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Factors influencing organized populational screening for colorectal cancer in the Lisbon and Tagus Valley Health Region: a six-year analysis of demographic and organizational influences

Eunice Carrapiço,[1] Matilde Ourique,[2] Rodrigo Marques[3]

ABSTRACT

Introduction: Colorectal cancer (CRC) ranks third among malignant neoplasms in Portugal, emphasizing the importance of early detection. The initiation of a population-based CRC screening program (CRCSP) in the Lisbon and Tagus Valley Health Region (LTVHR) in 2017 prompted this study to assess and inform health policies. It aims to identify associations between screening participation outcomes, user geodemographics, and organizational features (2017-2022).

Methods: This cross-sectional study analysed 87,223 users aged 50 to 74 undergoing CRCSP in LTVHR, in 3 rounds (2017-2018, 2019-2020, and 2021-2022). We compared screening uptake and test results across sex, age, health centre grouping, unit type, and family physician assignment using chi-square tests and adjusted relative frequency ratios (RFa) derived from a generalized linear model.

Results: Screening participation differed by sex, with a 5.8% higher rate in women (RFa 1.058; CI1.047-1.068). Younger groups exhibited lower adherence, with those aged 50-54, 55-59, and 60-64 showing RFa of 0.826, 0.887, and 0.968, respectively. Family Health Units (FHU) and users with a Family Physician (FP) showed higher participation rates. There was a 37.7% higher RFa in the 1st-round screenings and a 31.4% lower RFa in the 2nd-round. Positivity rates varied among Health Centres Grouping (HCG), with no differences by health unit type or FP assignment. Most screened users belonged to specific HCG (63.6%), particularly HCG 1, indicating potential organizational influences.

Keywords: Mass screening; Colorectal cancer; Cancer screening tests; Health equity; Health services accessibility.

INTRODUCTION

Colorectal cancer (CRC) is a concern in Europe, ranking third in diagnoses and second in cancer-related deaths.[1-3] In Portugal, it is the third most common cancer, affecting both genders.[4] High mortality in Portuguese men highlights the urgency of addressing CRC.[5] Screening strategies for CRC vary between countries, with invasive and non-invasive tests available. Immunochemical faecal occult blood tests (I-FOB) have demonstrated higher detection rates for advanced adenomas and CRC when compared to the guaiac method.[5] Although more sensitive, the I-FOB has less specificity and allows greater adherence due to its practicality, different testing methodologies

1. Médica Assistente de Medicina Geral e Familiar. Direção Clínica para a Área dos Cuidados de Saúde Primários, Unidade Local de Saúde de Santa Maria. Lisboa, Portugal.
2. Médica Interna de Saúde Pública. Unidade de Saúde Pública, Unidade Local de Saúde de Santa Maria. Lisboa, Portugal.
3. Médico Assistente de Saúde Pública. Direção Clínica para a Área dos Cuidados de Saúde Primários, Unidade Local de Saúde do Oeste. Lisboa, Portugal.

result in varying cutoff values between countries, affecting the specificity and sensitivity of screening methods.[6]

Since 2003, the European Council recommended CRC screening for individuals aged 50 to 74, leading to implementation in 24 European countries by 2015.[7-8] In 2017, the Regional Health Administration of Lisbon and Tagus Valley (RHALTV) initiated a CRC screening program (CRCSP) to improve access to healthcare and reduce morbimortality.[9-10] In 2020, the majority of programmed health assistance was suspended due to the COVID-19 pandemic, affecting the ability to sustaining the screening activities.[8]

The evidence suggests that CRCSP improves access once there is a proactive attitude in reaching out to the entire eligible population. Otherwise, only regular attendees would access screening, which generally includes those who are most concerned about health and are more likely to engage in preventive activities. Currently, the Lisbon and Tagus Valley Health Region (LTVHR) experiences low population coverage, primarily attributed to a shortage of human resources and sociodemographic factors that affect the implementation capacity of the CRCSP.[5,7] This study aims to describe the CRCSP results in this health region and identify associations between participation in screening and its results with geodemographic and organisational variables in this region.[11-12]

METHODS

A cross-sectional study of Primary Care users in LTVHR, aged 50-74, invited to the Populational CRCSP from July/2017 to December/2022. The screening process implemented by functional units involved confirming eligibility (individuals aged 50 to 74), issuing invitations via phone, mail, or opportunistically, providing a faecal collection device, and guiding the user through sample collection at home. Participants returned samples for immunochemical faecal occult blood testing (I-FOBT) at a reading centre. Individuals with positive results received offers for colonoscopy, while those with negative results were re-invited for I-FOBT screening within two years – we excluded inconclusive results, mostly associated with technical issues during sample collection, once participants repeated the I-FOBT to confirm a positive or negative result. Colonoscopies were conducted at a referral hospital. Participants with colonoscopy negative results continued I-FOBT screening, while those with positive results received tailored follow-up based on lesion type. Exclusion criteria included refusal to participate or presentation of any acute or chronic gastrointestinal condition (such as haemorrhage, cancer, inflammatory disease, Lynch syndrome, or familial adenomatous polyposis). Analysis included the first three rounds (2017-2018, 2019-2020, and 2021-2022), with 87,223 screened out of 202,238 invited.

We obtained data from the LTVHR registration platform. Dependent variables include screening uptake and test results, and independent variables comprise gender, age, health centre grouping (HCG), unit type (family health unit – FHU or personalized health unit – PHU), and family physician (FP) assignment.

Statistical analysis employed SPSS v. 29. The chi-square test assessed group differences. We calculated the frequency ratio (FR) as the association measure and modelled it using a generalized linear model with Poisson distribution, log link function, and robust estimator, considering 95% confidence intervals and $p<0.05$. We included the statistically significant factors identified in the bivariate analysis in our modelling process. To ensure model fit and obtain adjusted FR (aFR), we employed a backward stepwise approach, wherein the p-value of each variable in the model was interpreted in descending order, and the corresponding variable was removed from the model if its p-value was >0.10.

RESULTS

We analysed participant demographics (Table 1).

The 202,238 invitees received faecal collection devices. Among them, 87,223 (43.1%) underwent screening, with I-FOB testing, resulting in 5.0% of positives.

Screenings comprised 14,735 (7.3%) individuals in the first round, 87,182 (43.1%) in the second round, and 100,321 (49.6%) in the third round (Table 1). More than 80% of the screened population belonged to FHUs. Women conducted 5.8% more screenings, and users in the 50-54, 55-59, and 60-64 age groups were 17.4%, 11.3%, and 3.2% less screened than those in the reference age group (70-74 years old) (Table 2). FHU users were 36% more screened than PHU users (aFR=1.363; CI 1.335--1.391), and individuals with FP were 23% more screened

TABLE 1. Descriptive analysis of individuals invited for colon and rectal cancer screening between 2017 and 2022, in the Lisbon and Tagus Valley Health Region

	Users invited for screening (*n*=202238), *n* (%)
Sex	
Female	114,668 (57.60)
Male	87,580 (43.30)
Age group(years)	
50-54	54,878 (27.14)
55-59	41,061 (20.30)
60-64	37,214 (18.40)
65-69	36,429 (18.01)
70-74	32,656 (16.15)
Health Centres Grouping	
1	57,979 (28.67)
2	19,953 (9.87)
3	7,888 (3.90)
4	4,351 (2.15)
5	22,110 (10.93)
6	6,183 (3.06)
7	7,851 (3.88)
8	18,605 (9.20)
9	17,380 (8.59)
10	9,895 (4.89)
11	11,013 (5.45)
12	4,094 (2.02)
13	1,226 (0.61)
14	8,111 (4.01)
15	5,599 (2.77)
Typology	
PHU	35,672 (17.64)
FHU	166,566 (82.36)
Family physician assignment	
With FP	181,065 (89.53)
Without FP	21,173 (10.47)
Cluster	
2017-2018	14,735 (7.29)
2019-2020	87,182 (43.11)
2021-2022	100,321 (49.61)
Completed screening	
Yes	87,223 (43.13)
No	115,015 (56.87)
Screening result*	
Positive	4,364 (5.00)
Negative	82,859 (95.00)

*Participants who completed the screening.

than those without FP (aFR=1.234; CI 1.203-1.266) (Table 2). In the first round, there was 37.1% more adherence to the CRCSP, and in the second round, 31.5% less than in the third round.

We used 'positivity' to refer to the positive test proportions among different groups. There were no differences in positivity between FHU and PHU (aFR=1.064; CI 0.953-1.189), or regarding FP assignment (aFR=0.922; CI 0.806-1.056) (Table 3_Supplementary). Women exhibited 9.9% fewer positive results than men (aFR=0.60; CI 0.574-0.645). Individuals aged 50-54, 55-59, and 60-64 had 33.7%, 29.4%, and 18.3% fewer positive results, respectively. HCG 2, 5, 8, 9, 10, and 13 showed higher positivity than HCG15, while HCG 1 and 4 had lower positivity (Table 3_Supplementary). Compared to the third round, the positivity rate was 11.3% lower in the second round.

DISCUSSION

Sixty-three per cent of screened belonged to five HCGs, compelled by organizational factors and accessibility. Pilot units of HCG1, with better monitoring in the implementation phase, consistently had the highest engagement throughout the study period. FHU users and users with FP showed higher screening proportions. Despite FHUs covering 64% of the LTVHR population (vs. 36% by PHUs), 82.4% of the screened belonged to FHUs. CRCSP implementation primarily targeted FHUs, where professionals work in teams with tailored strategies and receive financial incentives tied to CRCSP goals, which is prone to impact observed patterns. Additionally, strategies targeted users

TABLE 2. Study of factors associated with adherence to screening using the Poisson regression model

Variables	n/N screened/invited§	Crude FR (CI95%)	*p*-value†*	Poisson Regression#	
				Adjusted FR (CI95%)	*p*-value*
Sex					
Female	51,023/114668	1.076 (1.065-1.087)	<0.001*	1.058 (1.047-1.068)	<0.001*
Male	36,200/87570	1		1	
Age group(years)					
50-54	20,808/54,878	0.798 (0.786-0.811)	<0.001*	0.826 (0.814-0.838)	<0.001*
55-59	16,943/41,061	0.868 (0.584-0.883)	<0.001*	0.887 (0.873-0.901)	<0.001*
60-64	16,798/37,214	0.950 (0.935-0.965)	<0.001*	0.968 (0.954-0.983)	<0.001*
65-69	17,156/36,429	00991 (0.977-1.007)	0.265	1.007 (0.992-1.023)	0.333
70-74	15,518/32,656	1		1	
Health Centres Grouping					
1	28,060/57,979	1.248 (1.206-1.291)	<0.001*	1.401 (1.354-1.45)	<0.001*
2	7,808/19,953	1.009 (0.972-1.047)	0.646	1.237 (1.192-1.284)	<0.001*
3	4,736/7,888	1.548 (1.491-1.607)	<0.001*	1.648 (1.585-1.712)	<0.001*
4	2,916/4,351	1.728 (1.662-1.796)	<0.001*	1.63 (1.566-1.696)	<0.001*
5	8,151/22,110	0.950 (0.916-0.986)	0.008*	1.138 (1.096-1.181)	<0.001*
6	3,268/6,183	1.362 (1.308-1.419)	<0.001*	1.443 (1.385-1.504)	<0.001*
7	3,964/7,851	1.302 (1.251-1.354)	<0.001*	1.524 (1.464-1.586)	<0.001*
8	8,854/18,605	1.227 (1.183-1.272)	<0.001*	1.343 (1.295-1.393)	<0.001*
9	5,441/17,380	0.807 (0.776-0.840)	<0.001*	1.011 (0.971-1.052)	0.605
10	2,059/9,895	0.536 (0.510-0.564)	<0.001*	0.67 (0.638-0.705)	<0.001*
11	2,113/11,013	0.495 (0.470-0.520)	<0.001*	0.573 (0.545-0.602)	<0.001*
12	3,129/4,094	1.970 (1899-2.045)	<0.001*	2.181 (2.099-2.265)	<0.001*
13	899/1,226	1.890 (1.803-1.981)	<0.001*	1.84 (1.75-1.936)	<0.001*
14	3,653/8,111	1.161 (1.115-1.209)	<0.001*	1.362 (1.308-1.417)	<0.001*
15	2,172/5,599	1		1	
Typology					
FHU	77,191/166,566	1.648 (1.619-1.677)	<0.001*	1.363 (1.335-1.391)	<0.001*
PHU	10,032/35,672	1		1	
Family physician assignment					
With FP	81,504/181,065	1.667 (1.629-1.705)	<0.001*	1.234 (1.203-1.266)	<0.001*
Without FP	5,719/21,173	1		1	
Cluster					
2017 to 2018	11,148/14,735	1.598 (1.580-1.616)	<0.001*	1.377 (1.359-1.395)	<0.001*
2019 to 2020	29,036/87,182	0.710 (0.700-0.715)	<0.001*	0.686 (0.678-0.694)	<0.001*
2021 to 2022	47,039/100,321	1		1	

R = Frequency ratio; § = Excluded participants with inconclusive results; † = Chi-square test; * = p<0.05 statistically significant; # = Robust estimator; Omnibus test: *p*-value<0.001; AIC = 307513.261.

without FP, where over 30% of the screened belonged to four HCGs – in HCG9, the majority were enrolled in PHU (64.1%).

Women had 5.8% more screenings, possibly due to their higher healthcare-seeking behaviour, and younger individuals had lower screening rates, likely influenced by perceiving better health.[14] The adherence was 37.7% higher in the 1st-round and 31.4% lower in the second round. The first round marked the first years of CRCSP in the LTVHR, the second coincided with the pandemic, and the third with the post-pandemic period, showing a gradual recovery in healthcare activities and user utilization.

In this study, 43.1% underwent CRCSP, with 5.0% of expected positive results.[1,3] Variability in I-FOB positivity (2.8-6.3%) among HCGs may stem from diverse ages, newness to CRCSP, and technical/logistical factors (e.g., different haemoglobin cutoff between the two reference laboratories) (Table 4_Supplementary). HCG1, 3, and 4 showed higher positivity (5.7-6.3%) with readings from one laboratory, while others used a different lab (2.8-5.1%). Further research is needed to investigate the link between I-FOB positivity and colonoscopy outcomes.

We observed no differences in positivity between FHU and PHU (aFR=1.064; CI 0.953-1.189) or FP assignment (aFR=0.922; CI 0.806-1.056), suggesting consistent screening methods across units (Table 3_Supplementary).

These findings advocate that implementation processes (e.g., team monitoring, professional motivation, specific strategies to increase participation, hospital availability to perform diagnostic testing) and technical aspects (e.g., haemoglobin cutoff) likely influence results more than population characteristics, although further investigation is required.

Women had a 39.9% lower frequency of positive results (aFR=0.609; CI 0.574-0.645) than men, consistent with CRC incidence rates.[4] Despite CRC being more prevalent in males, women participated more in screening when invited (44.5% vs 41.3% in males), which is in accordance with previous data.[13-14] Younger users typically have lower I-FOB positivity due to lower comorbidity.[15-16] The rising positivity with age, from 4.3% (55-59 years) to 6.3% (70-74 years), also aligns with the natural history of precursor lesions and CRC.

Different positivity among HCGs may stem from implementation heterogeneity, varying screening rates, methodological disparities (e.g., teaching strategies for using the faecal collection device), sociodemographic factors (such as the ageing index or literacy levels); differences in the prevalence of CRC and other intestinal diseases in the population; and technical aspects, the most obvious being the existence of a limit value for haemoglobin concentration in samples inherent to the technique used in its quantification, which is different in the two reading centers implemented at RSLVT.[16]

Positivity was lower in the first and second rounds due to the CRCSP implementation's early stage and potentially reduced sensitivity of screening in a very selected population of users. In the second round, lower positivity may be attributed to pandemic-related disruptions, including CRCSP suspension and users' hesitancy.[17] The third round saw higher positivity, likely due to expanded screening of unscreened populations or unaddressed potential cases during the pandemic.

While our cross-sectional study facilitated the estimation of associations, several limitations should be acknowledged. The studied population may not fully represent the broader population due to self-selection and hetero selection bias. Furthermore, the influence of unknown socioeconomic factors, varying levels of health literacy, and accessibility conditions may have impacted our conclusions. Additionally, the propensity of regular visitors to undergo more screenings could introduce bias, compelling to further investigation into unit protocols. Moreover, there may be additional confounding biases that were not accounted for in our analysis.

Our investigation aimed to identify associations between participation and results of CRCSP with geodemographic and organisational variables in the LTVHR. We investigated factors influencing screening engagement and positivity rates among HCGs, as well as the impact of organizational factors, accessibility, and geodemographic characteristics on CRCSP outcomes. Our findings revealed that 63% of the screened population belonged to five HCGs, with pilot units of HCG1 consistently demonstrating the highest engagement levels, probably linked to organizational factors (closer monitoring and individualized training for the pilot units; greater motivation and involvement of the leaders of

some HCGs and greater motivation and availability of the hospital teams responsible for the diagnosis and follow-up of patients with positive screening). Furthermore, FHU users and individuals with FP exhibited higher screening proportions, despite FHUs covering 64% of the LTVHR population. Notably, 82.4% of screened individuals belonged to FHUs, probably related to the organizational model, with financial incentives tied to CRCSP goals. Interestingly, we found that women had a 5.8% higher screening rate, possibly due to their higher healthcare-seeking behaviour, and younger individuals exhibited lower screening rates, likely influenced by a perception of better health.

Regarding positivity rates, we observed variability among HCGs, possibly stemming from diverse demographic factors and technical/logistical disparities. While no differences in positivity were noted between FHUs and PHUs or FP assignments, further investigation is warranted to elucidate the underlying factors contributing to these variations. Despite limitations, our investigation provides insights into strategies for enhancing CRCSP effectiveness, such as targeting underrepresented demographics (e.g., men or older individuals).

Additionally, we need to better understand the relationship between positivity rates and colonoscopy outcomes for optimizing screening protocols.

In conclusion, our findings underscore the importance of implementing diverse strategies to ensure equitable access to CRCSP across all HCGs. By addressing organizational factors, accessibility barriers, and demographic disparities, we can promote greater participation in CRCSP, ultimately contributing to improved CCR detection and prevention efforts.

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AUTHORS CONTRIBUTION
EC: Conceptualization; Methodology; Validation; Formal analysis; Investigation; Data curation; Writing – original draft; Writing – review & editing; Visualization; Supervision; Project administration. MO: Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data curation; Writing – original draft; Writing – review & editing; Visualization. RM: Conceptualization; Methodology; Validation; Formal analysis; Investigation; Resources; Writing – review & editing; Visualization; Supervision; Project administration.

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ENDEREÇO PARA CORRESPONDÊNCIA
Eunice Carrapiço
E-mail: eunicecarrapico@gmail.com
https://orcid.org/0000-0002-2703-0563

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RESUMO

FATORES QUE INFLUENCIAM O RASTREIO POPULACIONAL ORGANIZADO DO CANCRO COLORRETAL NA REGIÃO DE SAÚDE DE LISBOA E VALE DO TEJO: UMA ANÁLISE DE SEIS ANOS DE INFLUÊNCIAS DEMOGRÁFICAS E ORGANIZACIONAIS

Introdução: O cancro colorretal (CCR) é a terceira neoplasia maligna mais prevalente em Portugal, evidenciando a importância da deteção precoce. O início de um programa de rastreio do CCR de base populacional (PRCCR) na Região de Saúde de Lisboa e Vale do Tejo (RSLVT) em 2017 motivou esta investigação e a contribuição para a discussão de políticas de saúde subjacentes. Esta investigação procura identificar associações entre os resultados da participação no rastreio, as características geodemográficas dos utilizadores e as características organizacionais (2017-2022).

Métodos: Este estudo transversal analisou 87.223 utentes com idades entre os 50 e os 74 anos, que participaram no PRCCR na RSLVT, em três rondas (2017-2018, 2019-2020 e 2021-2022). Compararam-se a adesão ao rastreio e os resultados dos testes entre os sexos, idades, Agrupamentos de Centros de Saúde (ACeS), tipos de unidade e atribuição de médico de família utilizando o teste do qui-quadrado e o estudo das razões de frequências relativas ajustadas (RFa), obtidas a partir de um modelo linear generalizado.

Resultados: A participação no rastreio diferiu por sexo, com uma razão 5,8% superior nas mulheres (RFa 1,058; CI 1,047-1,068). Os mais jovens aderiram menos e os participantes com 50-54, 55-59 e 60-64 anos apresentaram RFa de 0,826, 0,887 e 0,968, respetivamente. Os utentes inscritos nas Unidades de Saúde Familiar (USF) e com médico de família (MF) participaram numa proporção superior. Houve um aumento de 37,7% dos rastreios da 1.ª ronda e uma diminuição de 31,4% na 2.ª ronda. A positividade variou entre os ACeS, sem diferenças por tipo de unidade de saúde ou em relação à atribuição de MF. A maioria dos utentes rastreados pertencia a ACeS específicos (63,6%), particularmente ao ACeS1, sugerindo potenciais influências organizacionais.

Palavras-chave: Rastreio populacional; Cancro colorretal; Pesquisa de sangue oculto nas fezes; Equidade em saúde; Acessibilidade aos serviços de saúde.

SUPLEMENTARY MATERIAL

TABLE 3. Frequencies of screenings performed per lap in each HCG (line percentages correspond to the proportion of screenings in each lap, by HCG)

HCG	Cluster (Years)							
	2017-2018		2019-2020		2021-2022		Total	
	N	%	*N*	%	*N*	%	*N*	%
1	2,779	4.8%	29,175	50.3%	26,025	44.9%	57,979	100.0%
2	1,291	6.4%	8,749	43.5%	10,054	50.0%	20,094	100.0%
3	2,161	27.4%	3,795	48.1%	1,932	24.5%	7,888	100.0%
4	1,212	27.9%	1,211	27.8%	1,928	44.3%	4,351	100.0%
5	921	4.1%	14,878	67.0%	6,414	28.9%	22,213	100.0%
6	23	0.4%	773	12.4%	5,415	872%	6,211	100.0%
7	371	4.7%	3,081	39.1%	4,423	56.2%	7,875	100.0%
8	1,487	8.0%	8,719	46.6%	8,495	45.4%	18,701	100.0%
9	0	0.0%	346	2.0%	17,119	98.0%	17,465	100.0%
10	402	4.0%	3,215	32.4%	6,314	63.6%	9,931	100.0%
11	1,223	11.1%	7,393	67.1%	2,409	21.9%	11,025	100.0%
12	923	22.4%	1,798	43.6%	1,401	34.0%	4,122	100.0%
13	394	31.9%	485	39.2%	358	28.9%	1,237	100.0%
14	1,551	19.1%	3,594	44.2%	2,994	36.8%	8,139	100.0%
15	0	0.0%	96	1.7%	5,521	98.3%	5,617	100.0%

Legend: *N = Absolute frequency; % = Row percentage.

TABLE 4. Comparison of RCCR proportions by typology, by each HCG

HCG	Organizational Typology of the Functional Unit					
	PHU		FHU		Total	
	N	%	N	%	N	%
1	2,417	4.2%	55,562	95.8%	57,979	100.0%
2	7,447	37.1%	12,647	62.9%	20,094	100.0%
3	1,655	21.0%	6,233	79.0%	7,888	100.0%
4	68	1.6%	4,283	98.4%	4,351	100.0%
5	228	1.0%	21,985	99.0%	22,213	100.0%
6	1,189	19.1%	5,022	80.9%	6,211	100.0%
7	1,852	23.5%	6,023	76.5%	7,875	100.0%
8	577	3.1%	18,124	96.9%	18,701	100.0%
9	11,191	64.1%	6,274	35.9%	17,465	100.0%
10	4,449	44.8%	5,482	55.2%	9,931	100.0%
11	3	0.0%	11,022	100.0%	11,025	100.0%
12	1,264	30.7%	2,858	69.3%	4,122	100.0%
13	19	1.5%	1,218	98.5%	1,237	100.0%
14	2,932	36.0%	5,207	64.0%	8,139	100.0%
15	478	8.5%	5,139	91.5%	5,617	100.0%
Total	35,769	17.6%	167,079	82.4%	202,848	100.0%

Legend: *N = Absolute frequency; % = Row percentage.