Screening the CITY: optimizing population-based cancer screening in the Netherlands from a primary care perspective

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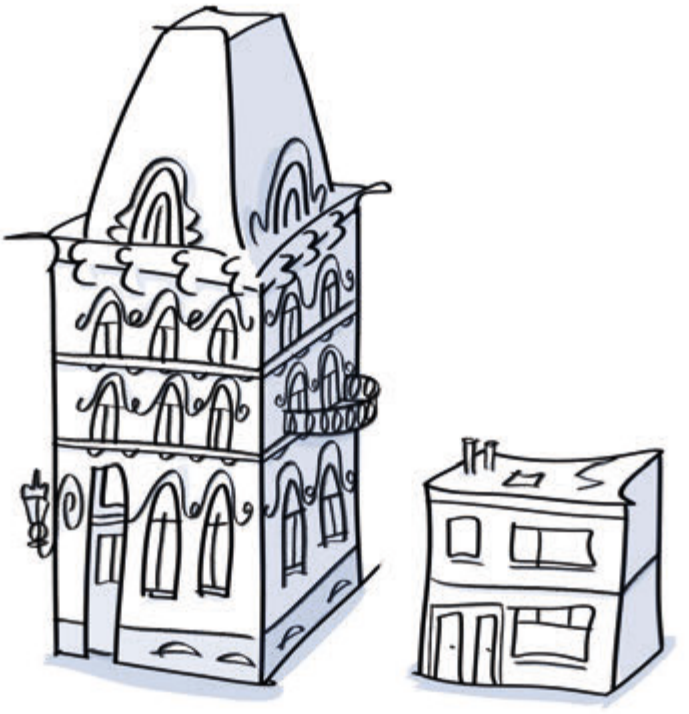

CHAPTER 3

Attendance characteristics of the breast and colorectal cancer screening programmes in a highly urbanised region of the Netherlands: a retrospective observational study

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Abstract

Objectives

Throughout Europe many countries offer population-based cancer screening programmes (CSPs). In the Netherlands two implemented CSPs are targeting people of 50 years and older, aiming at breast cancer (BC) and colorectal cancer (CRC). In order for a CSP to be (cost-)effective, high participation rates and outreach to the populations at risk are essential. People living in highly urbanised areas and big cities are known to participate less in CSPs. The aim of this study was to gain further insight in the participation rates of a screening-eligible population of 50 years and over, living in a highly urbanised region, over a longer time period.

Design

A retrospective observational study.

Setting

Participation data of the regional screening organization, linked to the cancer incidence data derived from the Netherlands Cancer Registry, concerning the city of The Hague, between 2005 to 2019. Attendance groups were defined as attenders (attending >50% of the invitations) and non-attenders (attending ≤50% of the invitations) and were mutually compared.

Results

The databases contained 106.377 unique individuals on the BC screening programme (SP), and 73.669 on the CRC-SP. Non-attendance at both CSPs was associated with living in a lower socioeconomic status (SES) neighbourhood and as a counter effect, also associated with a more unfavourable, relatively late-stage, tumour diagnosis. When combining the results of the two CSPs, our results imply high screening adherence over time. Women who did not participate in both CSPs were older, and more often lived in neighbourhoods with a lower SES-score.

Conclusions

Since low screening uptake is one of the factors that contribute to increasing inequalities in cancer survival, future outreach strategies should be focussed on engaging specific non-attending subgroups.

Strengths and limitations of this study

- For this study, regional screening invitation and attendance data were combined with cancer incidence data from the Netherlands Cancer Registry.
- By comparing the breast and colorectal cancer screening programmes, it allowed comparing a long-term programme with a relatively new programme.
- The city of The Hague can be seen as true 'living lab' to test for differences in screening attendance between different subgroups, due to strong differences between the different neighbourhoods, all well represented by socioeconomic status scores.
- Since the screening programme aiming at colorectal cancer is a relative new screening programme, data were only available on the implementation phase of the programme.

Introduction

Many European countries offer population based cancer screening programmes (CSPs) to its inhabitants.[1] The most common screening programmes (SPs) in Europe focus at the early detection of cervical, breast and colorectal cancer.[1] CSPs aim to detect cancers in an early or precursor stage, and thereby improving chances of survival due to early intervention. Early intervention is thought to lead to a better prognosis, and to less extensive treatment options.[2-4] Also in the Netherlands there are currently three CSPs implemented. The SPs concerning breast cancer (BC) and colorectal cancer (CRC) are most comparable, both target the same age-groups (starting at 50 and 55 years of age, respectively), and biennially invite potential participants.[5] While the BC-SP was phased in as early as 1990 and reached national coverage in 1996,[6] the CRC-SP was only phased in from 2014, and has only been fully operational since 2019.[7]

For a screening programme to be (cost-)effective, it is important that as many of the potential participants that are targeted, indeed participate.[8, 9] The World Health Organization (WHO) suggests that at least 70% of a target population should actually be screened, for the SP in order to be beneficial to population health.[10-12] Throughout Europe attendance at CSPs varies substantially, yet the Netherlands is known for its high attendance rates.[1] Latest Dutch attendance rates – from before the Covid-19 pandemic – were 76% and 72%, for the BC-SP and CRC-SP, respectively.[13, 14] Although these numbers might seem reassuring on a national level, the attendance rates were already declining gradually over the past years, and regional differences in screening attendance increased.[15] Current screening uptake is lowest in the highly urbanised areas and big cities of the Netherlands, and in neighbourhoods with low socioeconomic status (SES).[16]

The city of The Hague is the third largest city of the country and represents a densely populated area, with a rich mixture of different cultures and ethnicities, and with major differences in health outcomes between various neighbourhoods. In 2019 The Hague's average attendance rates were 64% and 57%, for the BC-SP and CR-CSP, respectively.[17] Hence, both are below the minimal intended rate of 70%.

To be able to promote participation in CSPs, it is important that the programmes are designed and operate as well as possible and are in accordance with the targeted populations. Further insight into the characteristics of attenders and non-attenders, especially in highly urbanised regions, is thus needed. The aim of this study was to gain insight in the background of differing attendance rates of a screening-eligible population aged 50 years and over, living in a highly urbanised region, over a longer period of time.

Methods

A retrospective observational study was performed among all screening-eligible people concerning the BC-SP and the CRC-SP living in The Hague, the Netherlands, between 2005 to 2019.

Screening programmes in the Netherlands

The Netherlands hosts CSPs aimed at cervical, breast and CRC. Screening participation is on a voluntary basis, and the screening tests are offered free of charge by the Dutch government.[5]

The BC-SP invites women between 50-75 years of age and uses a bilateral mammography as screening tool. After a an abnormal screening result the participant will be referred to the hospital by the general practitioner (GP).[6]

The CRC-SP invites both women and men aged between 55-75 years and uses a faecal immunochemical test (FIT) as screening tool. After a positive FIT, participants will be scheduled for a coloscopy in a contracted colonoscopy centre by the screening organization.[7]

Data management

In the Netherlands, The National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieu, RIVM) and the national screening organisation are in charge of organizing and coordinating the CSPs. Detailed data on national participation rates are publicly available through the RIVM website.[5] Regional screening invitation and attendance data were retrieved via the national screening organisation, region South-West (Bevolkingsonderzoek Zuid-West, BVO-ZW). Cancer incidence data were retrieved from the Netherlands Cancer Registry (NCR) via the Netherlands Comprehensive Cancer Organisation (Integraal Kankercentrum Nederland, IKNL).[18] Both datasets were linked on an individual level by IKNL after approval from the privacy officers of both organisations. On forehand the Ethics Committee of the Leiden University Medical Centre issued a waiver of consent (G18.096). At time of the data extraction (2020), most recent complete datasets were extracted relating to the screening data of BVO-ZW. For the BC-SP extracted data was from 2005 to 2019. For the CRC-SP extracted data was from 2014 to 2019. Since the CRC-SP was only fully integrated and functioning from 2019, included data was of the implementation phase of the CRC-SP.

The BVO-ZW-database contained the variables: gender; year of birth; 4-digit zip code, tests results: mammography and colonoscopy. The NCR-database contained the

variables: gender; year of birth; date of diagnosis of the tumour, tumour type (BC/CRC), and tumour stage. Within the combined dataset several new variables were determined: 'number of times invited', 'number of times participated', and 'percentage participated after being invited'.

For every 4-digit zip code a neighbourhood SES-score was set by the Netherlands Institute for Social Research (Sociaal en Cultureel Planbureau, SCP) on a continues scale in 2017.[19] This score incorporates data on house value and income. We categorised this score into quartiles (1-4: the higher the number, the higher the SES), including all neighbourhoods in the Netherlands. Thereafter the 4-digit zip code for neighbourhoods of The Hague were assigned with a neighbourhood SES-score.

Data analysis

The subdivision of attendance groups for both CSPs was determined over the set time period: how many people were invited, how many people did participate, and how many people were registered with a cancer diagnosis. We distinguished invitees who always (100%), sometimes (>0% and <100%), and never (0%) participated after receiving an invitation.

For further analysis we divided our data in 'attenders' and 'non-attenders'. Attenders were defined as: invitees who participated in the CSPs in more than 50%, after being invited. Non-attenders were defined as: invitees who participated in 50% or less, after being invited. The proportion of attenders and non-attenders was presented descriptively, using counts and percentages. To test independent continuous variables, Mann-Whitney U and Kruskal-Wallis tests were conducted. For categorical independent variables, univariate regression analyses were performed with an α 0.05 and β 0.8. This resulted in odds ratios (ORs) per attendance group, with corresponding 95% confidence intervals (95% CIs). Likelihood Ratio tests were performed to test for the influence of each independent variable in the regression models. Our data was stored and analysed by making use of IBM SPSS (version 25).

Patient and public involvement

The development of the research question, study design and outcome measures were developed by a team of experienced primary care doctors and researchers, who also concerned patients' and public's interests. Patients were not directly involved in these processes. The results of this research work are going to be published open access and disseminated to whom is interested, among others primary care doctors and the Municipal Health Services.

Results

The databases contained 106.377 unique individuals on the BC-SP, and 73.669 on the CRC-SP. Analysis showed an overlap of 38,071 individuals, thus around a third, receiving invitations for both CSPs.

Breast cancer screening programme

Most women received seven invitations (27.0%), with a maximum of nine invitations (0.1%). Within the time period of 14 years, n=48,126 women (45.2%) received their first BC-SP invitation. In total n=79,594 women (74.8%) participated at least once. Among the invitees, n=3,820 (3.6%) women were diagnosed with BC, regardless of whether this tumour was screen-detected.

The largest group of BC-SP invitees always participated in the CSP after receiving an invitation (n=47,087; 44.3%). About a quarter of the invited women never participated (n=26,783; 25.2%). Among the 'always-attenders', 1.6% (n=755) of the women were diagnosed with BC, compared with 6.8% (n=2,198) and 3.2% (n=867) of the 'sometimes' and 'never-attenders', respectively (Figure 1).

A total of 61.9% (n=65,853) of the invitees were identified as 'attenders', hence 38.1% (n=40,524) as 'non-attenders'. Non-attenders were found to be two years younger (Mann-Whitney U: p<.01). The number of BCs were evenly divided between the two attendance-groups (50.6% versus 49.4%). Women in the non-attenders group with BC, were two years younger (Mann-Whitney U: p<.01) and diagnosed with BC five years earlier in live (Mann-Whitney U: p<.01), compared to women with BC in the attenders' group (Table 1).

Table 1. Characteristics invitees and cancer cases, concerning the breast cancer screening programme.

	Total invitees (n=106,377)				Invitees with BC (n=3,820)			
Attendance group*	**Attenders**		**Non-attenders**		**Attenders**		**Non-attenders**	
Proportion % (n)	61.9 (65,853)		38.1 (40,524)		50.6 (1,932)		49.4 (1,888)	
Year of birth Median (25-75%)	1953 (1945–1960)		1955 (1945–1962)		1948 (1942-1954)		1950 (1944–1957)	
Age at diagnosis Median (25-75%)	-		-		65 (59-71)		60 (54-67)	
Neighbourhood SES-score	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
1	17,656	30.5	12,813	38.4	520	27.9	560	31.0
2	12,127	21.0	6,829	20.5	391	20.9	398	22.0
3	4,488	7.8	2,301	6.9	145	7.8	132	7.3
4	23,539	40.7	11,384	34.2	811	43.4	718	39.7
Unknown	8,043		7,197		65		80	

BC= breast cancer, SES= social economic status (SES 1: low; SES 4: high)
*Attenders: people who participated in >50%, after being invited. Non-attenders: people who participated in ≤50%, after being invited.

The neighbourhood SES-score differed statistically significant between attenders and non-attenders (Likelihood Ratio test: p<.01). Women living in a neighbourhood with the highest SES-scores, were more likely to participate (ascending ORs from 1.29 to 1.50; for SES-2 to SES-4, compared to SES-1). The neighbourhood SES-scores were not statistical different between the different attendance-groups with BC (Likelihood Ratio test: p=.08). Despite, people living in a SES-4 neighbourhood were more likely to participate (OR 1.22), compared to people living a SES-1 neighbourhood. Attendance was associated with a lower BC-stage (declining ORs from 0.95 to 0.15). In addition, when the interaction effect for both independent variables was determined, non-attenders were more likely to live in neighbourhoods with lower SES-score and had the more unfavourable cancer stages as an outcome (Likelihood Ratio test: p<.01) (Table 2).3

Table 2. Results univariate regression analyses on attendance, concerning invitees and breast cancer cases.

	OR (95% CI)	p-value	n
SES (invitees)			
SES 1	reference	<.01*	30,469
SES 2	1.29 (1.24-1.34)	<.01*	18,956
SES 3	1.42 (1.34-1.50)	<.01*	6,789
SES 4	1.50 (1.45-1.55)	<.01*	34,923
SES (invitees with BC)			
SES 1	reference	0.08	1,080
SES 2	1.06 (0.89-1.27)	0.55	789
SES 3	1.18 (0.91-1.54)	0.21	277
SES 4	1.22 (1.04-1.42)	0.01*	1,529
Stage			
CIS	reference	<.01*	517
Stage 1	0.95 (0.78-1.16)	0.61	1,469
Stage 2	0.49 (0.40-0.61)	<.01*	1,116
Stage 3	0.32 (0.24-0.42)	<.01*	316
Stage 4	0.15 (0.10-0.24)	<.01*	156
SES x Stage			
SES 4 x CIS	reference	<.01*	217
SES 4 x Stage 1	0.78 (0.57-1.09)	0.15	620
SES 4 x Stage 2	0.46 (0.33-0.64)	<.01*	465
SES 4 x Stage 3	0.35 (0.22-0.56)	<.01*	125
SES 4 x Stage 4	0.17 (0.09-0.32)	<.01*	62
SES 3 x CIS	0.59 (0.30-1.18)	0.13	38
SES 3 x Stage 1	0.68 (0.43-1.08)	0.10	119
SES 3 x Stage 2	0.54 (0.33-0.88)	0.01*	93
SES 3 x Stage 3	0.20 (0.07-0.59)	0.01*	18
SES 3 x Stage 4	0.00 (0.00-0.00)	1.00	1
SES 2 x CIS	0.82 (0.51-1.32)	0.41	107
SES 2 x Stage 1	0.84 (0.59-1.21)	0.35	319
SES 2 x Stage 2	0.32 (0.22-0.47)	<.01*	229
SES 2 x Stage 3	0.26 (0.15-0.44)	<.01*	82
SES 2 x Stage 4	0.13 (0.05-0.34)	<.01*	30

Table 2. Results univariate regression analyses on attendance, concerning invitees and breast cancer cases. **(continued)**

	OR (95% CI)	p-value	n
SES 1 x CIS	0.71 (0.47-1.09)	0.12	155
SES 1 x Stage 1	0.78 (0.56-1.10)	0.15	411
SES 1 x Stage 2	0.38 (0.26-0.54)	<.01*	329
SES 1 x Stage 3	0.18 (0.10-0.31)	<.01*	91
SES 1 x Stage 4	0.09 (0.04-0.19)	<.01*	63

SES= social economic status (SES 1: low; SES 4: high), BC= breast cancer, CIS= carcinoma in situ
*Statistically significant associated with attendance at the cancer screening programmes

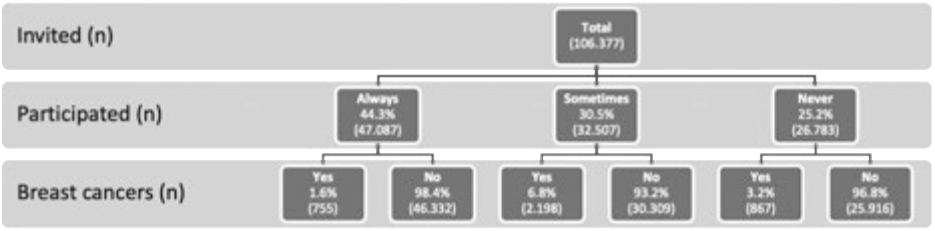

Figure 1. Subdivision of the attendance groups at the breast cancer screening programme.

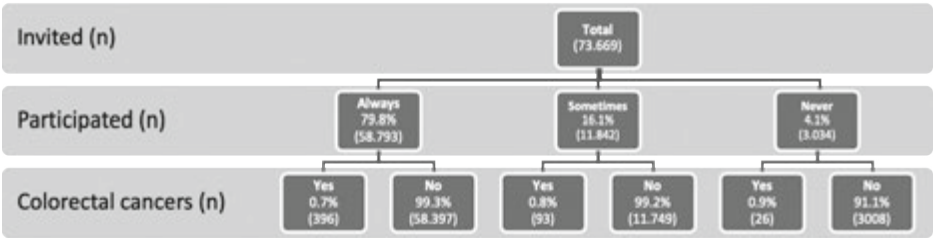

Figure 2. Subdivision of the attendance groups at the colorectal cancer screening programme.

Colorectal cancer screening programme

Most invitees received one invitation (48.2%), with a maximum of three invitations (12.8%). Since all acquired data were from the implementation period of the SP, all invitees received their first invitation during the set time period. In total n=70,638 (95.9%) people participated at least once. Among the invitees, n=515 (0.7%) were diagnosed with CRC, regardless of whether this tumour was screen-detected. The number of male participants with CRC was 1.2 times higher, compared with female participants (55% (n=284) versus 45% (n=231)).

The largest group of CRC-SP invitees always participated in the CSP after receiving an invitation (n=58,3793; 79.8%). Only a very small part of the invitees never participated (n=3,034; 4.1%). Among the 'always-attenders', 0.7% (n=396) of the participants were diagnosed with CRC, compared with 0.8% (n=93) and 0.9% (n=26) of the 'sometimes' and 'never-attenders', respectively (Figure 2).

A total of 83% (n=61,132) of the invitees were identified as 'attenders', hence 17% (n=12,537) as 'non-attenders'. In the attenders-group 46.5% of the people were male, compared with 47.4% in the non-attenders-group (Likelihood Ratio: p=.08). Median age of the non-attenders was found to be two years older (Mann-Whitney U: p<.01). Most CRCs were found in the attenders-group (79.2% versus 20.8%). Median age of the invitees in the non-attenders group with CRC was one year lower (Mann-Whitney U, p=.27), but they were diagnosed with CRC around the same median age (Mann-Whitney U, p=.67), compared to invitees with CRC in the attenders' group (Table 3).

Table 3. Characteristics invitees and colorectal cancer cases, concerning the colorectal cancer screening programme.

	Total invitees (n=73,669)				**Invitees with CRC (n=515)**			
Attendance group*	**Attenders**		**Non-attenders**		**Attenders**		**Non-attenders**	
Proportion % (n)	83.0 (61,132)		17.0 (12,537)		79.2 (408)		20.8 (107)	
Sex % (n)	M: 46.5 (28,450) F: 53.5 (32,681)		M: 47.7 (5,974) F: 52.3 (6,563)		M: 53.9 (220) F: 46.1 (188)		M: 59.8 (64) F: 40.2 (43)	
Year of birth Median (25-75%)	1953 (1947-1958)		1951 (1947-1954)		1948 (1945-1953)		1949 (1946-1952)	
Age at diagnosis Median (25-75%)	-		-		67 (55-77)		67 (64-69)	
Neighbourhood SES-score	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
1	16,908	27.8	4,693	37.6	110	27.0	41	38.3
2	12,664	20.8	2,453	19.7	103	25.2	11	10.3
3	4,697	7.7	869	7.0	38	9.3	7	6.5
4	26,546	43.7	4,451	35.7	157	38.5	48	44.9
Unknown	317		71		0		0	

CRC= colorectal cancer, M= male, F= female, SES= social economic status (SES 1: low; SES 4: high)
*Attenders: people who participated in >50%, after being invited. Non-attenders: people who participated in ≤50%, after being invited.

The neighbourhood SES-score differed statistically significant between attenders and non-attenders (Likelihood Ratio test: p<.01). Women living in a neighbourhood with the highest SES-scores, were the more likely to participate (ascending ORs from 1.43 to 1.66; for SES-2 to SES-4, compared to SES 1). The neighbourhood SES-scores also differed statistically between the different attendance-groups with CRC (Likelihood Ratio test: p=.05). People living in a SES-2 neighbourhood were more likely to participate (OR 1.64), compared to people living in a SES-1 neighbourhood. Attendance was not statistical different between the several CRC-stages. Despite, a stage 4 CRC had an OR of 0.56 on attendance, compared with a stage 1. In addition, when the interaction effect for both independent variables was determined, no statistical differences could be established (Likelihood Ratio test: p=0.24). However, when taken the ORs into account non-attenders, there seems to be a tendency that non-attenders were more likely to live in neighbourhoods with lower SES-scores and had the more unfavourable cancer stages. (Table 4).

Table 4. Results univariate regression analyses on attendance, concerning invitees and significant abnormalities.

	OR (95% CI)	**p-value**	**n**
SES (invitees)			
SES 1	reference	<.01*	21,601
SES 2	1.43 (1.36-1.51)	<.01*	15,117
SES 3	1.50 (1.39-1.62)	<.01*	5,566
SES 4	1.66 (1.58-1.73)	<.01*	30,997
SES (invitees with CRC)			
SES 1	reference	0.05*	151
SES 2	1.64 (1.18-2.26)	0.01*	114
SES 3	1.67 (1.05-2.64)	0.12	45
SES 4	1.56 (1.19-2.05)	0.42	205
Stage			
Stage 1	reference	0.38	198
Stage 2	0.76 (0.43-1.36)	0.36	109
Stage 3	0.80 (0.47-1.38)	0.43	147
Stage 4	0.56 (0.29-1.08)	0.09	61
SES x Stage			
SES 4 x Stage 1	reference	0.24	78

Table 4. Results univariate regression analyses on attendance, concerning invitees and significant abnormalities. **(continued)**

	OR (95% CI)	p-value	n
SES 4 x Stage 2	1.25 (0.49-3.17)	0.64	39
SES 4 x Stage 3	1.12 (0.50-2.49)	0.79	58
SES 4 x Stage 4	0.89 (0.34-2.31)	0.80	30
SES 3 x Stage 1	2.15 (0.57-8.03)	0.26	23
SES 3 x Stage 2	>10.00 (0.00- >10.00)	1.00	9
SES 3 x Stage 3	0.97 (0.18-5.19)	0.97	8
SES 3 x Stage 4	0.48 (0.08-3.11)	0.44	5
SES 2 x Stage 1	3.46 (1.10-10.91)	0.03*	47
SES 2 x Stage 2	1.85 (0.57-6.03)	0.31	27
SES 2 x Stage 3	4.83 (1.06-22.13)	0.04*	32
SES 2 x Stage 4	2.25 (0.26-19.51)	0.46	8
SES 1 x Stage 1	1.45 (0.60-3.56)	0.40	50
SES 1 x Stage 2	0.59 (0.25-1.13)	0.24	34
SES 1 x Stage 3	0.81 (0.36-1.81)	0.60	49
SES 1 x Stage 4	0.64 (0.21-2.00)	0.44	18

SES= social economic status (SES 1: low; SES 4: high), CRC= colorectal cancer
*Statistically significant associated with attendance at the cancer screening programmes

Comparison of the two screening programmes

In total n=38,071 women were invited for both CSPs. Most of these women attended both programmes, n=26,560 (69.8%). Only a small number of women did not participate in any programme, n=1,679 (4.4%). Between the four different subgroups, both 'year of birth' (Kruskal-Walllis: p<.01) and 'neighbourhood SES-score' were statistically different (Likelihood Ratio: p<.01). Women who did not attend the BC-SP but did attend the CRC-SP were the youngest, with a median year of birth of 1954. Non-attenders tended to live more in the neighbourhoods with lower SES-scores. Especially non-attendance at the CRC-SP seemed to be associated with lower a SES-score (BC+, CRC-; SES-score 1= 37.3%, and BC-, CRC-; SES-score 1= 40.7%, compared to BC+, CRC+; SES-score 1= 27.5%.) (Table 5).

Table 5. Combination of the datasets; invited women and their attendance status.

	Total amount of invited women (n=38,071)								
Attendance CSP (+/-)	**BC+ CRC+**		**BC+ CRC-**		**BC- CRC+**		**BC- CRC-**		**Statistical test**
Proportion % (n)	69.8 (26,560)		12.4 (4,721)		13.3 (5,111)		4.4% (1,679)		
Year of birth Median (25-75%)	1953 (1947-1958)		1951 (1947-1954)		1954 (1947-1959)		1951 (1948-1954)		Kruskal-Walllis p<.01
Neighbourhood SES-score	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	Likelihood Ratio p<.01
1	7,289	27.5	1,757	37.3	1,597	31.4	682	40.7	
2	5,704	21.5	922	19.6	1,050	20.6	327	19.5	
3	2,129	8.0	351	7.4	408	8.0	115	6.9	
4	11,373	42.9	1,684	35.7	2,036	40.0	552	32.9	
Unknown	62		7		20		3		

CSP= cancer screening programme, BC= breast cancer, CRC= colorectal cancer, SES= social economic status (SES 1: low; SES 4: high), (+)= attendance, (-)= non-attendance

Discussion

This retrospective observational study, among people eligible for attending the BC-SP and CRC-SP, conducted in a highly urbanised region between 2005 to 2019, delivered multiple insights concerning screening attendance, screening adherence and cancer risks within subgroups. Non-attendance for both CSPs was found in lower SES neighbourhoods and associated with a more unfavourable (late-stage) tumour diagnosis. When combining the results of the two CSPs, our results imply high screening adherence over time. Women who did not participate in both CSPs were older, and more often lived in neighbourhoods with a lower SES-score.

Several studies conducted in the Netherlands did focus on SES as a determinant for screening attendance and/or adherence, and did report the same conclusion: living in a lower SES-area/region/neighbourhood is associated with lower screening uptake.[20-22] Our study thus confirms this 'SES-effect', and shows to remain valid, even within a highly urbanised region. Additionally, our study adds that non-attenders living in a lower SES-neighbourhood, are more often diagnosed with a more unfavourable form of BC, and the same tendency seems to exist for CRCs. In this study we did not look into mechanisms on why people living in lower SES-neighbourhoods developed these more

unfavourable forms of cancer, but in literature factors related to health illiteracy are often mentioned.[23] Just recently, Kregting et al. compared the screening attendance of women at the screening ages of 55/65 years, and concluded that women living in areas with higher population density and lower SES-score were less likely to participated in more CSPs.[24] Three studies conducted in the United Kingdom compared barriers for the CSPs and concluded that women who lived in a more deprived region, participated less in the CSPs.[25-27] Age as a variable, was earlier described in two studies. One did not find any influence,[25] the other reported a lower age to be associated with lesser screening attendance.[26] Within our study we saw a mixed influence of age, depending on the CSP. With respect to screening adherence, we found rather high overall screening attendance rates for both CSPs. The yearly monitoring reports of RIVM show the same high screening adherence on a national level.[13, 14] In terms of cancer risk, we found that men were more likely to be diagnosed with CRC than women, which is consistent with national trends.[14]

By conducting this study, we were able to compare a long-lasting programme with a relatively new programme. We focused on the city of The Hague since we believe, The Hague can be seen as a true 'living lab' to test for differences in screening attendance between different subgroups, due to strong differences between the different neighbourhoods, all well represented by the SES-scores.[28] This also allows our study findings to be directly translated and applied into daily practice. While the segregation between neighbourhoods in The Hague is probably the most evident, we expect our findings to be also applicable for other large cities, as for example Amsterdam and Rotterdam, given their generally similar demographic characteristics.[29-31]

Our study has some limitations that need to be reflected on. Since the CRC-SP is a relative new CPS, we only had access to data of the implementation phase of the CSP, over a period of 4 years. This resulted in relatively little data on the CRC-SP, compared with the data on the BC-SP, and in particular resulted in small CRC numbers. Thereby, one might question the relevance of comparing the data of a CSP in the implementation phase, with a 'steady state' CSP. However, we felt it was relevant to compare the two CSPs at this early stage, as any shortcomings could then be addressed as early as possible. Another limitation has to do with the degree of crudeness of our variables. In the initial study design, we planned to look into several specific characteristics of potential participants and their association with screening attendance. Despite the large number of invited people by the CPSs, adding more patient specific characteristics would possibly lead to identification of individual participants. To avoid this risk, we decided to only look at relatively undetailed patient characteristics, such as: year of birth, age of diagnosis, sex, and neighbourhood SES-scores.

When thinking of clinical relevance and usability of the study findings, our main conclusion is that more effort should be made to engage people living in neighbourhoods with a lower SES-score. Current low-attendance in these areas may lead to a further increasing inequality in cancer survival, in a subpopulation already confronted with several other health-risks and problems. Our study underlines a longstanding hypothesis: people who are possibly the most at risk for the development of an advanced form of cancer, are the less likely to be screened.[32]

Future development therefore should focus on more specific outreach strategies to engage people living in neighbourhoods with a lower SES-score that are at specific risk of non-attendance, as partly earlier was suggest by Woudstra et al.[33] We suggest to encourage healthcare professionals, policymakers and politicians to look into such kind of 'novel solutions'. We also suggest that GPs, or primary health care professionals in general, take on a more prominent role in promoting and educating people on the CSPs. Previous studies showed that GP-involvement has a positive impact on (cervical) screening uptake, in particular for the classic 'hard to reach' subgroups.[34, 35] Especially in deprived areas, people generally trust and have a good long-term relationship with their GP, and primary healthcare centres in these areas are the only available link to enter healthcare and to gain information on health issues.[36] A remaining question would be, how exactly the role of GP practice centres should be improved while avoiding the risk to further increase workload. Perhaps just being enlisted with a primary healthcare centre, and being invited to participate through that centre, could already make a difference.

Conclusion

Non-attendance at both the BC and CRC-SPs tends to be associated with living in a lower SES-score neighbourhood. In addition, non-attenders living in these lower SES-neighbourhoods, were more often diagnosed with the unfavourable forms of cancer, as targeted by the specific CSPs. Since low screening uptake thus contributes to increasing inequalities in cancer survival, future outreach should be focussed on engaging specific groups of people living in lower SES-neighbourhoods carrying the highest risks.

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Contributions
THGB and FLB designed the study, collected, and combined the datasets. Data analysis was undertaken by THGB, supervised by FLB, and in a later stage by LdM and MAGE. THGB drafted the first version of the paper. ORG and MEN helped to interpret the results. All authors reviewed and edited the manuscript.

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