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Sociodemographic factors associated with psychosocial consequences of false-positive colorectal cancer screening: a prospective cohort study

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ABSTRACT

Objectives Receiving a false positive in colorectal cancer screening is associated with psychosocial consequences, yet the reasons why some people are more affected than others remain unclear. This study examines the association between sociodemographic factors and psychosocial consequences among screening participants with false positives in colorectal cancer screening.

Design Prospective cohort study.

Participants 1432 screening participants with positive faecal immunochemical test (FIT) screening with a follow-up colonoscopy with either no abnormalities or benign polyps (low or medium-high risk).

Outcome measures We measured psychosocial consequences with the Consequences Of Screening – ColoRectal Cancer (COS-CRC) questionnaire, after the positive FIT but before the follow-up colonoscopy and again 1 year later. Sociodemographic factors were obtained from national registers and included sex, age, urbanicity, educational level, occupational status, income, assets, cohabitation status and Charlson Comorbidity Index. Psychosocial consequences were measured before colonoscopy (baseline) and 1 year after, and sociodemographic factors were assessed at baseline.

Results We tested 19×2×3=114 associations between the sociodemographic factors and psychosocial consequences within the three groups of false positives and five associations were significant. We found that for participants with medium- and high-risk polyps, experiencing short-term psychosocial consequences was significantly associated with having a university degree compared with secondary school (OR=5.04 (1.38; 18.37), p=0.0142) and being unemployed compared with being employed (OR=5.61 (1.42; 22.14), p=0.0139). For participants with low-risk polyps, long-term consequences were significantly associated with the mid-income quartile (OR=2.32 (1.13; 4.76), p=0.0224) and the highest income quartile (OR=5.47 (1.13; 26.48), p=0.0349) compared with the lowest quartile. For participants with no abnormalities, there was an association between short-term psychosocial consequences and having comorbidities compared with none (OR=2.95 (1.13; 7.71), p=0.0277).

Conclusion This study found few significant associations between psychosocial consequences and sociodemographic factors and with no apparent pattern in these. This suggests no strong evidence that specific sociodemographic groups should be especially vulnerable to experiencing psychosocial consequences after a false-positive result from colorectal cancer screening. Thus, there is currently weak evidence for identifying screening participants at higher risk for psychosocial consequences and developing targeted interventions to reduce psychosocial consequences.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ An important strength of this study is the longitudinal design, ensuring temporality in associations.
⇒ The measurement of psychosocial consequences was done with a rigorously-validated questionnaire.
⇒ Potential for selection bias in who participates in health research; healthy worker bias.
⇒ Potential issues resulting from type 1 errors due to multiple testing.

INTRODUCTION

Colorectal cancer screening has been implemented in many countries. In Denmark, adults aged 50–74 are invited to screening with faecal immunochemical test (FIT) biennially and colonoscopy as a follow-up procedure. Colorectal screening aims to detect early stages of cancer and polyps that might develop into cancer.

However, not all polyps develop into colorectal cancer and can be cases of overdiagnosis, and screening will necessarily cause false-positive screening results.[1 2] A false-positive result is defined as receiving a diagnosis of polyps or no abnormalities after an initial positive screening test. Such false positives have proven to cause psychosocial consequences, including anxiety, negative impact on sexuality and behaviour, and changes in social relations and existential values.[3–9] Such harms of screening have historically been under-investigated but are important for

informed decision-making about screening—both at an individual and structural level.

Not everyone will be affected psychosocially by receiving a false-positive result in screening, while others will be psychosocially harmed decades later.[4 10] Sociodemographic factors have previously been described as predictors of psychosocial consequences following false-positive screening results in various cancer screening programmes.[11–15] Reasons for this relationship might be explained by the fact that some sociodemographic factors increase general vulnerability, while other factors increase resilience and thus the given individual's ability to cope with a given stressor such as a false-positive screening result.[16] Identifying which factors are associated with psychosocial consequences can help us target interventions to reduce unintended negative consequences, and inform future intervention studies on psychosocial consequences.[17]

This study examines the association between sociodemographic factors and psychosocial consequences of following false-positive screening results in colorectal cancer screening. This study uses a prospective design and a validated outcome questionnaire to measure psychosocial consequences.

METHODS

This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline.[18] This study is a prospective cohort study with questionnaire and national register data.

Context

This study was conducted following the implementation of the Danish Colorectal Cancer Screening Programme in 2014. In the first screening round, all adults aged 50–74 were during a period of 4 years invited to screening with the FIT. The implementation was quasi-randomised based on birth month.[19] The standard diagnostic procedure following a positive FIT is a colonoscopy, where potential polyps are identified and removed. During the first 4 years of screening, about 1.2 million FITs were analysed and the mean yearly FIT positive rate was 6.9%.[20] In Denmark, the individual will receive a test result within 10 days from delivering the test. In case the test is positive, the individual will be offered a colonoscopy within 14 days.

Survey administration and sampling

We sampled among all participants with a positive FIT in one of the five regions of Denmark: Region Zealand from April to September 2017. We counted all positive FIT without cancer as false-positive results, that is, participants with no abnormalities and participants with benign polyps. We surveyed the study population at two time points: baseline in 2017 before the colonoscopy and 1 year after the FIT was confirmed as a false positive with a colonoscopy.

Table 1 COS-CRC and scales

	Part I—short-term consequences	Part II—long-term consequences
Scales	Anxiety	Relaxed/calm
	Behaviour	Social relations
	Sense of dejection	Existential values
	Sleep	Impulsivity
	Taking mind off things	Empathy

COS-CRC, Consequences Of Screening – ColoRectal Cancer.

Outcome measures

Psychosocial consequences were measured with the Consequences Of Screening – ColoRectal Cancer (COS-CRC) questionnaire.[21] COS-CRC is a condition-specific questionnaire validated to measure psychosocial consequences of colorectal cancer screening. COS-CRC consists of two parts: short- and long-term consequences relating to the nature of the questions: short-term consequences include anxiety, sense of dejection, and negative impact on sleep, behaviour and sexuality.[22] Long-term consequences relate to changes to social relations, existential values and empathy (table 1). We modelled two outcomes based on COS-CRC: short- and long-term psychosocial consequences comparing baseline sumscores with follow-up sumscores, and any increase in score indicated psychosocial consequences. This was coded as a binary variable.

We collected information about sociodemographic factors from Danish administrative electronic registers from start 2017. This information is registered by the Danish Authorities and is linked with an individual social security number/identifier.[23] We included the following factors: sex, age, cohabitation status, urbanicity, educational level, occupational status, income, assets and Charlson Comorbidity Index (CCI). Health and demographic variables are updated in real time; for example, if a person receives a diagnosis with their health provider or changes their address, this is automatically uploaded in the relevant registers. Variables such as income, education, occupation and assets are updated yearly. These variables were selected based on a literature review that revealed that these factors were associated with psychosocial consequences as well as extensive experience within the author group conducting interviews with people who have had false-positive results in cancer screening.[3 4 11–15 21 24 25]

Statistical methods

We estimated the association between psychosocial measures and sociodemographic factors using logistic regression models. We grouped false-positive results into three groups: no abnormalities, low-risk polyps and medium-high-risk polyps based on clinical characteristics.[6 26] Because of non-response to the questionnaires,

the outcomes are not observed for a considerable part of the cohort. We controlled for such potential differential non-response by inverse probability weighting (IPW), that is, by analysing the participants with observed outcomes weighted with the inverse probability of being observed; the latter estimated from a logistic regression model on the investigated variables.[27] To adjust the variance of the estimates to this weighting (overdispersed variance), Generalised Estimating Equations were used.[28 29]

To understand the contribution of each variable to the psychosocial consequences, we estimated the relative importance of each sociodemographic variable on the outcome.[30] Relative importance is a division of the coefficient of determination (R^2—here Tjur's pseudo R^2 for logistic regression was used) of a full multivariable model into the contributions of the individual variables. This division is estimated by averaging the increase in R^2 adding a specific variable, over all possible models; this average increase is the contribution in terms of fit of the given variable. The relative importance is expressed in percentage of the R^2 of the total model, that is, as the average increase in R^2 for a given variable divided by the total R^2.

To perform the analyses, we used SAS, V.9.4 (SAS Institute Inc., Cary, North Carolina, USA) and the R software package, V.3.4.1.[31]

Patient and public involvement

The Consequences Of Screening – ColoRectal Cancer (COS-CRC) questionnaire was developed in collaboration with 16 screening participants who had false-positive results. No patients with colorectal cancer were involved in the development of this study.

RESULTS

A total of 51 204 were screened in Region Zealand in 2017; of these, 3710 were positive, 3381 underwent a colonoscopy, 206 had colorectal cancer and the remaining 3175 had either polyps or no abnormalities. A total of 1854 screening participants had a positive FIT in Region Zealand from April to September 2017 and of these 1071 (57.9%) responded to the survey before their colonoscopy.

1432 positive screening participants who had a colonoscopy and did not have colorectal cancer were invited to the 1-year follow-up survey, where 954 (66.6%) responded (figure 1).

Groups were similar in regard to age and cohabitation status (table 2). There was a higher proportion of men among low-risk polyps (52.7%) and medium-high-risk polyps (65.6%) compared with no abnormalities (49.6%). Participants with no abnormalities were more likely to live in rural areas compared with the polyp groups. Participants with medium-high-risk polyps were more likely to be employed and to have low income and assets and less likely to be pensioners. Participants with no abnormalities were slightly more likely to have a CCI ≥2.

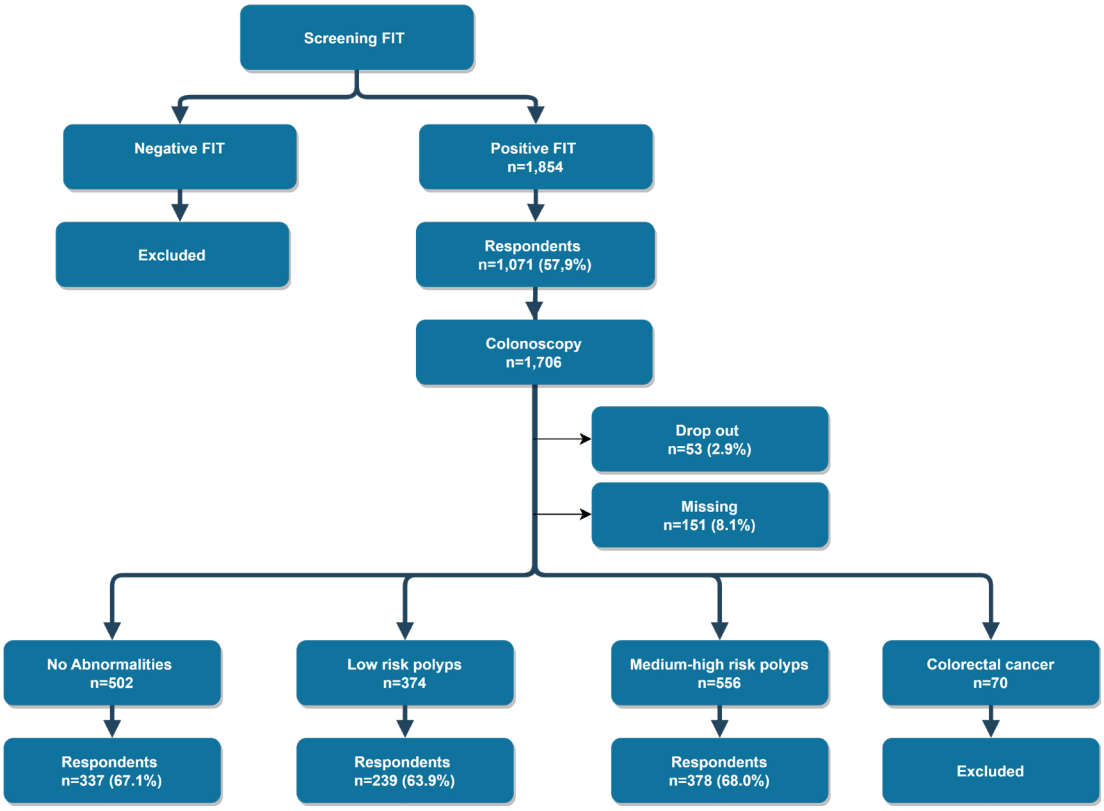

Figure 1 Flowchart of study inclusion and response rate at 1-year follow-up. FIT, faecal immunochemical test.

Table 2 Sociodemographic characteristics

Variable	Value	All n=1432 Count (%)	No abnormalities n=502 Count (%)	LR polyps n=374 Count (%)	MHR polyps n=556 Count (%)
Age	Mean (SD)	65.2 (5.9)	65.1 (6.1)	64.9 (5.9)	65.6 (5.7)
Sex	Male	811 (56.6)	249 (49.6)	197 (52.7)	365 (65.6)
	Female	621 (43.4)	253 (50.4)	177 (47.3)	191 (34.4)
Cohabitation status	Living alone	398 (27.8)	150 (29.9)	114 (30.5)	134 (24.1)
	Living with partner or family	1034 (72.2)	352 (70.1)	260 (69.5)	422 (75.9)
Urbanicity	Capital city	93 (6.5)	35 (7.0)	23 (6.2)	35 (6.3)
	Small city	585 (40.9)	190 (37.8)	161 (43.0)	234 (42.1)
	Rural	754 (52.6)	277 (55.2)	190 (50.8)	287 (51.6)
Occupational status	Employed	538 (37.6)	167 (33.3)	159 (42.5)	212 (38.1)
	Unemployed	153 (10.7)	64 (12.7)	41 (11.0)	48 (8.6)
	Pensioner	741 (51.7)	271 (54.0)	174 (46.5)	296 (53.3)
Educational level (highest obtained degree)	Elementary school	391 (27.3)	143 (28.5)	103 (27.5)	145 (26.1)
	Secondary school	703 (49.1)	227 (45.2)	191 (51.1)	285 (51.3)
	Short higher education*	261 (18.2)	99 (19.7)	61 (16.3)	101 (18.1)
	Long higher education†	54 (3.8)	21 (4.2)	17 (4.6)	16 (2.9)
	Missing	23 (1.6)	12 (2.4)	2 (0.5)	9 (1.6)
Annual income (EUR)	<26 800	662 (46.2)	229 (45.6)	160 (42.8)	273 (49.1)
	26 800–40 200	420 (29.3)	159 (31.7)	116 (31.0)	145 (26.1)
	40 201–67 000	282 (19.7)	91 (18.1)	78 (20.9)	113 (20.3)
	>67 000	68 (4.8)	23 (4.6)	20 (5.3)	25 (4.5)
Assets (EUR)	<11 800	535 (37.4)	211 (42.0)	136 (36.4)	188 (33.8)
	11 800–67 000	320 (22.3)	109 (21.7)	90 (24.0)	121 (21.8)
	>67 000	577 (40.3)	182 (36.3)	148 (39.6)	247 (44.4)
Charlson Comorbidity Index (CCI)	0	983 (68.5)	330 (65.8)	269 (71.9)	384 (69.1)
	1	220 (15.4)	80 (15.9)	55 (14.7)	85 (15.3)
	≥2	229 (16.0)	92 (18.3)	50 (13.4)	87 (15.6)

*Short higher education includes academic 2-year degree programmes, for example, business academies.
†Long higher education covers undergraduate and graduate programmes (university degrees).
LR, low risk; MHR, medium-high risk.

Main results

Table 3 shows the percentage of participants who reported psychosocial consequences.

Overall, 21.5% of participants reported short-term psychosocial consequences and 59.1% reported long-term consequences (table 3). Table 4 and figure 2 show the association between sociodemographic variables and the short- and long-term psychosocial consequences for no abnormalities, low-risk polyps and medium-high-risk polyps.

Short-term psychosocial consequences

For participants with no abnormalities, there was only a significant association between short-term consequences and CCI; participants had higher odds of short-term

Table 3 Psychosocial consequences

	All n=954	No abnormalities n=337	LR polyps n=239	MHR polyps n=378
Part I—short-term consequences	21.5%	19.6%	26.5%	40.3%
Part II—long-term consequences	59.1%	57.5%	60.3%	59.8%

LR, low risk; MHR, medium-high risk.

Table 4 OR, 95% CI and p values for logistic regression models

		Part I—short-term consequences			Part II—long-term consequences		
		No abnormalities	LR polyps	MHR polyps	No abnormalities	LR polyps	MHR polyps
		n=337	n=239	n=378	n=337	n=239	n=378
Variable	Value	OR (95% CI) p value	OR (95% CI) p value	OR (95% CI) p value	OR (95% CI) p value	OR (95% CI) p value	OR (95% CI) p value
Sex	Male	ref	ref	ref	ref	ref	ref
	Female	1.81 (0.79; 4.12) p=0.1608	0.90 (0.33; 2.44) p=0.8374	0.73 (0.31; 1.74) p=0.4820	0.84 (0.54; 1.31) p=0.4373	0.73 (0.43; 1.25) p=0.2542	1.57 (0.99; 2.50) p=0.0554
Age	50–60	ref	ref	ref	ref	ref	ref
	61–65	0.98 (0.32; 3.04) p=0.9856	0.75 (0.23; 2.40) p=0.6256	1.57 (0.55; 4.52) p=0.4010	0.62 (0.31; 1.26) p=0.1896	0.56 (0.24; 1.32) p=0.1856	0.86 (0.42; 1.76) p=0.6853
	66–70	0.57 (0.17; 1.91) p=0.3669	0.26 (0.07; 1.00) p=0.0510	1.07 (0.41; 2.78) p=0.8888	0.86 (0.45; 1.65) p=0.6502	0.65 (0.29; 1.47) p=0.3010	0.89 (0.48; 1.67) p=0.7251
	>70	1.00 (0.36; 2.77) p=0.9992	0.60 (0.16; 2.18) p=0.4327	0.52 (0.19; 1.48) p=0.2224	0.81 (0.44; 1.48) p=0.4934	0.69 (0.30; 1.60) p=0.3848	0.62 (0.33; 1.16) p=0.1331
Urbanicity	Capital city	ref	ref	ref	ref	ref	ref
	Small city	1.30 (0.31; 5.43) p=0.7154	1.42 (0.27; 7.63) p=0.6842	0.53 (0.15; 1.80) p=0.3053	1.33 (0.55; 3.22) p=0.5251	0.90 (0.28; 2.86) p=0.8612	0.69 (0.27; 1.73) p=0.4256
	Rural	0.85 (0.21; 3.35) p=0.8112	0.43 (0.07; 2.50) p=0.3451	0.45 (0.13; 1.52) p=0.1955	0.99 (0.43; 2.31) p=0.9840	0.64 (0.20; 2.00) p=0.4405	0.76 (0.31; 1.87) p=0.5446
Occupational status	Employed	ref	ref	ref	ref	ref	ref
	Unemployed	1.52 (0.36; 6.55) p=0.5700	1.15 (0.21; 6.25) p=0.8750	5.61 (1.42; 22.14) p=0.0139	0.56 (0.25; 1.26) p=0.1605	0.95 (0.34; 2.66) p=0.9120	1.14 (0.44; 2.92) p=0.7884
	Pensioner	0.92 (0.40; 2.10) p=0.8325	0.42 (0.15; 1.16) p=0.0943	0.94 (0.46; 1.91) p=0.8555	0.85 (0.52; 1.38) p=0.5131	0.70 (0.40; 1.22) p=0.2012	0.72 (0.46; 1.12) =0.1469
Educational level	Elementary school	1.01 (0.40; 2.54) p=0.9872	1.23 (0.40; 3.82) p=0.7195	1.40 (0.56; 3.51) p=0.4718	1.43 (0.84; 2.45) p=0.1914	1.19 (0.61; 2.31) p=0.6110	1.11 (0.66; 1.88) p=0.6873
	Secondary school	ref	ref	ref	ref	ref	ref
	Short higher education*	0.32 (0.09; 1.19) p=0.0900	0.88 (0.27; 2.84) p=0.8324	1.13 (0.48; 2.71) p=0.7770	1.06 (0.58; 1.94) p=0.8493	0.99 (0.49; 2.00) p=0.9800	0.67 (0.40; 1.20) p=0.1889
	Long higher education†	0.43 (0.05; 3.65) p=0.4413	2.31 (0.48; 11.20) p=0.2976	5.04 (1.38; 18.37) p=0.01420	0.59 (0.20; 1.80) p=0.3562	4.64 (0.99; 21.80) p=0.0516	0.83 (0.25; 2.73) p=0.7625

Continued

Table 4 Continued

Variable	Value	Part I—short-term consequences			Part II—long-term consequences		
		No abnormalities	LR polyps	MHR polyps	No abnormalities	LR polyps	MHR polyps
		n=337	n=239	n=378	n=337	n=239	n=378
		OR (95% CI) p value	OR (95% CI) p value	OR (95% CI) p value	OR (95% CI) p value	OR (95% CI) p value	OR (95% CI) p value
Annual income (EUR)	<26 800	ref	ref	ref	ref	ref	ref
	26 800–40 200	0.80 (0.31; 2.12) p=0.6600	0.86 (0.23; 3.29) p=0.8297	0.65 (0.27; 1.53) p=0.3240	0.96 (0.57; 1.62) p=0.8765	1.59 (0.85; 3.00) p=0.1490	1.02 (0.61; 1.70) p=0.9478
	40 201–67 000	0.92 (0.34; 2.44) p=0.8605	2.28 (0.84; 9.14) p=0.0940	1.04 (0.46; 2.34) p=0.9350	0.74 (0.40; 1.37) p=0.3410	2.32 (1.13; 14.76) p=0.0224	1.64 (0.92; 2.93) p=0.0940
	>67 000	0.45 (0.04; 3.88) p=0.4635	2.70 (0.58; 12.50) p=0.2050	0.23 (0.03; 1.88) p=0.1697	0.92 (0.33; 2.55) p=0.8779	5.47 (1.13; 26.48) p=0.0349	1.01 (0.38; 2.82) p=0.9365
Assets (EUR)	<11 800	ref	ref	ref	ref	ref	ref
	11 800–67 000	0.82 (0.27; 2.51) p=0.7268	0.62 (0.19; 2.02) p=0.4254	0.84 (0.28; 2.50) p=0.7552	0.97 (0.53; 1.76) p=0.9095	0.87 (0.43; 1.75) p=0.6960	1.08 (0.60; 1.94) p=0.8085
	>67 000	1.25 (0.51; 3.06) p=0.6319	0.48 (0.17; 1.34) p=0.1612	1.00 (0.47; 2.13) p=0.9975	1.18 (0.71; 1.94) p=0.5277	1.59 (0.85; 2.99) p=0.1468	1.14 (0.70; 1.86) p=0.5867
Charlson Comorbidity Index (CCI)	0	ref	ref	ref	ref	ref	ref
	1	2.95 (1.13; 7.71) p=0.0277	0.31 (0.04; 2.51) p=0.2693	1.05 (0.38; 2.89) p=0.9201	0.59 (0.33; 1.07) p=0.0816	1.45 (0.66; 3.21) p=0.3600	0.76 (0.42; 1.39) p=0.3770
	≥2	2.69 (0.84; 8.66) p=0.0972	1.16 (0.28; 4.83) p=0.8363	1.61 (0.68; 3.83) p=0.2792	1.08 (0.58; 2.01) p=0.8164	0.64 (0.29; 1.43) p=0.2727	0.67 (0.37; 1.21) p=0.1787
Cohabitation status	Living alone	ref	ref	ref	ref	ref	ref
	Living with partner or family	0.85 (0.30; 2.46) p=0.7703	1.20 (0.39; 3.70) p=0.7458	0.91 (0.39; 2.11) p=0.8256	0.92 (0.55; 1.52) p=0.7403	0.86 (0.48; 1.55) p=0.6111	1.50 (0.90; 2.52) p=0.1236

*Short higher education includes academic 2-year degree programmes, for example, business academies.
†Long higher education covers undergraduate and graduate programmes (university degrees).
LR, low risk; MHR, medium-high risk.

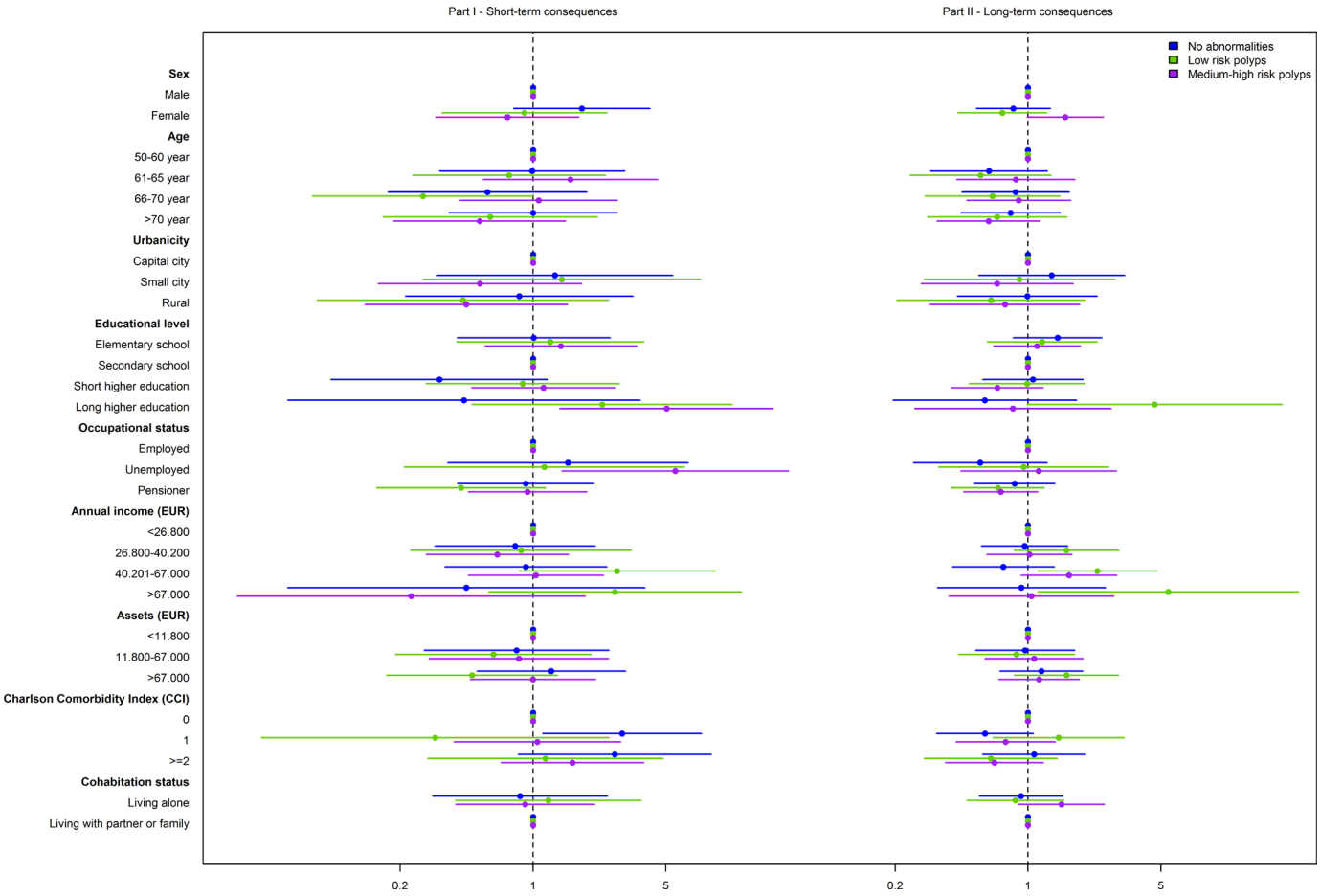

Figure 2 Forest plot of the association between sociodemographic variables and short- and long-term psychosocial consequences. Data are ORs with 95% CI.

psychosocial consequences if they had a CCI >0 (figure 2 and table 4). For participants with low-risk polyps, there were no significant associations between short-term consequences and sociodemographic variables (figure 2). For participants with medium-high-risk polyps, there was a significant association between short-term psychosocial consequences and educational and occupational status; participants had higher odds of experiencing short-term psychosocial consequences if they had a long education and were unemployed (figure 2).

Long-term psychosocial consequences

For participants with no abnormalities, there were no significant associations between long-term consequences and sociodemographic variables (figure 2). For participants with low-risk polyps, there was a significant association between long-term consequences and income; participants had higher odds of experiencing long-term consequences if they had a high income (figure 2). For participants with medium-high-risk polyps, there were no significant associations between long-term consequences and sociodemographic variables (figure 2).

Relative importance analyses

For participants with no abnormalities, comorbidity and educational level were the two most relative important variables for short- and long-term psychosocial consequences (table 5).

For participants with low-risk polyps, degree of urbanisation and income were the two most relatively important variables for short-term consequences. For long-term consequences, degree of urbanisation had a lower relative importance and education a higher relative importance (table 5).

For participants with medium-high-risk polyps, occupational and educational status had the highest relative importance for reporting short-term psychosocial consequences, while sex, income and educational status had the highest relative importance for long-term psychosocial consequences (table 5).

DISCUSSION

We tested 114 associations between the sociodemographic factors and psychosocial consequences within the three groups of false positives: no abnormalities, low-risk polyps, and medium-high-risk polyps; and five were significant. Participants with medium- to high-risk polyps had higher odds of short-term psychosocial consequences if they had a university degree compared with secondary education and more likely if they were unemployed.

Table 5 Relative importance of sociodemographic factors on psychosocial consequences. Green colour intensifies with relative importance.

	Part I—short-term consequences			Part II—long-term consequences		
	No abnormalities	LR polyps	MHR polyps	No abnormalities	LR polyps	MHR polyps
Sex	11.2%	1.0%	2.3%	4.2%	4.0%	17.4%
Age	5.7%	15.9%	12.2%	5.8%	12.7%	9.5%
Cohabitation	0.3%	0.1%	0.0%	0.6%	2.3%	6.9%
Degree of urbanisation	4.7%	27.8%	7.0%	7.6%	6.2%	2.4%
Occupational status	2.8%	5.7%	24.3%	16.9%	5.7%	6.4%
Educational status	25.6%	4.2%	26.3%	32.5%	16.3%	27.1%
Income	9.6%	29.4%	15.7%	10.7%	34.3%	16.5%
Assets	7.8%	8.0%	3.3%	1.1%	10.3%	2.1%
Comorbidity (CCI)	32.4%	7.9%	8.8%	20.6%	8.2%	11.8%

CCI, Charlson Comorbidity Index; LR, low risk; MHR, medium-high risk.

Participants with low-risk polyps were more likely to experience long-term consequences if they had higher income levels compared with lower income levels. For participants with no abnormalities, psychosocial consequences were associated with comorbidities compared with no comorbidities. This shows that there are no apparent patterns in associations. Thus, there is no strong evidence that specific groups are more likely to experience and report psychosocial consequences from false-positive results in colorectal cancer screening.

Comparison to literature

Previous studies found that women are more likely to suffer psychosocial consequences following a false-positive result in colorectal cancer screening.[3 24] We did not reproduce this finding, potentially due to the validity of the measurement of psychosocial consequences or differences among populations. Other studies on breast cancer screening found that psychosocial consequences were associated with age, education, urbanicity, occupational status, social support and ethnicity.[11–14] We also found that educational level and occupational status were associated with short-term psychosocial consequences among participants with medium-risk to high-risk polyps, but no association to urbanicity.

Strengths and limitations

An important strength of this study is the temporality, baseline measurement and longitudinal design, ensuring that it was not baseline level or individual levels of psychosocial consequences that were associated with sociodemographic variables. Furthermore, this study used a rigorously validated questionnaire to measure psychosocial consequences: the COS-CRC. The vast majority of studies measuring psychosocial consequences of colorectal cancer screening often use non-validated and generic measures, which might falsely associate variables with levels of psychosocial consequences or underestimate levels of consequences.[5] Danish registers have high validity, and therefore, there is low risk of information bias on sociodemographic variables. This study contributed to the body of evidence by providing high-quality data to examine the association between sociodemographic variables and psychosocial consequences.

However, there might be a selection bias in who participates in health research and responds to a questionnaire; therefore, we might have selected the population who are the most robust and not the most vulnerable population (healthy worker bias).[32] Qualitative research has revealed that lay people believe specific types of people are more vulnerable to psychosocial consequences and that those who experience psychosocial consequences are a 'worried type' and distance themselves from this stereotype.[33 34] This can be considered a social desirability bias or faking-good bias which describes the tendency to give answers that are in accordance with societal norms. We accounted for attrition bias with IPW, which is important in survey studies. We did include individuals with screen-detected polyps even though some researchers do not categorise these as false-positive results. Instead, we stratified analysis so that findings could be applicable to and inclusive of both definitions of false-positive results. However, a low number of people had low-risk polyps (n=374), which resulted in lower power to detect associations in this group. Multiple testing (n=114) will produce type I errors so we would expect some of the tests to be significant simply by chance. We visually presented the associations, which did neither lead to an identification of patterns in the associations. To describe the importance of sociodemographic factors on psychosocial consequences, we estimated the relative importance of the individual variables.[30]

Implications

Previous literature supports that receiving false-positive results in colorectal cancer screening, and other screening programmes, is associated with psychosocial consequences.[5 6] Qualitative research has revealed that lay

people also believe that specific groups are more vulnerable to psychosocial consequences, in Denmark coined the 'worried type'.[33 34] However, we found no evidence that sociodemographic factors could explain such a variance in who experiences psychosocial consequences. Thus, we found no support for identifying screening participants at higher risk for psychosocial consequences and developing targeted interventions to reduce psychosocial consequences from colorectal cancer screening. Structural interventions in screening, such as social support or clinical practices, might therefore be better suited.[11 35] Such could be explored and tested in future studies.[17] The costs, benefits and harms of such interventions should be weighed against the potential harm of screening in general. In this study, a high percentage of screening participants experienced psychosocial consequences.

CONCLUSION

This study found no strong evidence that sociodemographic variables are associated with psychosocial consequences from false-positive results in colorectal cancer screening.

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Patient and public involvement Patients and/or the public were involved in the design, conduct, reporting or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants. This study received prospective review and approval from the Data Protection Agency at the University of Copenhagen (514-0479/20-3000), which serves as the registered ethical approval for this research. Additionally, the Danish Patient Safety Authority granted a waiver of consent (3-3013-1753/1/), allowing us to contact screening participants and conduct the survey. Participants gave informed consent to participate in the study before taking part.

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REFERENCES

1 Øines M, Helsingen LM, Bretthauer M, *et al*. Epidemiology and risk factors of colorectal polyps. *Best Pract Res Clin Gastroenterol* 2017;31:419–24.
2 Vleugels JLA, Hazewinkel Y, Fockens P, *et al*. Natural history of diminutive and small colorectal polyps: a systematic literature review. *Gastrointest Endosc* 2017;85:1169–76.
3 Vermeer NCA, van der Valk MJM, Snijders HS, *et al*. Psychological distress and quality of life following positive fecal occult blood testing in colorectal cancer screening. *Psychooncology* 2020;29:1084–91.
4 Toft EL, Kaae SE, Malmqvist J, *et al*. Psychosocial consequences of receiving false-positive colorectal cancer screening results: a qualitative study. *Scand J Prim Health Care* 2019;37:145–54.
5 Gram EG, Á Rogvi J, Heiberg Agerbeck A, *et al*. Methodological quality of PROMs in psychosocial consequences of colorectal cancer screening: a systematic review. *Patient Relat Outcome Meas* 2023;14:31–47.
6 Malmqvist J, Siersma VD, Hestbech MS, *et al*. Short and long-term psychosocial consequences of participating in a colorectal cancer screening programme: a matched longitudinal study. *BMJ Evid Based Med* 2022;27:87–96.
7 van der Velde JL, Blanker MH, Stegmann ME, *et al*. A systematic review of the psychological impact of false-positive colorectal cancer screening: What is the role of the general practitioner? *Eur J Cancer Care* 2017;26:e12709.
8 Bond M, Pavey T, Welch K, *et al*. Systematic review of the psychological consequences of false-positive screening mammograms. *Health Technol Assess* 2013;17:1–170, .
9 Salz T, Richman AR, Brewer NT. Meta-analyses of the effect of false-positive mammograms on generic and specific psychosocial outcomes. *Psychooncology* 2010;19:1026–34.
10 Gram EG, Siersma V, Brodersen JB. Long-term psychosocial consequences of false-positive screening mammography: a cohort study with follow-up of 12-14 years in Denmark. *BMJ Open* 2023;13:e072188.
11 Bolejko A, Hagell P, Wann-Hansson C, *et al*. Prevalence, long-term development, and predictors of psychosocial consequences of false-positive mammography among women attending population-based screening. *Cancer Epidemiol Biomarkers Prev* 2015;24:1388–97.
12 Olsson P, Armelius K, Nordahl G, *et al*. Women with false positive screening mammograms: how do they cope? *J Med Screen* 1999;6:89–93.
13 Brett J, Bankhead C, Henderson B, *et al*. The psychological impact of mammographic screening. A systematic review. *Psychooncology* 2005;14:917–38.
14 Meystre-Agustoni G, Paccaud F, Jeannin A, *et al*. Anxiety in a cohort of Swiss women participating in a mammographic screening programme. *J Med Screen* 2001;8:213–9.
15 McFadden K, Nickel B, Rankin NM, *et al*. Participant factors associated with psychosocial impacts of lung cancer screening: A systematic review. *Cancer Med* 2024;13:e70054.
16 Van Breda A. A critical review of resilience theory and its relevance for social work. Social Work (Stellenbosch) 2018;54.
17 McFadden K, Rankin NM, Nickel B, *et al*. Lung cancer screening program factors that influence psychosocial outcomes: A systematic review. *Psychooncology* 2024;33:e6252.
18 STROBE Checklists, Available: https://www.strobe-statement.org/checklists/
19 Malmqvist J, Siersma V, Hestbech MS, *et al*. Psychosocial consequences of invitation to colorectal cancer screening: a matched cohort study. *J Epidemiol Community Health* 2021;75:867–73.
20 Danish Bowel Cancer Screening Database, Available: https://www.sundhed.dk/sundhedsfaglig/kvalitet/kliniske-kvalitetsdatabaser/screening/dansk-tarmkraeftscreeningsdatabase/
21 Malmqvist J, Siersma V, Bang CW, *et al*. Consequences of screening in colorectal cancer (COS-CRC): development and dimensionality of a questionnaire. *BMC Psychol* 2021;9:7.
22 Brodersen J, Thorsen H. Consequences of Screening in Breast Cancer (COS-BC): development of a questionnaire. *Scand J Prim Health Care* 2008;26:251–6.
23 Thygesen LC, Daasnes C, Thaulow I, *et al*. Introduction to Danish (nationwide) registers on health and social issues: structure, access, legislation, and archiving. *Scand J Public Health* 2011;39:12–6.
24 Brasso K, Ladelund S, Frederiksen BL, *et al*. Psychological distress following fecal occult blood test in colorectal cancer screening--a population-based study. *Scand J Gastroenterol* 2010;45:1211–6.
25 Wiggins AT, Pavlik EJ, Andrykowski MA. Demographic, clinical, dispositional, and social-environmental characteristics associated with psychological response to a false positive ovarian cancer screening test: a longitudinal study. *J Behav Med* 2018;41:277–88.

26 Njor SH, Friis-Hansen L, Andersen B, *et al*. Three years of colorectal cancer screening in Denmark. *Cancer Epidemiol* 2018;57:39–44.
27 Dufouil C, Brayne C, Clayton D. Analysis of longitudinal studies with death and drop-out: a case study. *Stat Med* 2004;23:2215–26.
28 Diggle P, *et al*. Analysis of Longitudinal Data2nd ed. Oxford, UK: Oxford University Press, 2013.
29 Fitzmaurice G, Laird N, Ware J. Applied Longitudinal Analysis2nd ed. New Jersey, United States of America: John Wiley & Sons, Inc, 2011.
30 Johnson JW, Lebreton JM. History and use of relative importance indices in organizational research. *Organ Res Methods* 2004;7:238–57.
31 Ripley BD. The R Project in Statistical Computing. *MSOR Connections* 2001;1:23–5.
32 Hestbech MS, Siersma V, Dirksen A, *et al*. Participation bias in a randomised trial of screening for lung cancer. *Lung Cancer* 2011;73:325–31.
33 Gram EG, Jønsson ABR, Brodersen JB, *et al*. Questioning 'informed choice' in medical screening: the role of neoliberal rhetoric, culture, and social context. *Healthcare (Basel)* 2023;11:1230.
34 Damhus CS, Brodersen JB, Risør MB. Luckily-I am not the worrying kind: experiences of patients in the Danish cancer patient pathway for non-specific symptoms and signs of cancer. *Health (London)* 2023;27:1059–75.
35 Gram EG, Jønsson ABR, Larsen LB, *et al*. Communicating the risk of recall in mammography screening - Enskilment in breast radiography. *Radiography (Lond)* 2025;31:139–45.