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Adverse lifestyle effects of colorectal cancer screening –

Does the utilization of selected lifestyle-related co morbidities change dependent upon a screening outcome?

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Abstract

Background: Mass-screening programs have the potential of prevent or even cure cancer. A criticism of screening however has been the risk of patient misinterpretation of the result, specifically the Health Certificate Effect. The study's aim is to examine whether a screening result could change the amount of health care services used in six different lifestyle related diseases.

Method: A sample of 100,116 patients from the NORCCAP trial was studied from 1998 to 2003. Each patient with one of the three lifestyle-related disease groups was identified and tracked over the six years. A logistic panel regression method was used to see if health care utilization in each of the lifestyle-related disease groups changed following the screening outcome. Changes in disease related health care utilization was compared to a control group.

Results: Screening results did appear to change the incidence of lifestyle related diseases, however not all of the results could be explained by a Health Certificate Effect. Participants who had a negative test result did appear to be at an increased risk for required outpatient care for complications relating to Diabetes Mellitus, COPD and Hypertension.

Conclusion: Attention must be paid to the effects of screening outcomes when evaluating a mass-screening program. This study has demonstrated that screening results can change the risk of requiring care for other lifestyle-related diseases.

Keyword: *Health care utilization, screening, panel data, adverse lifestyle effects, comorbidities*

1. Introduction

Colorectal cancer (CRC) is one of the most common cancers in the Nordic countries with a 50-74 years old incidence rate varying between 70-130 cases per 100,000 people among females and 150 cases per 100,000 among males (Hakama et. al. 2005). A number of screening methods are available to screen for CRC, which have been introduced as a means to improve the survival time either by detect of CRC at an early stage or by locating potentially cancerous adenomatous polyps before they turn malignant.

The incidence of CRC has been growing in Norway steadily in both males and females), these increases do appear to be slowing and in some cases levelling off (NORDCAN 2010). The prevalence and incidence of CRC has been largely linked to a country's affluence and trends in lifestyle (Hakama et. al. 2005). For this reason, affluence could be an explanation of increasing CRC incidence trends within the Nordic countries. Similarly, this problem can be exacerbated by inadequate screening that is not backed up by educational programs involving information on lifestyle choices in relation to disease. With criticisms of mass screening programs leading to adverse events and patient misunderstanding of the results, there is an ever-increasing need to identify areas of weakness in screening programs and remedy the persistent problems.

Since a decision to introduce screening to the population involves considerable investments, with implications for the allocations of resources not only within the specific disease area, like cancer, but within the whole health care sector. From an economics point of view, but depending on perspective, evaluating the cost-effectiveness of screening programs should include all costs and consequences (Drummond et al 2005). Traditionally, the costs included in economic evaluations of screening programs consists of important cost components, such as costs associated with the screening test and work-up tests, treatment of both the primary cancer and recurrences and surveillance. Sometimes, costs like production loss and gain and private costs are included. But this list is not any exhaustive list of cost components, for instance most likely the cost-effectiveness analyses do not include future related and non-related health care costs, which is discussed in the literature (see Garber and Phelps, Weinstein et al). If screening programs lead to adverse events, this must be included in cost-effectiveness analysis of screening. Thus, the objective of this paper is to add to the literature on future health care costs, by analysing the effect of a screening outcome on the use of treatment for lifestyle-related co morbidities.

The paper is organized as follow. In Section 2 we present the Health Certificate Effect, a framework in which the effect of a screening outcome on lifestyle-related diseases is explained. In the next Section 3, the data is presented before the empirical specification is discussed in Section 4. The results are presented in Section 5, before a Discussion and Conclusions are included in Section 6 and 7, respectively.

2. Examining the Health Certificate Effect

There have been frequent concerns expressed about what has been termed the 'Health Certificate Effect' (HCE), where results from screening studies can appear skewed, unexplainable or against the hypothesis. These unintended effects are often linked to increased costs being incurred that could be

inaccurately transferred to mass screening programs for CRC. This research paper used data from the NORCCAP trial to explore how participants perceive their health based upon their screening result and whether these results have any relation to changes in reported life-style related co morbidities. Six lifestyle-related co morbidities were selected, Diabetes Mellitus, Hypertension, Chronic Obstructive Pulmonary Disease, Angina Pectoris, Acute Myocardial Infarction, and Ischemic Heart Disease, based upon their risk factors demonstrating a strong correlation to lifestyle patterns such as smoking, dietary habits, alcohol consumption and physical activity.

The HCE is a concept that is concerned with the interpretation of a health result by an individual and is identified as a major obstacle within screening programs (Robinson et. al. 1999, Thiis-Evensen et. al. 2006). The primary concern lies within the belief that a negative screening (no illness detected), could be wrongly interpreted as meaning that the individual is 'healthy'. Further, the screening result could be interpreted as meaning a 'clean bill of health' which can reinforce the belief that perceived risky health behaviours such as smoking or the intake of unhealthy foods could 'justifiably' continue (Tymstra & Bieleman 1987). Therefore, as opposed to the patient understanding that they are free of the disease that they were screened for; the patient may now continue their risky health behaviour and view the negative screening result as a medical justification to continue doing so. While there is an emphasis on the need to screen for preventable or manageable disease, the practice of mass screening risks presenting unintended consequences such as the HCE which can severely hinder the effectiveness of the mass screening program.

If a HCE were present, a marked change in the incidence of the six lifestyle-related diseases should occur following the moment that the screening result is made available.

If a Health Certificate Effect were present, the method used in this study should be able to accurately demonstrate whether or not adverse effects of screening could be explained by the results. An illustration of the potential hypothetical result is given below in Figure 7. Figure 7 demonstrates the purpose of the statistical model. Given the incidence path of disease *X*, it would be expected that the control would be a constant rate for the given disease since they would not be affected by a screening result 'shock'. Those who were screened, should an adverse screening effect be present, would be expected to have a change in incidence of disease differing from the constant. The intervention may either 'shock' the individual into adopting a negative or positive lifestyle change. A positive lifestyle change following the screening intervention would be expected to lead to a decrease in incidence illustrated by the royal blue (3) arrow. A negative lifestyle change, would be associated with an increase in the incidence of disease *X* at a higher rate than that of the constant as illustrated by the yellow (1) arrow.

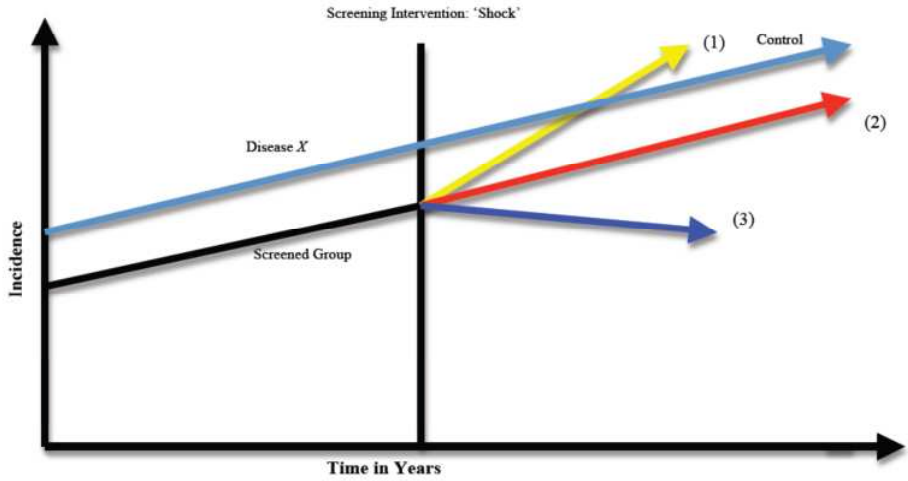

Figure 1: An illustration of the HCE of utilization of health care, measured by incidenses of treatment

In the context of this study, it would be predicted that those within the Negative Findings and Non-Attendee groups would be at risk of being affected by the Health Certificate Effect as illustrated by the yellow arrow (1). This would mean that the invitees who had a Negative Finding or Non-Attendee would deem themselves as being healthy, but could in fact be suffering from another medical condition; this could be known or unknown to the participant.

Examining whether a HCE may be present in especially important when the costs of undertaking a mass screening are being evaluated, particularly in regards to the holistic nature of a national health system. While a high degree of emphasis is placed upon the cost of the screening test, there is further cost examination of how the total costs of the mass screening program compare to that of treating patients with CRC. All associated costs must therefore be known; this may include the financial costs but also the potential outcomes, including all adverse outcomes of the program (Drummond et. al 2005). It is known that a large share of medical costs are incurred in the final months of a patient's life, it is therefore important to use screening as a tool to reduce these potential costs of end-of-life care (Howard et. al. 2009).

3. Data

Data for use in this project was collected in conjunction with NPR data of patients within the NORCCAP trial consisting of both controls and invitees. Further patient information was also provided by the Norwegian Cancer Registry and SSB. This data encompassed 8 years of information between the years of 1998 and 2003. The various data sources were then combined and identified using assigned patient numbers. This data included information concerning patient CRC screening outcomes, socioeconomic status, education, year of admission to hospital, ICD 9 and 10 coding, hospital code, county location of screening, civil status, age, birth country, and type of care received (inpatient or outpatient).

Patients were then identified using ICD-9 and ICD-10 code grouping on the basis of disease selected for study that were identified as being associated with patient lifestyle. The data set was narrowed to 6 disease groups that were selected based upon their ICD-9 or 10 coding (see Appendix 1 for details), these diseases included Diabetes Mellitus, COPD, Hypertension, Angina Pectoris, Acute Myocardial Infarction and Ischemic Heart Disease. A patient had to have either a main diagnosis and/or a maximum of seven secondary diagnoses of within the selected ICD-9 or 10 codes to remain in the data sample. For example, a patient may have a main diagnosis of Diabetes Mellitus, and only a third secondary diagnosis with a relevant ICD-9 or 10 codes. Should a patient have multiple diagnoses of the same coding within the same year, it was only recorded once for that year. However, having a COPD coding for example, in one year would be recorded again and counted again if it appeared following the initial diagnosis in the following year. All patients who did not fulfill the ICD-9 or 10 disease coding requirements were removed from the sample.

The definition of the other variables included in the analysis are presented in Table1, while the discriptive statistics are presented in Appendix 2. The percentages are listed in proportion to the total sample in the outpatient and inpatient groups. With regards to the disease proportions, there were differences within the two treatment care categories; it was for this reason that a separation of inpatient and outpatient groups was made. While there is evidence of patients requiring care within both the inpatient and outpatient setting, the majority of treatments for Diabetes Mellitus and COPD were handled in the outpatient setting. This separation is important to maintain should further work study a cost component of screening outcomes.

Variable	Description	Observation Year
Age 1999	*The age of the patient corresponding to their age in 1999.*	*1999*
Age Squared	*The age in 1999 variable was squared in order to determine the steepness of the change in age and the shape of the curve*	
Inssb	*The assigned patient number identifier; it does not correspond to their real national number*	
Income	*Patient income is listed in both a figure in Norwegian Kroner (NOK) and divided into groupings from (1) 0 – 99 999, (2) 100 000 – 199 999, (3) 200 000 – 299 999, (4) 300 000 – 399 999, (5) 400 000 – 599 000, and (6) 600 000 +*	*1999*
Education	*The level of education attained at 1999, divided by low <10 years, intermediate < 14 years, and high > years.*	*1999*
Birth Country	*Patients were recorded as either being born in Norway or being born abroad*	*1999*
County	*There were two principle counties in the study of either Oslo or Telemark, however a third 'Other' group was established for those residing in a different county.*	
Intention to Treat	*This group was divided into controls and those invited to the screening*	*1999,2000,2001*
Findings Group	*This group includes controls, attendance to screening with a positive test for CRC, a positive test for adenomatous polyps or a negative test, those who did not attend, those with returned mail or died, and those who were excluded due to the exclusion criteria of the NORCCAP study.*	*1999,2000,2001*
Civil Status	*This group was divided into single, married, common-law, widow, separated and divorced*	*1999*
Gender	*Male or Female.*	
Year	*The time dimension within the statistical model*	*1998-2003*

4. Empirical specification

The dataset was prepared for statistical analysis using a method called Logistic Panel Regression which allows changes within the six disease groups to be studied over time. The dataset is perfectly balanced, as each patient was observed over all six years the data were provided (1998-2003). Thevariables finding group, civil status, education, income, and disease diagnosis by year were defined into binary outcomes. It was assumed throughout the analysis that zero was to represent 'not present' and one was

to represent 'present'. This statistical analysis was used because of its ability to easily measure the probability of changes over time in a variety of independent variables on the given dependent variable of Disease Group. The goal of this study was to measure utilization of health care services following a screening program. Let y_{it} be the likelihood that an individual are being observed at an outpatient clinic or at an inpatient stay at time t be given by

$$y_{it} = \alpha x_i + \delta_p p_i + \mu S_{it,} + \varphi p_i S_{it} + v_i + \varepsilon_{it} \quad (1)$$

$where, i = 1,.....n, t = 1998,.....2003,$ x_i is the time independant individual characterstics, $p-$ participation status and S is whether or not the individual has been invited to screening S=$(0,1)$. S=0 if ether the individual is not participating in the screening or for the years before the individual was participating in the screening. S=1 from the time the individual was participating in the screening. The parameters α, δ, μ *and* φ are to be estimated within the model. v_i is the random effect term and ε_{it} the stochastic error term.

A new variable was created in order to measure the time dimension of disease between years within the same patient dependent upon being screened or not screened. This new variable was labeled as "interaction" and corresponded to the seven possible screening findings outcomes divided by those who had their screenings in 1999, 2000 and 2001 ($\varphi p_i S_{it}$). The 'interaction' variable was calculated by multiplying the 'findings group' variable by the patients who had a screening. The interaction variable was created as a means to demonstrate whether the screening result would result in a change in disease incidence for the given disease groups dependent upon the finding outcomes.

The factor ρ is an additional panel-level variance component which explains the total proportion of the total variance contributed to by the panel-level variance (σ_v squared). When ρ = 0, the panel-level data component is not important and the panel estimator is the same as the pooled estimator.

$$\rho = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_\varepsilon^2} \quad (2)$$

The measures the goodness of fit or the predictability of *y* within the model, where R^2 represents the deviance within the random effect panel regression model. The fitting of the model is found using the log likelihood from the output of the constant represented by $\log_e L_1$ is compared to $\log_e L_1$ the measures of the full model (Fox 1997).

$$R^2 = 1 - \frac{G_1^2}{G_0^2} = 1 - \frac{\log_e L_1}{\log_e L_0} \quad (3)$$

The variable 'Year' in the dataset corresponds to the time dimension within the Logit Regression Model. Regressions were run assuming normal distribution and the separation of outpatient and inpatient data was maintained.

There were two regressions run for each disease group in each inpatient group and outpatient group. There were a total of four regressions done for each of the six lifestyle-related disease groups. The intention to treat group did not have an analysis using the interaction variable because the intention to treat variable was already accounted for in the interaction variable groups. The Coefficients are written in normal text and the Standard Errors are written in parenthesis in each of the tables. A calculation to determine the log likelihood of each regression result given by formula (3) in the Methods section will be written in the description of each disease group result as well as the 'rho' from formula (2) given by ρ.

5. Results

In all six of the regressions, ρ is greater than zero therefore the variance between the panel levels is important; this was true for each of the six disease groups.

Diabetes Mellitus (DM)

In regards to group findings, those in the Non-Attendee group show a significantly higher risk of being treated for DM than the control group within the inpatient treatment side at the 1% level. Those who are in the invited group with a negative screening result, show a decreased risk of being treated for DM at the 10% significance level in the inpatient sample group when compared to controls. The lone significant result in the outpatient group was those who occupied the returned mail or died group, which demonstrated a decreased risk of DM than controls; this group was a small sample.

In the interaction category of the results, those who attended screening and had a positive or negative result showed 10% significance on the inpatient side; both results showed a decrease in incidence when compared to the control group. The non-attendee group demonstrated an increased risk of incidence with significance at the 10% level. The outpatient side showed highly significant results for increases in incidence for those who received a negative result and those who failed to attend the screening at the 1% level.

The risk of incidence of being treated for DM increases with each passing year within the study sample, and this holds significant at the 1% level in both inpatient and outpatient categories. Similarly, this same trend applies to one's increasing age, however the significance levels are different between inpatient at 10% significance and outpatient at 1%. The difference is partly due to the majority of treatment associated with DM being undertaken at the outpatient level.

Diabetes Mellitus		Inpatient		Outpatient	
Variable	**Category**	**Findings Group**	**Intention to Treat**	**Findings Group**	**Intention to Treat**
Age	Age in 1999	0.393 (.206) *	0.382 (.206) *	0.679 (.237) ***	0.633 (.234) ***
	Age Squared	-0.003 (002)	-0.003 (.002)	-0.006 (.002) ***	-0.005 (.002) ***
Year	Time Measure	0.127 (.013) ***	0.127 (.013) ***	0.245 (.012) ***	0.237 (.012) ***
Education	Low <10 yrs.		*Reference*		
	Intermediate <14 yrs.	-0.335 (.076) ***	-0.349 (.076) ***	-0.193 (.092) **	-0.194 (.091) **
	High > 14 yrs.	-1.062 (.108) ***	-1.079 (.108) ***	-0.450 (.115) ***	-0.454 (.114) ***
Income	0 - 99,999		*Reference*		
	100,000 - 199,999	0.132 (.099)	0.126 (.098)	-0.149 (.118)	-0.141 (.117)
	200,000 - 299,999	-0.701 (.108) ***	-0.723 (.108) ***	-0.588 (.123) ***	-0.582 (.122) ***
	300,000 - 399,999	-0.945 (.140) ***	-0.973 (.140) ***	-0.887 (.156) ***	-0.883 (.155) ***
	400,000 - 599,999	-1.165 (.175)***	-1.193 (.175) ***	-0.980 (.184) ***	-0.973 (.182) ***
	600,000+	-1.002 (.208) ***	-1.028 (.208) ***	-0.814 (.211) ***	-0.807 (.210) ***
Civil Status	Single		*Reference*		
	Married	-0.192 (.106) *	-0.214 (.106) **	-0.040 (.123)	-0.041 (.122)
	Cohabitation	0.573 (.176) ***	0.554 (.176) ***	0.540 (.213) **	0.538 (.211) **
	Widowed	-0.147 (.120)	-0.159 (.120)	-0.165 (.141)	-0.170 (.140)
	Separated	-0.246 (.200)	-0.259 (.200)	0.067 (.220)	0.062 (.218)
	Divorced	-1.452 (1.254)	-1.476 (1.257)	-1.001 (1.237)	-1.001 (1.228)
Birth Country	Norway		*Reference*		
	Other	0.786 (.093) ***	0.799 (.093) ***	0.967 (.108) ***	0.966 (.106) ***
Gender	Male		Reference		
	Female	-1.115 (.075) ***	-1.128 (.075) ***	-1.020 (.086) ***	-1.018 (.085) ***
County	Oslo		*Reference*		
	Telemark	-0.077 (.083)	-0.093 (.082)	-0.097 (.094)	-0.095 (.093)
	Other	-1.197 (.547) **	-1.199 (.549) **	-2.457 (1.291) *	-2.428 (1.266) *
Groups: Findings	Control		*Reference*		
	Attended - CRC	0.958 (1.334)		0.153 (1.785)	
	Attended - Positive	-0.195 (.244)		-0.130 (.263)	
	Attended - Negative	-0.230 (.126) *		-0.117 (.133)	
	Non-Attendee	0.330 (.119) ***		-0.008 (.146)	
	Returned Mail or Died	-0.255 (.507)		-1.477 (.831) *	
	Excluded	1.635 (.357) ***		0.572 (.514)	
Intention to Treat	Control		*Reference*		
	Invited		0.079 (.084)		0.026 (.095)
Interaction: Time	Control		*Reference*		
	Attended - CRC	-20.201 (31598.79)		-20.386 (154458.2)	
	Attended - Positive	-1.111 (.636) *		0.173 (.440)	
	Attended - Negative	-0.420 (.241) *		0.825 (.192) ***	
	Non-Attendee	0.294 (.170) *		1.047 (.197) ***	
	Returned Mail or Died	0.134 (.843)		0.461 (1.250)	
	Excluded	0.845 (.426) **		-0.295 (1.297)	
R^2 = Log Likelihood		0.133	0.134	0.310	0.310
ρ = rho		0.733	0.735	0.891	0.888

*** significant at a 1% level, ** significant at a 5% level, * significant at a 10% level

Hypertension

The group findings showed that those in the inpatient wing who attended the screening with a negative test were less likely than controls to be treated for complications related to Hypertension than controls; this was at the highest significance level. When the interaction variable was added, results for those who attended the screening in the inpatient wing were all significant. Those who had a CRC result were at an increased risk than controls to have Hypertension complications, while those with positive or negative tests where shown to have a decreased risk of Hypertension complications. On the outpatient side, only those with a negative result at screening showed a decreased risk when compared to controls.

The risk of being treated for complications associated with Hypertension increases with age and the risk increases as years in the trial progress. Similar trends are observed for patients in both the inpatient and outpatient groups suggesting that various complications can be treated in both types of care within this disease group.

Chronic Obstructive Pulmonary Disease (COPD)

In the findings group variable those who attended the screening with a negative result were significant on both treatment sides with a reduced risk of COPD than the control group. The invitees who did not attend were at increased risk of COPD on the inpatient side. The excluded group was highly significant on the inpatient and outpatient side within the findings group; this variable will be explained in further detail within the discussion.

Age did not appear to have any significance on the inpatient side; however it was significant at the 5% level on the outpatient side. The year variable was significant at the highest level and increased the risk of COPD with each passing trial year at both patient levels.

Hypertension

Variable	Category	Inpatient		Outpatient	
		Findings Group	Intention to Treat	Findings Group	Intention to Treat
Age	Age in 1999	0.325 (.117) ***	0.328 (.117) ***	0.610(.138) ***	0.594 (.138) ***
	Age Squared	-0.002 (.001) **	-0.002 (.001) **	-0.005 (.001) ***	-0.005 (.001) ***
Year	Time Measure	0.173 (.009) ***	0.175 (.009) ***	0.181 (.010) ***	0.178 (.010) ***
Education	Low <10 yrs.	*Reference*			
	Intermediate <14 yrs.	-0.186 (.045) ***	-0.191 (.045) ***	0.065 (.057)	0.069 (.057)
	High > 14 yrs.	-0.553 (.059) ***	-0.560 (.059) ***	-0.049 (.068)	-0.044 (.068)
Income	0 – 99,999	*Reference*			
	100,000 – 199,999	0.195 (.061) ***	0.196 (.061) ***	0.227 (.081) ***	0.236 (.081) ***
	200,000 – 299,999	-0.081 (.064)	-0.085 (.063)	0.315 (.080) ***	0.326 (.080) ***
	300,000 – 399,999	-0.180 (.079) **	-0.186 (.078) **	0.266 (.095) ***	0.277 (.095) ***
	400,000 – 599,999	-0.365 (.095) ***	-0.371 (.095) ***	0.288 (.107) ***	0.300 (.107) ***
	600,000+	-0.326 (.113) ***	-0.334 (.113) ***	0.450 (.121) ***	0.461 (.121) ***
Civil Status	Single	*Reference*			
	Married	0.113 (.064) *	0.109 (.064) *	0.118 (.074)	0.123 (.074) *
	Cohabitation	0.208 (.109) *	0.200 (.109) *	0.278 (.129) **	0.276 (.129) **
	Widowed	0.053 (.072)	0.049 (.072)	-0.093 (.085)	-0.095 (.085)
	Separated	0.117 (.114)	0.112 (.114)	0.149 (.131)	0.147 (.131)
	Divorced	0.452 (.418)	0.450 (.418)	0.125 (.506)	0.131 (.506)
Birth Country	Norway	*Reference*			
	Other	-0.117 (.063) *	-0.120 (.063) *	-0.218 (.077) ***	-0.227 (0.077) ***
Gender	Male	*Reference*			
	Female	-0.543 (.042) ***	-0.551 (.041) ***	-0.403 (.049) ***	-0.398 (.049) ***
County	Oslo	*Reference*			
	Telemark	0.114 (.046) **	0.112 (.045) **	-0.010 (.055)	0.0002 (0.055)
	Other	-0.480 (.270) *	-0.480 (.270) *	-0.334 (.280)	-0.348 (.281)
Groups: Findings	Control	*Reference*			
	Attended – CRC	-0.026 (.885)		-0.544 (1.253)	
	Attended – Positive	0.160 (.120)		-0.013 (.149)	
	Attended – Negative	-0.162 (.068) ***		-0.007 (.073)	
	Non-Attendee	-0.020 (.075)		-0.122 (.094)	
	Returned Mail or Died	-0.452 (.373)		-1.209(.622) *	
	Excluded	0.856 (.215) ***		0.652 (.285) **	
Intention to Treat	Control		*Reference*		
	Invited		-0.067 (.048)		-0.003 (0.057)
Interaction: Time	Control	*Reference*			
	Attended - CRC	2.599 (1.032) **		-21.994 (170068.6)	
	Attended - Positive	-0.700 (.325) **		0.158 (.364)	
	Attended - Negative	-0.621 (.173) ***		0.430 (.151) ***	
	Non-Attendee	0.081 (.148)		0.305 (.203)	
	Returned Mail or Died	0.609 (.684)		-20.751 (50457.12)	
	Excluded	1.103 (.307) ***		0.818 (.617)	
R^2 – Log Likelihood		0.040	0.040	0.070	0.070
ρ = rho		0.515	0.516	0.610	0.611

*** significant at a 1% level, ** significant at a 5% level, * significant at a 10% level

COPD		Inpatient		Outpatient	
Variable	Category	Findings Group	Intention to Treat	Findings Group	Intention to Treat
Age	Age in 1999	0.221 (.243)	0.225 (.244)	0.554 (.242)**	0.542 (.240) **
	Age Squared	-0.001 (.002)	-0.001 (.002)	-0.004 (.002) *	-0.004 (.002) *
Year	Time Measure	0.167 (.015) ***	0.165 (.015) ***	0.247 (.014) ***	0.244 (.014) ***
Education	Low <10 yrs.	*Reference*			
	Intermediate <14 yrs.	-0.687 (.085) ***	-0.705 (.085) ***	-0.462 (.086) ***	-0.466 (.085) ***
	High > 14 yrs.	-1.743 (.145) ***	-1.772 (.146) ***	-1.658 (.141) ***	-1.667 (.140) ***
Income	0 - 99,999	*Reference*			
	100,000 - 199,999	0.320 (.109) ***	0.313 (.109) ***	0.437 (.120) ***	0.441 (.119) ***
	200,000 - 299,999	-0.830 (.125) ***	-0.860 (.125) ***	-0.037 (.126)	-0.044 (.125)
	300,000 - 399,999	-1.110 (.175) ***	-1.145 (.176) ***	-0.220 (.163)	-0.232 (.162)
	400,000 - 599,999	-1.182 (.226) ***	-1.214 (.227) ***	-0.396 (.207) *	-0.397 (.205) *
	600,000+	-2.366 (.405) ***	-2.415 (.408) ***	-1.049 (.308) ***	-1.050 (.305) ***
Civil Status	Single	*Reference*			
	Married	-0.349 (.130) ***	-0.380 (.131) ***	0.035 (.134)	0.023 (.132)
	Cohabitation	0.581 (.198) ***	0.551 (.199) ***	0.572 (.210) ***	0.547 (.208) ***
	Widowed	0.585 (.137) ***	0.569 (.137) ***	0.711 (.142) ***	0.698 (.141) ***
	Separated	0.340 (.219)	0.322 (.219)	0.417 (.225) *	0.410 (.223) *
	Divorced	0.434 (.987)	0.417 (.994)	0.600 (.898)	0.591 (.895)
Birth Country	Norway	*Reference*			
	Other	-0.633 (.139) ***	-0.631 (.139) ***	-0.372 (.132) ***	-0.372 (.131) ***
Gender	Male	*Reference*			
	Female	-0.452 (.084) ***	-0.470 (.084) ***	-0.380 (.083) ***	-0.386 (.082) ***
County	Oslo	*Reference*			
	Telemark	0.231 (.092) **	0.226 (.092) **	-0.188 (.095) **	-0.185 (.094) **
	Other	-0.650 (.567)	-0.639 (.570)	-2.193 (.857) ***	-2.175 (.850) **
Groups: Findings	Control	*Reference*			
	Attended - CRC	-19.397 (11642.7)		-22.866 (38638.53)	
	Attended - Positive	-0.224 (.276)		-0.282 (.273)	
	Attended - Negative	-0.334 (.144) **		-0.408 (.143) ***	
	Non-Attendee	0.346 (.135) ***		0.044 (.144)	
	Returned Mail or Died	-0.707 (.694)		-1.708 (1.003)	
	Excluded	2.838 (.334) ***		2.488 (.430) ***	
Intention to Treat	Control	*Reference*			
	Invited		0.138 (.096)		-0.109 (.098)
Interaction: Time	Control	*Reference*			
	Attended - CRC	22.185 (11642.7)		0.431 (.136)	
	Attended - Positive	0.517 (.422)		0.570 (.519)	
	Attended - Negative	0.158 (.228)		0.173 (.284)	
	Non-Attendee	0.116 (.205)		-0.111 (.295)	
	Returned Mail or Died	1.583 (.844) *		1.975 (1.394)	
	Excluded	-0.524 (.453)		0.219 (.624)	
R^2 = Log Likelihood		0.160	0.160	0.195	0.197
ρ = rho		0.755	0.760	0.809	0.805

*** significant at a 1% level, ** significant at a 5% level, * significant at a 10% level

Angina Pectoris (AP)

Those who were invited for screening appeared to have a decreased risk of requiring treatment for AP, this was only observed on the outpatient side and was at the lowest significance level; this observation did not occur in the inpatient group. There were no significant results on the inpatient side within the findings group and only those with a negative screening result and those who did not attend screening had significant results at the 10% level that resulted in a decrease on the outpatient side. When the interaction variable was included, only the excluded group had significant results at the 5% level in both treatment cases resulting in an increase in treatment for AP.

The age variable was only significant at the 10% level in the outpatient group, which resulted in an increase in the treatment for AP. The year variable was highly significant, but only on the outpatient side. Risks of AP appeared to only increase on the outpatient side but not the inpatient side; this may suggest that treatment is largely handled by outpatient care.

Acute Myocardial Infarction (AMI)

With respect to the findings group, those who attended the screening with a negative result were significant on both the inpatient and outpatient side resulting in a decrease in AMI risk. Those who were non-attendees had a lower risk of AMI on the outpatient side with significance at the 10% level. Those who were invited to screening (ITT) had a lower risk of AMI at the 5% level than controls; however the number of people in this group is small. When the interaction variable was included, the only significant groups were those who attended the screening with a positive test and those with a negative, their risk were both decreases on the inpatient side only.

The risk in suffering from an AMI is significant and increases with age in both inpatient and outpatient categories at the 5% and 10% level. In regards to the year variable, as the study progresses the risk of being treated for AMI decreases in the inpatient group, but increases in the outpatient group. This could be explained by the much lower sample group within the outpatient group compared to the inpatient; although the number of patients suffering from an AMI is low when compared to the other lifestyle-related diseases in this study.

Angina Pectoris		Inpatient		Outpatient	
Variable	Category	Findings Group	Intention to Treat	Findings Group	Intention to Treat
Age	Age in 1999	0.082 (.167)	0.082 (.167)	0.327 (.180) *	0.315 (.180) *
	Age Squared	0.0001 (.001)	0.0001 (.002)	-0.002 (.002)	-0.002 (.002)
Year	Time Measure	-0.014 (.012)	-0.015 (.012)	0.106 (.014) ***	0.104 (.014) ***
Education	Low <10 yrs.	*Reference*			
	Intermediate <14 yrs.	-0.343 (.063) ***	-0.348 (.063) ***	-0.171 (.069) **	-0.173 (.069) **
	High > 14 yrs.	-0.854 (.086) ***	-0.858 (.086) ***	-0.533 (.091) ***	-0.531 (.091) ***
Income	0 - 99,999	*Reference*			
	100,000 - 199,999	0.334 (.090) ***	0.339 (.090) ***	0.391 (.099) ***	0.385 (.099) ***
	200,000 - 299,999	-0.111 (.094)	-0.114 (.094)	0.103 (.103)	0.095 (.102)
	300,000 - 399,999	-0.470 (.117) ***	-0.476 (.116) ***	-0.073 (.124)	-0.084 (.123)
	400,000 - 599,999	-0.579 (.137) ***	-0.584 (.137) ***	-0.377 (.151) **	-0.386 (.151) ***
	600,000+	-0.545 (.162) ***	-0.548 (.161) ***	-0.420 (.182) **	-0.427 (.181) **
Civil Status	Single	*Reference*			
	Married	0.583 (.102) ***	0.582 (.102) ***	0.459 (.109) ***	0.461 (.109) ***
	Cohabitation	1.003 (.162) ***	0.991 (.162) ***	0.406 (.187) **	0.397 (.187) **
	Widowed	0.573 (.112) ***	0.568 (.112) ***	0.495 (.119) ***	0.495 (.119) ***
	Separated	0.950 (.157) ***	0.945 (.157) ***	0.623 (.173) ***	0.628 (.173) ***
	Divorced	0.633 (.633)	0.634 (.634)	0.802 (.626)	0.804 (.626)
Birth Country	Norway	*Reference*			
	Other	0.267 (.082) ***	0.264 (.082) ***	0.212 (.090) **	0.207 (.090) **
Gender	Male	*Reference*			
	Female	-1.529 (.065) ***	-1.531 (.065) ***	-1.068 (.067) ***	-1.071 (.067) ***
County	Oslo	*Reference*			
	Telemark	0.139 (.065) **	0.143 (.065) **	0.513 (.068) ***	0.513 (.067) ***
	Other	-0.614 (.387)	-0.613 (.388)	-0.150 (.373)	-0.145 (.373)
Groups: Findings	Control	*Reference*			
	Attended - CRC	-17.559 (4624.384)		-28.280 (1170670)	
	Attended - Positive	-0.099 (.184)		-0.248 (.193)	
	Attended - Negative	-0.058 (.096)		-0.191 (.101) *	
	Non-Attendee	-0.003 (.106)		-0.222 (.118) *	
	Returned Mail or Died	-0.623 (.501)		0.169 (.440)	
	Excluded	1.605 (.270) ***		1.090 (.287) ***	
Intention to Treat	Control	*Reference*			
	Invited		0.020 (.068)		-0.125 (.073) *
Interaction: Time	Control	*Reference*			
	Attended - CRC	-0.011 (11323.17)		0.185 (.400)	
	Attended - Positive	-0.288 (.355)		0.460 (.429)	
	Attended - Negative	-0.098 (.167)		0.198 (.229)	
	Non-Attendee	0.254 (.167)		0.240 (.272)	
	Returned Mail or Died	-0.711 (1.136)		-28.245 (1169321)	
	Excluded	0.708 (.348) **		1.116 (.529) **	
R^2 = Log Likelihood		0.089	0.090	0.053	0.054
ρ = rho		0.649	0.651	0.589	0.590

*** significant at a 1% level, ** significant at a 5% level, * significant at a 10% level

Acute Myocardial Infarction		Inpatient		Outpatient	
Variable	Category	Findings Group	Intention to Treat	Findings Group	Intention to Treat
Age	Age in 1999	0.283 (.168) *	0.278 (.167) *	0.993 (.445) **	1.000 (.445) **
	Age Squared	-0.002 (.002)	-0.002 (.002)	-0.008 (.004) **	-0.008 (.004) **
Year	Time Measure	-0.039 (.016) **	-0.037 (.016) **	0.068 (.039) *	0.069 (.039) *
Education	Low <10 yrs.		*Reference*		
	Intermediate <14 yrs.	-0.256 (.062) ***	-0.264 (.062) ***	-0.034 (.169)	-0.030 (.169)
	High > 14 yrs.	-0.738 (.087) ***	-0.749 (.087) ***	-0.493 (.216) **	-0.488 (.216) **
Income	0 - 99,999		*Reference*		
	100,000 - 199,999	0.001 (.091)	0.002 (.091)	-0.208 (.246)	-0.190 (.246)
	200,000 - 299,999	-0.096 (.093)	-0.106 (.092)	-0.134 (.240)	-0.114 (.240)
	300,000 - 399,999	-0.290 (.113) ***	-0.303 (.112) ***	-0.368 (.290)	-0.348 (.290)
	400,000 - 599,999	-0.308 (.130) **	-0.317 (.130) **	-0.117 (.311)	-0.096 (.311)
	600,000+	-0.576 (.170) ***	-0.588 (.170) ***	0.287 (.329)	0.302 (.329)
Civil Status	Single		*Reference*		
	Married	0.240 (.097) **	0.230 (.097) **	0.305 (.253)	0.312 (.253)
	Cohabitation	0.654 (.159) ***	0.641 (.159) ***	0.594 (.432)	0.588 (.432)
	Widowed	0.364 (.106) ***	0.358 (.106) ***	0.405 (.277)	0.399 (.276)
	Separated	0.399 (.158) **	0.394 (.158) **	0.234 (.436)	0.231 (.436)
	Divorced	-0.690 (1.012)	-0.696 (1.012)	-19.889 (33659.08)	-22.041 (99192.8)
Birth Country	Norway		*Reference*		
	Other	-0.010 (.087)	-0.009 (.086)	0.214 (.208)	0.200 (.208)
Gender	Male		*Reference*		
	Female	-1.394 (.068) ***	-1.401 (.068) ***	-1.492 (.181) ***	-1.489 (.180) ***
County	Oslo		*Reference*		
	Telemark	0.306 (.063) ***	0.302 (.063) ***	-0.007 (.173)	0.011 (.172)
	Other	-0.001 (.325)	0.001 (.325)	0.206 (.744)	0.206 (.744)
Groups: Findings	Control		*Reference*		
	Attended - CRC	0.422 (1.034)		-20.392 (74389.88)	
	Attended - Positive	0.001 (.174)		-0.154 (.449)	
	Attended - Negative	-0.167 (.101) *		-0.586 (.292) **	
	Non-Attendee	0.078 (.103)		-0.638 (.341) *	
	Returned Mail or Died	-0.182 (.460)		-20.536 (26206.11)	
	Excluded	1.082 (.242) ***		1.003 (.637)	
Intention to Treat	Control		*Reference*		
	Invited		-0.046 (.067)		-0.502 (.197) **
Interaction: Time	Control		*Reference*		
	Attended - CRC	-18.725 (25435.11)		-0.011 (.276)	
	Attended - Positive	-2.048 (1.015) **		-20.039 (30558.27)	
	Attended - Negative	-0.504 (.275) *		0.698 (.644)	
	Non-Attendee	0.074 (.223)		-19.407 (16094.16)	
	Returned Mail or Died	-18.195 (8740.974)		0.006 (81873.9)	
	Excluded	0.203 (.510)		-21.139 (74786.77)	
R^2 = Log Likelihood		0.001	0.001	0.009	0.009
ρ = rho		0.228	0.232	0.524	0.526

*** significant at a 1% level, ** significant at a 5% level, * significant at a 10% level

Ischemic Heart Disease (IHD)

The findings group had only one significant result at the 10% level for those who had a negative screening test on the inpatient side with a reduced risk of IHD complications. A similar result was observed for the interaction variable, with only the negative screening test sample showing any significance at a 10% level with their risk of IHD complications reduced when compared to the control group.

Increases in the sample's age, as well as in the progression of the study's years resulted in an increased risk of IHD in both the inpatient and outpatient group at the 1% significance level; however the age variable in the outpatient side was only significant at the 10% level.

6. Discussion

The aim of this study was to explore the behaviours of the Norwegian population towards a mass screening program for CRC and whether the outcomes have an effect on the lifestyle related diseases of Diabetes Mellitus, Hypertension, Chronic Obstructive Pulmonary Disease, Angina Pectoris, Acute Myocardial Infarction and Ischemic Heart Disease. The results indicated that when looking at the Findings Group and Interaction Group, the group that was most expected to experience the Heath Certificate Effect, the Negative Findings group, did have significant results. It was predicted at the start of the study that the Negative Findings group would be the group at most risk for increases in the six disease groups due to a HCE, however this group experienced a general decrease in incidence when compared to the control group. The described decrease occurred in all the disease groups with exception to Angina Pectoris. There was also significance found in the Non-Attendee group that resulted in an increased risk for Diabetes Mellitus, Hypertension and COPD, while there was a decreased risk in Acute Myocardial Infarction, Angina Pectoris and Ischemic Heart Disease.

Although the significant results did not always occur in the expected group, the Findings Group results may still exhibit a Health Certificate Effect. The Non-Attendee members in the sample show an increased risk in two diseases that are highly correlated to lifestyle factors and this demonstrates that this group is a health risk group. The Negative Findings group did show an increased risk of Hypertension on the outpatient side when the Interaction variable was included as well as for Diabetes Mellitus on the Outpatient side; these results were both at the highest significance level. One could expect that when tracking the risk of giving a screening, the Negative Results group and the Non-Attendee do present increased risk when the screening interaction with time is added for Diabetes Mellitus and Hypertension. If the time following the screening were increased, the trend could be better followed; there was only a 1 to 3-year follow-up from the screening 'shock'.

There is another possibility that the Negative Findings group should not be the group of concern. These results may actually show that those in the Negative Findings group may in fact be the healthiest. It could quite possibly be that the Non-Attendee group should be the group requiring the most attention.

Ischemic Heart Disease		Inpatient		Outpatient	
Variable	Category	Findings Group	Intention to Treat	Findings Group	Intention to Treat
Age	Age in 1999	0.533 (.183) ***	0.530 (.183) ***	0.346 (.193) *	0.337 (.193) *
	Age Squared	-0.004 (.002) **	-0.004 (.002) **	-0.002 (.002)	-0.002 (.002)
Year	Time Measure	0.048 (.011) ***	0.048 (.011) ***	0.205 (.012) ***	0.204 (.012) ***
Education	Low <10 yrs.	*Reference*			
	Intermediate <14 yrs.	-0.259 (.070) ***	-0.267 (.070) ***	-0.166 (.075) **	-0.172 (.075) **
	High > 14 yrs.	-0.857 (.091) ***	-0.863 (.091) ***	-0.862 (.098) ***	-0.866 (.098) ***
Income	0 - 99,999	*Reference*			
	100,000 - 199,999	0.414 (.102) ***	0.422 (.102) ***	0.408 (.116) ***	0.423 (.116) ***
	200,000 - 299,999	-0.034 (.105)	-0.036 (.105)	0.259 (.116) **	0.266 (.116) **
	300,000 - 399,999	-0.262 (.124) **	-0.269 (.124) **	-0.044 (.135)	-0.042 (.135)
	400,000 - 599,999	-0.344 (.141) **	-0.348 (.141) **	-0.065 (.151)	-0.060 (.151)
	600,000+	-0.509 (.168) ***	-0.519 (.168) ***	-0.226 (.179)	-0.223 (.179)
Civil Status	Single	*Reference*			
	Married	0.592 (.106) ***	0.593 (.106) ***	0.617 (.112) ***	0.624 (.112) ***
	Cohabitation	1.025 (.178) ***	1.012 (.178) ***	0.775 (.203) ***	0.758 (.203) ***
	Widowed	0.627 (.116) ***	0.626 (.117) ***	0.561 (.124) ***	0.560 (.124) ***
	Separated	0.770 (.173) ***	0.771 (.173) ***	0.804 (.182) ***	0.802 (.182) ***
	Divorced	-0.294 (.813)	-0.290 (.817)	0.205 (.741)	0.218 (.744)
Birth Country	Norway	*Reference*			
	Other	0.218 (.089) **	0.214 (.089) **	-0.027 (.099)	-0.038 (.099)
Gender	Male	*Reference*			
	Female	-2.120 (.074) ***	-2.128 (.074) ***	-2.072 (.082) ***	-2.076 (.081) ***
County	Oslo	*Reference*			
	Telemark	-0.193 (.073) ***	-0.187 (.073) ***	-0.123 (.077)	-0.119 (.076)
	Other	-0.826 (.422) **	-0.806 (.421) *	-0.855 (.443) *	-0.870 (.446) *
Groups: Findings	Control	*Reference*			
	Attended - CRC	-18.741 (6406.406)		-20.716 (16359.33)	
	Attended - Positive	0.024 (.190)		-0.063 (.203)	
	Attended - Negative	-0.176 (.106) *		-0.179 (.111)	
	Non-Attendee	-0.014 (.115)		-0.082 (.124)	
	Returned Mail or Died	-0.643 (.519)		-1.077 (.662)	
	Excluded	2.158(.283) ***		2.420 (.291) ***	
Intention to Treat	Control	*Reference*			
	Invited		-0.008 (.074)		-0.006 (.079)
Interaction: Time	Control	*Reference*			
	Attended - CRC	0.043 (15718.26)		0.314 (56636.71)	
	Attended - Positive	-0.091 (.315)		-0.892 (.632)	
	Attended - Negative	-0.310 (.185) *		0.296 (.209)	
	Non-Attendee	0.191 (.169)		0.348 (.240)	
	Returned Mail or Died	-0.079 (889)		-19.756 (22602.52)	
	Excluded	0.745 (.325) **		0.666 (.466)	
R^2 = Log Likelihood		0.138	0.140	0.138	0.139
ρ = rho		0.714	0.717	0.730	0.733

*** significant at a 1% level, ** significant at a 5% level, * significant at a 10% level

Limitations

The time length after screening presents a large challenge for accurately presenting the results and whether a Health Certificate Effect is present regardless of the significant results in the disease groups. A follow up of more years after the initial screening would enable a stronger and more accurate reporting of the time trends.

This study did not account for deaths, part of this reason was that the number of dead was so small and the primary concern in this study was the effect of the various independent variables on the dependent disease group variables. When one considers the relatively short 5-year survival rate of those diagnosed with CRC, there is a strong possibility that those with a CRC result from the screening trial would not as many as the initial 41 patients at the end of the data period. By not including death, the incidence of the various disease groups could appear higher than in reality or a death may be inaccurately reported as 'no disease' present for that year. However, because all the findings groups were measured the same way the risk of inflating or deflating the number of disease cases would be shared and most likely would not change the regression results a great deal. Similarly, the CRC-invited group, which would most likely have the most deaths, did not have significant results.

The data was a combination of dataset from many sources. One challenge was how part of the data was written using the ICD-9 coding and some used the ICD-10 coding, while all was done to match the coding together there is some risk that corresponding codes could have been missed. All was done to stay consistent and the codes used are listed in Appendix I with the equivalents used throughout the study's progression. Further, as new diagnostic tools become available for detecting disease become available, the criteria for coding a disease risks changing as well. An example of this was in the diagnosis of Acute Myocardial Infarction that changed following the use of an ECG. The World Health Organisation has made amendments to the ICD-9 coding by providing supplements, however there was an additional code used in the ICD-9 called Old Myocardial Infarction, this was included and recorded as Acute Myocardial Infarction in this study; it is unclear how many patients this might have affected.

The selection of diseases related to the heart and circulatory system proved to be problematic. Both Angina Pectoris and Acute Myocardial Infarction are forms of Ischemic Heart Disease so it could be argued that diseases in this category could have been counted three times. All three diseases are a result of the building of plague in the main arteries and heart valves, however each of the three diseases manifested themselves differently and each has different treatment and health outcomes. For example, Angina Pectoris is non-fatal and is largely characterized by stress-induced pain, while an Acute Myocardial Infarction is a sudden and often fatal bout of pain caused by inadequate nutrients coming to the heart. It is also possible to have Ischemic Heart Disease and not experience an Acute Myocardial Infarction or have an Angina Pectoris episode. Since the three diseases were coded differently in the ICD-9 and 10 from each other, there were numerous instances where only one of the diseases was coded in the same patient and that the study was largely based upon reason for inpatient and outpatient care, this did not appear to be that great of a problem.

The Excluded findings group provided a challenge within this study in that the majority of disease groups selected for this study where conditions within the NORCCAP trial's exclusion criteria. For this reason, the Exclusion group had highly significant results in all lifestyle-related disease groups and their risk of complications where higher than controls. The conclusions to draw from this group are difficult to interpret since the exclusion group is small and their initial health issues led to them being excluded from the NORCCAP trial.

Due to the use of a Logistic Panel Regression, many of the categorical variables had to be changed into binary coding, for example, the Income Group had to change to each income level being separated and then coded as zero for 'not present' and 1 for 'present'. While this was a simple method to prepare the data, there was a risk of over-simplifying and increasing the size of outputs from the regression. A number of assumptions had to be made using this binary method, particular in the Interaction variables. A patient who was invited to screening was identified by a '1', while the remaining controls where identified using a '0'. An invited participant was assigned a '1' from the time of their screening through to the end of the sample year of 2003. While this would report changes between years within the same patient, there is of course a risk of patient having numerous cases of the diseases within the same year; this makes changes hard to report and difficult to track. A more dynamic model instead of a binary model may show different findings.

Strengths

This study presents a simple method to track and measure potential adverse effects of undertaking a mass-screening program for CRC. A great deal of literature has been presented about concerns about the Health Certificate Effect and for the most part it has been only discussed, no study has attempted to demonstrate it using statistical methods.

The methods in this study could be easily transferred and used to evaluate other screening programs, specifically in terms of tracking changes over the years with a given dependent variable of concern within a single patient. The use of a panel data method enables the times series to be easily tracked within each patient rather easily. Similarly, by isolating variables in a binary manner, changes were simple to see and the data was easy to prepare.

The interaction variable used to track a change in disease patterns within each patient following the results from the findings group is a strong method to determine whether unexpected effects could be seen in the given screening program studied. With a longer study period and a sample over a greater number of years, it would be a suitable model to investigate trends and a good method to test for the Health Certificate Effect.

These results also show that existing methods used to evaluate screening programs are at risk for missing all costs and consequences. In the scope of this study, areas of potential costs were demonstrated based upon a screening result alone. Changes in behaviour and risk do occur following screening. The work of Howard and colleagues has identified cost savings in lifetime treatment costs in those with detected polyps than undetected; one area that they were unable to analyze however was

net cost of screening (2009). By adding the lifestyle related disease component from this study, determining a better estimate for net CRC screening costs could be partly achieved.

Future Study and Implications

A common criticism from the literature concerning undertaking a mass screening program has to do with the adverse implications that could occur within the screened group. A professional and randomized standard to carrying-out a trial must be maintained which at times requires the necessity of determining the effectiveness of the method of the study and providing the educational information needed for the participants to understand the results. It is the misinterpretation of the results that can lead to adverse events following the screening results.

Future studies could explore the Cost-Effectiveness component further. To do so, one would need to identify the costs associated with undertaking a mass-screening program and then determine the amount of information needed in order for patients to fully understand their results with their associated costs. Further, the results of this study would be used to examine the DRG costs associated with the disease groups. By determining the costs to treat the adverse events, there would be evidence to demonstrate both the risk of requiring treatment for the disease groups in question and the additional health costs associated with treating the other disease groups based upon a screening result. The cost component could also be explored over the years of the trial and following the trial. The conclusions drawn from adding the cost component would provide a better estimate of what costs are associated with mass screening and the adverse event costs.

7. Conclusion

This research paper aimed to determine whether outcomes of a mass screening could have an effect on life-style related diseases. In working to answer this question a methodology was created to track changes in disease related admissions to either inpatient or outpatient health care.

It was hypothesized that a potential Health Certificate Effect could be present where patients who had negative results in their CRC screening may interpret the result as meaning that they are healthy. The assumption was that patients who did not believe that they were unhealthy would continue their same lifestyle choices, as they had no ‘shock’ to make them think otherwise. In this study, it was hypothesized the patients who were invited to the screening but did not attend and those who had a negative test would be at increased risk for other life-style related diseases. The results did show that a Health Certificate Effect might be present in the Diabetes Mellitus, Hypertension and COPD disease groups. When compared to the Control group patients in the Negative Screening Result Group and the Non-Attendee group, required more health care for those conditions and the risks did change when following their screening test. However these results were not consistent between the Findings and Interaction group so there is the possibility, that in some cases those patients with a Negative Finding might in fact be in good health.

The statistical method used and the framework in this study could be a good tool to use when seeking to evaluate indirect costs associated with mass screening programs.

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Appendix I: Coding for ICD9 and ICD10

Diabetes Mellitus – ICD-9 **250**, ICD-10 **E10-E14**.

Hypertension, Secondary Hypertension & Hypertensive Heart Disease – ICD-9 **401, 402, 405**, ICD-10 **I10, I11, I15**.

Chronic Obstructive Pulmonary Disease – ICD-9 **496 & 492**, ICD-10 **J43 & J44**.

Angina Pectoris – ICD-9 **413**, ICD-10 **I20**.

Acute Myocardial Infarction & Old Myocardial Infarction – ICD-9 **410 & 412**, ICD-10 **I21**.

Ischemic Heart Disease Acute and Chronic – ICD-9 **411 & 414**, ICD-10 **I25**.

Appendix 2.

Table A2: Individual Patient Characteristic of the Data Sample

Data Characteristics		Outpatient*	Inpatient
Age 1999			
	50 - 54 years	51.6%	
	55 - 64 years	48.4%	
Education	**Low**	24.2%	
	Intermediate	47.1%	
	High	28.7%	
Income	**Level 1**	13.5%	
	Level 2	25.3%	
	Level 3	32.4%	
	Level 4	14.2%	
	Level 5	8.7%	
	Level 6	5.1%	
Civil Status	**Single**	11.4%	
	Married	59.8%	
	Common-law	3.8%	
	Widow	20.4%	
	Separated	3.7%	
	Divorced	0.2%	
Birth Place	**Norway**	88%	
	Other	12%	
Gender	**Female**	50.1%	
	Male	49.9%	
Intention to Treat	**Control**	79.4%	
	Invited	20.6%	

Findings Groups	**Control**	79.4%	
	Attended - CRC	0.004%	
	Attended - POS	2.2%	
	Attended - NEG	10.6%	
	Non-Attendee	7%	
	Returned / Dead	0.4%	
	Excluded	0.4%	
County	**Oslo**	72.7%	
	Telemark	25.5%	
	Other	0.9%	
Average Number of Cases per Year			
	Diabetes Mellitus	732	436
	Hypertension	686	800
	COPD	429	353
	Angine Pectoris	332	510
	AMI	40	242
	IHD	532	620
Total Number of Patients in Sample		100,116	100,106

*For all individual characteristics, the numbers are identical between in- and outpatent.