

Introduction

Across Europe, breast and prostate cancer are the most common diseases and the leading causes of cancer-related death for women and men, respectively, while colorectal cancer is the second leading cause of cancer-related death amongst both sexes (Ferlay et al. 2013). Cancer is thus a key public health concern and a central priority of health policy in Europe (European Commission 2014). The European Council unanimously recognises and recommends cancer screening as an effective weapon in the fight against cancer. More specifically, cancer screening makes it possible to detect and treat cancers in an early stage, thereby greatly increasing the prospects of cure (Hakama et al. 2008). In this way, cancer screening has the potential to reduce both cancer-related morbidity and mortality rates (Commission 2003; Ferlay et al. 2013; Hashim et al. 2016).

Despite its great importance, few studies have considered either participation in cancer screening or equal access to it in terms of educational level. This omission in the literature is striking, given that the World Health Organisation has classified equal access to preventive healthcare as a public health priority since the late 1970s (UNICEF and WHO 1978). Moreover, existing studies tend to focus either on specific countries (Damiani et al. 2012; Frederiksen et al. 2010; Lorant et al. 2002; Missinne et al. 2014; Sabates and Feinstein 2006; Zapata-Moya et al. working paper) or on participation in screening for specific cancer types (e.g., breast cancer; cervical cancer; colorectal cancer) (Kesic et al. 2012; Missinne and Bracke 2014).

The application of a cross-national perspective to studying screening participation for specific cancer types is not sufficient. In fact, variations by cancer type are likely to occur even within the same country, due to organisation-related characteristics of cancer screenings (Palència et al.

2010; Walsh et al. 2011). Examples include screening strategy (some cancer screenings are organised nationally, while others are opportunistic) or reimbursement (some screenings are free of charge, while others are only partially covered). Characteristics specific to cancer types and organisational practices might also affect the extent of educational inequalities in cancer screening participation. At the same time, however, it is not sufficient to limit the investigation to studying screening participation across cancer types within specific countries. This is because educational inequalities can vary across countries, due to characteristics related to their health system, including public health expenditures, the density of general practitioners, payment schemes for general practitioners and specialists, the amount of private out-of-pocket payments and the design of the healthcare system (e.g. public/private/mix) (Jusot et al. 2012; Lorant et al. 2002).

The central aim of the current study is to extend the existing literature on educational inequalities in cancer screening participation in two ways. First, we combine two comparative perspectives: one across cancer types and one across countries, by studying educational inequalities in participation in screening for three cancer types (i.e., cervical, breast and colorectal cancer) across 27 European countries. Only two previous studies have adopted a similar approach (Carrieri and Wübker 2013; Jusot et al. 2012). These studies, however, focus more on preventive care utilisation in general, including such non-cancer-related preventive measures as influenza vaccination, eye examination and blood tests, in addition to screening for breast and colorectal cancer. Both studies confirm the existence of educational inequalities favouring individuals with higher levels of education in breast and colorectal cancer screening participation, both within and across European countries. They nevertheless do not account for contextual factors relating to cancer screening (e.g., cross-national variations in screening strategy or target population).

Second, we address an important contextual factor for cancer screening participation: whether a country's screening strategy for a specific cancer type is organised or opportunistic. Organised cancer screening is defined as 'population-based screening programmes aimed at the entire resident population of a given age range and sex, designed to detect cancer during the detectable preclinical phase, organised at national or regional level, with an explicit policy, a team responsible for organisation and for health care, and a structure for quality assurance' (p. 2702–2703 Bastos et al. 2010). In opportunistic cancer screening, participation depends solely on the willingness, ability and subjective risk assessment of the individual (Walsh et al. 2011). As established by previous research (Miles et al. 2004; Palència et al. 2010; Walsh et al. 2011) and by the European Council Recommendation (Karsa et al. 2008), organised screening strategies are preferable to opportunistic screenings, as they are better able to enhance effectiveness and diminish social inequalities in participation.

Two previous studies on educational inequalities in participation in screening for cervical and breast cancer across Europe do take the screening strategies of countries into account (Palència et al. 2010; Walsh et al. 2011). Although the study by Walsh et al. (2011) builds on the limitations of the work of Palència et al. (2010), it does not focus on educational inequalities. Instead, it addresses education as an imperfect indicator of social class. In addition to preceding employment, personal life, and income, however, education bears a strong influence on these aspects and is more stable over time (Von Dem Knesebeck et al. 2006). Moreover, Walsh et al. (2011) only include countries from the EU-15, arguing that the inclusion of other countries would lead to excessive heterogeneity in terms of the maturity of publicly funded healthcare systems. Heterogeneity exists within the EU-15 as well, however, particularly in the ways in which healthcare systems are financed and organised (Wendt 2009). The inclusion of all European member states makes it possible to investigate whether such heterogeneity contributes to variations in educational inequalities, in addition to providing a more complete and nuanced overview. Finally, Walsh et al. (2011) do not account for possible similarities amongst individuals living in the same country (Hox et al. 2010). They are, therefore, unable to provide a statistical test of whether and how country-specific screening strategies affect the association between education and cancer screening participation. The current study addresses these limitations in the investigation of the following research questions:

1. Do educational inequalities exist in cancer screening participation and, if so, how do these inequalities vary across cancer types and across European countries?
2. Do educational inequalities in cancer screening participation vary according to country-specific screening strategies?

Methods

Dataset

Data were derived from Eurobarometer 66.2, Health in the European Union, a large population-based survey collected through face-to-face interviews conducted in 2006 (Papacostas 2006). The participants were selected through multistage national samples of EU citizens aged 15 years and older, living in private households. Despite European guidelines concerning the appropriate target population for each cancer type being screened (women 25–64 years of age for cervical cancer, women 50–69 years of age for breast cancer, and men and women 50–74 years of age for colorectal cancer), wide variations exist across European countries (European Commission 2003). In the current study, therefore, the final sample sizes are restricted to the country-specific target populations for each cancer type. When no country-specific information was available, the European guideline was adopted for that country. The final sample sizes are as follows: 9965 women for cervical cancer screening, 5327 women for breast cancer screening, and 9643 men and women for colorectal cancer screening, after excluding the cases with missing information [76 (0.01%), 92 (0.02%), and 184 (0.02%), respectively], and the individuals diagnosed with cancer at the time of the interview [1659 (3.7%)].

Variables

Individual indicators of cancer screening participation

The three dependent variables are participation in screening for cervical, breast and colorectal cancer. Respondents were asked whether they had participated in a cervical smear test, a mammography or a colorectal cancer test in the preceding 12 months. The available answers were: 'Yes, own initiative'; 'Yes, doctor's initiative'; 'Yes, screening programme'; 'No'. These variables were recoded into dichotomous variables (0 = non-participant, 1 = participant).

Respondents were asked to indicate the age at which they had finished full-time education. For the current study, this variable was categorised into the following categories, which roughly correspond to primary, secondary and tertiary education (Schneider 2008): (1) 'finished education at 15 years of age or younger' (2) 'finished education between 16 and 19 years of age' (3) 'finished education at 20 years of age or older'. Given that previous studies have demonstrated that cancer screening participation is associated with several additional factors (Jusot et al. 2012; Lorant et al. 2002; Rodin et al. 2012; Walsh et al. 2011), the following control variables are included as well: gender (0 = male, 1 = female), work status (0 = employed, 1 = unemployed, 2 = non-employed), marital status (0 = no partner, 1 = partner) and self-reported health (0 = bad, 1 = good).

Contextual indicator of cancer screening participation

The country's situation in 2006 regarding the screening strategy for each cancer type was used as a contextual variable in this study. Data concerning this variable, as well as the country-specific target population, were obtained from Altobelli and Lattanzi (2014), Altobelli et al. (2014), Anttila and Ronco (2009), Bastos et al. (2010) and Karsa et al. (2008). A cancer screening strategy was considered opportunistic (0) if there was no formal programme or if the programme was only in a pilot phase in 2006. If a country had a population-based programme or well-established regional programmes in 2006, the cancer screening strategy was considered organised (1).

Statistical analyses

In the first step, the participation rate (PR) for breast, cervical, and colorectal cancer screening in the preceding 12 months was calculated for each country, both overall and by educational level. We then measured absolute educational inequalities according to participation rate differences (PRD PR highest educational group–PR lowest educational group) and relative educational inequalities according to participation rate ratios (PRR PR highest educational group/PR lowest educational group). Both measures of inequality are important. For example, a cancer screening participation rate that is five times higher would be much less remarkable if the absolute difference were only 8% (2 vs. 10%) than it would be if the absolute difference were 40% (10 vs. 50%) (Mackenbach and Kunst 1997). The advantages of these simple measures of inequality are that they allow easy calculations and straightforward interpretations. In addition, the measurement scale required for the independent variable (in this case, educational level) is ordinal or even nominal.

In the second step, multilevel logistic regressions were performed to determine the association between education and cancer screening participation, and to assess whether this association depends on a country's screening strategy. The multilevel models consist of two levels: (1) individuals nested in (2) 27 European countries. This statistical technique accounts for possible similarities amongst individuals living in the same country (Hox et al. 2010). The analysis is built up stepwise for each cancer type. The first model includes the main effects and control variables. The second model adds the cross-level interaction between educational level and a country's screening strategy. The models were analysed using the software program MLwiN (version 2.33), and estimates were derived using second-order PQL. To facilitate interpretation, regression coefficients are presented as odds ratios with 95% confidence intervals (CIs).

Results

Tables 1, 2, and 3 outline the variations in screening strategy, target population and cancer screening participation rates across 27 European countries. For cervical cancer

Table 1 Number of cases, participation rate (%) (overall and by educational level), participation rate difference (PRD participation tertiary–participation primary) and participation rate ratio (PRR participation tertiary/participation primary) of cervical cancer screening in the preceding 12 months in women within the appropriate age range, by country of residence and type of cancer screening strategy. Source: [Eurobarometer 66.2 (European Union-2006)]

Cervical cancer screening

Screening type and country	*N*	Age range	Overall participation (%)	Participation by educational level (%)			PRD (%)	PRR (%)
				Primary	Secondary	Tertiary		
Organised	3846		46	41.5	45.9	49.2	7.7	1.19
Netherlands	304	30–60	31.6	14.8	31.2	35.3	20.5	2.39
Estonia	257	30–59	29.2	30.8	31.7	25.7	− 5.1	0.83
Finland	327	25–65	51.7	30.6	46.2	58.1	27.5	1.9
Sweden	297	23–60	44.1	54.5	40.2	45.2	− 9.3	0.83
UK	460	20–64	41.7	37.5	42	45.2	7.7	1.21
Portugal	353	25–64	50.7	50.9	52.6	45.7	− 5.2	0.90
Italy	475	25–64	52	48.2	51.7	57.8	9.6	1.20
Slovenia	382	20–64	55.8	46.8	54.1	63.8	17	1.36
Croatia	369	–	53.1	34.7	56.3	59.8	25.1	1.72
Lithuania	258	30–60	40.7	25	36.2	47.3	22.3	1.89
Hungary	364	25–65	46.2	28.9	52.8	58.5	29.6	2.02
Opportunistic	6119		49.4	37	50.3	55.9	18.9	1.51
Austria	440	20+	69.3	64.5	72	66.1	1.6	1.02
Germany	706	20+	54.5	40	58.2	66.7	26.7	1.67
Luxembourg	244	15+	66	59.1	63.9	74.1	15	1.25
France	359	20–65	61.8	48.8	62	65.1	16.3	1.33
Belgium	358	25–64	63.7	51.9	55.3	72.4	20.5	1.39
Denmark	258	23–59	41.9	20	25.9	44.2	24.2	2.21
Latvia	487	20–70	61	53.5	58.3	68.5	15	1.28
Ireland	343	25–60	38.2	24.5	37.7	47	22.5	1.92
Spain	373	18–65	41.6	34.4	38.9	59.8	25.4	1.74
Greece	487	20+	46	29.2	53.8	68.4	39.2	2.34
Cyprus	167	30–60	49.1	46.7	52.4	44	− 2.7	0.94
Poland	308	25–59	40.6	26.5	34.8	51.3	24.8	1.94
Czech Republic	484	25–69	47.5	25.6	50.3	45.7	20.1	1.79
Slovakia	502	23–64	56	25	57.6	57.6	32.6	2.30
Romania	318	25–65	9.4	3.1	10.2	12.7	9.6	4.10
Bulgaria	285	31–65	19.6	8.1	12.7	34.7	26.6	4.28
Europe	9965		48.1	38.8	48.7	53	14.2	1.37

screening, overall participation ranged from 9.4% in Romania to 69.3% in Austria, with a similar overall participation rate in countries with organised (46%) and opportunistic screening (49.4%) (Table 1). Overall, breast cancer screening participation varied between 8.5% in Romania to 72.1% in Austria and France, with 11.9% (52.3–40.4%) more participation in countries with organised screening strategies (Table 2). In comparison with cervical and breast cancer screening, participation in colorectal cancer screening was much lower, ranging from 2.5% in Sweden to 31.8% in Germany. In addition, only 5 of the 27 European countries had organised screening strategies for colorectal cancer (Table 3).

The results indicate that educational inequalities existed in every cancer screening participation, although they varied considerably by cancer type, by country and by screening strategy. As shown in Table 1, the greatest educational inequalities in cervical cancer screening participation were identified in two countries with opportunistic screening: Greece (PRD = 39.2%; PRR = 2.34) and Bulgaria (PRD = 26.6%; PRR = 4.28). For participation in breast cancer screening, the results reported in Table 2 indicate that the greatest educational inequalities occurred in countries with organised screening—Spain (PRD = 28.4%; PRR = 1.66) and Sweden (PRD = 20.8%; PRR = 1.54)—as well as in countries

Table 2 Number of cases, participation rate (%) (overall and by educational level), participation rate difference (PRD = participation tertiary–participation primary) and participation rate ratio (PRR = participation tertiary/participation primary) for breast cancer screening in the preceding 12 months in women within the appropriate age range, by country of residence and type of cancer screening strategy. Source: [Eurobarometer 66.2 (European Union-2006)]

Breast cancer screening

Screening type and country	*N*	Age range	Overall participation (%)	Participation by educational level (%)			PRD (%)	PRR (%)
				Primary	Secondary	Tertiary		
Organised	3055		52.3	52.6	52.7	51.6	− 1	0.98
Luxembourg	78	50–69	71.8	87.5	63.9	66.7	− 20.8	0.76
France	154	50–74	72.1	76.4	65.2	78.8	2.4	1.03
Belgium	148	50–69	66.2	60	66.2	69.8	9.8	1.16
Netherlands	200	50–75	60.5	59.6	52.3	73.7	14.1	1.24
Denmark	161	50–69	21.1	8.3	21.7	22.2	13.9	2.67
Estonia	102	50–59	53.9	40	52.8	59	19	1.48
Finland	185	50–69	54.6	61.5	57.8	48.8	− 12.7	0.79
Sweden	277	40–74	55.2	38.5	52.4	59.3	20.8	1.54
UK	218	50–70	40.4	39.6	42.1	37.5	− 2.1	0.95
Portugal	229	45–69	69	69.3	72	60	− 9.3	0.87
Spain	188	45–70	46.3	43	43.6	71.4	28.4	1.66
Italy	152	50–69	62.5	61.4	60.3	70.8	9.4	1.15
Croatia	171	50–69	41.5	34.8	44.9	47.2	12.4	1.36
Cyprus	108	50–69	44.4	41.3	47.5	60	18.7	1.45
Lithuania	197	50–69	23.4	20.6	22.1	26	5.4	1.26
Czech Republic	281	45–69	53.4	42.1	54.1	59.6	17.5	1.42
Hungary	206	45–65	61.7	51.3	71	57.5	6.2	1.12
Opportunistic	2272		40.4	32.2	43	45.3	13.1	1.41
Austria	240	40–69	72.1	63.6	76.1	71.9	8.3	1.13
Germany	237	50–69	46.4	48.3	42.2	52.1	3.8	1.08
Latvia	171	50–69	38	37.9	34.7	44.7	6.8	1.18
Ireland	119	50–64	44.5	51.5	42	41.2	− 10.3	0.80
Slovenia	200	50–69	37	29.8	39.4	40.8	11	1.37
Greece	195	40–64	45.6	33.7	51.6	65.8	32.1	1.95
Poland	160	50–69	39.4	24.4	40	53.3	28.9	2.18
Slovakia	453	40+	49.7	36.4	52.9	48	11.6	1.32
Romania	164	50–69	8.5	4	1.8	29.4	25.4	7.35
Bulgaria	333	40+	15.9	9	13.6	26.7	17.7	2.97
Europe	5327		47.3	44.7	47.9	49.4	4.7	1.11

with opportunistic screening: Greece (PRD = 32.1%; PRR = 1.95), Poland (PRD = 28.9%; PRR = 2.18) and Romania (PRD = 25.4%; PRR = 7.35). As presented in Table 3, the greatest educational inequalities in colorectal cancer screening participation occurred in countries with opportunistic screening: Austria (PRD = 19.1%; PRR = 1.97), Spain (PRD = 17.1%; PRR = 4.35) and Ireland (PRD = 13.3%; PRR = 2.99).

Table 4 provides the results of the multilevel logistic regressions. Educational inequalities in screening participation were significant for the three cancer types. Compared to the lowest educational group, the probability of an individual from the highest educational group participating in screening was 1.770 times higher for cervical cancer (95% CI 1.50–2.034), 1.383 times higher for breast cancer (95% CI 1.159–1.649) and 1.486 times higher for colorectal cancer (95% CI 1.212–1.822). In addition, being employed and having a partner significantly increased the probability of participating in cervical cancer screening and breast cancer screening. The cross-level interactions indicate that educational inequalities in cervical cancer screening participation varied significantly according to a country's screening strategy: educational inequalities were smaller in countries with organised cervical cancer

Table 3 Number of cases, participation rate (%) (overall and by educational level), participation rate difference (PRD participation tertiary–participation primary) and participation rate ratio (PRR participation tertiary/participation primary) for colorectal cancer screening in the preceding 12 months in men and women within the appropriate age range, by country of residence and type of cancer screening strategy. Source: [Eurobarometer 66.2 (European Union-2006)]

Colorectal cancer screening

Screening type and country	*N*	Age range	Overall participation (%)	Participation by educational level (%)			PRD (%)	PRR (%)
				Primary	Secondary	Tertiary		
Organised	2154		7.6	7.8	7.5	7.8	0	1
Finland	183	60–69	11.5	19.6	12.1	5.6	− 14	0.29
UK	575	45–74	5.6	7	5.1	3.2	− 3.8	0.46
Italy	278	50–74	8.6	9.4	4.9	15.4	6	1.64
Poland	217	50–65	6.9	3.8	6.7	10	6.2	2.63
Czech Republic	446	50+	9	11.9	9.2	5.6	− 6.3	0.47
Opportunistic	7489		10.4	9.9	10.2	11.2	1.3	1.13
Austria	372	50+	27.2	19.7	29.3	38.8	19.1	1.97
Germany	592	50–74	31.8	28.9	31.8	37	8.1	1.28
Luxembourg	172	–	19.2	17	22.2	17	0	1
France	317	50–74	16.1	18.6	14.3	16.3	− 2.3	0.88
Belgium	353	50–75	10.5	13.1	9.9	9.4	− 3.7	0.72
Netherlands	298	55–75	4.7	1.3	3.3	9.4	8.1	7.23
Denmark	459	45–75	8.3	6.3	8.3	8.4	2.1	1.33
Latvia	327	50–74	16.5	18	9.4	30.6	12.6	1.7
Estonia	389	50–74	3.3	1.6	4.6	2.3	0.7	1.44
Sweden	201	50–60	2.5	0	3.4	2.5	2.5	–
Ireland	224	55–74	10.3	6.7	10.1	20	13.3	2.99
Portugal	297	50–70	12.8	11.5	17.9	20	8.5	1.74
Spain	215	50–69	7	5.1	7.5	22.2	17.1	4.35
Slovenia	313	50–69	3.5	6.4	2.1	2.7	− 3.7	0.42
Croatia	335	50–74	3.6	7	2.2	1.2	− 5.8	0.17
Greece	455	50+	7	5.9	6.7	13.3	7.4	2.25
Cyprus	260	50+	3.1	3.8	2.7	0	− 3.8	0
Lithuania	384	–	7.3	3.2	7.5	10	6.8	3.13
Slovakia	491	50+	9.4	3.9	10.2	11.1	7.2	2.85
Hungary	365	50–70	4.9	7.6	3.8	2.1	− 5.5	0.28
Romania	353	50–74	3.1	3.7	2.1	4.2	0.5	1.14
Bulgaria	772	31+	4.4	0.6	5.2	6	5.4	10
Europe	9643		9.8	9.4	9.5	10.7	1.3	1.14

screening strategies than they were in countries with opportunistic screening strategies (OR = 0.716, 95% CI 0.549–0.935). A similar interaction was observed with regard to screening participation for breast and colorectal cancer, albeit with marginal significance.

Discussion

The primary aim of the present study was to extend the existing scientific literature on educational inequalities in cancer screening participation in two ways. First, it involved the simultaneous application of two comparative perspectives, one across cancer types and one across countries, by focussing on participation in screening for cervical, breast and colorectal cancer across 27 different European countries. Second, it involved a statistical test for variations in educational inequalities in cancer screening participation according to country-specific screening strategies.

With respect to the first research question ('Do educational inequalities exist in cancer screening participation and, if so, how do these inequalities vary across cancer types and across European countries?'), our findings indicate that educational level was significantly associated with cancer screening participation: individuals with higher

Table 4 Multilevel logistic regressions using logistic odds ratios (OR > 1 = more participation) for cervical cancer screening participation ($N_{individuals} = 9965$, $N_{country} = 27$), breast cancer screening participation ($N_{individuals} = 5327$, $N_{country} = 27$), and colorectal cancer screening participation ($N_{individuals} = 9643$, $N_{country} = 27$). Source: [Eurobarometer 66.2 (European Union-2006)]

	Cervical cancer screening		Breast cancer screening		Colorectal cancer screening	
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Education (primary)						
Secondary	1.343 (1.187–1.520)	1.422 (1.213–1.667)	1.121 (0.966–1.301)	1.261 (1.003–1.586)	1.141 (0.953–1.367)	1.206 (0.987–1.472)
Tertiary	1.770 (1.540–2.034)	2.034 (1.702–2.431)	1.383 (1.159–1.649)	1.694 (1.287–2.229)	1.486 (1.212–1.822)	1.629 (1.300–2.041)
Age	0.988 (0.984–0.992)	0.988 (0.984–0.992)	0.979 (0.970–0.989)	0.980 (0.971–0.990)	1.005 (0.993–1.017)	1.005 (0.993–1.017)
Work status (employed)						
Unemployed	0.830 (0.703–0.981)	0.830 (0.703–0.981)	0.457 (0.338–0.620)	0.460 (0.339–0.624)	0.944 (0.639–1.394)	0.944 (0.639–1.394)
Non-employed	0.796 (0.719–0.882)	0.797 (0.720–0.882)	0.814 (0.703–0.943)	0.813 (0.702–0.942)	1.077 (0.889–1.305)	1.080 (0.891–1.309)
Partner (no partner)	1.395 (1.272−1.530)	1.392 (1.270–1.527)	1.358 (1.198–1.539)	1.355 (1.195–1.536)	1.006 (0.862–1.174)	1.007 (0.863−1.176)
Good self-reported health (bad)	1.049 (0.949−1.159)	1.052 (0.952–1.163)	0.884 (0.775–1.008)	0.884 (0.775–1.008)	0.730 (0.625–0.852)	0.731 (0.626–0.854)
Organised screening (opportunistic)	0.896 (0.537–1.494)	1.073 (0.621–1.853)	1.870 (1.049–3.334)	2.221 (1.212–4.070)	0.969 (0.483–1.948)	1.219 (0.578–2.572)
Female (male)					0.914 (0.789–1.059)	0.915 (0.790–1.060)
Organised screening × secondary education		0.868 (0.682–1.105)		0.820 (0.610–1.103)		0.765 (0.492–1.189)
Organised screening × tertiary education		0.716 (0.549–0.935)		0.712 (0.503–1.007)		0.607 (0.359–1.026)
Country variance (SE)	0.431 (0.121)	0.432 (0.121)	0.520 (0.149)	0.511 (0.146)	0.540 (0.162)	0.547 (0.163)

levels of education were more likely to participate in screening for cervical, breast and colorectal cancer than were those with less education. This finding clearly highlights the crucial role of education in the likelihood of participating in cancer screening. It is in contrast to the results of a similar study by Walsh et al. (2011), which do not explicitly demonstrate this effect. In addition to being accompanied by a greater probability of being more future-oriented and more willing to commit to long-term goals [e.g., prevention; see (Mirowsky and Ross 2003)], higher educational levels are also associated with better risk perception (Kim et al. 2008), thereby leading to more participation in cancer screening. In contrast, it has been suggested that individuals with lower levels of education may not perceive the usefulness of asymptomatic screening, as it provides no immediate benefits (Lorant et al. 2002). In summary, higher education implies the acquisition of skills and knowledge that can be converted into a healthy lifestyle, including cancer screening participation (Mirowsky and Ross 2003).

Another finding with regard to the first research question is that the extent of educational inequalities in screening participation varied across cancer types. The greatest inequalities were observed in cervical cancer screening participation, with the most highly educated group being almost twice as likely to participate as the group with the least education. This result can be interpreted in the light of the problem of overscreening for cervical cancer in the EU (at intervals less than 3 years), which is especially common amongst women with higher levels of education (Almeida et al. 2013). It is particularly interesting to note that significant educational inequalities were also observed for colorectal cancer screening participation, even though colorectal cancer screening had only recently been launched in most countries at the time of the survey (2006), and trial evidence for the efficacy of such screening was very recent (Altobelli et al. 2014; Bastos et al. 2010). Our results also reveal that the overall rates of participation in colorectal screening were remarkably lower than the rates for the other cancer types, and that only a few countries had organised screening strategies.

The paradox highlighted by these results—that increasing knowledge concerning the prevention, diagnosis and treatment of a disease tends to increase health disparities rather than decreasing them—can be explained according to fundamental cause theory (FCT) (Link and Phelan 1995). According to this theory, when a cancer type becomes more preventable due to the introduction of new medical knowledge and technologies (e.g., cancer screenings), this creates health opportunities that are more accessible to individuals with higher levels of education given their greater access to knowledge, money, status and beneficial social connections. As demonstrated by previous research, educational inequalities emerged in breast cancer screening participation once mammography had become widely implemented and endorsed (Link et al. 1998). In line with FCT, therefore, the results of the current study may illustrate the emergence of educational inequalities in colorectal cancer screening participation following the introduction of this new life-saving cancer screening. Moreover, according to a study by Wang et al. (2012), the protective impact of higher socio-economic status on colorectal cancer mortality has increased over time, despite the innovation of colorectal cancer screening.

A third finding with regard to the first research question is that educational inequalities vary both within and across the different European countries. Previous cross-national research on educational inequalities in preventive service utilisation in Europe has indicated that characteristics relating to healthcare systems play an important role in explaining between-country variations in educational inequalities (Jusot et al. 2012; Stirbu et al. 2007). High public health expenditures, high density of general practitioners and fee-for-service payment schemes seem to be associated with greater use of preventive care (Jusot et al. 2012). With regard to participation in cancer screening, our results demonstrate that some of the highest educational inequalities in breast and cervical cancer screening participation were observed in Greece and Poland. This was the case for both participation rate differences and participation rate ratios. These two countries are characterised by low levels of public investment (about 4% of the GDP, in contrast to the average of 7%) (Jusot et al. 2012) and high private out-of-pocket payments (Golinowska and Tambor 2012; Wendt 2009). These characteristics create problems of equal access to cancer screenings. Educational inequalities in colorectal cancer screening participation were highest in Austria and Spain. These results cannot be explained by characteristics related to the healthcare system, however, as both countries have average public investments and private out-of-pocket payments. We can thus conclude that, in addition to the organisation and financing of healthcare systems, the screening strategies adopted within countries for the various cancer types may also play an important role in explaining cross-national variations.

With regard to the second research question (‘Do educational inequalities in cancer screening participation vary according to country-specific screening strategies?’), the results of this study clearly indicate that countries with organised cancer screening allow for more equality in cancer screening participation between groups with lower and higher education than do countries with opportunistic screening. The marginal significance of this result for breast and colorectal cancer suggests that country-specific screening strategies are particularly likely to moderate the association between education and participation in the case of cervical cancer screening. Although overall rates of participation in cervical cancer screening were higher in countries with opportunistic screening, educational inequalities in participation were significantly smaller in countries with organised screening. In addition to indicating greater educational inequalities in opportunistic screening strategies for cervical cancer screening, this result also points to the over-use of this type of screening amongst women with higher levels of education. It is known that organised screening programmes are more likely to be more cost-effective and to protect against the harmful effects associated with poor quality in excessively frequent screening (Miles et al. 2004).

Despite the new insights generated by the findings, this study is subject to several limitations. First, the cross-sectional research design prevents any causal interpretation of the results. Nevertheless, other studies (e.g. Silles (2009)) provide compelling evidence of a causal relationship running from more schooling to better health. Moreover, all of the outcomes in our study occurred after the participants had completed their education. Second, the questions in the Eurobarometer concerned only cancer screening participation in the preceding 12 months. The figures may, therefore, under-estimate the actual participation rates, particularly given that the screening intervals specified in European recommendations are 2 years for breast cancer and 3 years for cervical and colorectal cancer (European Commission 2003). Third, Eurobarometer measures level of education only by asking the age at which respondents had stopped formal education. These figures thus do not take into account the fact that, despite identical duration, educational programmes differ widely within and between European countries (Schneider 2008). Fourth, despite the aforementioned advantages of participation rate differences and ratios as measurements of inequality, these simple measures ignore parts of the available information (e.g., the participation rates of the middle educational group). More sophisticated regression-based measures [e.g., relative index of inequality (RII) and slope index of inequality (SII)], however, impose greater restrictions on the data used in their calculation. As indicated by the results of exploratory analyses, the final sample sizes in the current study were indeed too small to calculate these sophisticated measures for each country. Fifth, the situation regarding country-specific screening strategies has evolved since 2006, with most EU countries now having implemented organised screening programmes for cervical, breast and colorectal cancer. It would therefore be interesting to study whether and how educational inequalities in cancer screening participation have evolved since 2006. Unfortunately, a more recent wave of Eurobarometer 66.2 ‘Health in the European Union’ does not exist. Finally, we recognise that the classification of a country’s screening strategy as either organised or opportunistic is somewhat artificial, as opportunistic screening may still take place in countries where population-based programmes are being implemented.

In conclusion, European countries differ in terms of target populations for screening and cancer screening participation rates (both overall and by educational level), as well as in the screening strategies that they adopt for different cancer types. As indicated by the results of this study, educational inequalities are evident across Europe with regard to participation in cervical, breast and colorectal cancer screening, with the strongest educational inequalities observed in cervical cancer screening participation. The findings nevertheless provide support for the European Council Recommendation for population-based screening programmes (Karsa et al. 2008), as they demonstrate that countries can reduce these educational inequalities by applying an organised screening strategy. Finally, given that educational inequalities in cancer screening participation seem to vary across cancer types and across European countries, cancer screening policies should be cancer-specific by responding to the properties of each cancer type being screened (e.g., screening strategy, target population and the accessibility of screening), as well as to general knowledge, awareness and risk perception within the population. In addition, cancer screening policies should be country-specific, meaning that they should be efficiently embedded within the existing healthcare system. Future research on educational inequalities in cancer screening participation would, therefore, benefit from devoting additional attention to the contexts in which these inequalities emerge. More specifically, given that this study focuses primarily on characteristics related to the cancer type being screened—with less attention to characteristics related to the healthcare system—it could be interesting for future studies to investigate the relationships between these different context factors (i.e., those specific to cancer screening and those specific to healthcare systems) in explaining educational inequalities in cancer screening participation.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Statement of human rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Statement on the welfare of animals This article does not contain any studies involving human participants or animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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