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The impact of driving time on participation in colorectal cancer screening with sigmoidoscopy and faecal immunochemical blood test

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ABSTRACT

Background: High participation rates are important for a colorectal cancer (CRC) screening programme to be effective. Having a long travelling distance to screening centres may impede participation.
Methods: We analysed the association between driving time from home address to screening centre and participation among individuals invited to screening with faecal immunochemical test (FIT) (n = 68,624) or sigmoidoscopy (n = 46,076) in a randomized trial in Norway in 2012–17. Two screening centres were involved. We fitted multiple logistic regression models, adjusted for demographic, socioeconomic and health characteristics, and reported odds ratios (OR) with 95% confidence intervals (CI).
Results: Participation rates were 58.9 % (n = 40,445) for FIT and 51.9 % (n = 23,911) for sigmoidoscopy. In sigmoidoscopy, participation was 56.9 % and 47.9 % in those living < 20 and > 60 min by car from the screening centres, respectively. For each 10 min driving time increase, OR for participating in sigmoidoscopy screening was 0.93 (95 % CI 0.91–0.95). There was a significant difference between the two screening centres (p-value for heterogeneity <0.001). Participation in FIT screening were 61.2 % and 57.1 % in those with < 20 and > 60 min driving time, respectively, and the OR was 0.98 (95 % CI 0.96–0.99) for each 10 min increase (heterogeneity between screening methods, P-value <0.001). Among those with a positive FIT, compliance to colonoscopy was higher in those living < 20 compared to > 60 min from the centres (95.1 % vs. 92.9 %, respectively, OR 0.86; 95 % CI 0.77–0.93 for each 10 min increase).
Conclusions: Driving time to screening centre was a significant predictor of participation, mainly in sigmoidoscopy. There were local differences in the impact of driving time on participation. Driving time also affected compliance to colonoscopy after a positive FIT. When planning a CRC screening programme, one should consider offering people living far from screening sites special assistance to facilitate their participation.

1. Introduction

Colorectal cancer (CRC) is the third most commonly diagnosed malignancy and the second leading cause of cancer death worldwide [1]. Randomized trials have shown that screening with sigmoidoscopy can reduce both CRC incidence and mortality [2], while screening with faecal occult blood tests can reduce mortality [3]. High participation rates are important for the success of a screening programme. Therefore, understanding the factors that are associated with CRC screening participation is vital.

The participation rates have not been satisfactory across screening trials, being lower than 50 % on average for both endoscopic and faecal occult blood test screening methods [4]. We know from previous studies that old age, high level of education, high income, not belonging to

Abbreviations: CI, confidence interval; CRC, colorectal cancer; FIT, faecal immunochemical test; OR, odds ratio.

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ethnic minorities, having a spouse, perception of own health as good, regular visits to the doctor, and family history of CRC screening are associated with a high participation [5–7]. Anticipated pain and embarrassment [8], and lack of interest and time, fear of colonoscopy or of positive results [9] are barriers against participation in CRC screening. Several studies suggested that living in rural areas may be an additional barrier [8,10–17]. In fact, a recent meta-analysis showed that uptake of cancer screening is poorer in rural than urban populations, particularly for hospital-based screening examinations, and this points to the possible impact of travel burden on participation [18].

The potential effect of travel time to the screening facility on participation has been studied in some US states, but the results are contradicting [6,19,20] and raise a question of whether geographical variation in participation is explained by other factors in rural and urban areas rather than purely by differences in travel time [19].

The importance of driving distance for participation in screening may be culture-specific, and research results may not be transferrable from one country to another, from one screening method to another, or even between screening centres within the same geographic region. Therefore, we aimed at elucidating the impact of driving time from home to the screening centres on participation in a large-scale population-based colorectal cancer screening trial in Norway comparing sigmoidoscopy and faecal immunochemical test (FIT).

2. Methods

2.1. Design and participants

This study is a sub-study of a population-based CRC screening trial, which between 2012 and 2019 enrolled approximately 140,000 individuals aged 50–74 years, residing in two geographic areas in South-East Norway, and who were randomly assigned in a 1:1 ratio to either once-only sigmoidoscopy or to FIT every second year for four rounds [21]. During the study period, there was no national CRC screening programme in Norway. For the current study, we included participants invited to sigmoidoscopy and the first round of FIT. Data extraction was conducted in October 2017. Attenders in the sigmoidoscopy arm provided written informed consent on attendance at the screening centre, while return of the faecal sample was considered as consent to participate in the FIT arm. From a population of 116,938 individuals invited between March 2012 and April 2017, we finally included 114,710 (98.1 %) individuals with a valid address in the two screening areas at the time of extraction. We have recently shown differences in the screening participation in this population by public registry-based demographic, socioeconomic and health factors [22]. The study was approved by the Regional Committee for Medical Research Ethics in South East Norway (2011/1272).

2.2. Screening invitation and methods

Invitations for screening and mailing of test kits were handled by an independent body (Cancer Registry of Norway). Individuals randomized to FIT were mailed an invitation to participate together with the FIT sampling kit (OC Sensor, Eiken chemicals) and instructions on how to perform the test. Individuals randomized to sigmoidoscopy were mailed a letter indicating a pre-specified time for out-patient sigmoidoscopy (n = 36,293, 77.4 %) or an open invitation with an opportunity to book the time for sigmoidoscopy in the screening centre at a suitable time point (n = 10,626, 22.6 %). If no reply was received within six weeks, a reminder letter was sent. No preparations at home were required prior to sigmoidoscopy. There were no dietary restrictions prior to FIT testing. Participants with a positive screening-test, defined as blood (> 15 ug haemoglobin per gram faeces) detected in the FIT sample or any significant lesions (any polyp ≥10 mm, ≥3 adenomas, an adenoma with high-grade dysplasia or ≥25 % villous architecture, or CRC) in the sigmoidoscopy [21] were referred for out-patient colonoscopy at a screening centre within four weeks. Participating in both sigmoidoscopy and FIT screening was free of charge for the participant, but participants themselves had to cover a co-payment of NOK 450 (approximately 45 €) for the follow-up colonoscopy examination in case of a positive test. Participants had to cover their costs for the travel to the screening centre for both sigmoidoscopy and the follow-up colonoscopy, but parking at the screening centre was free of charge.

2.3. Exposure variables and covariates/driving time from home to screening centre

The main exposure variable was the driving time from invitees' home to screening centre. Driving times were estimated using coordinates for each invitees' home postal area and postal area of the screening centre to which the invitee belonged. Coordinates were downloaded from The GeoNames geographical database [23] to specify the natural centre for a postal area. All zip codes with the same postal area therefore have identical coordinates. Home addresses at the time of data extraction were used. Driving times were calculated by an automatic lookup for each postal area in Google Maps, estimating the driving time in minutes by car from the postal area coordinates to the coordinates of the screening centre. In order to minimize risk of participant identification, driving distance was rounded to the nearest 5 min. All driving times of 120 min or more were grouped together into one category.

The two hospitals which hosted the screening centres were Bærum and Moss hospitals. The municipalities constituting the catchment area of these hospitals, respectively, were all defined as urban municipalities according to the municipality centrality class [24].

Data on marital status, immigration status, education, employment and income for each individual were retrieved from Statistics Norway. Data on drug prescriptions for each individual were obtained from the Norwegian Prescription Database. The variables from Statistics Norway were first linked to the variables from the screening database (driving time, screening arm, screening participation, age and sex), before the data on drug prescriptions were merged in the dataset and the dataset was de-identified at the Norwegian Prescription Database.

2.4. Outcome

The primary outcome of this study was participation in screening (i.e. returning the FIT kit or attending sigmoidoscopy examination). The secondary outcome was compliance to the follow-up colonoscopy after a positive screening test.

2.5. Statistical analyses

We used the Chi-square test to assess the statistical significance of differences in participation between strata of categorical variables. We estimated the association between driving time and participation using logistic multivariable regression models, reporting odds ratios (OR) and 95 % confidence intervals (CI) separately for the two methods of CRC screening: FIT and sigmoidoscopy. We also estimated the association between driving time and compliance to the follow-up colonoscopy invitation after a positive FIT result. We did not estimate the association for follow-up colonoscopy after a positive sigmoidoscopy result because the compliance was almost complete (97.8 %). We adjusted all models for screening centre, sex, age at time of invitation, level of education (categorized as primary school, high school, up to 4 years at university and more than 4 years at university), occupational status (employed, outside labour force/retired and unemployed), household income (quartiles), marital status (single/living alone and married/cohabiting), immigration status (born abroad with two foreign-born parents versus all others), and prescription of several types of drugs [22]. For the latter, we used two prescriptions of the following drugs during the year before invitation as surrogates for co-morbidity: drugs used in diabetes

treatment (anatomical therapeutic chemical code A10), cardiac therapy (C01), antihypertensives (C07/08/09), antithrombotic agents (B01), drugs for obstructive airway diseases (R03), anti-Parkinson drugs (N04), and psychotropic drugs (N05A, N05B, N05C and N06A).

We used the Cochran's Q test to test the heterogeneity between estimates, i.e., if the driving distance had a different effect by screening method, sex, age group and screening centre.

All tests were two-tailed and p-values < 0.05 were considered as statistically significant. Statistical analyses were conducted in R version 3.5.1 (http://cran.r-project.org) and SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

3. Results

We included 68,624 individuals invited to FIT, and 46,076 invited to sigmoidoscopy. Characteristics of the population are reported in Table 1. Driving time to the screening centre was < 20 min for 29,546 (44.7 %) invited to FIT and 19,733 (47.0 %) invited to sigmoidoscopy, while it was > 60 min for 1.3 % and 1.1 %, respectively (Table 1). Participation rates were 58.9 % (n = 40,445) in the first round of FIT and 51.9 % (n = 23,911) in sigmoidoscopy (Table 2). More women than men participated in FIT screening, while no significant sex difference was seen in sigmoidoscopy. In both arms, participation increased with age from 50 to 69 years and declined thereafter.

Table 1
Characteristics of the invited population by screening method.

	FIT N (col %)	Sigmoidoscopy N (col %)
All invited	68,624 (100.0)	46,076 (100.0)
Sex		
Female	34,877 (50.8)	23,475 (50.7)
Male	33,747 (49.2)	22,601 (49.3)
Age in years at invitation		
50–54	10,119 (14.7)	5 974 (13.0)
55–59	16,294 (23.7)	10,950 (23.7)
60–64	14,468 (21.1)	9 765 (21.2)
65–69	14,394 (21.0)	9 497 (20.6)
≥ 70	13,349 (19.5)	9 890 (21.5)
Mean, standard deviation	62.6 (7.0)	62.9 (7.0)
Screening centre		
Moss	35,708 (51.0)	24,636 (51.1)
Bærum	32,916 (49.0)	21,440 (48.9)
Education		
Primary school	14,859 (21.9)	10,099 (22.2)
High school	31,491 (46.3)	21,112 (46.3)
Up to 4 years at university	15,380 (22.7)	10,312 (22.7)
More than 4 years at university	6 173 (9.1)	3 994 (8.8)
Occupational status		
Employed	41,541 (60.5)	27,644 (60.0)
Retired	26,620 (38.8)	18,141 (39.4)
Unemployed	453 (0.7)	283 (0.6)
Household income quartiles[a]		
Q1	16,975 (24.7)	11,697 (25.4)
Q2	17,143 (25.0)	11,526 (25.0)
Q3	17,196 (25.1)	11,475 (24.9)
Q4	17,301 (25.2)	11,369 (24.8)
Marital / Cohabitant status		
Single / living alone	17,745 (20.9)	12,115 (20.0)
Cohabitant / married	50,847 (79.1)	33,945 (80.0)
Immigration background		
Native	62,765 (93.2)	42,208 (94.5)
Immigrant	5 858 (6.8)	3 868 (5.5)
Drug prescriptions		
Drugs used in diabetes	4 552 (6.6)	3 142 (6.8)
Cardiac therapy	1 432 (2.1)	959 (2.1)
Antihypertensives	24,204 (35.3)	16,459 (35.7)
Antithrombotic agents	13,910 (20.3)	9 553 (20.7)
Drugs for obstructive airway diseases	6 288 (9.2)	4 248 (9.2)
Anti-Parkinson drugs	533 (0.8)	329 (0.7)
Psychotropic drugs	13,044 (19.0)	8 864 (19.2)
Driving time in minutes		
0–20	29,546 (44.7)	19,733 (47.0)
21–40	25,677 (36.7)	17,297 (35.8)
41–60	12,481 (17.3)	8 486 (16.1)
> 60	920 (1.3)	560 (1.1)

Numbers might not add up to the total because of missing values. a Q1: first quartile, ≤ 485,000 NOK; Q2: second quartile, 485,001–756 000 NOK; Q3: third quartile, 756,001–1 130,000 NOK; Q4: forth quartile, > 1 130.000.

3.1. Driving time and participation in the screening

Among participants invited for FIT screening, participation rates for people with a driving time of ≤20, 21–40, 41–60 and >60 min to the screening centre were 61.2 %, 57.8 %, 56.0 % and 57.1 %, respectively (Table 2, Fig. 1). The corresponding numbers were 59.9 %, 57.4 %, 56.7 % and 59.1 % for Moss centre and 61.6 %, 59.5 %, 55.0 % and 50.5 % for Bærum centre (Fig. 2). In multivariate analyses, the OR for participation was 0.98 (95 % CI 0.97–0.99) for each 10 min increase in travel time. Longer travel time was associated with lower participation in sigmoidoscopy in both sexes. In FIT, this applied only in females (P-value for heterogeneity between sexes 0.041; Table 3).

In the sigmoidoscopy arm, participation rates for people with a driving time of ≤ 20, 21–40, 41–60 and > 60 min to the screening centre were 56.9 %, 49.5 %, 45.4 % and 47.9 %, respectively (Table 2, Fig. 1). The corresponding numbers were 53.6 %, 49.3 %, 46.7 % and 50.7 % for Moss centre and 58.1.6 %, 50.2 %, 43.3 % and 38.6 % for Bærum centre (Fig. 2). In multivariate analyses, the OR for participation was 0.93 (95 % CI 0.92–0.94) for each 10 min increase in travel time. This OR was significantly different between the screening centres; 0.95 (95 % CI 0.94–0.97) vs. 0.91 (95 % CI 0.89–0.93) in Moss vs. Bærum centre (p-value for heterogeneity <0.001). The inverse association between driving time and participation was significantly larger for sigmoidoscopy than FIT screening (p-value for heterogeneity <0.001; Table 3). Participation rate in FIT and sigmoidoscopy screening in the municipalities of the two geographical screening areas covered by the Moss and Bærum screening centres are illustrated in Fig. 3. Participation decreases (the grey colour in the illustration gets darker) with increasing geographical distance from the screening centres.

3.2. Driving time and compliance to follow-up colonoscopy

Among the participants in the first FIT round, 3253 participants (8.0 %) had a positive result and were invited to a follow-up colonoscopy. Of these, 3062 (94.1 %) underwent the colonoscopy (Table 2). Compliance to colonoscopy decreased from 95.1 % in those living < 20 min from the centres to 92.9 % in those living > 60 min from the centres, leading to an adjusted OR of 0.86 (95 % CI 0.78–0.95; Table 4) for each 10 min increase in driving time. There was no statistically significant difference in this association between the screening centres, sexes or age groups.

4. Discussion

In this large population-based study, we found that travel time had a significant impact on participation in CRC screening, mainly in screening with sigmoidoscopy. The odds of participating in sigmoidoscopy screening declined by 7 % percent for every 10 min increase in the driving time, a result that is both statistically and clinically significant. For FIT screening, the association had a much smaller magnitude, and may not be clinically important. However, FIT positive participants with a long driving time had a lower compliance to the follow-up colonoscopy.

Studies that have explored the impact of driving distance on participation in CRC screening are scarce, have conflicting results as well as varying ways to categorize and analyse travel time. Several US studies support in part our findings of a negative association between driving distance and participation in sigmoidoscopy. In North Carolina, publicly insured individuals living more than 25 miles away from the

Table 2
Participation by screening method and compliance to colonoscopy after positive FIT.

	Participation in screening					
	FIT			Sigmoidoscopy		
	Invited	Participants (row %)	p-value	Invited	Participants (row %)	p-value
All invited	68,624	40,445 (58.9)		46,076	23,911 (51.9)	
Sex			< 0.001			0.285
Female	34,877	21,534 (61.7)		23,475	12,125 (51.7)	
Male	33,747	18,911 (56.0)		22,601	11,786 (52.1)	
Age in years at invitation			< 0.001			<0.001
50–54	10,119	5 268 (52.1)		5 974	2 874 (48.1)	
55–59	16,294	9 076 (55.7)		10,950	5 516 (50.4)	
60–64	14,468	8 754 (60.5)		9 765	5 210 (53.4)	
65–69	14,394	9 211 (64.0)		9 497	5 316 (56.0)	
≥ 70	13,349	8 136 (60.9)		9 890	4 995 (50.5)	
Screening centre						
Moss	35,708	20,622 (57.8)	< 0.001	24,636	12,220 (49.6)	< 0.001
Bærum	32,916	19,823 (60.2)		21,440	11,691 (54.5)	
Driving time in minutes						
0–20	29,546	18,083 (61.2)	< 0.001	19,733	11,233 (56.9)	< 0.001
21–40	25,677	14,845 (57.8)		17,297	8 555 (49.5)	
41–60	12,481	6 992 (56.0)		8 486	3 855 (45.4)	
> 60	920	525 (57.1)		560	268 (47.9)	
	Compliance to colonoscopy after positive FIT					
	Invited	Participants (row %)	p-value			
Driving time in minutes			0.005			
0–20	1 322 (41.1)	1 257 (95.1)				
21–40	1 303 (40.2)	1 230 (94.4)				
41–60	586 (17.5)	536 (91.5)				
>60	42 (1.3)	39 (92.9)				

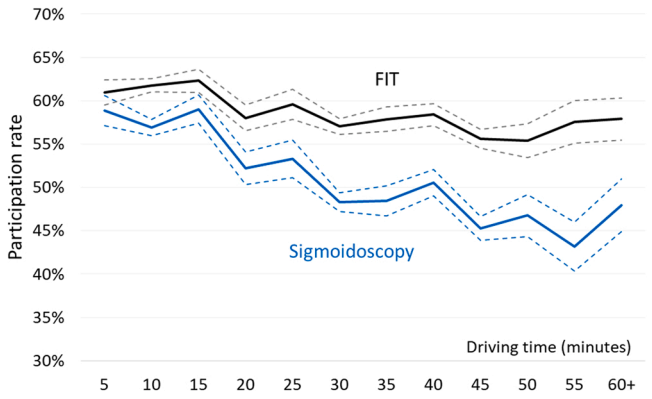

Fig. 1. Participation in the two screening arms according to driving time. Footnote: FIT: Faecal immunochemical test. Dotted lines represent 95% confidence intervals.

screening centre had significantly lower odds of any CRC testing (endoscopic examination or faecal test) than those who lived zero to five miles away. However, no linear trend emerged [20]. In Texas, lower CRC screening uptake was observed at driving distance of more than 20 miles to the nearest primary care unit [25]. In Utah and Oregon, rural vs. urban residence was more determining for participation than a long vs. short travel distance to the closest endoscopic facility [6,19]. In an underserved urban population in New York, travel time to screening centre had no effect on the uptake [26]. The limitation with the US studies is that both faecal and endoscopic screening are offered, and participation was assessed as adherence to any screening method. It is therefore not possible to differentiate the impact of distance to screening facility on participation between endoscopic and faecal screening and thereby compare with the present results. An Italian study showed that when the screening participant had to pick up the test kit at a hospital or a general practitioner him/herself, a travel time of more than 30 min as compared to less than 15 min to the provider was a major barrier to screening participation [27]. An earlier Norwegian sigmoidoscopy screening trial showed lower participation rates among urban than rural population, but distance to screening facility was not assessed [28]. In the present study, we observed lower participation in sigmoidoscopy by decreasing centrality class, but no truly rural areas were included in the trial according to the municipality centrality class [24]. Two breast cancer screening studies supported the evidence that living far from screening centres is associated with lower participation rates [29,30]. In Denmark, non-participation increased by increasing distance to the screening facility, but a more important determinant for participation than distance was access to a vehicle [29]. In the Quebec Breast Cancer Screening Programme in Canada, women living in rural areas were less sensitive to distance than their urban counterparts [30].

Our study does not provide data which may explain why driving distance played a larger role for participants in sigmoidoscopy to Bærum centre (mainly central areas) than Moss centre (largely less central uptake area). A search for reasons for this difference can only be speculative, one of which is that population in the municipalities in Bærum centre area has higher education and income levels than the population in the municipalities in Moss centre area. In any case, the results suggest that participation rate in one centre may not be easily extrapolated to other centres. All municipalities in the present screening areas are well served by public transport. Further studies should explore cultural differences and inherent tolerances to urban traffic jams versus more peaceful but time-consuming travel.

In our study, driving time seemed to affect participation not only in sigmoidoscopy screening, but also to some extent in the FIT group of invitees where the screening itself did not require attendance at a screening centre. This might be due to the fact that it was made clear to FIT invitees in their invitation that they would be advised to have a colonoscopy if the FIT was positive. The prospects of this combined with long travel distance might have demotivated them from returning the FIT in the first place. However, it is more worrisome that long driving distance was associated with a lower compliance for colonoscopy after a positive FIT. In fact, among those who had a positive FIT and attended

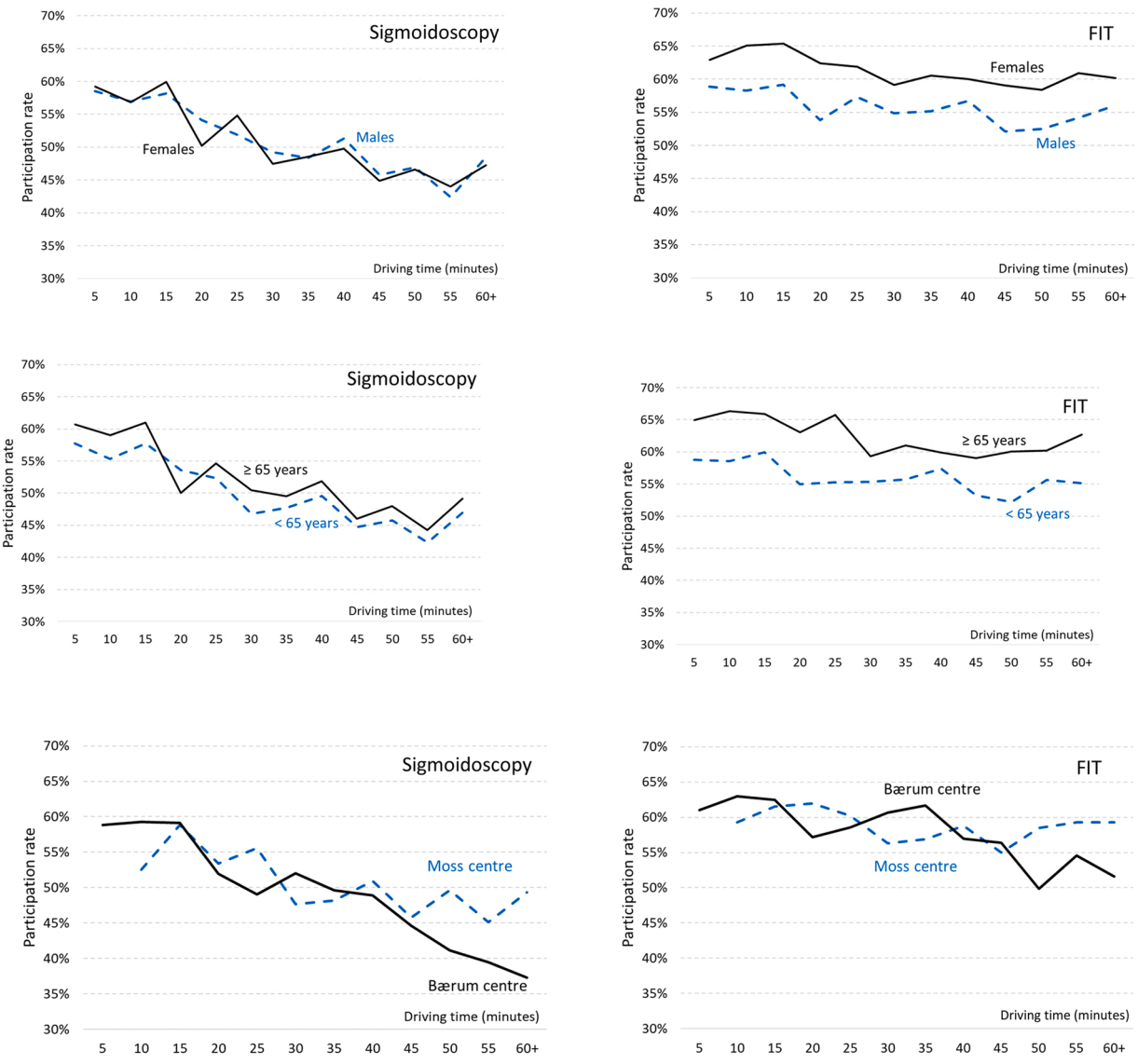

Fig. 2. Participation in the two screening arms according driving time, stratified by gender, age and screening centre. Footnote: FIT: Faecal immunochemical test.

Table 3
Association between screening participation and driving time, by arm, screening centre, sex and age.

	FIT			Sigmoidoscopy		
	OR (95% CI)	OR (95% CI)	P-value	OR (95% CI)	OR (95% CI)	P-value
Driving time						< 0.001[a]
Continuous per 10 min		0.98 (0.97–0.99)			0.93 (0.92–0.94)	
	Moss	**Bærum**		**Moss**	**Bærum**	
Driving time			0.368[b]			< 0.001[b]
Continuous per 10 min	0.99 (0.97–1.00)	0.98 (0.96–0.99)		0.95 (0.94–0.97)	0.91 (0.89–0.93)	
	Females	**Males**		**Females**	**Males**	
Driving time			0.041[b]			0.066[b]
Continuous per 10 min	0.97 (0.95–0.98)	0.99 (0.98–1.01)		0.92 (0.90–0.94)	0.94 (0.92–0.96)	
	< 65 years	**65 years or more**		**< 65 years**	**65 years or more**	
Driving time			0.341[b]			0.352[b]
Continuous per 10 min	0.98 (0.97–1.00)	0.97 (0.96–0.99)		0.92 (0.90–0.94)	0.93 (0.92–0.95)	

OR: odds ratio; CI: confidence intervals. Models were adjusted for sex, age, screening centre, education, occupational status, household income, immigration status, marital / cohabitant status, and prescriptions of drugs used in diabetes, cardiac therapy, antihypertensives, antithrombotic agents, drugs for obstructive airway diseases, anti-Parkinson drugs and psychotropic drugs; a Heterogeneity test between arms; b Heterogeneity test between groups, within each arm.

the work-up colonoscopy, more than one third had a CRC or an advanced adenoma [21]. We believe that people with a positive FIT who are living far from screening sites should be offered special assistance to facilitate their participation. A transport service might be an option. In Norwegian mammography screening, offering bus transport of women from remote areas to mammography screening centres has been a great

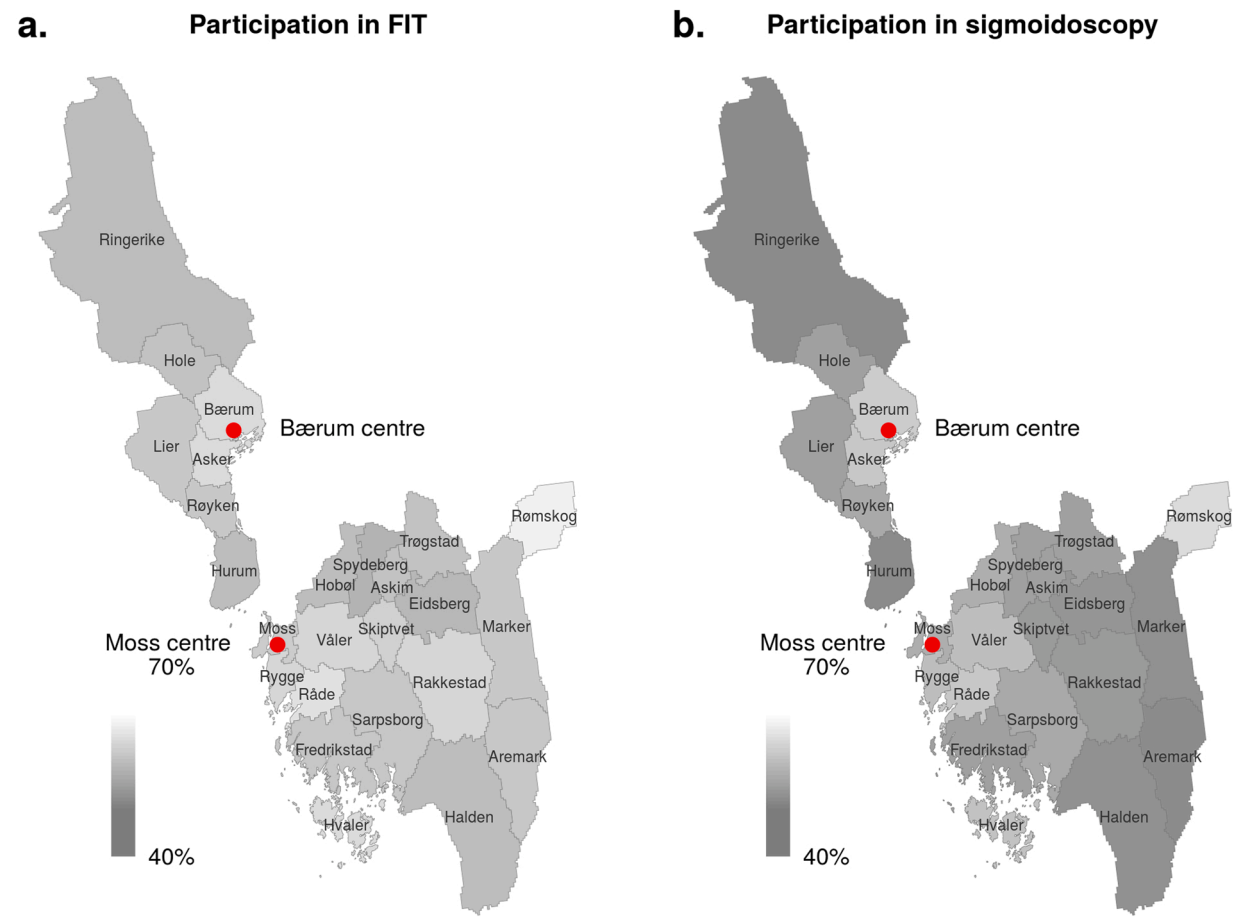

Fig. 3. Participation in the two screening arms by municipality. The two screening centres (Moss centre and Bærum centre) in each screening area marked with a red dot.

Table 4
Association between compliance to colonoscopy after positive FIT and driving time, overall and by screening centre, sex and age.

	OR_{adj} (95 % CI)	OR_{adj} (95 % CI)	P-value[a]
Driving time			
Continuous per 10 min		0.86 (0.78–0.95)	
	Moss	**Bærum**	0.210
Driving time			
Continuous per 10 min	0.94 (0.80–1.10)	0.82 (0.73–0.93)	
	Females	**Males**	0.190
Driving time			
Continuous per 10 min	0.80 (0.70–0.92)	0.91 (0.79–1.05)	
	< 65 years	**65 years or more**	0.348
Driving time			
Continuous per 10 min	0.89 (0.78–1.01)	0.81 (0.70–0.94)	

OR: odds ratio; CI: confidence intervals. Models were adjusted for sex, age, screening centre, education, occupational status, household income, immigration status, marital / cohabitant status, and prescriptions of drugs used in diabetes, cardiac therapy, antihypertensives, antithrombotic agents, drugs for obstructive airway diseases, anti-Parkinson drugs and psychotropic drugs; a Heterogeneity test between groups

success. To our knowledge, there are no studies that have examined an effect of transport service to CRC screening centres.

The major strengths of the current study are the large population and the adjustment on important demographic, socioeconomic and health characteristics, and that the data were derived from a randomized trial. A limitation is that we do not have information on access to a vehicle. The importance of access to a car for participation in sigmoidoscopy screening was reported by Sutton and colleagues [31]. Lack of access to a vehicle may affect invitees' opportunity to participate in CRC screening with sigmoidoscopy, rather than the driving distance per se. It is a limitation that the driving times were calculated based on the coordinates of the invitees' postal area and not of their actual addresses. This may only have introduced non-differential misclassification, diluting the real associations between the driving time and screening participation. Another weakness is that we, due to limitations in the data linkage, used driving times based on the address registered for each participant in 2017. We estimate that approximately 5 % of the population had a driving time at the date of first screening invitation that was different from the one used in the data analysis.

In conclusion, driving time was a significant predictor of participation in CRC screening, mainly for sigmoidoscopy, and its effect may vary by screening centre. Choosing FIT as CRC screening modality may increase participation rates in sparsely populated areas with long distances to health care facilities. However, we observed that long driving time might lower the compliance to work-up colonoscopy after a positive FIT. Therefore, whichever the screening method is used, one should consider offering people living far from screening sites special assistance to facilitate their participation, such as a free customized bus transport.

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Ethical approval

The study was approved by the Regional Committee for Medical Research Ethics in South East Norway (2011/1272).

CRediT authorship contribution statement

Mona Berthelsen: Formal analysis, Investigation, Methodology, Writing - original draft. **Paula Berstad**: Funding acquisition, Investigation, Project administration, Writing - review & editing. **Kristin R. Randel**: Investigation, Writing - review & editing. **Geir Hoff**: Funding acquisition, Investigation, Methodology, Project administration, Writing - review & editing. **Erik Natvig**: Data curation, Methodology, Writing - review & editing. **Øyvind Holme**: Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing - review & editing. **Edoardo Botteri**: Formal analysis, Investigation, Methodology, Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors report no declarations of interest.

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