

Physician-linked mailed invitation to be screened improves uptake in an organized colorectal cancer screening program: Two linked cohort studies.

Journal:	BMJ Open
Manuscript ID:	bmjopen-2013-004494
Article Type:	Research
Date Submitted by the Author:	18-Nov-2013
Complete List of Authors:	Tinmouth, Jill; Sunnybrook Health Sciences Centre, Baxter, Nancy; University of Toronto, St Michaels Hopsital, Surgery Paszat, Lawrence; Institute for Clinical Evaluative Sciences, Rabeneck, Linda; University of Toronto, Sutradhar, Rinku; Institute for Clinical Evaluative Sciences, Yun, Lingsong; Institute for Clinical Evaluative Sciences,
Primary Subject Heading :	Gastroenterology and hepatology
Secondary Subject Heading:	Oncology, Public health, General practice / Family practice, Health services research
Keywords:	Gastrointestinal tumours < GASTROENTEROLOGY, PREVENTIVE MEDICINE, PRIMARY CARE, PUBLIC HEALTH

SCHOLARONE[™] Manuscripts

TITLE PAGE

Title: Physician-linked mailed invitation to be screened improves uptake in an organized colorectal cancer screening program: Two linked cohort studies.

Short tile: Physician-linked invitations for colorectal cancer screening

Authors:

Jill Tinmouth^{1,3,5,6} Nancy N. Baxter^{3,5,7} Lawrence F. Paszat^{2,3,4} Linda Rabeneck^{1,3,4,5,6} Rinku Sutradhar^{3,4} Lingsong Yun³

Affiliations: Departments of Medicine¹ and Radiation Oncology², Sunnybrook Health Sciences Centre, Toronto, Canada; Institute for Clinical Evaluative Sciences, Toronto, Canada³; Dalla Lana School of Public Health, University of Toronto, Toronto, Canada⁴; Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Canada⁵; Cancer Care Ontario, Toronto, Canada⁶; Department of General Surgery and Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Canada⁷.

Corresponding Author Information:

Jill Tinmouth MD PhD FRCPC Sunnybrook Health Sciences Centre 2075 Bayview Ave Rm HG40 Toronto ON M4N 3M5 416 480-5910 t 416 480-4845 f jill.tinmouth@sunnybrook.ca

Email addresses of authors:

Nancy N. Baxter Lawrence F. Paszat Linda Rabeneck Rinku Sutradhar Lingsong Yun n: ntre
BaxterN@smh.toronto.on.ca <u>lawrence.paszat@ices.on.ca</u> <u>Linda.Rabeneck@cancercare.on.ca</u> Rinku.Sutradhar@ices.on.ca Lingsong.Yun@ices.on.ca

Word count: 2637 (main text), 242 (abstract)

Number of Tables: 4

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Number of Figures: 1

Number of References: 40

Key words: Mailed invitations, colorectal cancer, organized screening

ABSTRACT

<u>Objectives</u>: A central tenet of organized cancer screening is that all persons in a target population are invited. The aims of this study are to identify patient and physician factors associated with response to mailed physician-linked invitations (Study 1) and to evaluate their effectiveness in an organized colorectal (CRC) screening program (Study 2).

<u>Design and setting</u>: Two linked cohort studies conducted in context of Ontario's organized province-wide CRC screening program.

<u>Participants</u>: 102 family physicians and 11,302 associated eligible patients participating in a technical evaluation ("the Pilot") of large scale mailed invitations for CRC screening were included. Matched controls were randomly selected using propensity scores from among eligible patients associated with family physicians in similar practice types as the Pilot physicians.

Intervention: Physician-linked mailed invitation to have CRC screening.

<u>Outcomes</u>: Uptake of FOBT within 6 months of mailed invitation (primary) and uptake of FOBT or colonoscopy within 6 months of mailed invitation (secondary). <u>Results</u>: Factors significantly associated with uptake of FOBT included prior FOBT use, older patient age, greater patient co-morbidity and having a female physician. In the matched analysis, Pilot patients were more likely to complete an FOBT (22% vs. 8%, p<0.0001) or an FOBT or colonoscopy (25% vs. 11%, p<0.0001) within 6 months of

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

mailed invitation than matched controls. The number needed to invite to screen one additional person was 7.

Conclusions: Centralized large scale mailing of physician-linked invitations is both

feasible and effective in an organized CRC screening program.

BMJ Open

ARTICLE SUMMARY

Strengths and limitations of this study:

- Implementation and effectiveness of physician-linked invitations in an organized colorectal screening program have not yet been reported
- We have shown that centralized large scale mailing of physician-linked invitations is feasible
- We found that physician linked mailed invitations improve CRC screening participation by 14% such that 7 physician-linked invitations need to be mailed to screen one additional person
- We were limited to data found in Ontario health administrative databases; for example, we were not able to determine family history
- Findings are promising but require appropriate infrastructure in order to be implemented in other jurisdictions

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

INTRODUCTION

Colorectal cancer (CRC) is the 3rd most common cancer and the 4th leading cause of cancer-related death worldwide.[1] FOBT[2-4] and flexible sigmoidoscopy[5-7] have been shown to decrease CRC mortality in randomized controlled trials.

Given these data, organized CRC screening programs[8] are being implemented worldwide.[9] On April 1 2008, Ontario launched Canada's first organized provincewide CRC screening program, ColonCancerCheck (CCC).[10] CCC has a dual strategy: through the primary care physician, FOBT is offered to people at average risk for CRC and colonoscopy to those at increased risk based on family history. The CCC program uses a non-rehydrated guaiac FOBT (Hema-Screen, Immmunostics, Inc., NJ, USA) requiring 3 stool samples from separate stools. The only recommended dietary restriction is to avoid vitamin C for 3 days prior to and during the collection period.

A central tenet of organized screening programs is that all persons in the target population be invited to participate.[8] Operationalization of this strategy can vary: invitations may be sent with an FOBT kit, can include physician recommendation or may incorporate tailored messaging.[11,12] Some of these approaches, such as incorporation of physician recommendation, present significant implementation challenges for organized screening programs such as Ontario's.

In 2009, the CCC program conducted the CCC Invitation Pilot (the "Pilot"), an evaluation that tested the technical feasibility of a centralized approach to sending physician-linked mailed invitations for CRC screening. In this paper, we describe the structure and the implementation of the Pilot. In addition, we report on patient and physician factors associated with response to mailed physician-linked invitations and on the effectiveness of these invitations in an organized CRC screening program.

METHODS

The CCC Invitation Pilot – Implementation and Evaluation

The Pilot was conducted by CCC in November 2009 in order to develop and test the technical infrastructure required for large scale centralized physician-linked mailed invitations in Ontario. For the Pilot, invitation letters were generated by the CCC program on behalf of 102 family physicians and sent to all their eligible enrolled patients. Just over 11,000 patients received mailed invitations requesting they visit their family physician to obtain an FOBT kit or, if appropriate based on family history, a referral for colonoscopy. In this paper, we report on the 2 linked quantitative studies done using this cohort. Ethics approval was obtained from the research ethics boards at Sunnybrook Health Sciences Centre and the Institute for Clinical Evaluative Sciences (ICES) and permission to use the Pilot data was obtained from Cancer Care Ontario's Data Access

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Committee. All analyses were conducted using SAS v.9 (SAS Institute, Cary, NC). A p-value of 0.05 was used to determine statistical significance.

Data Sources

The quantitative Pilot study was conducted at ICES which holds the administrative health records for all 12.4 million Ontarians. CCC program databases were linked to the ICES administrative databases using an encrypted version of the provincial health insurance number.

The ICES databases used include the Canadian Institute of Health Information (CIHI) databases, the Ontario Health Insurance Program (OHIP) Claims History Database, the Registered Persons Database (RPDB), the Ontario Cancer Registry, the ICES Physician Database, and the Client Agency Program Enrollment (CAPE) registry. The CIHI, OHIP, RPDB and the Ontario Cancer Registry and the ICES Physician Database have been previously described.[13,14] The CAPE registry tracks patients registered to a specific physician in patient enrolled models (PEMs) of care. PEMs comprise family physicians who provide enrolled patients with comprehensive health care and extended hours; PEM physicians receive incentives for the use of preventive care measures such as CRC screening.[15] PEMs vary in terms of structure, services provided and remuneration (varying from enhance fee-for-service to blended capitation). It is estimated that 75% of Ontario residents received their care via a PEM in 2009.[16]

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

The CCC program has collected data on CRC screening since its inception using Laboratory Reporting Tool (LRT) and comprises data related to the FOBT kits administered by the CCC program, including the results of these tests.

Study 1: Factors associated with response to the mailed invitation

<u>Cohort Definition</u>: For the Pilot, a convenience sample of physicians participating in PEM practices was recruited via Cancer Care Ontario's Provincial Primary Care Cancer Network. Prior to the Pilot mailing, CCC generated lists of patients eligible for CRC screening for each participating physician using CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT. Patients aged 50 to 74 years without a history of CRC and who were due for CRC screening (without a record of recent FOBT (previous two years) or lower GI investigation including flexible sigmoidoscopy and colonoscopy (previous 5 years)) were eligible.

<u>The Mailing</u>: Invitations were mailed in November 2009. The date of mailing was the index date. The letters were compiled centrally by the CCC program but were physician-linked; patients received a letter from their own physician, as indicated by their name at the bottom of the letter in an italicized font (Figure 1). The letter asked patients to visit their family physician for screening; it did not include an FOBT kit. They were

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

accompanied by an CRC screening information brochure and sent in an envelope with the family physician name in the front upper left corner.

<u>Response to Mailed Invitation</u>: We defined response to the mailed invitation as a record of FOBT in OHIP or in LRT within 6 months of the index date. We were not able to measure response in persons at increased risk of CRC as we do not have family history data available in the administrative databases.

Patient and Physician Factors: We characterized patients by age group, sex, comorbidity, median neighborhood income[17,18], health region[19], immigration status, and prior FOBT. Comorbidity was measured by counting the number of Aggregated Diagnosis Groups (ADGs) in the prior 12 months according to the Johns Hopkins ACG Case-Mix System.[20] This system has been shown to accurately predict mortality in a general population ambulatory cohort in Ontario.[21] We used date of registration in the RPDB as a proxy measure for immigration status; patients were considered recent immigrants if their date of registration was within 5 years of the index date.[22]

Physicians were characterized according to age, sex, training location (attended Canadian medical school vs. outside of Canada), practice type, size of practice, ageeligible rate of colonoscopy or FOBT over prior 2 years as well as the age-eligible rate of annual physical exams or influenza vaccinations in the prior year. All physicians were in

BMJ Open

PEMs; practice types included family health groups (FHGs, enhanced fee-for-service models), family health organizations or networks (FHO/FHNs, blended capitation models), FHO/FHN with family health team (FHO/FHN-FHT, interprofessional team model with a blended capitation fee structure) and other PEMs.[23] We measured practice size as the number of enrolled patients stratified in a binary fashion (≤1800 vs. >1800 enrolled patients) as larger practice sizes have been shown to be associated with poorer preventative care.[24] For the remaining physician characteristics, we identified all enrolled and non-enrolled patients aged 50-74 years in their practices as of the index date. Age-eligible FOBT and colonoscopy rates were obtained for each Pilot physician by calculating the proportion of their age-eligible patients who had had an FOBT or colonoscopy in the 2 years prior to the index date. Similarly, we calculated their rates of age-eligible annual physical exams or influenza vaccine in the year prior to the index date. These variables were derived in order to estimate physician adherence to CRC screening and preventive medicine practices at baseline.

<u>Analysis</u>: The number and proportion of persons in the cohort who responded to the mailed invitation within 6 months was determined overall and by patient and physician characteristics. Multivariate logistic regression modeling was used to identify patient and physician factors associated with response to the mailed invitation. In order to account for potential clustering of patients within physicians, Generalized Estimating Equations (GEE) were used in the model.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Overview and study participants: This was a matched double cohort analysis, comparing uptake of FOBT in those who received a mailed invitation (Pilot cohort) to a matched control group who were not sent a mailed invitation. The Pilot cohort comprised all members of the cohort described in Study 1 for whom a matched control could be identified. We identified potential patient controls as follows: 1) Pilot physicians were matched to non-Pilot physicians practicing in PEMs in a 1:5 ratio using physician age, sex, size and practice type; 2) enrolled patients belonging to the selected control physicians were retained if they met the same inclusion/exclusion criteria as those in the intervention cohort (aged 50 to 74 years with no prior CRC who were due for CRC screening). Propensity scores that modeled the probability of belonging to the Pilot group were calculated for each patient. The variables in this model included age (as a continuous measure), sex, co-morbidity, median neighborhood income quintile, health region, immigration status, and FOBT from 2 to 5 years prior. [25,26] Pilot patients were matched to controls in a 1:1 fashion based on propensity scores using a caliper width of 0.25. This methodology was implemented to balance the distribution of patient-level variables between the Pilot and control groups.

<u>Response to mailed invitation</u>: For our primary outcome, we defined response to the mailed invitation as above, FOBT within 6 months of the index date. For our secondary

BMJ Open

outcome, response was defined as a record of either FOBT or colonoscopy (in OHIP) within 6 months of the index date. For the purposes of this study, controls were assigned the same index date as their matched counterpart in the Pilot group.

<u>Analysis</u>: Standard differences between the Pilot participants and controls were calculated for the variables included in the propensity score. Important differences between the 2 groups were defined by a standardized difference exceeding 0.1.[26,27] In the primary analysis, we compared the number and proportion in the Pilot and control groups responding to the mailed invitation with FOBT using McNemar's test.[26] We determined the number of invitations mailed in order to screen one additional person with FOBT. We repeated the above analyses using our secondary outcome in order to determine if observed differences in FOBT uptake could be attributed to a differences in colonoscopy uptake (i.e., patients had CRC screening but chose colonoscopy over FOBT). As the matching only accounted for patient level variables, we repeated our analyses using conditional logistic regression in order to adjust for physician covariates (age, sex, practice type and size).

RESULTS

Study 1: Factors associated with response to the mailed invitation

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

There were 11,311 eligible patients associated with the 102 family physicians in the Pilot cohort. Nine patients were excluded as we were unable to determine their health region and/or income quintile; this left 11,302 patients for the analysis. The majority of patients were 50 to 59 years of age, 52% were women, 48% had no or low co-morbidity and 14% had completed an FOBT from 2 to 5 years prior to the mailing. Two thirds of patients had a male physician, approximately half were part of a primary care team reimbursed via an enhanced fee-for-service arrangement and just under half were enrolled in larger practices (>1800 enrolled patients) (Table 1).

2503 (22%) completed an FOBT within 6 months of mailing. In the multivariate regression, the strongest patient factor associated with FOBT completion was prior FOBT use (2 to 5 years prior vs. > 5 years or never: OR 2.8, 95% C.I.: 2.5 to 3.3, p < 0.0001). Other significant factors associated with FOBT completion included older patient age, greater co-morbidity, and having a female physician (Table 2).

Study 2: Evaluation of the effectiveness of mailed invitations

Of the 11,302 patients in Study 1, 10,652 patients were successfully matched to 10,652 controls using propensity scores. Standardized differences for the patient characteristics included in the propensity score were all <0.1, indicating that the two cohorts were well matched for measurable potential confounders (Table 3).

Pilot patients were significantly more likely than controls to complete FOBT alone (2387 (22%) versus 854 (8%), p<0.0001) and FOBT or colonoscopy (2664 (25%) vs. 1191 (11%), p<0.0001) within 6 months of mailing. The association between the mailed invitation and CRC screening participation (either FOBT alone or FOBT or colonoscopy) remained after adjusting for physician level characteristics (Table 4).

DISCUSSION

In the current study, we have demonstrated that physician-linked mailed invitations are both feasible and effective in the context of a large organized, population-based screening program; only 7 letters would need to be sent in order to screen one additional person. Furthermore, we have found that older patients, those with greater co-morbidity, those who have previously been screened and patients of female physicians were more likely to respond to this type of invitation. Our findings are of particular interest to other jurisdictions planning or who already have organized CRC screening.

In other published studies of mailed invitations, an FOBT kit is often included. Three studies done outside organized screening programs have found physician-linked invitations superior to non-linked invitations; 2 studies of invitations included an FOBT kit,[28,29] and the third study did not.[30] Other studies have examined mailed invitations with FOBT kits in the context of primary care practices in the USA.[31-33] While the results from these trials were largely supportive of mailed invitations, kit

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

inclusion can make it difficult to separate the convenience of receiving the FOBT kit directly by mail from the impact of an invitation from one's own physician.

Our study demonstrates the effectiveness and feasibility of physician-linked invitations in the context of a large organized CRC screening program with an estimated target population of over 3 million persons. Implementation in this context confers challenges in terms of technological infra-structure, privacy and regulatory issues. There are 2 studies (from the United Kingdom[34] and Italy[35]) that have reported on mailed invitations in the context of organized colorectal cancer screening programs and found them to be effective. Both studies included FOBT kits and one studied the impact of physician endorsement specifically.[34] Our findings are important because they support a potentially more cost-effective approach that avoids wasting kits that are mailed but not used.

Our results highlight the critical role of physician recommendation, a finding supported by others. For example, in the NHS Bowel Cancer Screening Programme (BCSP) currently, the primary care physician receives the result but is not directly involved in the mailed invitation or the actual screening. Recently, a randomized controlled trial conducted in the context of the BCSP showed that an endorsement letter from the primary care provider increased participation by 6%.[34] In 2 studies from Australia,

BMJ Open

endorsement improved initial participation [28, 29] and over 4 successive screening rounds.[29]

Our study has several limitations. As mentioned above, we are unable to determine family history using Ontario administrative data. A second limitation is that a single generic letter was used. Tailored letters with key messages for specific subgroups may be more effective, [12] a finding that may be relevant in Ontario as we did find that response to the letter appeared to differ in various subgroups. Finally, while our findings are promising, there are challenges to widespread implementation in other populationbased screening programs, including the requirement for a centralized database that links patients and physicians. Finally, implementation of this strategy in population based screening is predicated on physician acceptability and agreement. While we have found that this approach is acceptable in principle to many Ontario physicians,[36] processes to determine physician agreement have not been worked out for the entire CCC program which comprises an estimated 7000 primary care physicians.

In summary, we have demonstrated that physician-linked mailed invitations for CRC screening, even without the inclusion of an FOBT kit, can have substantial effect on participation in an organized CRC screening program and that it is technically feasible to centrally organize and mail physician-linked invitations on a large scale. Organized

CONCLUSIONS

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

screening programs, which often use unlinked invitations, should consider adopting this approach given its demonstrated effectiveness and feasibility.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Peter Austin PhD for his expert statistic advice. They also wish to acknowledge the support of the Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and Cancer Care Ontario. The opinions, results and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and Cancer Care Ontario is intended or should be inferred.

COMPETING INTERESTS STATEMENT

Dr. Tinmouth is the Lead Scientist for the ColonCancerCheck program and Dr. Rabeneck oversees the ColonCancerCheck program in her capacity as the Vice-President, Cancer Prevention and Control at Cancer Care Ontario. None of the other authors have any conflicts of interest to report.

FUNDING STATEMENT

This study was conducted with the support of the Ontario Institute for Cancer Research and Cancer Care Ontario's Health Services Research Network, which is independent of

the ColonCancerCheck program, provided funding for this work. This work was also supported in part by a grant from the Canadian Institutes for Health Research (grant # CST-85478). Dr. Tinmouth was supported by a Canadian Institutes of Health Research New Investigator Award during the period of this study.

AUTHOR CONTRIBUTION:

Authors contributed substantially to each of the following areas:

-conception and design (JT, LFP, LR) or analysis and interpretation of data (JT, NB,

LFP, LR, RS, LY)

-drafting the article (JT) or revising it critically for important intellectual content (JT, NB,

LFP, LR, RS, LY)

-final approval of the version to be published (JT, NB, LFP, LR, RS, LY)

REFERENCES

- 1. Center MM, Jemal A, Ward E. International trends in colorectal cancer incidence rates. Cancer Epidemiol. Biomarkers Prev. 2009;**18**(6):1688-94.
- 2. Mandel JS, Church TR, Bond JH, et al. The effect of fecal occult-blood screening on the incidence of colorectal cancer. N. Engl. J. Med. 2000;**343**(22):1603-7.
- 3. Hardcastle JD, Chamberlain JO, Robinson MH, et al. Randomised controlled trial of faecal-occult-blood screening for colorectal cancer. Lancet 1996;**348**(9040):1472-7.
- 4. Kronborg O, Fenger C, Olsen J, et al. Randomised study of screening for colorectal cancer with faecal-occult-blood test. Lancet 1996;**348**(9040):1467-71.
- Atkin WS, Edwards R, Kralj-Hans I, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. Lancet 2010;**375**(9726):1624-33.
- Segnan N AP, Bonelli L, Risio M, Sciallero S, Zappa M, Andreoni B, Arrigoni A, Bisanti L, Casella C, Crosta C, Falcini F, Ferrero F, Giacomin A, Giuliani O, Santarelli A, Visioli CB, Zanetti R, Atkin WS, Senore C, and and the SCORE Working Group. Once-Only Sigmoidoscopy in Colorectal Cancer Screening: Followup Findings of the Italian Randomized Controlled Trial—SCORE J. Natl. Cancer Inst. 2011;103(17):1310-22
- Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. N. Engl. J. Med. 2012;366(25):2345-57 doi: 10.1056/NEJMoa1114635.
- 8. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. Cancer 2004;**104**(5 Suppl):1201-13.
- 9. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Last update: Feb 9 2009. http://appliedresearch.cancer.gov/icsn/colorectal/screening.html.
- 10. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. Last update: January 24, 2008 2012. http://www.health.gov.on.ca/english/public/program/colorectal_cancer/colorecancer/colorectal_cancer/colorectal
- Khalid-de Bakker C, Jonkers D, Smits K, et al. Participation in colorectal cancer screening trials after first-time invitation: a systematic review. Endoscopy 2011;43(12):1059-86 doi: 10.1055/s-0031-1291430.
- 12. Rawl SM, Skinner CS, Perkins SM, et al. Computer-delivered tailored intervention improves colon cancer screening knowledge and health beliefs of African-Americans. Health Educ. Res. 2012;**27**(5):868-85 doi: 10.1093/her/cys094.
- 13. Alharbi O, Rabeneck L, Sutradhar R, et al. A population-based analysis of outpatient colonoscopy in adults assisted by an anesthesiologist. Anesthesiology 2009;**111**(4):734-40.

14. Robles SC, Marrett LD, Clarke EA, et al. An application of capture-recapture	
methods to the estimation of completeness of cancer registration. J. Clin. Epidemic)I.
1988; 41 (5):495-501.	

- 15. HealthForceOntario. Family Practice Models. Last update: May 3 2013 2013. <u>http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideOntario/Pr</u> <u>actisingInOntario/family_practice_models.aspx</u>.
- 16. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012.
- Alter DA, Naylor CD, Austin P, et al. Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction. N. Engl. J. Med. 1999;341(18):1359-67.
- Singh SM, Paszat LF, Li C, et al. Association of socioeconomic status and receipt of colorectal cancer investigations: a population-based retrospective cohort study. Can. Med. Assoc. J. 2004;171(5):461-5.
- 19. Anonymous. Ontario's Local Health Integration Networks. Last update: May 30 2013 2013. <u>http://www.lhins.on.ca/home.aspx</u>.
- 20. Anonymous. The Johns Hopkins University ACG Case-Mix System. Last update: 2012. <u>http://www.acg.jhsph.edu/</u>.
- 21. Austin PC, van Walraven C, Wodchis WP, et al. Using the Johns Hopkins Aggregated Diagnosis Groups (ADGs) to predict mortality in a general adult population cohort in Ontario, Canada. Med. Care 2011;**49**(10):932-9 doi: 10.1097/MLR.0b013e318215d5e2.
- Ray JG, Vermeulen MJ, Schull MJ, et al. Results of the Recent Immigrant Pregnancy and Perinatal Long-term Evaluation Study (RIPPLES). 2007;**176**(10):1419-26 doi: 10.1503/cmaj.061680.
- 23. Glazier RH, Klein-Geltink J, Kopp A, et al. Capitation and enhanced fee-for-service models for primary care reform: a population-based evaluation. Can. Med. Assoc. J. 2009;**180**(11):E72-E81 doi: 10.1503/cmaj.081316.
- 24. Dahrouge S, Hogg WE, Russell G, et al. Impact of remuneration and organizational factors on completing preventive manoeuvres in primary care practices. CMAJ 2012;**184**(2):E135-43 doi: 10.1503/cmaj.110407.
- 25. D'Agostino RB, Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Stat. Med. 1998;**17**(19):2265-81.
- Austin PC. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. Multivariate behavioral research 2011;46(3):399-424 doi: 10.1080/00273171.2011.568786.
- 27. Normand ST, Landrum MB, Guadagnoli E, et al. Validating recommendations for coronary angiography following acute myocardial infarction in the elderly: a matched analysis using propensity scores. J. Clin. Epidemiol. 2001;**54**(4):387-98.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

- Cole SR, Young GP, Byrne D, et al. Participation in screening for colorectal cancer based on a faecal occult blood test is improved by endorsement by the primary care practitioner. J. Med. Screen. 2002;9(4):147-52.
- 29. Zajac IT, Whibley AH, Cole SR, et al. Endorsement by the primary care practitioner consistently improves participation in screening for colorectal cancer: a longitudinal analysis. J. Med. Screen. 2010;**17**(1):19-24 doi: 10.1258/jms.2010.009101.
- 30. Grazzini G, Castiglione G, Isu A, et al. Colorectal cancer screening by fecal occult blood testing: results of a population-based experience. Tumori 2000;**86**(5):384-8.
- 31. Myers RE, Sifri R, Hyslop T, et al. A randomized controlled trial of the impact of targeted and tailored interventions on colorectal cancer screening. Cancer 2007;**110**(9):2083-91 doi: 10.1002/cncr.23022.
- Sequist TD, Zaslavsky AM, Marshall R, et al. Patient and physician reminders to promote colorectal cancer screening: a randomized controlled trial. Arch. Intern. Med. 2009;169(4):364-71.
- 33. Walsh JM, Salazar R, Terdiman JP, et al. Promoting use of colorectal cancer screening tests. Can we change physician behavior? J Gen Intern Med 2005;**20**(12):1097-101.
- Hewitson P, Ward AM, Heneghan C, et al. Primary care endorsement letter and a patient leaflet to improve participation in colorectal cancer screening: results of a factorial randomised trial. Br. J. Cancer 2011;**105**(4):475-80 doi: 10.1038/bjc.2011.255.
- Giorgi Rossi P, Grazzini G, Anti M, et al. Direct mailing of faecal occult blood tests for colorectal cancer screening: a randomized population study from Central Italy. J. Med. Screen. 2011;18(3):121-7 doi: 10.1258/jms.2011.011009.
- Tinmouth J, Ritvo P, McGregor SE, et al. ColonCancerCheck Primary Care Invitation Pilot project: family physician perceptions. Can. Fam. Physician 2012;58(10):e570-7.

BMJ Open

Tables.

Table 1. Patient and physician characteristics for Pilot participants in Study 1

	FOBT within 6 months	No FOBT within 6 months	Total
	(n=2,503)	(n=8,799)	(n=11,302)
Patients			
Age group in years, No. (%)			
50-59	1,279 (51%)	5,384 (61%)	6,663 (59%)
60-69	894 (36%)	2,637 (30%)	3,531 (31%)
70-74	330 (13%)	778 (9%)	1,108 (10%)
Sex, No. (%)			
Female	1,299 (52%)	4,554 (52%)	5,853 (52%)
Male	1,204 (48%)	4,245 (48%)	5,449 (48%)
Co-morbidity*, No. of ADGs (%)		. ,	
0	257 (10%)	1,279 (15%)	1,536 (14%)
1-2	828 (33%)	3,044 (35%)	3,872 (34%)
3-4	712 (28%)	2,241 (25%)	2,953 (26%)
5-6	393 (16%)	1,224 (14%)	1,617 (14%)
7+	313 (13%)	1,011 (11%)	1,324 (12%)
Median neighborhood income quintile, No. (%)			
Rural	394 (16%)	1,431 (16%)	1,825 (16%)
Low Urban	360 (14%)	1,375 (16%)	1,735 (15%)
2	402 (16%)	1,418 (16%)	1,820 (16%)
3	429 (17%)	1,430 (16%)	1,859 (16%)
4	432 (17%)	1,552 (18%)	1,984 (18%)
High Urban	486 (19%)	1,593 (18%)	2,079 (18%)
Health region, No. (%)			
Erie St.Clair	125 (5%)	337 (4%)	462 (4%)
South West	284 (11%)	823 (9%)	1,107 (10%)
Waterloo Wellington	76 (3%)	251 (3%)	327 (3%)
Hamilton Niagara	289 (12%)	976 (11%)	1,265 (11%)
Central West	138 (6%)	482 (5%)	620 (5%)
Mississauga Halton	22 (1%)	120 (1%)	142 (1%)
Toronto Central	111 (4%)	392 (4%)	503 (4%)
Central	24 (1%)	177 (2%)	201 (2%)
Central East	361 (14%)	1,282 (15%)	1,643 (15%)
South East	162 (6%)	697 (8%)	859 (8%)
Champlain	219 (9%)	676 (8%)	895 (8%)
North Simcoe-Muskoka	77 (3%)	188 (2%)	265 (2%)
North East	291 (12%)	1,118 (13%)	1,409 (12%)
North West	324 (13%)	1,280 (15%)	1,604 (14%)

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Recent immigrant, No. (%)	23 (1%)	88 (1%)	111 (1%)
FOBT 2 to 5 years prior to mailing, No. (%)	643 (26%)	905 (10%)	1,548 (14%)
Physician			
Median age in years (IQR)	52 (45-59)	53 (46-59)	52 (45-59)
Sex, No. (%)			
Female	936 (37%)	3,044 (35%)	3,980 (35%)
Male	1,567 (63%)	5,755 (65%)	7,322 (65%)
Training location, No. (%)			
Outside Canada	312 (12%)	1,196 (14%)	1,508 (13%)
In Canada	2,191 (88%)	7,603 (86%)	9,794 (87%)
Practice type, No. (%)	1 000 (400/)	4 000 (400()	
FHG FHO/FHN	1,082 (43%)	4,266 (48%)	5,348 (47%)
FHO/FHN FHO/FHN-FHT	432 (17%) 881 (35%)	1,456 (17%) 2,620 (30%)	1,888 (17%) 3,501 (31%)
Other PEM	108 (4%)	457 (5%)	565 (5%)
Practice size (enrolled patients), No. (%)			
>1800 patients	1,105 (44%)	4,104 (47%)	5,209 (46%)
Age-eligible rate of colonoscopy quintile, No. (%)			
Low	485 (19%)	1,619 (18%)	2,104 (19%)
2	548 (22%)	1,940 (22%)	2,488 (22%)
3	637 (25%)	2,279 (26%)	2,916 (26%)
4	477 (19%)	1,696 (19%)	2,173 (19%)
High	356 (14%)	1,265 (14%)	1,621 (14%)
Age-eligible rate of FOBT quintile, No. (%)			
Low	487 (19%)	1,888 (21%)	2,375 (21%)
2	504 (20%)	1,886 (21%)	2,390 (21%)
3	533 (21%)	1,890 (21%)	2,423 (21%)
4	522 (21%)	1,680 (19%)	2,202 (19%)
High	457 (18%)	1,455 (17%)	1,912 (17%)
Age-eligible rate of annual physical exams quintile, No. (%)			
Low	496 (20%)	2,009 (23%)	2,505 (22%)
2	490 (20%)	1,625 (18%)	2,115 (19%)
3	472 (19%)	1,638 (19%)	2,110 (19%)
4	509 (20%)	1,686 (19%)	2,195 (19%)
High	536 (21%)	1,841 (21%)	2,377 (21%)

Page 25 of 35

BMJ Open

Tinmouth et al.

Physician-linked mailed invitations for colorectal cancer screening

Age-eligible rate of influenza vaccine quintile, No. (%)			
Low	548 (22%)	1,997 (23%)	2,545 (23%)
2	549 (22%)	1,765 (20%)	2,314 (20%)
3	435 (17%)	1,930 (22%)	2,365 (21%)
4	485 (19%)	1,770 (20%)	2,255 (20%)
High	486 (19%)	1,337 (15%)	1,823 (16%)

*Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

Other PEM = other patient enrolled model of care

FOBT = fecal occult blood test

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 2. Multivariate logistic regression analysis using Generalized Estimating Equations for the characteristics of patients and physicians associated with completing an FOBT within 6 months of the mailing date.

Patients	Odds ratio (95% C.I.)	P-value
Age group, years		
50-59	0.6 (0.5, 0.8)	<.0001
60-69	0.8 (0.7, 1.0)	NS
70-74	Reference	N/A
Sex		
Female	0.9 (0.9, 1.0)	NS
Male	Reference	N/A
Co-morbidity*, No. of ADGs		
0	0.7 (0.6, 0.8)	0.0002
1-2	0.9 (0.7, 1.0)	NS
3-4	1.0 (0.9, 1.2)	NS
5-6	1.0 (0.9, 1.2)	NS
7+	Reference	N/A
Median neighborhood income quintile		
Rural	0.9 (0.7, 1.1)	NS
Low Urban	0.9 (0.7, 1.0)	NS
2	1.0 (0.8, 1.1)	NS
3	1.0 (0.9, 1.1)	NS
4	0.9 (0.8, 1.1)	NS
High Urban	Reference	N/A
Health region		
Erie St.Clair	1.3 (0.9, 1.8)	NS
South West	0.9 (0.6, 1.4)	NS
Waterloo Wellington	0.8 (0.6, 1.2)	NS
Hamilton Niagara	0.9 (0.6, 1.2)	NS
Central West	1.0 (0.7, 1.4)	NS
Mississauga Halton	0.6 (0.3, 1.2)	NS
Toronto Central	0.8 (0.6, 1.2)	NS
Central	0.5 (0.4, 0.7)	0.0004
South East	0.8 (0.4, 0.7)	NS
Champlain	1.0 (0.7, 1.4)	NS
North Simcoe-Muskoka	0.9 (0.6, 1.4)	NS
North East	1.1 (0.7, 1.5)	NS
North West	0.7 (0.5, 1.0)	0.03
Central East	Reference	N/A
Recency of immigration		
Remote or non-immigrant	1.0 (0.6, 1.6)	NS
Recent immigrant	Reference	N/A
Prior FOBT Use		
2 to 5 years prior to mailing	2.8 (2.5, 3.3)	<.0001

BMJ Open

> 5 years or never	Reference	
Physician		
Increasing age (per year)	1.0 (1.0, 1.0)	NS
Sex		
Female	1.3 (1.0, 1.5)	0.02
Male	Reference	N/A
Training location		
In Canada	0.9 (0.7, 1.2)	NS
Outside Canada	Reference	N/A
Practice type		
FHG	0.9 (0.7, 1.1)	NS
FHO/FHN	0.8 (0.6, 1.1)	NS
Other PEM	0.7 (0.4, 1.0)	0.05
FHO/FHN-FHT	Reference	N/A
Practice size (enrolled patients)	Helefelde	11/7 1
≤ 1800 patients	1.1 (0.9, 1.3)	NS
> 1800 patients	Reference	N/A
Age-eligible rate of colonoscopy quintile	Telefence	IN/A
Low	1.1 (0.8, 1.5)	NS
2	1.2 (1.0, 1.6)	NS
3		NS
3	1.0 (0.8, 1.2)	NS
	1.0 (0.8, 1.3)	
High	Reference	N/A
Age-eligible rate of FOBT quintile		NO
2	0.9 (0.6, 1.3)	NS
3	0.9 (0.7, 1.2)	NS
4	1.1 (0.8, 1.4)	NS
High	0.9 (0.7, 1.3)	NS
Low	Reference	N/A
Age-eligible rate of annual physical exams		
quintile		
2	1.4 (0.9, 2.0)	NS
3	1.3 (0.9, 1.8)	NS
4	1.3 (0.9, 1.8)	NS
High	1.1 (0.8, 1.5)	NS
Low	Reference	N/A
Age-eligible rate of influenza vaccine quintile		
2	1.0 (0.8, 1.2)	NS
3	0.8 (0.6, 1.0)	0.02
4	0.9 (0.7, 1.2)	NS
High	1.3 (1.0, 1.7)	NS
Low	Reference	N/A

*Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Other PEM = other patient enrolled model of care NS = not significant N/A - not applicable to beet to the month FOBT = fecal occult blood test

BMJ Open

Table 3. Characteristics of the 2 cohorts matched by propensity score in Study 2

	Pilot participants C		Standardized Difference*	
	(n=10,652)	(n=10.652)	Difference	
Patients				
Age group in years, No. (%)				
50-59	6,248 (59%)	6,324 (59%)	0.01	
60-69	3,342 (31%)	3,316 (31%)	0.01	
70-74	1,062 (10%)	1,012 (10%)	0.02	
Sex, No. (%)				
Female	5548 (52%)	5477 (51%)	0.01	
Male	5,104 (48%)	5,175 (49%)	0.01	
Co-morbidity**, No. of ADGs (%)				
0	1,462 (14%)	1,425 (13%)	0.01	
1-2	3,647 (34%)	3,716 (35%)	0.01	
3-4	2,764 (26%)	2,835 (27%)	0.02	
5-6	1,536 (14%)	1,473 (14%)	0.02	
7+	1,243 (12%)	1,203 (11%)	0.01	
Median neighborhood income quintile,				
No. (%)				
Rural	1,825 (17%)	1,889 (18%)	0.02	
Low Urban	1,628 (15%)	1,699 (16%)	0.02	
2	1,698 (16%)	1,728 (16%)	0.01	
3	1,728 (16%)	1,681 (16%)	0.01	
4	1,831 (17%)	1,753 (16%)	0.02	
High Urban	1,942 (18%)	1,902 (18%)	0.01	
Health region, No. (%)				
Erie St.Clair	462 (4%)	423 (4%)	0.02	
South West	1,107 (10%)	1,114 (10%)	0	
Waterloo Wellington	327 (3%)	343 (3%)	0.01	
Hamilton Niagara	1,265 (12%)	1,290 (12%)	0.01	
Central West	620 (6%)	580 (5%)	0.02	
Mississauga Halton	142 (1%)	144 (1%)	0	
Toronto Central	503 (5%)	478 (4%)	0.01	
Central	201 (2%)	209 (2%)	0.01	
Central East	1,643 (15%)	1,702 (16%)	0.02	
South East	859 (8%)	891 (8%)	0.01	
Champlain	895 (8%)	904 (8%)	0	
North Simcoe-Muskoka	265 (2%)	242 (2%)	0.01	
North East	1,409 (13%)	1,378 (13%)	0.01	
North West	954 (9%)	954 (9%)	0	
Recent immigrant, No. (%)	111 (1%)	105 (1%)	0.01	
FOBT 2 to 5 years prior to mailing, No. (%)	1,476 (14%)	1,240 (12%)	0.07	
Physician				

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Median age in years (IQR)	52 (45-59)	52 (47-58)	N/A
Sex, No. (%)			
Female	3,875 (36%)	3,335 (31%)	N/A
Male	6,777 (64%)	7,317 (69%)	IN/A
Practice type, No. (%)			
FHG	4,854 (46%)	4,885 (46%)	
FHO/FHN	1,859 (17%)	1,718 (16%)	NI/A
FHO/FHN-FHT	3,374 (32%)	3,027 (28%)	N/A
Other PEM	565 (5%)	1,022 (10%)	
Practice size (enrolled patients), No.			
(%)			
>1800 patients	5,366 (50%)	5,026 (47%)	N/A

*Standardized differences for physician level variables not reported as propensity scores were estimated using patient level characteristics only

**Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

Other PEM = other patient enrolled model of care

FOBT = fecal occult blood test

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 4. Association between mailed invitation and FOBT completion or mailed invitation and FOBT or colonoscopy completion after adjusting for physician factors.

	FOBT completion		FOBT or Colonoscopy complete	
	Odds ratio (95% C.I.)	P-value	Odds ratio (95% C.I.)	P-value
lailed invitation				
Yes (Pilot)	3.3 (3.1, 3.6)	<.0001	2.7 (2.5, 2.9)	<.0001
No (Controls)	Reference	N/A	Reference	N/A
ncreasing age (per year)	1.0 (1.0, 1.0)	NS	1.0 (1.0, 1.0)	0.03
Sex, No. (%)				
Female	1.0 (0.9, 1.1)	NS	1.0 (0.9, 1.1)	NS
Male	Reference	N/A	Reference	N/A
Practice type, No. (%)				
FHG	0.7 (0.6, 0.8)	<.0001	0.7 (0.7, 0.8)	<.0001
FHO/FHN	0.8 (0.7, 0.9)	<.0001	0.8 (0.7, 0.9)	<.0001
Other PEM	0.8 (0.7, 1.0)	0.03	0.8 (0.7, 1.0)	NS
FHO/FHN-FHT	Reference	N/A	Reference	N/A
Practice size (enrolled patients)				
≤ 1800 patients	1.2 (1.1, 1.3)	0.0004	1.2 (1.1, 1.3)	<.0001
> 1800 patients	Reference	N/A	Reference	N/A

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Figure Legends

Figure 1. Mock-up of physician-linked invitation used in the Pilot.

BMJ Open

C cancer care | action cancer ontario | ontario

Colon Cancer Check

Contrôle Cancer Colorectal

From the office of Dr. George Black

June 1, 2009

Lawren Harris 456 Superior Street Lindsay ON K2L 3M4

Dear Lawren Harris:

You have received this letter because it is time to be screened for colon cancer. Our records as of April 1st, 2009 show that you have never had a fecal occult blood test (FOBT) or we do not know when you had your last FOBT. All adults between the ages of 50 and 74 years who are at average risk for colon cancer should do a FOBT every two years.

If your parent, brother, sister or child has had colon cancer, your risk is higher and you should have a colonoscopy.

Please call my office to set up an appointment to talk about your risk for colon cancer and which test is right for you.

If you have recently completed colon cancer screening, please disregard this letter.

I look forward to hearing from you soon.

Dr. George Black 705-555-1212

GET THE FACTS. GET CHECKED.

- Colon cancer is the second most common cause of cancer death in Ontario
- Colon cancer can develop without any early warning signs.
- If it is caught early enough, 9 out of every 10 people can be cured.
- Regular screening is the best way to catch colon cancer early.
- The FOBT is a simple test that can be done at home.

For more information please visit <u>www.coloncancercheck.ca</u>

This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorectal cancer screening program. CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Cancer Care Ontario. If for any reason you do not wish to receive future correspondence from the program, simply call the ColonCancerCheck Information Line at 1-866-662-9233 during business hours.

Tinmouth at al D	veision linked meile	invitation to be correspond	d improvos untoko in on	arganized colorectal concer server	ina
I mmouth et al., Fi	Tysician-mikeu mane	I mynation to be screene	u miproves uptake m an i	organized colorectal cancer screen	шg

		BMJ Open		
Tinmouth et	t al., Physic	cian-linked mailed invitation to be screened improves uptake in ar program.	organized colore	ectal cancer screening
		Recommendation	Page	Comment
Title and abstract	1	(<i>a</i>) Indicate the study's design with a commonly used term in the title or the abstract	1, 3	
abstract		(b) Provide in the abstract an informative and balanced summary of	3	
		what was done and what was found	-	
Introduction				
Background/rationale	o 2	Explain the scientific background and rationale for the investigation being reported	07-Jun	
Objectives	3	State specific objectives, including any prespecified hypotheses	7, first paragraph	
Methods				
Study design	4	Present key elements of study design early in the paper	7, paragraph 2	
Setting	5	Describe the setting, locations, and relevant dates, including periods		
		of recruitment, exposure, follow-up, and data collection		
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and	9, paragraph 2,	
		methods of selection of participants. Describe methods of follow-up	10, paragraph 2	
			& 12, first	
			paragraph	
		<i>Case-control study</i> —Give the eligibility criteria, and the sources and	n/a	
		methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls		
		rationale for the choice of cases and controls		
		<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources	n/a	
		and methods of selection of participants		
		(b) Cohort study—For matched studies, give matching criteria and	12, first	
		number of exposed and unexposed	paragraph	
		Case-control study—For matched studies, give matching criteria	n/a	
Variables	7	and the number of controls per case Clearly define all outcomes, exposures, predictors, potential	0 10 8 11	
variables	7	confounders, and effect modifiers. Give diagnostic criteria, if applicable	9, 10 & 11	
Data sources/	8*	For each variable of interest, give sources of data and details of	8, 9, 10 & 11	
measurement		methods of assessment (measurement). Describe comparability of		
		assessment methods if there is more than one group		
Bias	9	Describe any efforts to address potential sources of bias	11, paragraph 2	
Dias	,	Describe any choits to address potential sources of bias	& 13, paragraph	
Study size	10	Explain how the study size was arrived at	5, paragraph 1	
Quantitative	10	Explain how quantitative variables were handled in the analyses. If	5, paragraph 1	
variables		applicable, describe which groupings were chosen and why		
Statistical	12	(<i>a</i>) Describe all statistical methods, including those used to control		
methods		for confounding	& 13, paragraph	
		(b) Describe any methods used to examine subgroups and interactions	n/a	
		interactions (c) Explain how missing data were addressed	14, first	
		- / Prain non missing data word addressed	paragraph	
		(d) Cohort study—If applicable, explain how loss to follow-up was	n/a	all patients followed
		addressed		through administrative
				data, therefore no loss
				f/u
		Case-control study—If applicable, explain how matching of cases	n/a	
		and controls was addressed		
		Cross-sectional study-If applicable, describe analytical methods	n/a	
		taking account of sampling strategy	• .	
Doculto		(\underline{e}) Describe any sensitivity analyses	n/a	
Results Participants	13*	(a) Report numbers of individuals at each stage of study—eg	14, first & last	
i ai ucipants	1.5	numbers potentially eligible, examined for eligibility, confirmed	paragraphs	
		eligible, included in the study, completing follow-up, and analysed	Paraprapris	
		(b) Give reasons for non-participation at each stage	14, first & last	
			paragraphs	

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Descriptive data 14* (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential <u>confounders</u> (b) Indicate number of participants with missing data for each variable of interest (c) Cohort study—Summarise follow-up time (eg, average and ta amount) Outcome data 15* Cohort study—Report numbers of outcome events or summary measures over time Case-control study—Report numbers of outcome events or summary measures of exposure Cross-sectional study—Report numbers of outcome events or summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they valued determine (b) Report category boundaries when continuous variables were categorized Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion 18 Summarise key results with reference to study objectives	for 6 months 15, 2nd paragraph & 16, 1st paragraph , or n/a n/a 15, 2nd val). paragraph, Table vere 2 & 4 Tables 2 & 4
confounders (b) Indicate number of participants with missing data for each variable of interest (c) Cohort study—Summarise follow-up time (eg, average and a amount) Outcome data 15* Cohort study—Report numbers of outcome events or summary measures over time Case-control study—Report numbers in each exposure category summary measures of exposure Cross-sectional study—Report numbers of outcome events or summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion Key results 18	15, first paragraph otal all followed up for 6 months 15, 2nd paragraph & 16, 1st paragraph , or n/a n/a 15, 2nd n/a 15, 2nd val). paragraph, Table vere 2 & 4 Tables 2 & 4
variable of interest (c) Cohort study—Summarise follow-up time (eg, average and a amount) Outcome data 15* Cohort study—Report numbers of outcome events or summary measures over time Case-control study—Report numbers in each exposure category summary measures of exposure Cross-sectional study—Report numbers of outcome events or summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion 18	paragraph otal all followed up for 6 months 15, 2nd paragraph & 16, 1st paragraph , or n/a 15, 2nd n/a 15, 2nd val). paragraph, Table vere 2 & 4 Tables 2 & 4
(c) Cohort study—Summarise follow-up time (eg, average and a amount) Outcome data 15* Cohort study—Report numbers of outcome events or summary measures over time Case-control study—Report numbers in each exposure category summary measures of exposure Cross-sectional study—Report numbers of outcome events or summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion 18	otal all followed up for 6 months 15, 2nd paragraph & 16, 1st paragraph , or n/a n/a 15, 2nd n/a 15, 2nd val). paragraph, Table vere 2 & 4 Tables 2 & 4
Outcome data 15* Cohort study—Report numbers of outcome events or summary measures over time Case-control study—Report numbers in each exposure category summary measures of exposure Cross-sectional study—Report numbers of outcome events or summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion 18 Summarise key results with reference to study objectives	15, 2nd paragraph & 16, 1st paragraph , or n/a n/a 15, 2nd val). paragraph, Table vere 2 & 4 Tables 2 & 4
measures over time Case-control study—Report numbers in each exposure category summary measures of exposure Cross-sectional study—Report numbers of outcome events or summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion Key results 18	paragraph & 16, lst paragraph , or n/a n/a 15, 2nd val). paragraph, Table vere 2 & 4 Tables 2 & 4
summary measures of exposure Cross-sectional study—Report numbers of outcome events or summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion 18 Summarise key results with reference to study objectives	, or n/a n/a 15, 2nd val). paragraph, Tabl vere 2 & 4 Tables 2 & 4
Cross-sectional study—Report numbers of outcome events or summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion 18 Summarise key results with reference to study objectives	15, 2nd val). paragraph, Table vere 2 & 4 Tables 2 & 4
summary measures Main results 16 (a) Give unadjusted estimates and, if applicable, confounder- adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion Key results 18	15, 2nd val). paragraph, Table vere 2 & 4 Tables 2 & 4
adjusted estimates and their precision (eg, 95% confidence inter Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion Key results 18	val). paragraph, Table vere 2 & 4 Tables 2 & 4
Make clear which confounders were adjusted for and why they vincluded (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion Key results 18	vere 2 & 4 Tables 2 & 4
(b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion Key results 18 Summarise key results with reference to study objectives	
(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion Key results 18 Summarise key results with reference to study objectives	n/a
absolute risk for a meaningful time period Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Discussion Key results 18 Summarise key results with reference to study objectives	
Discussion Summarise key results with reference to study objectives	<u> </u>
Discussion Summarise key results with reference to study objectives	n/a
	<u> </u>
Limitations 10 Discuss limitations of the start $(1, 1)$	16, paragraph 1
Limitations 19 Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnit	18, 2nd ude paragraph
of any potential bias Interpretation 20 Give a cautious overall interpretation of results considering	17 & 18
objectives, limitations, multiplicity of analyses, results from sim studies, and other relevant evidence	
Generalisability 21 Discuss the generalisability (external validity) of the study resul	ts 18, last paragrap
Other information	
Funding 22 Give the source of funding and the role of the funders for the pre- study and, if applicable, for the original study on which the pres- article is based	ent



Physician-linked mailed invitations to be screened in an organized colorectal cancer screening program: effectiveness and factors associated with response.

Journal:	BMJ Open
Manuscript ID:	bmjopen-2013-004494.R1
Article Type:	Research
Date Submitted by the Author:	27-Dec-2013
Complete List of Authors:	Tinmouth, Jill; Sunnybrook Health Sciences Centre, Baxter, Nancy; University of Toronto, St Michaels Hopsital, Surgery Paszat, Lawrence; Institute for Clinical Evaluative Sciences, Rabeneck, Linda; University of Toronto, Sutradhar, Rinku; Institute for Clinical Evaluative Sciences, Yun, Lingsong; Institute for Clinical Evaluative Sciences,
Primary Subject Heading :	Gastroenterology and hepatology
Secondary Subject Heading:	Oncology, Public health, General practice / Family practice, Health services research
Keywords:	Gastrointestinal tumours < GASTROENTEROLOGY, PREVENTIVE MEDICINE, PRIMARY CARE, PUBLIC HEALTH

SCHOLARONE[™] Manuscripts

TITLE PAGE

Title: Physician-linked mailed invitations to be screened in an organized colorectal cancer screening program: effectiveness and factors associated with response..

Short tile: Physician-linked invitations for colorectal cancer screening

Authors:

Jill Tinmouth^{1,3,5,6} Nancy N. Baxter^{3,5,7} Lawrence F. Paszat^{2,3,4} Linda Rabeneck^{1,3,4,5,6} Rinku Sutradhar^{3,4} Lingsong Yun³

Affiliations: Departments of Medicine¹ and Radiation Oncology², Sunnybrook Health Sciences Centre, Toronto, Canada; Institute for Clinical Evaluative Sciences, Toronto, Canada³; Dalla Lana School of Public Health, University of Toronto, Toronto, Canada⁴; Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Canada⁵; Cancer Care Ontario, Toronto, Canada⁶; Department of General Surgery and Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Canada⁷.

Corresponding Author Information:

Jill Tinmouth MD PhD FRCPC Sunnybrook Health Sciences Centre 2075 Bayview Ave Rm HG40 Toronto ON M4N 3M5 416 480-5910 t 416 480-4845 f jill.tinmouth@sunnybrook.ca

Email addresses of authors:

Nancy N. Baxter Lawrence F. Paszat Linda Rabeneck Rinku Sutradhar Lingsong Yun ntre BaxterN@smh.toronto.on.ca lawrence.paszat@ices.on.ca Linda.Rabeneck@cancercare.on.ca Rinku.Sutradhar@ices.on.ca Lingsong.Yun@ices.on.ca

Word count: 3211 (main text), 262 (abstract)

Number of Tables: 4

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Number of Figures: 1

Number of References: 40

Key words: Mailed invitations, colorectal cancer, organized screening

BMJ Open

ABSTRACT

<u>Objectives</u>: A central tenet of organized cancer screening is that all persons in a target population are invited. The aims of this study were to identify participant and physician factors associated with response to mailed physician-linked invitations (Study 1) and to evaluate their effectiveness in an organized colorectal (CRC) screening program (Study

2).

<u>Design and setting</u>: Two studies (Study 1 – cohort design and Study 2 – matched cohort design of Study 1 participants and a matched control group) conducted in context of Ontario's organized province-wide CRC screening program.

<u>Participants</u>: 102 family physicians and 11,302 associated eligible patients from a technical evaluation ("the Pilot") of large scale mailed invitations for CRC screening were included. Matched controls were randomly selected using propensity scores from among eligible patients associated with family physicians in similar practice types as the Pilot physicians.

Intervention: Physician-linked mailed invitation to have CRC screening.

<u>Outcomes</u>: Uptake of fecal occult blood test (FOBT) within 6 months of mailed invitation (primary) and uptake of FOBT or colonoscopy within 6 months of mailed invitation (secondary).

<u>Results</u>: Factors significantly associated with uptake of FOBT included prior FOBT use, older participant age, greater participant co-morbidity and having a female physician. In

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

the matched analysis, Pilot participants were more likely to complete an FOBT (22% vs. 8%, p<0.0001) or an FOBT or colonoscopy (25% vs. 11%, p <0.0001) within 6 months of <text> mailed invitation than matched controls. The number needed to invite to screen one additional person was 7.

Conclusions: Centralized large scale mailing of physician-linked invitations is both feasible and effective in an organized CRC screening program.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

ARTICLE SUMMARY

Strengths and limitations of this study:

- We describe the implementation of physician-linked invitations in an organized colorectal screening program that is characterized by a high level of primary care physician involvement and that operates in a context where opportunistic screening with colonoscopy is possible
- We have shown that centralized large scale mailing of physician-linked invitations is feasible and effective in this context
- We found that physician linked mailed invitations improve CRC screening participation by 14% such that 7 physician-linked invitations need to be mailed to screen one additional person
- We were limited to data found in Ontario health administrative databases; for example, we were not able to determine family history
- Findings are promising but require appropriate infrastructure in order to be implemented in other jurisdictions

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

INTRODUCTION

Colorectal cancer (CRC) is the 3rd most common cancer and the 4th leading cause of cancer-related death worldwide.[1] Fecal occult blood testing (FOBT)[2-4] and flexible sigmoidoscopy[5-7] have been shown to decrease CRC mortality in randomized controlled trials.

Given these data, organized CRC screening programs[8] are being implemented worldwide.[9] On April 1 2008, Ontario launched Canada's first organized provincewide CRC screening program, ColonCancerCheck (CCC).[10] CCC has a dual strategy: through the primary care physician, FOBT is offered to people at average risk for CRC and colonoscopy to those at increased risk based on family history. The CCC program uses a non-rehydrated guaiac FOBT (Hema-Screen, Immmunostics, Inc., NJ, USA) requiring 3 stool samples from separate stools. The only recommended dietary restriction is to avoid vitamin C for 3 days prior to and during the collection period.

Approximately 75% of Ontario residents received their care via a patient enrolled model (PEMs) of care at the time of the study (2009).[11] PEMs comprise teams of family physicians who provide their enrolled patients with comprehensive health care and extended hours.[12] PEMs vary in terms of structure, services provided and remuneration (varying from enhance fee-for-service to blended capitation). All Ontario physicians are remunerated for preventive care such as CRC screening however, PEM

BMJ Open

physicians are incented to a greater degree than those who are not in PEMs. Specifically, PEM physicians receive a \$7/patient fee for FOBT Distribution and Counseling, a \$6.86/patient fee for CRC Screening Management and an annual <u>Colorectal Cancer Screening Preventive Care Bonus (</u>\$220 to \$4000) depending on the proportion of enrolled patients who are up-to-date with FOBT (15-70%). The physician is entitled to the CRC Screening Management fee if the enrolled patient attends an appointment to discuss CRC screening, has declined the test verbally or in writing or there has been no response after 2 written notices and a telephone call from the physician.[13]

A central tenet of organized screening programs is that all persons in the target population be invited to participate.[8] Implementation of this aspect of organized screening vary: invitations may be sent with an FOBT kit, can include physician recommendation or may incorporate tailored messaging.[14,15] Some of these approaches, such as incorporation of physician recommendation, present significant implementation challenges for organized screening programs such as Ontario's. In 2009, the CCC program conducted the CCC Invitation Pilot (the "Pilot"), an evaluation that tested the technical feasibility of a centralized approach to sending physician-linked mailed invitations for CRC screening. In this paper, we describe the structure and the implementation of the Pilot. In addition, we report on participant and physician factors

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

associated with response to mailed physician-linked invitations and on the effectiveness of these invitations in an organized CRC screening program.

METHODS

The CCC Invitation Pilot – Implementation and Evaluation

The Pilot was conducted by CCC in November 2009 in order to develop and test the technical infrastructure required for large scale centralized physician-linked mailed invitations in Ontario. For the Pilot, invitation letters were generated by the CCC program on behalf of 102 family physicians and sent to all their eligible enrolled patients. Just over 11,000 eligible patient participants were sent mailed invitations requesting they visit their family physician to obtain an FOBT kit or, if appropriate based on family history, a referral for colonoscopy. In this paper, we report on 2 studies using this cohort. Study 1 examines participant and physician factors associated with response to the mailed invitation among those who were sent the mailed invitation. Study 2 evaluates the effectiveness of the mailed invitation by comparing uptake of CRC screening among Study 1 participants compared to a matched control group. Ethics approval was obtained from the research ethics boards at Sunnybrook Health Sciences Centre and the Institute for Clinical Evaluative Sciences (ICES) and permission to use the Pilot data was obtained from Cancer Care Ontario's (CCO) Data Access Committee. All analyses

BMJ Open

were conducted using SAS v.9 (SAS Institute, Cary, NC). A p-value of 0.05 was used to determine statistical significance.

Data Sources

The Pilot study was conducted at ICES, which houses the administrative health records for all 12.4 million Ontarians. CCC program databases were linked to the ICES administrative databases using an encrypted version of the provincial health insurance number.

The ICES databases used include the Canadian Institute of Health Information (CIHI) databases, the Ontario Health Insurance Program (OHIP) Claims History Database, the Registered Persons Database (RPDB), the Ontario Cancer Registry, the ICES Physician Database, and the Client Agency Program Enrollment (CAPE) registry. The CIHI, OHIP, RPDB and the Ontario Cancer Registry and the ICES Physician Database have been previously described.[16,17] The CAPE registry tracks patients enrolled to physicians who participate in PEMs and is a centralized electronic record of the linkage between specific patients and their physicians.,

The CCC program has collected data on CRC screening since its inception using Laboratory Reporting Tool (LRT) and comprises data related to the FOBT kits administered by the CCC program, including the results of these tests.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Study 1: Factors associated with response to the mailed invitation

<u>Cohort Definition</u>: For the Pilot, a convenience sample of physicians participating in PEM-type practices was recruited via CCO's Provincial Primary Care Cancer Network. Patients enrolled to these physicians, aged 50 to 74 years without a history of CRC and who were due for CRC screening (without a record of recent FOBT (previous two years) or lower GI investigation including flexible sigmoidoscopy and colonoscopy (previous 5 years)), were eligible. For the Pilot mailing, CCC generated lists of patient participants eligible for CRC screening for each participating physician using CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT. All persons who were sent an invitation were included in the cohort, regardless of whether the letter was returned to the sender.

<u>The Mailing</u>: Invitations were mailed in November 2009. The date of mailing was the index date. The letters were compiled centrally by the CCC program but were physician-linked; patient participants were sent a letter from their own physician, as indicated by their name at the bottom of the letter in an italicized font (Figure 1). The letter asked participants to visit their family physician for screening; it did not include an FOBT kit. The letter was accompanied by a CRC screening information brochure and sent in an envelope with the family physician name in the front upper left corner. For the purposes of the study, Pilot physicians were compensated an equivalent amount to the CRC Screening Management fee (\$6.86 per eligible enrolled patient) as Ontario PEM

physicians are eligible for this fee for contacting the patient by mail regarding CRC screening.

<u>Response to Mailed Invitation</u>: We used a broad definition of response to the mailed invitation: any record of FOBT in either OHIP or in LRT within 6 months of the index date, regardless of result (including rejected kits). Up to 10% of FOBT done in the province are captured only through OHIP, which does not have data on test results. We were not able to measure response in persons at increased risk of CRC as we do not have family history data available in the administrative databases.

Participant and Physician Factors: We characterized participants by age group, sex, comorbidity, median neighborhood income[18,19], health region[20], immigration status, and prior FOBT. Comorbidity was measured by counting the number of Aggregated Diagnosis Groups (ADGs) in the prior 12 months according to the Johns Hopkins ACG[®] Case-Mix System.[21] This system has been shown to accurately predict mortality in a general population ambulatory cohort in Ontario.[22] We used date of registration in the RPDB as a proxy measure for immigration status; participants were considered recent immigrants if their date of registration was within 5 years of the index date.[23]

Physicians were characterized according to age, sex, training location (attended Canadian medical school vs. outside of Canada), practice type, size of practice, age-

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

eligible rate of colonoscopy or FOBT over prior 2 years as well as the age-eligible rate of annual physical exams or influenza vaccinations in the prior year. All physicians were in PEMs; practice types included family health groups (FHGs, enhanced fee-for-service models), family health organizations or networks (FHO/FHNs, blended capitation models), FHO/FHN with family health team (FHO/FHN-FHT, interprofessional team model with a blended capitation fee structure) and other PEMs.[24] We measured practice size as the number of enrolled patients stratified in a binary fashion (\leq 1800 vs. >1800 enrolled patients) as larger practice sizes have been shown to be associated with poorer preventative care. [25] For the remaining physician characteristics, we identified all enrolled and non-enrolled patients aged 50-74 years in their practices as of the index date. Age-eligible FOBT and colonoscopy rates were obtained for each Pilot physician by calculating the proportion of their age-eligible patients who had had an FOBT or colonoscopy in the 2 years prior to the index date. Similarly, we calculated their rates of age-eligible annual physical exams or influenza vaccine in the year prior to the index date. These variables were derived in order to estimate physician adherence to CRC screening and preventive medicine practices at baseline.

<u>Analysis</u>: The number and proportion of persons in the cohort who responded to the mailed invitation within 6 months were determined overall and by participant and physician characteristics. Multivariate logistic regression modeling was used to identify participant and physician factors associated with response to the mailed invitation. In

BMJ Open

order to account for potential clustering of participants within physicians, Generalized Estimating Equations (GEE) were used in the model.

Study 2: Evaluation of the effectiveness of mailed invitations

<u>Overview and study participants</u>: This was a matched double cohort analysis, comparing uptake of FOBT in those who were sent a mailed invitation (Pilot cohort) to a matched control group who were not sent a mailed invitation. The control group comprised patients who were enrolled to PEM physicians who had not participated in the Pilot. Control participants received "usual care" for the CCC program in terms of screening promotion. As such, they received screening via their primary care physician who were eligible for the same financial incentives as Pilot physicians. Control participants were not sent a centralized physician-linked invitation from the CCC program although their physicians could send them a mailed invitation at their own discretion.

The Pilot cohort comprised all members of the cohort described in Study 1 for whom a matched control could be identified. We identified potential controls as follows: 1) Pilot physicians were matched to non-Pilot physicians who were also practicing in PEMs in a 1:5 ratio using physician age, sex, size and practice type; 2) individuals enrolled to the selected control physicians were retained if they met the same inclusion/exclusion criteria as those in the intervention cohort (aged 50 to 74 years with no prior CRC who were due for CRC screening). As with the identification of eligible participants in the

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Pilot, we used CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT to determine eligibility of potential control participants.

Propensity scores that modeled the probability of belonging to the Pilot group were calculated for each participant in the entire group (Pilot and control). The variables in this model included age (as a continuous measure), sex, co-morbidity, median neighborhood income quintile, health region, immigration status, and FOBT from 2 to 5 years prior.[26, 27] Pilot participants were matched to controls in a 1:1 fashion based on propensity scores using a caliper width of 0.25. This methodology was implemented to balance the distribution of participant-level variables between the Pilot and control groups.

<u>Response to mailed invitation</u>: For our primary outcome, we defined response to the mailed invitation as in Study 1, a record of FOBT regardless of result, within 6 months of the index date. For our secondary outcome, response was defined as a record of either FOBT or colonoscopy within 6 months of the index date. For the purposes of this study, controls were assigned the same index date as their matched counterpart in the Pilot group.

BMJ Open

Analysis: Standard differences between the Pilot participants and controls were calculated for the variables included in the propensity score. Important differences between the 2 groups were defined by a standardized difference exceeding 0.1.[27,28] In the primary analysis, we compared the number and proportion in the Pilot and control groups responding to the mailed invitation with FOBT using McNemar's test.[27] We determined the number of invitations mailed in order to screen one additional person with FOBT. We repeated the above analyses using our secondary outcome in order to determine if observed differences in FOBT uptake could be attributed to differences in colonoscopy uptake (i.e., participants had CRC screening but chose colonoscopy over FOBT). As the matching only accounted for participant-level variables, we repeated our analyses using conditional logistic regression in order to adjust for physician covariates (age, sex, practice type and size).

RESULTS

Study 1: Factors associated with response to the mailed invitation

There were 11,311 eligible patient participants associated with the 102 family physicians in the Pilot cohort. Nine participants were excluded as we were unable to determine their health region and/or income quintile; this left 11,302 participants for the analysis. The majority of participants were 50 to 59 years of age, 52% were women, 48% had no or low co-morbidity and 14% had completed an FOBT from 2 to 5 years prior to the mailing. Two thirds of participants had a male physician, approximately half were part of

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

a primary care team reimbursed via an enhanced fee-for-service arrangement and just under half were enrolled in larger practices (>1800 enrolled patients) (Table 1).

2503 (22%) completed an FOBT within 6 months of mailing. In the multivariate regression, the strongest participant factor associated with FOBT completion was prior FOBT use (2 to 5 years prior vs. > 5 years or never: OR 2.8, 95% C.I.: 2.5 to 3.3, p < 0.0001). Other significant factors associated with FOBT completion included older participant age, greater co-morbidity, and having a female physician (Table 2).

Study 2: Evaluation of the effectiveness of mailed invitations

Of the 11,302 participants in Study 1, 10,652 were successfully matched to 10,652 controls using propensity scores. Standardized differences for the participant characteristics included in the propensity score were all <0.1, indicating that the two cohorts were well matched for measurable potential confounders (Table 3).

Pilot participants were significantly more likely than controls to complete FOBT alone (2387 (22%) versus 854 (8%), p<0.0001) and FOBT or colonoscopy (2664 (25%) vs. 1191 (11%), p<0.0001) within 6 months of mailing. The association between the mailed invitation and CRC screening participation (either FOBT alone or FOBT or colonoscopy) remained after adjusting for physician level characteristics (Table 4).

BMJ Open

DISCUSSION

In the current study, we have demonstrated that physician-linked mailed invitations are both feasible and effective in the context of a large organized, population-based screening program; only 7 letters would need to be sent in order to screen one additional person. Furthermore, we have found that older participants, those with greater comorbidity, those who have previously been screened and those with female physicians were more likely to respond to this type of invitation. Our findings are of particular interest to other jurisdictions planning or who already have organized CRC screening.

In other published studies of mailed invitations, an FOBT kit is often included with the invitation. Three studies done outside organized screening programs have found physician-linked invitations superior to non-linked invitations; 2 of these studies included an FOBT kit,[29,30] and the third study did not.[31] Other studies have examined mailed invitations with FOBT kits in the context of primary care practices in the USA.[32-34] While the results from these trials were largely supportive of mailed invitations, kit inclusion can make it difficult to separate the convenience of receiving the FOBT kit directly by mail from the impact of an invitation from one's own physician.

Our study demonstrates the effectiveness and feasibility of physician-linked invitations in the context of a large organized CRC screening program with an estimated target population of over 3 million persons. Implementation in this context confers challenges in

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

terms of technological infra-structure, privacy and regulatory issues. There are 2 studies (from the United Kingdom[35] and Italy[36]) that have reported on mailed invitations in the context of organized colorectal cancer screening programs and found them to be effective. Both studies included FOBT kits and one studied the impact of physician endorsement specifically.[35] Our findings are important because they support a potentially more cost-effective approach that avoids wasting kits that are mailed but not used.

Our results highlight the critical role of physician recommendation, a finding supported by others. For example, in the NHS Bowel Cancer Screening Programme (BCSP) currently, the primary care physician receives the result but is not directly involved in the mailed invitation or the actual screening. Recently, a randomized controlled trial conducted in the context of the BCSP showed that an endorsement letter from the primary care provider increased participation by 6%.[35] In 2 studies from Australia, endorsement improved initial participation[29,30] and over 4 successive screening rounds.[30]

Uptake of FOBT in Ontario is lower than some organized CRC screening programs in other countries. For example, 30% of Ontarians were up-to-date with FOBT in 2008-9[37] compared to 52% participation in the United Kingdom program by October 2008,[38] 54% in the Italian program in 2007,[39] and 54% in the New Zealand pilot

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

program in 2012.[40] However, in the latter countries, there is very little, if any, opportunistic CRC screening using colonoscopy whereas Ontario's program operates in a hybrid environment where opportunistic colonoscopy is available as the initial screening test in persons at average risk. It has been noted that uptake of FOBT may be lower in settings, such as Ontario's or Australia's,[41] where opportunistic screening is available.[42] The findings from the current study indicate that physician-linked invitations for CRC screening can be effective in increasing uptake of FOBT in programs that operate in the context of opportunistic colonoscopy for average risk screening.

Our study has several limitations. As mentioned above, we are unable to determine family history using Ontario administrative data. A second limitation is that a single generic letter was used. Tailored letters with key messages for specific subgroups may be more effective,[15] an approach that may be relevant in Ontario as we did find that response to the letter appeared to differ in various subgroups. Additionally, while our findings are promising, there are challenges to widespread implementation in other population-based screening programs, including the requirement for a centralized database that links patients to their physicians. Finally, implementation of this strategy in population based screening is predicated on physician acceptability and agreement. While we have found that this approach is acceptable in principle to many Ontario physicians,[43] processes to confirm individual physician agreement have not been

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

determined for the entire CCC program which comprises an estimated 7000 primary care physicians.

CONCLUSIONS

In summary, we have demonstrated that physician-linked mailed invitations for CRC screening, even without the inclusion of an FOBT kit, can have substantial effect on participation in an organized CRC screening program and that it is technically feasible to centrally organize and mail physician-linked invitations on a large scale. Organized screening programs, which often use unlinked invitations, should consider adopting this approach given its demonstrated effectiveness and feasibility.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Peter Austin PhD for his expert statistic advice. They also wish to acknowledge the support of the Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and CCO. The opinions, results and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and CCO is intended or should be inferred.

COMPETING INTERESTS STATEMENT

Dr. Tinmouth is the Lead Scientist for the ColonCancerCheck program and Dr. Rabeneck oversees the ColonCancerCheck program in her capacity as the Vice-President, Cancer Prevention and Control at CCO. None of the other authors have any conflicts of interest to report.

FUNDING STATEMENT

This study was conducted with the support of the Ontario Institute for Cancer Research and CCO's Health Services Research Network, which is independent of the ColonCancerCheck program, provided funding for this work. This work was also supported in part by a grant from the Canadian Institutes for Health Research (grant # CST-85478). Dr. Tinmouth was supported by a Canadian Institutes of Health Research New Investigator Award during the period of this study.

AUTHOR CONTRIBUTION:

Authors contributed substantially to each of the following areas: -conception and design (JT, LFP, LR) or analysis and interpretation of data (JT, NB, LFP, LR, RS, LY) -drafting the article (JT) or revising it critically for important intellectual content (JT, NB, LFP, LR, RS, LY)

-final approval of the version to be published (JT, NB, LFP, LR, RS, LY)

REFERENCES

- 1. Center MM, Jemal A, Ward E. International trends in colorectal cancer incidence rates. Cancer Epidemiol. Biomarkers Prev. 2009;**18**(6):1688-94.
- 2. Mandel JS, Church TR, Bond JH, et al. The effect of fecal occult-blood screening on the incidence of colorectal cancer. N. Engl. J. Med. 2000;**343**(22):1603-7.
- Hardcastle JD, Chamberlain JO, Robinson MH, et al. Randomised controlled trial of faecal-occult-blood screening for colorectal cancer. Lancet 1996;348(9040):1472-7.
- 4. Kronborg O, Fenger C, Olsen J, et al. Randomised study of screening for colorectal cancer with faecal-occult-blood test. Lancet 1996;**348**(9040):1467-71.
- Atkin WS, Edwards R, Kralj-Hans I, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. Lancet 2010;375(9726):1624-33.
- 6. Segnan N AP, Bonelli L, Risio M, Sciallero S, Zappa M, Andreoni B, Arrigoni A, Bisanti L, Casella C, Crosta C, Falcini F, Ferrero F, Giacomin A, Giuliani O, Santarelli A, Visioli CB, Zanetti R, Atkin WS, Senore C, and and the SCORE Working Group. Once-Only Sigmoidoscopy in Colorectal Cancer Screening: Follow-up Findings of the Italian Randomized Controlled Trial—SCORE J. Natl. Cancer Inst. 2011;**103**(17):1310-22.
- 7. Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. N. Engl. J. Med. 2012;**366**(25):2345-57.
- 8. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. Cancer 2004;**104**(5 Suppl):1201-13.
- 9. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Last update: Feb 9 2009 2009. <u>http://appliedresearch.cancer.gov/icsn/colorectal/screening.html</u>.
- 10. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. Last update: Feb 2, 2012.
 - http://health.gov.on.ca/en/public/programs/coloncancercheck/.
- 11. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012.
- 12. HealthForceOntario. Family Practice Models. Last update: May 3 2013. <u>http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideOntario</u> <u>o/PractisingInOntario/family_practice_models.aspx</u>.
- 13. Ontario Ministry of Health and Long-Term Care. Bulletin 4482: ColonCancerCheck Physician Incentives. . Last update: July 22, 2008. http://www.health.gov.on.ca/en/pro/programs/ohip/bulletins/4000/bul4482.pdf.

 Khalid-de Bakker C, Jonkers D, Smits K, et al. Participation in colorectal cancer screening trials after first-time invitation: a systematic review. Endoscopy 2011;43(12):1059-86.

- Rawl SM, Skinner CS, Perkins SM, et al. Computer-delivered tailored intervention improves colon cancer screening knowledge and health beliefs of African-Americans. Health Educ. Res. 2012;27(5):868-85.
- Alharbi O, Rabeneck L, Sutradhar R, et al. A population-based analysis of outpatient colonoscopy in adults assisted by an anesthesiologist. Anesthesiology 2009;111(4):734-40.
- Robles SC, Marrett LD, Clarke EA, et al. An application of capture-recapture methods to the estimation of completeness of cancer registration. J. Clin. Epidemiol. 1988;41(5):495-501.
- Alter DA, Naylor CD, Austin P, et al. Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction. N. Engl. J. Med. 1999;341(18):1359-67.
- Singh SM, Paszat LF, Li C, et al. Association of socioeconomic status and receipt of colorectal cancer investigations: a population-based retrospective cohort study. Can. Med. Assoc. J. 2004;171(5):461-5.
- 20. Anonymous. Ontario's Local Health Integration Networks. Last update: May 30 2013 2013. <u>http://www.lhins.on.ca/home.aspx</u>.
- 21. Anonymous. The Johns Hopkins University ACG Case-Mix System. Last update: 2012. <u>http://www.acg.jhsph.edu/</u>.
- 22. Austin PC, van Walraven C, Wodchis WP, et al. Using the Johns Hopkins Aggregated Diagnosis Groups (ADGs) to predict mortality in a general adult population cohort in Ontario, Canada. Med. Care 2011;**49**(10):932-9.
- 23. Ray JG, Vermeulen MJ, Schull MJ, et al. Results of the Recent Immigrant Pregnancy and Perinatal Long-term Evaluation Study (RIPPLES). 2007;**176**(10):1419-26.
- 24. Glazier RH, Klein-Geltink J, Kopp A, et al. Capitation and enhanced fee-for-service models for primary care reform: a population-based evaluation. Can. Med. Assoc. J. 2009;**180**(11):E72-E81.
- 25. Dahrouge S, Hogg WE, Russell G, et al. Impact of remuneration and organizational factors on completing preventive manoeuvres in primary care practices. CMAJ 2012;**184**(2):E135-43 doi: 10.1503/cmaj.110407.
- D'Agostino RB, Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Stat. Med. 1998;17(19):2265-81.
- Austin PC. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. Multivariate behavioral research 2011;46(3):399-424.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

 Normand ST, Landrum MB, Guadagnoli E, et al. Validating recommendations for coronary angiography following acute myocardial infarction in the elderly: a matched analysis using propensity scores. J. Clin. Epidemiol. 2001;54(4):387-98.

- 29. Cole SR, Young GP, Byrne D, et al. Participation in screening for colorectal cancer based on a faecal occult blood test is improved by endorsement by the primary care practitioner. J. Med. Screen. 2002;9(4):147-52.
- Zajac IT, Whibley AH, Cole SR, et al. Endorsement by the primary care practitioner consistently improves participation in screening for colorectal cancer: a longitudinal analysis. J. Med. Screen. 2010;**17**(1):19-24.
- Grazzini G, Castiglione G, Isu A, et al. Colorectal cancer screening by fecal occult blood testing: results of a population-based experience. Tumori 2000;86(5):384-8.
- 32. Myers RE, Sifri R, Hyslop T, et al. A randomized controlled trial of the impact of targeted and tailored interventions on colorectal cancer screening. Cancer 2007;**110**(9):2083-91.
- Sequist TD, Zaslavsky AM, Marshall R, et al. Patient and physician reminders to promote colorectal cancer screening: a randomized controlled trial. Arch. Intern. Med. 2009;169(4):364-71.
- 34. Walsh JM, Salazar R, Terdiman JP, et al. Promoting use of colorectal cancer screening tests. Can we change physician behavior? J Gen Intern Med 2005;20(12):1097-101.
- 35. Hewitson P, Ward AM, Heneghan C, et al. Primary care endorsement letter and a patient leaflet to improve participation in colorectal cancer screening: results of a factorial randomised trial. Br. J. Cancer 2011;**105**(4):475-80.
- Giorgi Rossi P, Grazzini G, Anti M, et al. Direct mailing of faecal occult blood tests for colorectal cancer screening: a randomized population study from Central Italy. J. Med. Screen. 2011;18(3):121-7 doi: 10.1258/jms.2011.011009.
- 37. Cancer Quality Council of Ontario. Colorectal Cancer Screening: Participation. . Last update: 2013. http://www.csgi.on.ca/cms/one.aspx?portalld=258922&pageId=273238# LijgNM

http://www.csqi.on.ca/cms/one.aspx?portalld=258922&pageId=273238#.UijqNM akrmQ.

- 38. Logan RF, Patnick J, Nickerson C, et al. Outcomes of the Bowel Cancer Screening Programme (BCSP) in England after the first 1 million tests. Gut 2012;61(10):1439-46.
- 39. Parente F, Boemo C, Ardizzoia A, et al. Outcomes and cost evaluation of the first two rounds of a colorectal cancer screening program based on immunochemical fecal occult blood test in northern Italy. Endoscopy 2013;45(1):27-34.
- 40. New Zealand Ministry of Health. Bowel Screening Pilot January to June 2012 results. Last update: 26 April 2013. <u>http://www.health.govt.nz/our-</u> work/diseases-and-conditions/cancer-programme/bowel-cancer-

BMJ Open

Tinmouth et al.	
Physician-linked mailed invitations for colorectal cancer screening	

42. M	 programme/bowel-screening-pilot/bowel-screening-pilot-results/bowel-screening-pilot-january-june-2012-results. ajac IT, Flight I, Turnbull D, et al. Self-reported bowel screening rates in older Australians and the implications for public health screening programs. The Australasian medical journal 2013;6(8):411-7. loss SM, Ancelle-Park R, Brenner H. Evaluation and interpretation of screening outcomes. In: Patnick J, Segnan N, von Karsa L, eds. European guidelines for quality assurance in colorectal cancer screening and diagnosis. Luxembrourg: International Agency for Research on Cancer 2010. inmouth J, Ritvo P, McGregor SE, et al. ColonCancerCheck Primary Care Invitation
	Pilot project: family physician perceptions. Can. Fam. Physician 2012; 58 (10):e570-7.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Tables.

Table 1. Patient participant and physician characteristics for Study 1

	FOBT within 6 months	No FOBT within 6 months	Total
	(n=2,503)	(n=8,799)	(n=11,302)
Patient participants			
Age group in years, No. (%)			
50-59	1,279 (51%)	5,384 (61%)	6,663 (59%)
60-69	894 (36%)	2,637 (30%)	3,531 (31%)
70-74	330 (13%)	778 (9%)	1,108 (10%)
Sex, No. (%)			
Female	1,299 (52%)	4,554 (52%)	5,853 (52%)
Male	1,204 (48%)	4,245 (48%)	5,449 (48%)
Co-morbidity*, No. of ADGs (%)			
0	257 (10%)	1,279 (15%)	1,536 (14%)
1-2	828 (33%)	3,044 (35%)	3,872 (34%)
3-4	712 (28%)	2,241 (25%)	2,953 (26%)
5-6	393 (16%)	1,224 (14%)	1,617 (14%)
7+	313 (13%)	1,011 (11%)	1,324 (12%)
Median neighborhood income quintile, No. (%)			
Rural	394 (16%)	1,431 (16%)	1,825 (16%)
Low Urban	360 (14%)	1,375 (16%)	1,735 (15%)
2	402 (16%)	1,418 (16%)	1,820 (16%)
3	429 (17%)	1,430 (16%)	1,859 (16%)
4	432 (17%)	1,552 (18%)	1,984 (18%)
High Urban	486 (19%)	1,593 (18%)	2,079 (18%)
Health region, No. (%)			
Erie St.Clair	125 (5%)	337 (4%)	462 (4%)
South West	284 (11%)	823 (9%)	1,107 (10%)
Waterloo Wellington	76 (3%)	251 (3%)	327 (3%)
Hamilton Niagara	289 (12%)	976 (11%)	1,265 (11%)
Central West	138 (6%)	482 (5%)	620 (5%)
Mississauga Halton	22 (1%)	120 (1%)	142 (1%)
Toronto Central	111 (4%)	392 (4%)	503 (4%)
Central	24 (1%)	177 (2%)	201 (2%)
Central East	361 (14%)	1,282 (15%)	1,643 (15%)
South East	162 (6%)	697 (8%)	859 (8%)
Champlain	219 (9%)	676 (8%)	895 (8%)
North Simcoe-Muskoka	77 (3%)	188 (2%)	265 (2%)
North East	291 (12%)	1,118 (13%)	1,409 (12%)
North West	324 (13%)	1,280 (15%)	1,604 (14%)

Page 27 of 74

BMJ Open

Physician-linked mailed invitations for colorectal cancer screening

Recent immigrant, No. (%)	23 (1%)	88 (1%)	111 (1%)
FOBT 2 to 5 years prior to mailing, No. (%)	643 (26%)	905 (10%)	1,548 (14%)
Physician			
Median age in years (IQR)	52 (45-59)	53 (46-59)	52 (45-59)
Sex, No. (%)			
Female	936 (37%)	3,044 (35%)	3,980 (35%)
Male	1,567 (63%)	5,755 (65%)	7,322 (65%)
Training location, No. (%)	, <i>,</i> ,		
Outside Canada	312 (12%)	1,196 (14%)	1,508 (13%)
In Canada	2,191 (88%)	7,603 (86%)	9,794 (87%)
Practice type, No. (%)	, , , ,		
FHG	1,082 (43%)	4,266 (48%)	5,348 (47%)
FHO/FHN	432 (17%)	1,456 (17%)	1,888 (17%)
FHO/FHN-FHT	881 (35%)	2,620 (30%)	3,501 (31%)
Other PEM	108 (4%)	457 (5%)	565 (5%)
Practice size (enrolled patients), No. (%)			
>1800 patients	1,105 (44%)	4,104 (47%)	5,209 (46%)
Age-eligible rate of colonoscopy quintile, No. (%)			
Low	485 (19%)	1,619 (18%)	2,104 (19%)
2	548 (22%)	1,940 (22%)	2,488 (22%)
3	637 (25%)	2,279 (26%)	2,916 (26%)
4	477 (19%)	1,696 (19%)	2,173 (19%)
High	356 (14%)	1,265 (14%)	1,621 (14%)
Age-eligible rate of FOBT quintile, No. (%)			
Low	487 (19%)	1,888 (21%)	2,375 (21%)
2	504 (20%)	1,886 (21%)	2,390 (21%)
3	533 (21%)	1,890 (21%)	2,423 (21%)
4	522 (21%)	1,680 (19%)	2,202 (19%)
High	457 (18%)	1,455 (17%)	1,912 (17%)
Age-eligible rate of annual physical exams quintile, No. (%)			
Low	496 (20%)	2,009 (23%)	2,505 (22%)
2	490 (20%)	1,625 (18%)	2,115 (19%)
3	472 (19%)	1,638 (19%)	2,110 (19%)
4	509 (20%)	1,686 (19%)	2,195 (19%)
High	536 (21%)	1,841 (21%)	2,377 (21%)

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Age-eligible rate of influenza vaccine quintile, No. (%)			
Low	548 (22%)	1,997 (23%)	2,545 (23%)
2	549 (22%)	1,765 (20%)	2,314 (20%)
3	435 (17%)	1,930 (22%)	2,365 (21%)
4	485 (19%)	1,770 (20%)	2,255 (20%)
High	486 (19%)	1,337 (15%)	1,823 (16%)

*Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

Other PEM = other patient enrolled model of care

FOBT = fecal occult blood test

Table 2. Multivariate logistic regression analysis using Generalized Estimating Equations for the characteristics of participants and physicians associated with completing an FOBT within 6 months of the mailing date.

Participants	Odds ratio (95% C.I.)	P-value
Age group, years		
50-59	0.6 (0.5, 0.8)	<.0001
60-69	0.8 (0.7, 1.0)	NS
70-74	Reference	N/A
Sex		
Female	0.9 (0.9, 1.0)	NS
Male	Reference	N/A
Co-morbidity*, No. of ADGs		
0	0.7 (0.6, 0.8)	0.0002
1-2	0.9 (0.7, 1.0)	NS
3-4	1.0 (0.9, 1.2)	NS
5-6	1.0 (0.9, 1.2)	NS
7+	Reference	N/A
Median neighborhood income quintile		
Rural	0.9 (0.7, 1.1)	NS
Low Urban	0.9 (0.7, 1.0)	NS
2	1.0 (0.8, 1.1)	NS
3	1.0 (0.9, 1.1)	NS
4	0.9 (0.8, 1.1)	NS
High Urban	Reference	N/A
Health region		
Erie St.Clair	1.3 (0.9, 1.8)	NS
South West	0.9 (0.6, 1.4)	NS
Waterloo Wellington	0.8 (0.6, 1.2)	NS
Hamilton Niagara	0.9 (0.6, 1.2)	NS
Central West	1.0 (0.7, 1.4)	NS
Mississauga Halton	0.6 (0.3, 1.2)	NS
Toronto Central	0.8 (0.6, 1.2)	NS
Central	0.5 (0.4, 0.7)	0.0004
South East	0.8 (0.4, 0.7)	NS
Champlain	1.0 (0.7, 1.4)	NS
North Simcoe-Muskoka	0.9 (0.6, 1.4)	NS
North East	1.1 (0.7, 1.5)	NS
North West	0.7 (0.5, 1.0)	0.03
Central East	Reference	N/A
Recency of immigration		14// 1
Remote or non-immigrant	1.0 (0.6, 1.6)	NS
Recent immigrant	Reference	N/A
Prior FOBT Use		11/7
2 to 5 years prior to mailing	2.8 (2.5, 3.3)	<.0001

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Physician		
Increasing age (per year)	1.0 (1.0, 1.0)	NS
Sex		
Female	1.3 (1.0, 1.5)	0.02
Male	Reference	N/A
Training location		
In Canada	0.9 (0.7, 1.2)	NS
Outside Canada	Reference	N/A
Practice type		
FHG	0.9 (0.7, 1.1)	NS
FHO/FHN	0.8 (0.6, 1.1)	NS
Other PEM	0.7 (0.4, 1.0)	0.05
FHO/FHN-FHT	Reference	N/A
Practice size (enrolled patients)		
≤ 1800 patients	1.1 (0.9, 1.3)	NS
> 1800 patients	Reference	N/A
Age-eligible rate of colonoscopy quintile		
Low	1.1 (0.8, 1.5)	NS
2	1.2 (1.0, 1.6)	NS
3	1.0 (0.8, 1.2)	NS
4	1.0 (0.8, 1.3)	NS
High	Reference	N/A
Age-eligible rate of FOBT quintile		
2	0.9 (0.6, 1.3)	NS
3	0.9 (0.7, 1.2)	NS
4	1.1 (0.8, 1.4)	NS
High	0.9 (0.7, 1.3)	NS
Low	Reference	N/A
Age-eligible rate of annual physical exams		
quintile		
2	1.4 (0.9, 2.0)	NS
3	1.3 (0.9, 1.8)	NS
4	1.3 (0.9, 1.8)	NS
High	1.1 (0.8, 1.5)	NS
Low	Reference	N/A
Age-eligible rate of influenza vaccine quintile		
2	1.0 (0.8, 1.2)	NS
3	0.8 (0.6, 1.0)	0.02
4	0.9 (0.7, 1.2)	NS
High	1.3 (1.0, 1.7)	NS
Low	Reference	N/A

*Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

NS = not significant N/A - not applicable FOBT = fecal occult blood test

to beer terien only

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 3. Characteristics of the 2 cohorts matched by propensity score in Study 2

	Pilot participants	Control participants	Standardized Difference*
	(n=10,652)	(n=10.652)	
Participants			
Age group in years, No. (%)			
50-59	6,248 (59%)	6,324 (59%)	0.01
60-69	3,342 (31%)	3,316 (31%)	0.01
70-74	1,062 (10%)	1,012 (10%)	0.02
Sex, No. (%)			
Female	5548 (52%)	5477 (51%)	0.01
Male	5,104 (48%)	5,175 (49%)	0.01
Co-morbidity**, No. of ADGs (%)			
0	1,462 (14%)	1,425 (13%)	0.01
1-2	3,647 (34%)	3,716 (35%)	0.01
3-4	2,764 (26%)	2,835 (27%)	0.02
5-6	1,536 (14%)	1,473 (14%)	0.02
7+	1,243 (12%)	1,203 (11%)	0.01
Median neighborhood income quintile, No. (%)			
Rural	1,825 (17%)	1,889 (18%)	0.02
Low Urban	1,628 (15%)	1,699 (16%)	0.02
2	1,698 (16%)	1,728 (16%)	0.01
3	1,728 (16%)	1,681 (16%)	0.01
4	1,831 (17%)	1,753 (16%)	0.02
High Urban	1,942 (18%)	1,902 (18%)	0.01
Health region, No. (%)			
Erie St.Clair	462 (4%)	423 (4%)	0.02
South West	1,107 (10%)	1,114 (10%)	0
Waterloo Wellington	327 (3%)	343 (3%)	0.01
Hamilton Niagara	1,265 (12%)	1,290 (12%)	0.01
Central West	620 (6%)	580 (5%)	0.02
Mississauga Halton	142 (1%)	144 (1%)	0
Toronto Central	503 (5%)	478 (4%)	0.01
Central	201 (2%)	209 (2%)	0.01
Central East	1,643 (15%)	1,702 (16%)	0.02
South East	859 (8%)	891 (8%)	0.01
Champlain	895 (8%)	904 (8%)	0
North Simcoe-Muskoka	265 (2%)	242 (2%)	0.01
North East	1,409 (13%)	1,378 (13%)	0.01
North West	954 (9%)	954 (9%)	0
Recent immigrant, No. (%)	111 (1%)	105 (1%)	0.01
FOBT 2 to 5 years prior to mailing, No.			
(%)	1,476 (14%)	1,240 (12%)	0.07
Physician			

Page 33 of 74

BMJ Open

Tinmouth et al.

Physician-linked mailed invitations for colorectal cancer screening

Median age in years (IQR)	52 (45-59)	52 (47-58)	N/A
Sex, No. (%)			
Female	3,875 (36%)	3,335 (31%)	N1/A
Male	6,777 (64%)	7,317 (69%)	N/A
Practice type, No. (%)			
FHG	4,854 (46%)	4,885 (46%)	
FHO/FHN	1,859 (17%)	1,718 (16%)	N1/A
FHO/FHN-FHT	3,374 (32%)	3,027 (28%)	N/A
Other PEM	565 (5%)	1,022 (10%)	
Practice size (enrolled patients), No.			
(%)			
>1800 patients	5,366 (50%)	5,026 (47%)	N/A

*Standardized differences for physician level variables not reported as propensity scores were estimated using patient level characteristics only

**Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

Other PEM = other patient enrolled model of care

FOBT = fecal occult blood test

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 4. Association between mailed invitation and FOBT completion or mailed invitation and FOBT or colonoscopy completion after adjusting for physician factors.

	FOBT completion		FOBT or Colonoscop	by completion
	Odds ratio (95% C.I.)	P-value	Odds ratio (95% C.I.)	P-value
ailed invitation				
Yes (Pilot)	3.3 (3.1, 3.6)	<.0001	2.7 (2.5, 2.9)	<.0001
No (Controls)	Reference	N/A	Reference	N/A
creasing age (per year)	1.0 (1.0, 1.0)	NS	1.0 (1.0, 1.0)	0.03
ex, No. (%)				
Female	1.0 (0.9, 1.1)	NS	1.0 (0.9, 1.1)	NS
Male	Reference	N/A	Reference	N/A
ractice type, No. (%)				
FHG	0.7 (0.6, 0.8)	<.0001	0.7 (0.7, 0.8)	<.0001
FHO/FHN	0.8 (0.7, 0.9)	<.0001	0.8 (0.7, 0.9)	<.0001
Other PEM	0.8 (0.7, 1.0)	0.03	0.8 (0.7, 1.0)	NS
FHO/FHN-FHT	Reference	N/A	Reference	N/A
ractice size (enrolled patients)				
\leq 1800 patients	1.2 (1.1, 1.3)	0.0004	1.2 (1.1, 1.3)	<.0001
> 1800 patients	Reference	N/A	Reference	N/A
HG = family health group				

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Figure Legends

Figure 1. Mock-up of physician-linked invitation used in the Pilot.

.....

TITLE PAGE

Title: Physician-linked mailed invitations to be screened to be screened improves uptake-in an organized colorectal cancer screening program: effectiveness and factors associated with response. Two linked cohort studies.

Short tile: Physician-linked invitations for colorectal cancer screening

Authors:

Jill Tinmouth^{1,3,5,6} Nancy N. Baxter^{3,5,7} Lawrence F. Paszat^{2,3,4} Linda Rabeneck^{1,3,4,5,6} Rinku Sutradhar^{3,4} Lingsong Yun³

Affiliations: Departments of Medicine¹ and Radiation Oncology², Sunnybrook Health Sciences Centre, Toronto, Canada; Institute for Clinical Evaluative Sciences, Toronto, Canada³; Dalla Lana School of Public Health, University of Toronto, Toronto, Canada⁴; Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Canada⁵; Cancer Care Ontario, Toronto, Canada⁶; Department of General Surgery and Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Canada⁷. R Z O

Corresponding Author Information:

Jill Tinmouth MD PhD FRCPC Sunnybrook Health Sciences Centre 2075 Bayview Ave Rm HG40 Toronto ON M4N 3M5 416 480-5910 t 416 480-4845 f jill.tinmouth@sunnybrook.ca

Email addresses of authors:

Nancy N. Baxter Lawrence F. Paszat Linda Rabeneck Rinku Sutradhar Lingsong Yun

BaxterN@smh.toronto.on.ca lawrence.paszat@ices.on.ca Linda.Rabeneck@cancercare.on.ca Rinku.Sutradhar@ices.on.ca Lingsong.Yun@ices.on.ca

Word count: 2637-3211 (main text), 2642 (abstract)

1	
2 3	
4	Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening
5 6	
7 8	Number of Tables: 4
9 10	Number of Figures: 1
11 12 12	Number of References: 40
13 14	Key words: Mailed invitations, colorectal cancer, organized screening
15 16	
17	
18 19	
20	
21	
22 23	
24	
25 26	
27	
28 29	
30	
31 32	
33	
34 35	
36	
37	
38 39	
40	
41 42	
43	
44 45	
46	
47 48	
49	
50 51	
52	
53 54	
55	
56	2
57 58	
59	
60	

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

ABSTRACT

<u>Objectives</u>: A central tenet of organized cancer screening is that all persons in a target population are invited. The aims of this study <u>weare</u> to identify <u>patientparticipant</u> and physician factors associated with response to mailed physician-linked invitations (Study 1) and to evaluate their effectiveness in an organized colorectal (CRC) screening program (Study 2).

Design and setting: Two linked cohort studies (Study 1 – cohort design and Study 2 – matched cohort design of Study 1 participants and a matched control group) conducted in context of Ontario's organized province-wide CRC screening program. Participants: 102 family physicians and 11,302 associated eligible patients participating fromin a technical evaluation ("the Pilot") of large scale mailed invitations for CRC screening were included. Matched controls were randomly selected using propensity scores from among eligible patients associated with family physicians in similar practice types as the Pilot physicians.

Intervention: Physician-linked mailed invitation to have CRC screening.

<u>Outcomes</u>: Uptake of <u>fecal occult blood test</u> (FOBT) within 6 months of mailed invitation (primary) and uptake of FOBT or colonoscopy within 6 months of mailed invitation (secondary).

<u>Results</u>: Factors significantly associated with uptake of FOBT included prior FOBT use, older <u>patientparticipant</u> age, greater <u>patientparticipant</u> co-morbidity and having a female

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

physician. In the matched analysis, Pilot patientparticipants were more likely to complete an FOBT (22% vs. 8%, p<0.0001) or an FOBT or colonoscopy (25% vs. 11%, p <0.0001) within 6 months of mailed invitation than matched controls. The number needed to invite to screen one additional person was 7.

Conclusions: Centralized large scale mailing of physician-linked invitations is both feasible and effective in an organized CRC screening program.

ARTICLE SUMMARY

Strengths and limitations of this study:

- We describe the ilmplementation and effectiveness of physician-linked invitations in an organized colorectal screening program that is characterized by a high level of primary care physician involvement and that operates in a context where opportunistic screening with colonoscopy is possible have not yet been reported
- We have shown that centralized large scale mailing of physician-linked invitations is feasible and effective in this context
- We found that physician linked mailed invitations improve CRC screening • participation by 14% such that 7 physician-linked invitations need to be mailed to screen one additional person
- , story infrastructure in . We were limited to data found in Ontario health administrative databases; for example, we were not able to determine family history
- Findings are promising but require appropriate infrastructure in order to be implemented in other jurisdictions

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

INTRODUCTION

Colorectal cancer (CRC) is the 3rd most common cancer and the 4th leading cause of cancer-related death worldwide.[1] <u>Fecal occult blood testing (FOBT)[</u>2-4] and flexible sigmoidoscopy[5-7] have been shown to decrease CRC mortality in randomized controlled trials.

Given these data, organized CRC screening programs[8] are being implemented worldwide.[9] On April 1 2008, Ontario launched Canada's first organized provincewide CRC screening program, ColonCancerCheck (CCC).[10] CCC has a dual strategy: through the primary care physician, FOBT is offered to people at average risk for CRC and colonoscopy to those at increased risk based on family history. The CCC program uses a non-rehydrated guaiac FOBT (Hema-Screen, Immmunostics, Inc., NJ, USA) requiring 3 stool samples from separate stools. The only recommended dietary restriction is to avoid vitamin C for 3 days prior to and during the collection period.

Approximately 75% of Ontario residents received their care via a patient enrolled model (PEMs) of care at the time of the study (2009).[11] PEMs comprise teams of family physicians who provide their enrolled patients with comprehensive health care and extended hours.[12] PEMs vary in terms of structure, services provided and remuneration (varying from enhance fee-for-service to blended capitation). All Ontario physicians are remunerated for preventive care such as CRC screening however, PEM

Physician-linked mailed invitations for colorectal cancer screening physicians are incented to a greater degree than those who are not in PEMs. Specifically, PEM physicians receive a \$7/patient fee for FOBT Distribution and Counseling, a \$6.86/patient fee for CRC Screening Management and an annual Colorectal Cancer Screening Preventive Care Bonus (\$220 to \$4000) depending on the proportion of enrolled patients who are up-to-date with FOBT (15-70%). The physician is entitled to the CRC Screening Management fee if the enrolled patient attends an appointment to discuss CRC screening, has declined the test verbally or in writing or there has been no response after 2 written notices and a telephone call from the physician.[13]

Tinmouth et al.

A central tenet of organized screening programs is that all persons in the target population be invited to participate.[8] <u>Operationalization Implementation</u> of this strategy aspect of organized screening can vary: invitations may be sent with an FOBT kit, can include physician recommendation or may incorporate tailored messaging.[14,15] Some of these approaches, such as incorporation of physician recommendation, present significant implementation challenges for organized screening programs such as Ontario's.

In 2009, the CCC program conducted the CCC Invitation Pilot (the "Pilot"), an evaluation that tested the technical feasibility of a centralized approach to sending physician-linked mailed invitations for CRC screening. –In this paper, we describe the structure and the implementation of the Pilot. In addition, we report on <u>patientparticipant</u> and physician

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

factors associated with response to mailed physician-linked invitations and on the effectiveness of these invitations in an organized CRC screening program.

METHODS

The CCC Invitation Pilot – Implementation and Evaluation

The Pilot was conducted by CCC in November 2009 in order to develop and test the technical infrastructure required for large scale centralized physician-linked mailed invitations in Ontario. For the Pilot, invitation letters were generated by the CCC program on behalf of 102 family physicians and sent to all their eligible enrolled patients. Just over 11,000 eligible patient patients-participants received were sent mailed invitations requesting they visit their family physician to obtain an FOBT kit or, if appropriate based on family history, a referral for colonoscopy. In this paper, we report on the 2 linked quantitative studies done-using this cohort. Study 1 examines participant and physician factors associated with response to the mailed invitation among those who were sent the mailed invitation. Study 2 evaluates the effectiveness of the mailed invitation by comparing uptake of CRC screening among Study 1 participants compared to a matched control group. -Ethics approval was obtained from the research ethics boards at Sunnybrook Health Sciences Centre and the Institute for Clinical Evaluative Sciences (ICES) and permission to use the Pilot data was obtained from Cancer Care Ontario's (CCO) Data Access Committee. All analyses were conducted using SAS v.9

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

(SAS Institute, Cary, NC). A p-value of 0.05 was used to determine statistical significance.

Data Sources

The quantitative Pilot study was conducted at ICES, which holds houses the administrative health records for all 12.4 million Ontarians. CCC program databases were linked to the ICES administrative databases using an encrypted version of the provincial health insurance number.

The ICES databases used include the Canadian Institute of Health Information (CIHI) databases, the Ontario Health Insurance Program (OHIP) Claims History Database, the Registered Persons Database (RPDB), the Ontario Cancer Registry, the ICES Physician Database, and the Client Agency Program Enrollment (CAPE) registry. The CIHI, OHIP, RPDB and the Ontario Cancer Registry and the ICES Physician Database have been previously described.[16,17] The CAPE registry tracks patients <u>enrolled to physicians</u> who participate in PEMs and is a centralized electronic record of the linkage between specific patients and their physicians. registered to a specific physician in patient enrolled models (PEMs) of care. PEMs comprise family physicians who provide enrolled patients with comprehensive health care and extended hours; PEM physicians receive incentives for the use of preventive care measures such as CRC screening.[15] PEMs vary in terms of structure, services provided and remuneration (varying from enhance

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

fee for service to blended capitation). It is estimated that 75% of Ontario residents received their care via a PEM in 2009.[16].

The CCC program has collected data on CRC screening since its inception using Laboratory Reporting Tool (LRT) and comprises data related to the FOBT kits administered by the CCC program, including the results of these tests.

Study 1: Factors associated with response to the mailed invitation

<u>Cohort Definition</u>: For the Pilot, a convenience sample of physicians participating in PEM<u>-type</u>-practices was recruited via <u>Cancer Care OntarioCCO</u>'s Provincial Primary Care Cancer Network. Prior to the Pilot mailing, CCC generated lists of patients eligible for CRC screening for each participating physician using CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT. PatientPatients enrolled to these physicians,s aged 50 to 74 years without a history of CRC and who were due for CRC screening (without a record of recent FOBT (previous two years) or lower GI investigation including flexible sigmoidoscopy and colonoscopy (previous 5 years)), were eligible. For the Pilot mailing, CCC generated lists of patient participants eligible for CRC screening for each participating physician using CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT. All persons who were sent an invitation were included in the cohort, regardless of whether the letter was returned to the sender.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

<u>The Mailing</u>: Invitations were mailed in November 2009. The date of mailing was the index date. The letters were compiled centrally by the CCC program but were physician-linked; patientpatient participants received were sent a letter from their own physician, as indicated by their name at the bottom of the letter in an italicized font (Figure 1). The letter asked patientparticipants to visit their family physician for screening; it did not include an FOBT kit. The letter wasy were accompanied by an CRC screening information brochure and sent in an envelope with the family physician name in the front upper left corner. For the purposes of the study, Pilot physicians were compensated an equivalent amount to the CRC Screening Management fee (\$6.86 per eligible enrolled patient) as Ontario PEM physicians are eligible for this fee for contacting the patient by mail regarding CRC screening.

<u>Response to Mailed Invitation</u>: We defined-used a broad definition of response to the mailed invitation: as-any record of FOBT in <u>either</u>OHIP or in LRT_-within 6 months of the index date.—, regardless of result (including rejected kits). Up to 10% of FOBT done in the province are captured only through OHIP, which does not have data on test results. We were not able to measure response in persons at increased risk of CRC as we do not have family history data available in the administrative databases.

<u>PatientParticipant and Physician Factors</u>: We characterized <u>patientparticipant</u>s by age group, sex, co-morbidity, median neighborhood income[18,19], health region[20],

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

immigration status, and prior FOBT. Comorbidity was measured by counting the number of Aggregated Diagnosis Groups (ADGs) in the prior 12 months according to the Johns Hopkins ACG[®] Case-Mix System.[21] This system has been shown to accurately predict mortality in a general population ambulatory cohort in Ontario.[22] We used date of registration in the RPDB as a proxy measure for immigration status;

patientparticipants were considered recent immigrants if their date of registration was within 5 years of the index date.[23]

Physicians were characterized according to age, sex, training location (attended Canadian medical school vs. outside of Canada), practice type, size of practice, ageeligible rate of colonoscopy or FOBT over prior 2 years as well as the age-eligible rate of annual physical exams or influenza vaccinations in the prior year. All physicians were in PEMs; practice types included family health groups (FHGs, enhanced fee-for-service models), family health organizations or networks (FHO/FHNs, blended capitation models), FHO/FHN with family health team (FHO/FHN-FHT, interprofessional team model with a blended capitation fee structure) and other PEMs.[24] We measured practice size as the number of enrolled patients stratified in a binary fashion (≤1800 vs. >1800 enrolled patients) as larger practice sizes have been shown to be associated with poorer preventative care.[25] For the remaining physician characteristics, we identified all enrolled and non-enrolled patients aged 50-74 years in their practices as of the index date. Age-eligible FOBT and colonoscopy rates were obtained for each Pilot physician

by calculating the proportion of their age-eligible patients -who had had an FOBT or colonoscopy in the 2 years prior to the index date. Similarly, we calculated their rates of age-eligible annual physical exams or influenza vaccine in the year prior to the index date. These variables were derived in order to estimate physician adherence to CRC screening and preventive medicine practices at baseline.

<u>Analysis</u>: The number and proportion of persons in the cohort who responded to the mailed invitation within 6 months w<u>ereas</u> determined overall and by <u>patientparticipant</u> and physician characteristics. Multivariate logistic regression modeling was used to identify <u>patientparticipant</u> and physician factors associated with response to the mailed invitation. In order to account for potential clustering of <u>patientparticipant</u>s within physicians, Generalized Estimating Equations (GEE) were used in the model.

Study 2: Evaluation of the effectiveness of mailed invitations

<u>Overview and study participants</u>: This was a matched double cohort analysis, comparing uptake of FOBT in those who received were sent a mailed invitation (Pilot cohort) to a matched control group who were not sent a mailed invitation. <u>The control group</u> comprised patients who were enrolled to PEM physicians who had not participated in the Pilot. Control participants received "usual care" for the CCC program in terms of screening promotion. As such, they received screening via their primary care physician who were eligible for the same financial incentives as Pilot physicians. Control

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

participants were not sent a centralized physician-linked invitation from the CCC program although their physicians could send them a mailed invitation at their own discretion.

The Pilot cohort comprised all members of the cohort described in Study 1 for whom a matched control could be identified. We identified potential <u>patient</u>-controls as follows: 1) Pilot physicians were matched to non-Pilot physicians <u>who were also</u> practicing in PEMs in a 1:5 ratio using physician age, sex, size and practice type; 2) <u>individuals</u> enrolled patients belonging to the selected control physicians were retained if they met the same inclusion/exclusion criteria as those in the intervention cohort (aged 50 to 74 years with no prior CRC who were due for CRC screening). <u>As with the identification of eligible participants in the Pilot, we used CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT to determine eligibility of potential control participants.</u>

Propensity scores that modeled the probability of belonging to the Pilot group were calculated for each patientparticipant in the entire group (Pilot and control). The variables in this model included age (as a continuous measure), sex, co-morbidity, median neighborhood income quintile, health region, immigration status, and FOBT from 2 to 5 years prior.[26,27] Pilot patientparticipants were matched to controls in a 1:1 fashion based on propensity scores using a caliper width of 0.25. This methodology was

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

implemented to balance the distribution of <u>patientparticipant</u>-level variables between the Pilot and control groups.

<u>Response to mailed invitation</u>: For our primary outcome, we defined response to the mailed invitation as <u>abovein Study 1</u>, <u>a record of</u> FOBT <u>regardless of result</u>, within 6 months of the index date. For our secondary outcome, response was defined as a record of either FOBT or colonoscopy (in OHIP) within 6 months of the index date. For the purposes of this study, controls were assigned the same index date as their matched counterpart in the Pilot group.

<u>Analysis</u>: Standard differences between the Pilot participants and controls were calculated for the variables included in the propensity score. Important differences between the 2 groups were defined by a standardized difference exceeding -0.1.[27,28] In the primary analysis, we compared the number and proportion in the Pilot and control groups responding to the mailed invitation with FOBT using McNemar's test.[27] We determined the number of invitations mailed in order to screen one additional person with FOBT. We repeated the above analyses using our secondary outcome in order to determine if observed differences in FOBT uptake could be attributed to a-differences in colonoscopy uptake (i.e., patientparticipants had CRC screening but chose colonoscopy

over FOBT). As the matching only accounted for <u>patientparticipant</u>-level variables, we repeated our analyses using conditional logistic regression in order to adjust for physician covariates (age, sex, practice type and size).

RESULTS

Study 1: Factors associated with response to the mailed invitation

There were 11,311 eligible <u>patient patient patient patient participant</u>s associated with the 102 family physicians in the Pilot cohort. Nine <u>patient participant</u>s were excluded as we were unable to determine their health region and/or income quintile; this left 11,302 <u>patient participant</u>s for the analysis. The majority of <u>patient participant</u>s were 50 to 59 years of age, 52% were women, 48% had no or low co-morbidity and 14% had completed an FOBT from 2 to 5 years prior to the mailing. Two thirds of <u>patient participant</u>s had a male physician, approximately half were part of a primary care team reimbursed via an enhanced fee-for-service arrangement and just under half were enrolled in larger practices (>1800 enrolled patients) (Table 1).

2503 (22%) completed an FOBT within 6 months of mailing. In the multivariate regression, the strongest <u>patientparticipant</u> factor associated with FOBT completion was prior FOBT use (2 to 5 years prior vs. > 5 years or never: OR 2.8, 95% C.I.: 2.5 to 3.3, p < 0.0001). Other significant factors associated with FOBT completion included older <u>patientparticipant</u> age, greater co-morbidity, and having a female physician (Table 2).

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Study 2: Evaluation of the effectiveness of mailed invitations

Of the 11,302 patientparticipants in Study 1, 10,652 patients were successfully matched to 10,652 controls using propensity scores. Standardized differences for the patientparticipant characteristics included in the propensity score were all <0.1, indicating that the two cohorts were well matched for measurable potential confounders (Table 3).

Pilot patientparticipants were significantly more likely than controls to complete FOBT alone (2387 (22%) versus 854 (8%), p<0.0001) and FOBT or colonoscopy (2664 (25%) vs. 1191 (11%), p<0.0001) within 6 months of mailing. The association between the mailed invitation and CRC screening participation (either FOBT alone or FOBT or colonoscopy) remained after adjusting for physician level characteristics (Table 4).

DISCUSSION

In the current study, we have demonstrated that physician-linked mailed invitations are both feasible and effective in the context of a large organized, population-based screening program; only 7 letters would need to be sent in order to screen one additional person. Furthermore, we have found that older <u>patientparticipant</u>s, those with greater co-morbidity, those who have previously been screened and <u>patients ofthose with</u> female physicians were more likely to respond to this type of invitation. Our findings are

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

of particular interest to other jurisdictions planning or who already have organized CRC screening.

In other published studies of mailed invitations, an FOBT kit is often included <u>with the</u> <u>invitation</u>. Three studies done outside organized screening programs have found physician-linked invitations superior to non-linked invitations; 2<u>of these</u> studies of invitations included an FOBT kit,[29,30] and the third study did not.[31] -Other studies have examined mailed invitations with FOBT kits in the context of primary care practices in the USA.[32-34] -While the results from these trials were largely supportive of mailed invitations, kit inclusion can make it difficult to separate the convenience of receiving the FOBT kit directly by mail from the impact of an invitation from one's own physician.

Our study demonstrates the effectiveness and feasibility of physician-linked invitations in the context of a large organized CRC screening program with an estimated target population of over 3 million persons. Implementation in this context confers challenges in terms of technological infra-structure, privacy and regulatory issues. There are 2 studies (from the United Kingdom[35] and Italy[36]) that have reported on mailed invitations in the context of organized colorectal cancer screening programs and found them to be effective. Both studies included FOBT kits and one studied the impact of physician endorsement specifically.[35] Our findings are important because they support a

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

potentially more cost-effective approach that avoids wasting kits that are mailed but not used.

Our results highlight the critical role of physician recommendation, a finding supported by others. For example, in the NHS Bowel Cancer Screening Programme (BCSP) currently, the primary care physician receives the result but is not directly involved in the mailed invitation or the actual screening. Recently, a randomized controlled trial conducted in the context of the BCSP showed that an endorsement letter from the primary care provider increased participation by 6%.[35] In 2 studies from Australia, endorsement improved initial participation[29,30] and over 4 successive screening rounds.[30]

Uptake of FOBT in Ontario is lower than some organized CRC screening programs in other countries. For example, 30% of Ontarians were up-to-date with FOBT in 2008-9 [37] compared to 52% participation in the United Kingdom program by October 2008,[38] 54% in the Italian program in 2007,[39] and 54% in the New Zealand pilot program in 2012.[40] However, in the latter countries, there is very little, if any, opportunistic CRC screening using colonoscopy whereas Ontario's program operates in a hybrid environment where opportunistic colonoscopy is available as the initial screening test in persons at average risk. It has been noted that uptake of FOBT may be lower in settings, such as Ontario's or Australia's,[41] where opportunistic screening is

Formatted: Font: Arial Narrow
Formatted: Font: Arial Narrow

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

<u>available.[42] The findings from the current study indicate that physician-linked</u> <u>invitations for CRC screening can be effective in increasing uptake of FOBT in programs</u> that operate in the context of opportunistic colonoscopy for average risk screening.

Our study has several limitations. As mentioned above, we are unable to determine family history using Ontario administrative data. A second limitation is that a single generic letter was used. Tailored letters with key messages for specific subgroups may be more effective,[15] an approach finding that may be relevant in Ontario as we did find that response to the letter appeared to differ in various subgroups.

FinallyAdditionally, while our findings are promising, there are challenges to widespread implementation in other population-based screening programs, including the requirement for a centralized database that links patients and to their physicians. Finally, implementation of this strategy in population based screening is predicated on physician acceptability and agreement. While we have found that this approach is acceptable in principle to many Ontario physicians,[43] processes to determine confirm individual physician agreement have not been worked outdetermined for the entire CCC program which comprises an estimated 7000 primary care physicians.

CONCLUSIONS

In summary, we have demonstrated that physician-linked mailed invitations for CRC screening, even without the inclusion of an FOBT kit, can have substantial effect on

participation in an organized CRC screening program and that it is technically feasible to centrally organize and mail physician-linked invitations on a large scale. Organized screening programs, which often use unlinked invitations, should consider adopting this approach given its demonstrated effectiveness and feasibility.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Peter Austin PhD for his expert statistic advice. They also wish to acknowledge the support of the Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and Cancer Care OntarioCCO. The opinions, results and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and Cancer Care OntarioCCO is intended or should be inferred.

COMPETING INTERESTS STATEMENT

Dr. Tinmouth is the Lead Scientist for the ColonCancerCheck program and Dr. Rabeneck oversees the ColonCancerCheck program in her capacity as the Vice-President, Cancer Prevention and Control at <u>Cancer Care OntarioCCO</u>. None of the other authors have any conflicts of interest to report.

FUNDING STATEMENT

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

This study was conducted with the support of the Ontario Institute for Cancer Research and <u>Cancer Care OntarioCCO</u>'s Health Services Research Network, which is independent of the ColonCancerCheck program, provided funding for this work. This work was also supported in part by a grant from the Canadian Institutes for Health Research (grant # CST-85478). Dr. Tinmouth was supported by a Canadian Institutes of Health Research New Investigator Award during the period of this study.

AUTHOR CONTRIBUTION:

Authors contributed substantially to each of the following areas:

-conception and design (JT, LFP, LR) or analysis and interpretation of data (JT, NB,

LFP, LR, RS, LY)

-drafting the article (JT) or revising it critically for important intellectual content (JT, NB,

LFP, LR, RS, LY)

-final approval of the version to be published (JT, NB, LFP, LR, RS, LY)

Tinmouth et al.

3 4 Physician-linked mailed invitations for colorectal cancer screening 5 6 7 REFERENCES 8 9 1. Center MM, Jemal A, Ward E. International trends in colorectal cancer incidence 10 rates. Cancer Epidemiol. Biomarkers Prev. 2009;18(6):1688-94. 11 2. Mandel JS, Church TR, Bond JH, et al. The effect of fecal occult-blood screening on 12 the incidence of colorectal cancer. N. Engl. J. Med. 2000;343(22):1603-7. 13 3. Hardcastle JD, Chamberlain JO, Robinson MH, et al. Randomised controlled trial of 14 faecal-occult-blood screening for colorectal cancer. Lancet 15 16 1996;**348**(9040):1472-7. 17 4. Kronborg O, Fenger C, Olsen J, et al. Randomised study of screening for colorectal 18 cancer with faecal-occult-blood test. Lancet 1996;348(9040):1467-71. 19 5. Atkin WS, Edwards R, Kralj-Hans I, et al. Once-only flexible sigmoidoscopy screening 20 in prevention of colorectal cancer: a multicentre randomised controlled trial. 21 Lancet 2010;375(9726):1624-33. 22 6. Segnan N AP, Bonelli L, Risio M, Sciallero S, Zappa M, Andreoni B, Arrigoni A, 23 Bisanti L, Casella C, Crosta C, Falcini F, Ferrero F, Giacomin A, Giuliani O, 24 Santarelli A, Visioli CB, Zanetti R, Atkin WS, Senore C, and and the SCORE 25 Working Group. Once-Only Sigmoidoscopy in Colorectal Cancer Screening: 26 Follow-up Findings of the Italian Randomized Controlled Trial—SCORE J. Natl. 27 Cancer Inst. 2011;103(17):1310-22. 28 7. Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality 29 with screening flexible sigmoidoscopy. N. Engl. J. Med. 2012;366(25):2345-57. 30 8. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized 31 Screening Programs. Cancer 2004;104(5 Suppl):1201-13. 32 9. International Cancer Screening Network. Inventory of Colorectal Cancer Screening 33 Activities in ICSN Countries, May 2008. Last update: Feb 9 2009 2009. 34 http://appliedresearch.cancer.gov/icsn/colorectal/screening.html. 35 10. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. 36 Last update: Feb 2, 2012. 37 http://health.gov.on.ca/en/public/programs/coloncancercheck/. 38 11. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario 39 by Demographics, Case Mix and Emergency Department Use, 2008/09 to 40 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative 41 42 Sciences, 2012. 12. HealthForceOntario. Family Practice Models. Last update: May 3 2013. 43 44 http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideOntari o/PractisingInOntario/family practice models.aspx. 45 46 13. Ontario Ministry of Health and Long-Term Care. Bulletin 4482: ColonCancerCheck 47 Physician Incentives. . Last update: July 22, 2008. 48 http://www.health.gov.on.ca/en/pro/programs/ohip/bulletins/4000/bul4482.pdf. 49 50 51 52 53 54 55 56 57 58 59

1 2

60

Formatted: Space After: 0 pt

BMJ Open

1 2	
3	
4	Tinmouth et al.
5	Physician-linked mailed invitations for colorectal cancer screening
6	
7	14 Khalid de Bakker C. Jankers D. Smits K. et al. Dertisination in colorectal concer
8	14. Khalid-de Bakker C, Jonkers D, Smits K, et al. Participation in colorectal cancer
9	screening trials after first-time invitation: a systematic review. Endoscopy
10	2011; 43 (12):1059-86. 15. Rawl SM, Skinner CS, Perkins SM, et al. Computer-delivered tailored intervention
11	improves colon cancer screening knowledge and health beliefs of African-
12	Americans. Health Educ. Res. 2012; 27 (5):868-85.
13 14	16. Alharbi O, Rabeneck L, Sutradhar R, et al. A population-based analysis of outpatient
14	colonoscopy in adults assisted by an anesthesiologist. Anesthesiology
16	2009; 111 (4):734-40.
17	17. Robles SC, Marrett LD, Clarke EA, et al. An application of capture-recapture
18	methods to the estimation of completeness of cancer registration. J. Clin.
19	Epidemiol. 1988; 41 (5):495-501.
20	18. Alter DA, Naylor CD, Austin P, et al. Effects of socioeconomic status on access to
21	invasive cardiac procedures and on mortality after acute myocardial infarction.
22	N. Engl. J. Med. 1999; 341 (18):1359-67.
23	19. Singh SM, Paszat LF, Li C, et al. Association of socioeconomic status and receipt of
24	colorectal cancer investigations: a population-based retrospective cohort study.
25	Can. Med. Assoc. J. 2004; 171 (5):461-5.
26	20. Anonymous. Ontario's Local Health Integration Networks. Last update: May 30 2013
27	2013. http://www.lhins.on.ca/home.aspx.
28	21. Anonymous. The Johns Hopkins University ACG Case-Mix System. Last update:
29 30	2012. http://www.acg.jhsph.edu/.
31	22. Austin PC, van Walraven C, Wodchis WP, et al. Using the Johns Hopkins
32	Aggregated Diagnosis Groups (ADGs) to predict mortality in a general adult
33	population cohort in Ontario, Canada. Med. Care 2011; 49 (10):932-9.
34	23. Ray JG, Vermeulen MJ, Schull MJ, et al. Results of the Recent Immigrant
35	Pregnancy and Perinatal Long-term Evaluation Study (RIPPLES).
36	2007; 176 (10):1419-26.
37	24. Glazier RH, Klein-Geltink J, Kopp A, et al. Capitation and enhanced fee-for-service
38	models for primary care reform: a population-based evaluation. Can. Med.
39	Assoc. J. 2009; 180 (11):E72-E81.
40	25. Dahrouge S, Hogg WE, Russell G, et al. Impact of remuneration and organizational
41	factors on completing preventive manoeuvres in primary care practices. CMAJ
42	2012; 184 (2):E135-43 doi: 10.1503/cmaj.110407.
43 44	 D'Agostino RB, Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Stat. Med. 1998;17(19):2265-
44	81.
46	27. Austin PC. An Introduction to Propensity Score Methods for Reducing the Effects of
47	Confounding in Observational Studies. Multivariate behavioral research
48	2011; 46 (3):399-424.
49	2011,40(0).000 424.
50	
51	
52	
53	
54	
55	
56	24
57 58	
58 59	
~~	

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

- Normand ST, Landrum MB, Guadagnoli E, et al. Validating recommendations for coronary angiography following acute myocardial infarction in the elderly: a matched analysis using propensity scores. J. Clin. Epidemiol. 2001;54(4):387-98.
- Cole SR, Young GP, Byrne D, et al. Participation in screening for colorectal cancer based on a faecal occult blood test is improved by endorsement by the primary care practitioner. J. Med. Screen. 2002;9(4):147-52.
- Zajac IT, Whibley AH, Cole SR, et al. Endorsement by the primary care practitioner consistently improves participation in screening for colorectal cancer: a longitudinal analysis. J. Med. Screen. 2010;17(1):19-24.
- Grazzini G, Castiglione G, Isu A, et al. Colorectal cancer screening by fecal occult blood testing: results of a population-based experience. Tumori 2000;86(5):384-8.
- Myers RE, Sifri R, Hyslop T, et al. A randomized controlled trial of the impact of targeted and tailored interventions on colorectal cancer screening. Cancer 2007;110(9):2083-91.
- Sequist TD, Zaslavsky AM, Marshall R, et al. Patient and physician reminders to promote colorectal cancer screening: a randomized controlled trial. Arch. Intern. Med. 2009;169(4):364-71.
- Walsh JM, Salazar R, Terdiman JP, et al. Promoting use of colorectal cancer screening tests. Can we change physician behavior? J Gen Intern Med 2005;20(12):1097-101.
- 35. Hewitson P, Ward AM, Heneghan C, et al. Primary care endorsement letter and a patient leaflet to improve participation in colorectal cancer screening: results of a factorial randomised trial. Br. J. Cancer 2011;**105**(4):475-80.
- Giorgi Rossi P, Grazzini G, Anti M, et al. Direct mailing of faecal occult blood tests for colorectal cancer screening: a randomized population study from Central Italy. J. Med. Screen. 2011;18(3):121-7 doi: 10.1258/jms.2011.011009.
- 37. Cancer Quality Council of Ontario. Colorectal Cancer Screening: Participation. . Last update: 2013.

http://www.csqi.on.ca/cms/one.aspx?portalld=258922&pageId=273238#.UijqNM akrmQ.

- Logan RF, Patnick J, Nickerson C, et al. Outcomes of the Bowel Cancer Screening Programme (BCSP) in England after the first 1 million tests. Gut 2012;61(10):1439-46.
- 39. Parente F, Boemo C, Ardizzoia A, et al. Outcomes and cost evaluation of the first two rounds of a colorectal cancer screening program based on immunochemical fecal occult blood test in northern Italy. Endoscopy 2013;45(1):27-34.
- 40. New Zealand Ministry of Health. Bowel Screening Pilot January to June 2012 results. Last update: 26 April 2013. <u>http://www.health.govt.nz/our-</u> work/diseases-and-conditions/cancer-programme/bowel-cancer-

BMJ Open

י ר
2
3
4
3 4 5 6 7
6
7
1
8
9
10
11
11
12
13
14
15
16
10
17
9 10 11 12 13 14 15 16 17 18 19
19
20
22 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
22
23
24
25
26
20
27
28
29
30
21
31
32
33
34
35
26
30
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

programme/bowel-screening-pilot/bowel-screening-pilot-results/bowelscreening-pilot-january-june-2012-results.

- 41. Zajac IT, Flight I, Turnbull D, et al. Self-reported bowel screening rates in older Australians and the implications for public health screening programs. The Australasian medical journal 2013;6(8):411-7.
- 42. Moss SM, Ancelle-Park R, Brenner H. Evaluation and interpretation of screening outcomes. In: Patnick J, Segnan N, von Karsa L, eds. European guidelines for quality assurance in colorectal cancer screening and diagnosis. Luxembrourg: International Agency for Research on Cancer 2010.
- , I K ar scree. . I on Cancer. . et al. ColonCan. . perceptions. Can. F. 43. Tinmouth J, Ritvo P, McGregor SE, et al. ColonCancerCheck Primary Care Invitation Pilot project: family physician perceptions. Can. Fam. Physician 2012;58(10):e570-7.

Tables.

Table 1. PatientPatient participant and physician characteristics for Pilot participants in Study 1

	FOBT within 6 months	No FOBT within 6 months	Total
	(n=2,503)	(n=8,799)	(n=11,302)
PatientPatient participants			
Age group in years, No. (%)			
50-59	1,279 (51%)	5,384 (61%)	6,663 (59%)
60-69	894 (36%)	2,637 (30%)	3,531 (31%)
70-74	330 (13%)	778 (9%)	1,108 (10%)
Sex, No. (%)			
Female	1,299 (52%)	4,554 (52%)	5,853 (52%)
Male	1,204 (48%)	4,245 (48%)	5,449 (48%)
Co-morbidity*, No. of ADGs (%)			
0	257 (10%)	1,279 (15%)	1,536 (14%)
1-2	828 (33%)	3,044 (35%)	3,872 (34%)
3-4	712 (28%)	2,241 (25%)	2,953 (26%)
5-6	393 (16%)	1,224 (14%)	1,617 (14%)
7+	313 (13%)	1,011 (11%)	1,324 (12%)
Median neighborhood income quintile, No. (%)			
Rural	394 (16%)	1,431 (16%)	1,825 (16%)
Low Urban	360 (14%)	1,375 (16%)	1,735 (15%)
2	402 (16%)	1,418 (16%)	1,820 (16%)
3	429 (17%)	1,430 (16%)	1,859 (16%)
4	432 (17%)	1,552 (18%)	1,984 (18%)
High Urban	486 (19%)	1,593 (18%)	2,079 (18%)
Health region, No. (%)			
Erie St.Clair	125 (5%)	337 (4%)	462 (4%)
South West	284 (11%)	823 (9%)	1,107 (10%)
Waterloo Wellington	76 (3%)	251 (3%)	327 (3%)
Hamilton Niagara	289 (12%)	976 (11%)	1,265 (11%)
Central West	138 (6%)	482 (5%)	620 (5%)
Mississauga Halton	22 (1%)	120 (1%)	142 (1%)
Toronto Central	111 (4%)	392 (4%)	503 (4%)
Central Central East	24 (1%) 361 (14%)	177 (2%) 1,282 (15%)	201 (2%) 1,643 (15%)
South East	162 (6%)	697 (8%)	859 (8%)
Champlain	219 (9%)	676 (8%)	895 (8%)
North Simcoe-Muskoka	77 (3%)	188 (2%)	265 (2%)
North East	291 (12%)	1,118 (13%)	1,409 (12%)
North West	324 (13%)	1,280 (15%)	1,604 (14%)

Recent immigrant, No. (%)	23 (1%)	88 (1%)	111 (1%)
FOBT 2 to 5 years prior to mailing, No. (%)	643 (26%)	905 (10%)	1,548 (14%)
Physician			
Median age in years (IQR)	52 (45-59)	53 (46-59)	52 (45-59)
Sex, No. (%)			
Female Male	936 (37%) 1,567 (63%)	3,044 (35%) 5,755 (65%)	3,980 (35%) 7,322 (65%)
Training location, No. (%)	1,001 (0070)		1,022 (0070)
Outside Canada	312 (12%)	1,196 (14%)	1,508 (13%)
In Canada	2,191 (88%)	7,603 (86%)	9,794 (87%)
Practice type, No. (%) FHG	1,082 (43%)	4,266 (48%)	5,348 (47%)
FHO/FHN	432 (17%)	1,456 (17%)	1,888 (17%)
FHO/FHN-FHT	881 (35%)	2,620 (30%)	3,501 (31%)
Other PEM	108 (4%)	457 (5%)	565 (5%)
Practice size (enrolled patients), No. (%)			
>1800 patients	1,105 (44%)	4,104 (47%)	5,209 (46%)
Age-eligible rate of colonoscopy quintile, No. (%)			
Low	485 (19%)	1,619 (18%)	2,104 (19%)
2	548 (22%)	1,940 (22%)	2,488 (22%)
3 4	637 (25%) 477 (19%)	2,279 (26%) 1,696 (19%)	2,916 (26%) 2,173 (19%)
- High	356 (14%)	1,265 (14%)	1,621 (14%)
Age-eligible rate of FOBT quintile, No. (%)			
Low	487 (19%)	1,888 (21%)	2,375 (21%)
2	504 (20%)	1,886 (21%)	2,390 (21%)
3	533 (21%)	1,890 (21%)	2,423 (21%)
4 1 list	522 (21%)	1,680 (19%)	2,202 (19%)
High	457 (18%)	1,455 (17%)	1,912 (17%)
Age-eligible rate of annual physical exams quintile, No. (%)			
Low	496 (20%)	2,009 (23%)	2,505 (22%)
2 3	490 (20%)	1,625 (18%)	2,115 (19%)
3	472 (19%) 509 (20%)	1,638 (19%) 1,686 (19%)	2,110 (19%) 2,195 (19%)
4 High	536 (21%)	1,841 (21%)	2,195 (19%)

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Age-eligible rate of influenza vaccine quintile, No. (%)			
Low	548 (22%)	1,997 (23%)	2,545 (23%)
2	549 (22%)	1,765 (20%)	2,314 (20%)
3	435 (17%)	1,930 (22%)	2,365 (21%)
4	485 (19%)	1,770 (20%)	2,255 (20%)
High	486 (19%)	1,337 (15%)	1,823 (16%)
*Co-morbidity scored using number of Agg	regated Diagnosis Groups (AD	Gs) using the Johns Hopkins C	ase Mix System
FHG = family health group		, .	
FHO/FHN = family health organizations or			
Other PEM = other patient enrolled model	of care		
FOBT = fecal occult blood test			

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 2. Multivariate logistic regression analysis using Generalized Estimating Equations for the

characteristics of patientparticipants and physicians associated with completing an FOBT within 6 months of the mailing date.

PatientParticipants	Odds ratio (95% C.I.)	P-value
Age group, years		
50-59	0.6 (0.5, 0.8)	<.0001
60-69	0.8 (0.7, 1.0)	NS
70-74	Reference	N/A
Sex		
Female	0.9 (0.9, 1.0)	NS
Male	Reference	N/A
Co-morbidity*, No. of ADGs		
0	0.7 (0.6, 0.8)	0.0002
1-2	0.9 (0.7, 1.0)	NS
3-4	1.0 (0.9, 1.2)	NS
5-6	1.0 (0.9, 1.2)	NS
7+	Reference	N/A
Median neighborhood income quintile		
Rural	0.9 (0.7, 1.1)	NS
Low Urban	0.9 (0.7, 1.0)	NS
2	1.0 (0.8, 1.1)	NS
3	1.0 (0.9, 1.1)	NS
4	0.9 (0.8, 1.1)	NS
High Urban	Reference	N/A
Health region		
Erie St.Clair	1.3 (0.9, 1.8)	NS
South West	0.9 (0.6, 1.4)	NS
Waterloo Wellington	0.8 (0.6, 1.2)	NS
Hamilton Niagara	0.9 (0.6, 1.2)	NS
Central West	1.0 (0.7, 1.4)	NS
Mississauga Halton	0.6 (0.3, 1.2)	NS
Toronto Central	0.8 (0.6, 1.2)	NS
Central	0.5 (0.4, 0.7)	0.0004
South East	0.8 (0.4, 0.7)	NS
Champlain	1.0 (0.7, 1.4)	NS
North Simcoe-Muskoka	0.9 (0.6, 1.4)	NS
North East	1.1 (0.7, 1.5)	NS
North West	0.7 (0.5, 1.0)	0.03
Central East	Reference	N/A
Recency of immigration		1 11// 1
Remote or non-immigrant	1.0 (0.6, 1.6)	NS
Recent immigrant	Reference	N/A
Prior FOBT Use		13// 3
2 to 5 years prior to mailing	2.8 (2.5, 3.3)	<.0001

> 5 years or never	Reference	
Physician		
Increasing age (per year)	1.0 (1.0, 1.0)	NS
Sex		
Female	1.3 (1.0, 1.5)	0.02
Male	Reference	N/A
Training location		
In Canada	0.9 (0.7, 1.2)	NS
Outside Canada	Reference	N/A
Practice type		
FHG	0.9 (0.7, 1.1)	NS
FHO/FHN	0.8 (0.6, 1.1)	NS
Other PEM	0.7 (0.4, 1.0)	0.05
FHO/FHN-FHT	Reference	N/A
Practice size (enrolled patients)		
≤ 1800 patients	1.1 (0.9, 1.3)	NS
> 1800 patients	Reference	N/A
Age-eligible rate of colonoscopy quintile		
Low	1.1 (0.8, 1.5)	NS
2	1.2 (1.0, 1.6)	NS
3	1.0 (0.8, 1.2)	NS
4	1.0 (0.8, 1.3)	NS
High	Reference	N/A
Age-eligible rate of FOBT quintile		
2	0.9 (0.6, 1.3)	NS
3	0.9 (0.7, 1.2)	NS
4	1.1 (0.8, 1.4)	NS
High	0.9 (0.7, 1.3)	NS
Low	Reference	N/A
Age-eligible rate of annual physical exams		
quintile		
2	1.4 (0.9, 2.0)	NS
3	1.3 (0.9, 1.8)	NS
4	1.3 (0.9, 1.8)	NS
High	1.1 (0.8, 1.5)	NS
Low	Reference	N/A
Age-eligible rate of influenza vaccine quintile		
2	1.0 (0.8, 1.2)	NS
3	0.8 (0.6, 1.0)	0.02
4	0.9 (0.7, 1.2)	NS
High	1.3 (1.0, 1.7)	NS
Low	Reference	N/A

*Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

1	
2	
3	
4	Tinmouth et al.
5	Physician-linked mailed invitations for colorectal cancer screening
6	
7	
8	Other PEM = other patient enrolled model of care
9	NS = not significant N/A - not applicable
10	FOBT = fecal occult blood test
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49 50	
50	
51 52	
52 53	
53 54	
55 56	
50 57	32
57	
58 59	
60	
00	
	For neer review only - http://bmionen.hmi.com/site/about/quidelines.yhtml

Tahla 3	Characteristics of	of the 2 cohorts	matched by n	rononsity sco	no in Study 2
rable 5.			matched by p	score score	

	Pilot participants	Control patients participants	Standardized Difference*	
	(n=10,652)	(n=10.652)		
ParticipantsPatients				
Age group in years, No. (%)				
50-59	6,248 (59%)	6,324 (59%)	0.01	
60-69	3,342 (31%)	3,316 (31%)	0.01	
70-74	1,062 (10%)	1,012 (10%)	0.02	
Sex, No. (%)				
Female	5548 (52%)	5477 (51%)	0.01	
Male	5,104 (48%)	5,175 (49%)	0.01	
Co-morbidity**, No. of ADGs (%)				
0	1,462 (14%)	1,425 (13%)	0.01	
1-2	3,647 (34%)	3,716 (35%)	0.01	
3-4	2,764 (26%)	2,835 (27%)	0.02	
5-6	1,536 (14%)	1,473 (14%)	0.02	
7+	1,243 (12%)	1,203 (11%)	0.01	
Median neighborhood income quintile,				
No. (%)				
Rural	1,825 (17%)	1,889 (18%)	0.02	
Low Urban	1,628 (15%)	1,699 (16%)	0.02	
2	1,698 (16%)	1,728 (16%)	0.01	
3	1,728 (16%)	1,681 (16%)	0.01	
4	1,831 (17%)	1,753 (16%)	0.02	
High Urban	1,942 (18%)	1,902 (18%)	0.01	
Health region, No. (%)				
Erie St.Clair	462 (4%)	423 (4%)	0.02	
South West	1,107 (10%)	1,114 (10%)	0	
Waterloo Wellington	327 (3%)	343 (3%)	0.01	
Hamilton Niagara	1,265 (12%)	1,290 (12%)	0.01	
Central West	620 (6%)	580 (5%)	0.02	
Mississauga Halton	142 (1%)	144 (1%)	0	
Toronto Central	503 (5%)	478 (4%)	0.01	
Central	201 (2%)	209 (2%)	0.01	
Central East	1,643 (15%)	1,702 (16%)	0.02	
South East	859 (8%)	891 (8%)	0.01	
Champlain	895 (8%)	904 (8%)	0	
North Simcoe-Muskoka	265 (2%)	242 (2%)	0.01	
North East	1,409 (13%)	1,378 (13%)	0.01	
North West	954 (9%)	954 (9%)	0	
Recent immigrant, No. (%)	111 (1%)	105 (1%)	0.01	
FOBT 2 to 5 years prior to mailing, No.	1,476 (14%)	1,240 (12%)	0.07	
(%)	1,470 (1470)	1,270 (12/0)	0.07	

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Median age in years (IQR)	52 (45-59)	52 (47-58)	N/A
Sex, No. (%)			
Female	3,875 (36%)	3,335 (31%)	N/A
Male	6,777 (64%)	7,317 (69%)	N/A
Practice type, No. (%)			
FHG	4,854 (46%)	4,885 (46%)	
FHO/FHN	1,859 (17%)	1,718 (16%)	N/A
FHO/FHN-FHT	3,374 (32%)	3,027 (28%)	N/A
Other PEM	565 (5%)	1,022 (10%)	
Practice size (enrolled patients), No.			
(%)			
>1800 patients	5,366 (50%)	5,026 (47%)	N/A

*Standardized differences for physician level variables not reported as propensity scores were estimated using patient level characteristics only

s π. pris re **Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

Other PEM = other patient enrolled model of care

FOBT = fecal occult blood test

Table 4. Association between mailed invitation and FOBT completion or mailed invitation and FOBT or colonoscopy completion after adjusting for physician factors.

Odds ratio (95% C.I.) P-value Odds ratio (95% C.I.) P-value Mailed invitation Yes (Pilot) No (Controls) 3.3 (3.1, 3.6) Reference <.0001 2.7 (2.5, 2.9) N/A <.0001 Increasing age (per year) 1.0 (1.0, 1.0) NS 1.0 (1.0, 1.0) 0.03 Sex, No, (%) Female 1.0 (0.9, 1.1) NS 1.0 (0.9, 1.1) NS Practice type, No. (%) FHG 0.7 (0.6, 0.8) 0.7 (0.6, 0.8) <.0001 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) <.0001 Other PEM 0.8 (0.7, 0.9) <.0001 0.8 (0.7, 0.9) <.0001 Other PEM 0.8 (0.7, 1.0) N/A Reference N/A Practice size (enrolled patients) 1.2 (1, 1.3) 0.0004 1.2 (1.1, 1.3) <.0001 < 1800 patients 1.2 (1, 1.1.3) 0.0004 1.2 (1.1, 1.3) <.0001 < 1800 patients 1.2 (1, 1.1.3) 0.0004 1.2 (1.1, 1.3) <.0001 < 1800 patients 1.2 (1.1, 1.3) N/A Reference N/A FHG = family health group FHO/FHN = family health corganizations or networks N/A Reference N/A	Mailed invitation Yes (Pilot) $3.3 (3.1, 3.6)$ ReferenceNo (Controls)ReferenceIncreasing age (per year) $1.0 (1.0, 1.0)$ Sex, No. (%)1.0 (0.9, 1.1)Female $1.0 (0.9, 1.1)$ MaleReferencePractice type, No. (%)0.7 (0.6, 0.8)FHG $0.7 (0.6, 0.8)$ Other PEM $0.8 (0.7, 0.9)$ Other PEM $0.8 (0.7, 1.0)$ FHO/FHN-FHTReferencePractice size (enrolled patients) ≤ 1800 patients ≤ 1800 patients $1.2 (1.1, 1.3)$ > 1800 patientsReference	<.0001 N/A NS N/A <.0001 <.0001 0.03 N/A 0.0004 N/A	2.7 (2.5, 2.9) Reference 1.0 (1.0, 1.0) 1.0 (0.9, 1.1) Reference 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	<.0001 N/A 0.03 NS N/A <.0001 <.0001 NS N/A <.0001 N/A
Yes (Pilot) $3.3 (3.1, 3.6)$ <.0001	Yes (Pilot) 3.3 (3.1, 3.6) No (Controls) Reference Increasing age (per year) 1.0 (1.0, 1.0) Sex, No. (%) 1.0 (0.9, 1.1) Male Reference Practice type, No. (%) 0.7 (0.6, 0.8) FHG 0.7 (0.6, 0.9) Other PEM 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) ≤ 1800 patients ≤ 1800 patients 1.2 (1.1, 1.3) > 1800 patients Reference	N/A NS N/A <.0001 <.0001 0.03 N/A 0.0004 N/A	Reference 1.0 (1.0, 1.0) 1.0 (0.9, 1.1) Reference 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	N/A 0.03 NS N/A <.0001 <.0001 NS N/A <.0001 N/A
Yes (Pilot) $3.3 (3.1, 3.6)$ $<.0001$ $2.7 (2.5, 2.9)$ $<.0001$ No (Controls)ReferenceN/AReferenceN/AIncreasing age (per year) $1.0 (1.0, 1.0)$ NS $1.0 (1.0, 1.0)$ 0.03 Sex, No. (%) $1.0 (0.9, 1.1)$ NS $1.0 (0.9, 1.1)$ NS $1.0 (0.9, 1.1)$ NSFemale $1.0 (0.9, 1.1)$ NS $1.0 (0.9, 1.1)$ NS N/A ReferenceN/APractice type, No. (%) $Reference$ N/AReferenceN/A $Reference$ N/AFHG $0.7 (0.6, 0.8)$ $<.0001$ $0.7 (0.7, 0.8)$ $<.0001$ Other PEM $0.8 (0.7, 0.9)$ $<.0001$ $0.8 (0.7, 0.9)$ $<.0001$ Other PEM $0.8 (0.7, 1.0)$ 0.03 $0.8 (0.7, 1.0)$ NSFHO/FHN-FHTReferenceN/AReferenceN/APractice size (enrolled patients) $1.2 (1.1, 1.3)$ 0.0004 $1.2 (1.1, 1.3)$ $<.0001$ > 1800 patients $1.2 (1.1, 1.3)$ $Reference$ N/AReferenceN/AFHG = family health group $Reference$ N/AReferenceN/A	Yes (Pilot) 3.3 (3.1, 3.6) No (Controls) Reference Increasing age (per year) 1.0 (1.0, 1.0) Sex, No. (%) 1.0 (0.9, 1.1) Female 1.0 (0.9, 1.1) Male Reference Practice type, No. (%) 0.7 (0.6, 0.8) FHG 0.7 (0.6, 0.9) Other PEM 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) ≤ 1800 patients ≤ 1800 patients 1.2 (1.1, 1.3) > 1800 patients Reference	N/A NS N/A <.0001 <.0001 0.03 N/A 0.0004 N/A	Reference 1.0 (1.0, 1.0) 1.0 (0.9, 1.1) Reference 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	N/A 0.03 NS N/A <.0001 <.0001 NS N/A <.0001 N/A
$\begin{array}{c c} \mbox{Increasing age (per year)} & 1.0 (1.0, 1.0) & NS & 1.0 (1.0, 1.0) & 0.03 \\ \hline Sex, No. (\%) & & & & & \\ Female & 1.0 (0.9, 1.1) & NS & 1.0 (0.9, 1.1) & NS \\ Male & Reference & N/A & Reference & N/A \\ \hline Practice type, No. (\%) & & & & \\ FHG & 0.7 (0.6, 0.8) & <.0001 & 0.7 (0.7, 0.8) & <.0001 \\ FHO/FHN & 0.8 (0.7, 0.9) & <.0001 & 0.8 (0.7, 0.9) & <.0001 \\ Other PEM & 0.8 (0.7, 1.0) & 0.03 & 0.8 (0.7, 1.0) & NS \\ FHO/FHN-FHT & Reference & N/A & Reference & N/A \\ \hline Practice size (enrolled patients) & & \\ \leq 1800 \text{ patients} & 1.2 (1.1, 1.3) & 0.0004 & 1.2 (1.1, 1.3) & <.0001 \\ > 1800 \text{ patients} & Reference & N/A & Reference & N/A \\ \hline FHG = family health group & & \\ \hline \end{array}$	Increasing age (per year) 1.0 (1.0, 1.0) Sex, No. (%) 1.0 (0.9, 1.1) Female 1.0 (0.9, 1.1) Male Reference Practice type, No. (%) 0.7 (0.6, 0.8) FHG 0.7 (0.6, 0.8) 000 ther PEM 0.8 (0.7, 0.9) 00 ther PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) ≤ 1800 patients ≤ 1800 patients 1.2 (1.1, 1.3) > 1800 patients Reference	NS NS N/A <.0001 <.0001 0.03 N/A 0.0004 N/A	1.0 (1.0, 1.0) 1.0 (0.9, 1.1) Reference 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	0.03 NS N/A <.0001 <.0001 NS N/A <.0001 N/A
Sex, No. (%) Image for the second secon	Sex, No. (%) 1.0 (0.9, 1.1) Female 1.0 (0.9, 1.1) Male Reference Practice type, No. (%) 0.7 (0.6, 0.8) FHG 0.7 (0.6, 0.8) FHO/FHN 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) ≤ 1800 patients ≤ 1800 patients 1.2 (1.1, 1.3) > 1800 patients Reference FHG = family health group Explanation of the second s	NS N/A <.0001 <.0001 0.03 N/A 0.0004 N/A	1.0 (0.9, 1.1) Reference 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	NS N/A <.0001 <.0001 NS N/A <.0001 N/A
Sex, No. (%) Image for the second secon	Sex, No. (%) 1.0 (0.9, 1.1) Female 1.0 (0.9, 1.1) Male Reference Practice type, No. (%) 0.7 (0.6, 0.8) FHG 0.7 (0.6, 0.8) FHO/FHN 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) ≤ 1800 patients ≤ 1800 patients 1.2 (1.1, 1.3) > 1800 patients Reference FHG = family health group Explanation of the second s	NS N/A <.0001 <.0001 0.03 N/A 0.0004 N/A	1.0 (0.9, 1.1) Reference 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	N/A <.0001 <.0001 NS N/A <.0001 N/A
Female 1.0 (0.9, 1.1) NS 1.0 (0.9, 1.1) NS Male Reference N/A Reference N/A Practice type, No. (%)	Female 1.0 (0.9, 1.1) Male Reference Practice type, No. (%) 0.7 (0.6, 0.8) FHG 0.7 (0.6, 0.8) FHO/FHN 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) 1.2 (1.1, 1.3) > 1800 patients Reference FHG = family health group Experimental problematic	N/A <.0001 <.0001 0.03 N/A 0.0004 N/A	Reference 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	N/A <.0001 <.0001 NS N/A <.0001 N/A
Male Reference N/A Reference N/A Practice type, No. (%) 0.7 (0.6, 0.8) <.0001	Male Reference Practice type, No. (%) 0.7 (0.6, 0.8) FHG 0.7 (0.6, 0.8) FHO/FHN 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) 1.2 (1.1, 1.3) > 1800 patients Reference FHG = family health group 1.2 (1.1, 1.3)	N/A <.0001 <.0001 0.03 N/A 0.0004 N/A	Reference 0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	N/A <.0001 <.0001 NS N/A <.0001 N/A
Practice type, No. (%) 0.7 (0.6, 0.8) <.0001 0.7 (0.7, 0.8) <.0001 FHG 0.7 (0.6, 0.8) <.0001	Practice type, No. (%) 0.7 (0.6, 0.8) FHG 0.7 (0.6, 0.8) FHO/FHN 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) ≤ 1800 patients > 1800 patients 1.2 (1.1, 1.3) > 1800 patients Reference	<.0001 <.0001 0.03 N/A 0.0004 N/A	0.7 (0.7, 0.8) 0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	<.0001 <.0001 NS N/A <.0001 N/A
FHG 0.7 (0.6, 0.8) <.0001 0.7 (0.7, 0.8) <.0001 FHO/FHN 0.8 (0.7, 0.9) <.0001	FHG 0.7 (0.6, 0.8) FHO/FHN 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) < 1800 patients	<.0001 0.03 N/A 0.0004 N/A	0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	<.0001 NS N/A <.0001 N/A
FHO/FHN 0.8 (0.7, 0.9) <.0001 0.8 (0.7, 0.9) <.0001 Other PEM 0.8 (0.7, 1.0) 0.03 0.8 (0.7, 1.0) NS FHO/FHN-FHT Reference N/A Reference N/A Practice size (enrolled patients) 1.2 (1.1, 1.3) 0.0004 1.2 (1.1, 1.3) <.0001	FHO/FHN 0.8 (0.7, 0.9) Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) 1.2 (1.1, 1.3) > 1800 patients Reference FHG = family health group FHG	<.0001 0.03 N/A 0.0004 N/A	0.8 (0.7, 0.9) 0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	<.0001 NS N/A <.0001 N/A
Other PEM 0.8 (0.7, 1.0) 0.03 0.8 (0.7, 1.0) NS FHO/FHN-FHT Reference N/A Reference N/A Practice size (enrolled patients) 1.2 (1.1, 1.3) 0.0004 1.2 (1.1, 1.3) <.0001	Other PEM 0.8 (0.7, 1.0) FHO/FHN-FHT Reference Practice size (enrolled patients) 1.2 (1.1, 1.3) > 1800 patients Reference FHG = family health group FHG	0.03 N/A 0.0004 N/A	0.8 (0.7, 1.0) Reference 1.2 (1.1, 1.3) Reference	NS N/A <.0001 N/A
FHO/FHN-FHT Reference N/A Reference N/A Practice size (enrolled patients) 1.2 (1.1, 1.3) 0.0004 1.2 (1.1, 1.3) <.0001	FHO/FHN-FHT Reference Practice size (enrolled patients) ≤ 1800 patients 1.2 (1.1, 1.3) > 1800 patients Reference FHG = family health group	N/A 0.0004 N/A	Reference 1.2 (1.1, 1.3) Reference	N/A <.0001 N/A
Practice size (enrolled patients) 1.2 (1.1, 1.3) 0.0004 1.2 (1.1, 1.3) <.0001 > 1800 patients Reference N/A Reference N/A FHG = family health group FHG FHG FHG FHG	Practice size (enrolled patients) ≤ 1800 patients > 1800 patients Reference FHG = family health group	0.0004 N/A	1.2 (1.1, 1.3) Reference	<.0001 N/A
≤ 1800 patients 1.2 (1.1, 1.3) 0.0004 1.2 (1.1, 1.3) <.0001 > 1800 patients Reference N/A Reference N/A FHG = family health group FHG FHG FHG FHG FHG	< 1800 patients1.2 (1.1, 1.3)> 1800 patientsReferenceFHG = family health group	N/A	Reference	N/A
> 1800 patients Reference N/A Reference N/A FHG = family health group	> 1800 patients Reference FHG = family health group	N/A	Reference	N/A
FHG = family health group	FHG = family health group			

1	
2	
3	.
4	Tinmouth et al.
5	Physician-linked mailed invitations for colorectal cancer screening
6	
7	Figure Legende
8	Figure Legends
9	
10	
11	Figure 1. Mock-up of physician-linked invitation used in the Pilot.
12	
13	
14	
15	
16	
17	
18	
19	
20	Figure 1. Mock-up of physician-linked invitation used in the Pilot.
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	36
57	
58	
59	
60	

Contrôle Cancer Colorectal



From the office of Dr. George Black

June 1, 2009

Lawren Harris 456 Superior Street Lindsay ON K2L 3M4

Dear Lawren Harris:

You have received this letter because it is time to be screened for colon cancer. Our records as of April 1st, 2009 show that you have never had a fecal occult blood test (FOBT) or we do not know when you had your last FOBT. All adults between the ages of 50 and 74 years who are at average risk for colon cancer should do a FOBT every two years.

If your parent, brother, sister or child has had colon cancer, your risk is higher and you should have a colonoscopy.

Please call my office to set up an appointment to talk about your risk for colon cancer and which test is right for you.

If you have recently completed colon cancer screening, please disregard this letter.

I look forward to hearing from you soon.

Dr. George Black 705-555-1212

GET THE FACTS. GET CHECKED

- Colon cancer is the second most common cause of cancer death in Ontario
- Colon cancer can develop without any early warning signs.
- If it is caught early enough, 9 out of every 10 people can be cured.
- Regular screening is the best way to catch colon cancer early.
- The FOBT is a simple test that can be done at home.

For more information please visit www.coloncancercheck.ca

This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorectal cancer screening program. CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Cancer Care Ontario. If for any reason you do not wish to receive future correspondence from the program, simply call the ColonCancerCheck Information Line at 1-866-662-9233 during business hours.

BMJ Open

	Item No	Recommendation	Page	Comment
Title and	1	(a) Indicate the study's design with a commonly used term in the	1, 3	
abstract		title or the abstract		
		(b) Provide in the abstract an informative and balanced summary of	3	
		what was done and what was found		
Introduction			-	
Background/ratio	2	Explain the scientific background and rationale for the investigation	07-Jun	
nale		being reported		
Objectives	3	State specific objectives, including any prespecified hypotheses	7, first paragraph	
J			, <u>1</u> 8 1	
Methods				
Study design	4	Present key elements of study design early in the paper	7, paragraph 2	
Setting	5	Describe the setting, locations, and relevant dates, including periods	7, paragraph 2	
		of recruitment, exposure, follow-up, and data collection		
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and	9, paragraph 2,	
		methods of selection of participants. Describe methods of follow-up		
			& 12, first	
			paragraph	
		Case-control study—Give the eligibility criteria, and the sources and		
		methods of case ascertainment and control selection. Give the		
		rationale for the choice of cases and controls		
		<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources	n/a	
		and methods of selection of participants		
		(b) Cohort study—For matched studies, give matching criteria and	12, first	
		number of exposed and unexposed	paragraph	
		<i>Case-control study</i> —For matched studies, give matching criteria	n/a	
		and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential	9, 10 & 11	
		confounders, and effect modifiers. Give diagnostic criteria, if	-,	
		applicable		
Data sources/	8*	For each variable of interest, give sources of data and details of	8, 9, 10 & 11	
measurement		methods of assessment (measurement). Describe comparability of		
		assessment methods if there is more than one group		
			_	
Bias	9	Describe any efforts to address potential sources of bias	11, paragraph 2	
			& 13, paragraph	
Study size	10	Explain how the study size was arrived at	5, paragraph 1	
Quantitative	11	Explain how quantitative variables were handled in the analyses. If		
variables		applicable, describe which groupings were chosen and why		
		-FF		
Statistical	12	(a) Describe all statistical methods, including those used to control	11. paragraph 2	
methods		for confounding	& 13, paragraph	
		(b) Describe any methods used to examine subgroups and	n/a	
		interactions		
		(c) Explain how missing data were addressed	14, first	
			paragraph	
			paragraph	
		(<i>d</i>) <i>Cohort study</i> —If applicable, explain how loss to follow-up was		all patients followed
		(<i>d</i>) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed		all patients followed through administrative
				through administrative
				through administrative
				through administrative data, therefore no loss t
				through administrative data, therefore no loss t
		addressed	n/a	through administrative data, therefore no loss t
		addressed <i>Case-control study</i> —If applicable, explain how matching of cases	n/a	through administrative data, therefore no loss to
		addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	n/a	through administrative data, therefore no loss t
		addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods	n/a	through administrative data, therefore no loss t
Results		addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	n/a n/a	through administrative data, therefore no loss t
Results Participants	13*	addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	n/a n/a	through administrative data, therefore no loss t
	13*	addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	n/a n/a n/a	through administrative data, therefore no loss t
	13*	addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (<u>e</u>) Describe any sensitivity analyses (a) Report numbers of individuals at each stage of study—eg	n/a n/a n/a 14, first & last	through administrative data, therefore no loss t
	13*	addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	n/a n/a n/a 14, first & last	through administrative data, therefore no loss t
	13*	addressed Case-control study —If applicable, explain how matching of cases and controls was addressed Cross-sectional study —If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed	n/a n/a n/a 14, first & last	through administrative data, therefore no loss to

Tinmouth et al., Physician-linked mailed invitation to be screened improves uptake in an organized colorectal cancer screening

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	Table 1 & Table 3
		confounders	-
		(b) Indicate number of participants with missing data for each variable of interest	15, first paragraph
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total	
		amount)	for 6 months
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary	15, 2nd
		measures over time	paragraph & 16, 1st paragraph
		Case-control study-Report numbers in each exposure category, or	
		summary measures of exposure Cross-sectional study—Report numbers of outcome events or	n/a
		summary measures	11/ a
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-	15, 2nd
		adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were	
		included	2 & 4
		(b) Report category boundaries when continuous variables were	Tables 2 & 4
		categorized (c) If relevant, consider translating estimates of relative risk into	n/a
		absolute risk for a meaningful time period	u
Other analyses	17	Report other analyses done—eg analyses of subgroups and	n/a
Discussion		interactions, and sensitivity analyses	-
Key results	18	Summarise key results with reference to study objectives	16, paragraph 1
Limitations	19	Discuss limitations of the study, taking into account sources of	18, 2nd
		potential bias or imprecision. Discuss both direction and magnitude	paragraph
Interpretation	20	of any potential bias Give a cautious overall interpretation of results considering	17 & 18
1		objectives, limitations, multiplicity of analyses, results from similar	
Generalisability	21	studies, and other relevant evidence Discuss the generalisability (external validity) of the study results	19 lost nonograph
Generalisability	21	Discuss the generalisability (external valuaty) of the study results	18, last paragraph
Other informatio		Give the course of funding and the role of the fundary for the present	10.20
Other informati Funding	on 22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present	19, 20
			19, 20
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	
		study and, if applicable, for the original study on which the present article is based	



Using physician-linked mailed invitations in an organized colorectal cancer screening program: effectiveness and factors associated with response.

Journal:	BMJ Open
Manuscript ID:	bmjopen-2013-004494.R2
Article Type:	Research
Date Submitted by the Author:	04-Feb-2014
Complete List of Authors:	Tinmouth, Jill; Sunnybrook Health Sciences Centre, Baxter, Nancy; University of Toronto, St Michaels Hopsital, Surgery Paszat, Lawrence; Institute for Clinical Evaluative Sciences, Rabeneck, Linda; University of Toronto, Sutradhar, Rinku; Institute for Clinical Evaluative Sciences, Yun, Lingsong; Institute for Clinical Evaluative Sciences,
Primary Subject Heading :	Gastroenterology and hepatology
Secondary Subject Heading:	Oncology, Public health, General practice / Family practice, Health services research
Keywords:	Gastrointestinal tumours < GASTROENTEROLOGY, PREVENTIVE MEDICINE, PRIMARY CARE, PUBLIC HEALTH

SCHOLARONE[™] Manuscripts

TITLE PAGE

Title: Using physician-linked mailed invitations in an organized colorectal cancer screening program: effectiveness and factors associated with response.

Short tile: Physician-linked invitations for colorectal cancer screening

Authors:

Jill Tinmouth^{1,3,5,6} Nancy N. Baxter^{3,5,7} Lawrence F. Paszat^{2,3,4} Linda Rabeneck^{1,3,4,5,6} Rinku Sutradhar^{3,4} Lingsong Yun³

Affiliations: Departments of Medicine¹ and Radiation Oncology², Sunnybrook Health Sciences Centre, Toronto, Canada; Institute for Clinical Evaluative Sciences, Toronto, Canada³; Dalla Lana School of Public Health, University of Toronto, Toronto, Canada⁴; Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Canada⁵; Cancer Care Ontario, Toronto, Canada⁶; Department of General Surgery and Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Canada⁷.

Corresponding Author Information:

Jill Tinmouth MD PhD FRCPC Sunnybrook Health Sciences Centre 2075 Bayview Ave Rm HG40 Toronto ON M4N 3M5 416 480-5910 t 416 480-4845 f jill.tinmouth@sunnybrook.ca

Email addresses of authors:

Nancy N. Baxter Lawrence F. Paszat Linda Rabeneck Rinku Sutradhar Lingsong Yun S.. <u>n:</u> ntre BaxterN@smh.toronto.on.ca <u>lawrence.paszat@ices.on.ca</u> <u>Linda.Rabeneck@cancercare.on.ca</u> Rinku.Sutradhar@ices.on.ca Lingsong.Yun@ices.on.ca

Word count: 3159 (main text), 263 (abstract)

Number of Tables: 4

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Number of Figures: 1

Number of References: 45

Key words: Mailed invitations, colorectal cancer, organized screening

ABSTRACT

<u>Objectives</u>: A central tenet of organized cancer screening is that all persons in a target population are invited. The aims of this study were to identify participant and physician factors associated with response to mailed physician-linked invitations (Study 1) and to evaluate their effectiveness in an organized colorectal (CRC) screening program (Study

2).

<u>Design and setting</u>: Two studies (Study 1 – cohort design and Study 2 – matched cohort design, comprising Study 1 participants and a matched control group) conducted in context of Ontario's organized province-wide CRC screening program.

<u>Participants</u>: 102 family physicians and 11,302 associated eligible patients from a technical evaluation ("the Pilot") of large scale mailed invitations for CRC screening were included. Matched controls were randomly selected using propensity scores from among eligible patients associated with family physicians in similar practice types as the Pilot physicians.

<u>Intervention</u>: Physician-linked mailed invitation to have CRC screening. <u>Outcomes</u>: Uptake of fecal occult blood test (FOBT) within 6 months of mailed invitation (primary) and uptake of FOBT or colonoscopy within 6 months of mailed invitation (secondary).

<u>Results</u>: Factors significantly associated with uptake of FOBT included prior FOBT use, older participant age, greater participant co-morbidity and having a female physician. In

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

the matched analysis, Pilot participants were more likely to complete an FOBT (22% vs. 8%, p<0.0001) or an FOBT or colonoscopy (25% vs. 11%, p <0.0001) within 6 months of .e unut sale mailing of physician-lin. te context of organized CRC screening mailed invitation than matched controls. The number needed to invite to screen one additional person was 7.

Conclusions: Centralized large scale mailing of physician-linked invitations is both feasible and effective in the context of organized CRC screening.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

ARTICLE SUMMARY

Strengths and limitations of this study:

- We describe the implementation of physician-linked invitations in an organized colorectal screening program that is characterized by a high level of primary care physician involvement and that operates in a context where opportunistic screening with colonoscopy is possible
- We have shown that centralized large scale mailing of physician-linked invitations is feasible and effective in this context
- We found that physician linked mailed invitations improve CRC screening participation by 14% such that 7 physician-linked invitations need to be mailed to screen one additional person
- We were limited to data found in Ontario health administrative databases; for example, we were not able to determine family history
- Findings are promising but require appropriate infrastructure in order to be implemented in other jurisdictions

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

INTRODUCTION

Colorectal cancer (CRC) is the second leading cause of cancer-related death among men and the third among women in Canada.¹ Fecal occult blood testing (FOBT)²⁻⁴ and flexible sigmoidoscopy⁵⁻⁷ have been shown to decrease CRC mortality in randomized controlled trials.

Given these data, organized CRC screening programs⁸ are being implemented worldwide.⁹ On April 1 2008, Ontario launched ColonCancerCheck (CCC), Canada's first organized province-wide CRC screening program.¹⁰ Through the primary care physician, FOBT is offered to people at average risk for CRC and colonoscopy to those at increased risk based on family history. The CCC program uses a non-rehydrated guaiac FOBT (Hema-Screen, Immmunostics, Inc., NJ, USA) requiring samples from 3 separate stools. While there is data to suggest that dietary restriction may be unnecessary,¹¹ the program recommends avoiding vitamin C for 3 days prior to and during the collection period in order to minimize false negative results.

Approximately 75% of Ontario residents received their care via a patient enrolled model (PEM) of care at the time of the study (2009).¹² PEMs comprise teams of family physicians who provide their enrolled patients with comprehensive health care and extended hours.¹³ PEMs vary in terms of structure, services provided and remuneration (varying from enhance fee-for-service to blended capitation). All Ontario physicians are

BMJ Open

remunerated for preventive care such as CRC screening however, PEM physicians are incented to a greater degree than those who are not in PEMs. Specifically, PEM physicians receive a \$7/patient fee for "FOBT distribution and counseling", a \$6.86/patient fee for "CRC screening management" and an annual "Colorectal cancer screening preventive care bonus" (\$220 to \$4000) depending on the proportion of enrolled patients who are up-to-date with FOBT (15-70%). The physician is entitled to the CRC screening management fee if the enrolled patient attends an appointment to discuss CRC screening, has declined the test verbally or in writing or if there has been no response after 2 written notices and a telephone call from the physician.¹⁴

A central tenet of organized screening programs is that all persons in the target population be invited to participate.⁸ Implementation of this aspect of organized screening varies: invitations may be sent with an FOBT kit, can include physician recommendation or may incorporate tailored messaging.¹⁵¹⁶ Some of these approaches, such as incorporation of physician recommendation, present significant implementation challenges for organized screening programs such as Ontario's.

In 2009, the CCC program undertook the CCC Invitation Pilot (the "Pilot"), an evaluation that tested the technical feasibility of a centralized approach to sending physician-linked mailed invitations for CRC screening. In this paper, we describe the structure and the implementation of the Pilot. In addition, we report on participant and physician factors

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

associated with response to mailed physician-linked invitations and on the effectiveness of these invitations in Ontario's organized CRC screening program.

METHODS

The CCC Invitation Pilot – Implementation and Evaluation

The CCC program conducted the Pilot in November 2009. Invitation letters were generated by the CCC program on behalf of 102 family physicians and sent to all their eligible enrolled patients. Just over 11,000 eligible patient participants were sent mailed invitations requesting they visit their family physician to obtain an FOBT kit or, if appropriate based on family history, a referral for colonoscopy. In this paper, we report on 2 studies using this cohort. Study 1 examines participant and physician factors associated with response to the mailed invitation among those who were sent the mailed invitation. Study 2 evaluates the effectiveness of the mailed invitation by comparing uptake of CRC screening among Study 1 participants compared to a matched control group. Ethics approval was obtained from the research ethics boards at Sunnybrook Health Sciences Centre and the Institute for Clinical Evaluative Sciences (ICES) and permission to use the Pilot data was obtained from Cancer Care Ontario's (CCO) Data Access Committee. All analyses were conducted using SAS v.9 (SAS Institute, Cary, NC). A p-value of 0.05 was used to determine statistical significance.

Data Sources

The Pilot study was conducted at ICES, which houses the administrative health records for all 13.5 million Ontarians. CCC program databases were linked to the ICES administrative databases using an encrypted version of the provincial health insurance number.

The ICES databases used include the Canadian Institute of Health Information (CIHI) databases, the Ontario Health Insurance Program (OHIP) Claims History Database, the Registered Persons Database (RPDB), the Ontario Cancer Registry, the ICES Physician Database, and the Client Agency Program Enrollment (CAPE) registry. The CIHI, OHIP, RPDB and the Ontario Cancer Registry and the ICES Physician Database are described elsewhere.¹⁷ ¹⁸ The CAPE registry tracks patients enrolled to physicians who participate in PEMs and is a centralized electronic record of the linkage between specific patients and their physicians.

Since its inception, the CCC program has collected data related to the FOBT kits administered by the CCC program, including the results of these tests, using Laboratory Reporting Tool (LRT).

Study 1: Factors associated with response to the mailed invitation

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

<u>Cohort Definition</u>: For the Pilot, a convenience sample of physicians participating in PEM-type practices was recruited via CCO's Provincial Primary Care Cancer Network. Patients enrolled to these physicians, aged 50 to 74 years without a history of CRC and who were due for CRC screening (without a health administrative data record of recent FOBT (previous two years) or lower GI investigation including flexible sigmoidoscopy and colonoscopy (previous 5 years)), were eligible. For the Pilot mailing, CCC generated lists of patient participants eligible for CRC screening for each participating physician using CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT. All persons who were sent an invitation were included in the cohort, regardless of whether the letter was returned to the sender.

<u>The Mailing</u>: Invitations were mailed in November 2009. The date of mailing was the index date. The letters were compiled centrally by the CCC program but were physician-linked; patient participants were sent a letter from their own physician, as indicated by their name at the bottom of the letter in an italicized font (Figure 1). The letter asked participants to visit their family physician for screening; it did not include an FOBT kit. The letter was accompanied by a CRC screening information brochure and sent in an envelope with the family physician name in the front upper left corner. Pilot physicians were not compensated for study participation, however, they were able to apply the letter towards meeting the requirements for the CRC screening management fee (\$6.86 per eligible enrolled patient).

BMJ Open

<u>Response to Mailed Invitation</u>: We used a broad definition of response to the mailed invitation: any record of FOBT in either OHIP or in LRT within 6 months of the index date, regardless of result (including rejected kits). Up to 10% of FOBT done in the province are captured only in OHIP, which does not have data on test results. We were not able to measure response in persons at increased risk of CRC as we do not have family history data available in the administrative databases.

Participant and Physician Factors: We characterized participants by age group, sex, comorbidity, median neighborhood income,^{19 20} health region,²¹ immigration status, and prior FOBT. We measured comorbidity by counting the number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins ACG[®] Case-Mix System in the prior 12 months.²² Mortality in a general population ambulatory cohort in Ontario was accurately predicted using this system.²³ We used date of registration in the RPDB as a proxy measure for immigration status; participants were considered recent immigrants if their date of registration was within 5 years of the index date.²⁴

Physicians were characterized according to age, sex, training location (Canada vs. outside of Canada), practice type, size of practice, age-eligible rate of colonoscopy or FOBT over prior 2 years as well as the age-eligible rate of annual physical exams or influenza vaccinations in the prior year. All participating physicians were in PEMs;

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

practice types included family health groups (FHGs, enhanced fee-for-service models), family health organizations or networks (FHO/FHNs, blended capitation models), FHO/FHN with family health team (FHO/FHN-FHT, interprofessional team model with a blended capitation fee structure) and other PEMs.²⁵ We measured practice size as the number of enrolled patients stratified in a binary fashion (≤1800 vs. >1800 enrolled patients) as larger practice sizes have been shown to be associated with poorer preventative care.²⁶ For the remaining physician characteristics, we identified all enrolled and non-enrolled patients aged 50-74 years in their practices as of the index date. Ageeligible FOBT and colonoscopy rates were obtained for each Pilot physician by calculating the proportion of their age-eligible patients who had had an FOBT or colonoscopy in the 2 years prior to the index date. Similarly, we calculated their rates of age-eligible annual physical exams or influenza vaccine in the year prior to the index date. These variables were derived in order to estimate physician adherence to CRC screening and preventive medicine practices at baseline.

<u>Analysis</u>: The number and proportion of persons in the cohort who responded to the mailed invitation within 6 months were determined overall and by participant and physician characteristics. Multivariate logistic regression modeling was used to identify participant and physician factors associated with response to the mailed invitation. In order to account for potential clustering of participants within physicians, Generalized Estimating Equations (GEE)²⁷ were used in the model.

BMJ Open

Study 2: Evaluation of the effectiveness of mailed invitations

<u>Overview and study participants</u>: This was a matched double cohort analysis, comparing uptake of FOBT in those who were sent a mailed invitation (Pilot cohort) to a matched control group who were not sent a mailed invitation. The control group comprised patients who were enrolled to PEM physicians who had not participated in the Pilot. Control participants received "usual care" from the CCC program in terms of screening promotion. As such, they were eligible for screening via their primary care physician who was eligible for the same financial incentives as the Pilot physicians. Control participants were not sent a centralized physician-linked invitation from the CCC program although their physicians could send them a mailed invitation at their own discretion.

The Pilot cohort comprised all members of the cohort described in Study 1 for whom a matched control could be identified. We identified potential controls as follows: 1) Pilot physicians were matched to non-Pilot physicians who were also practicing in PEMs in a 1:5 ratio using physician age, sex, size and practice type; 2) individuals enrolled to the selected control physicians were retained if they met the same inclusion/exclusion criteria as those in the intervention cohort (aged 50 to 74 years with no prior CRC who were due for CRC screening). As with the identification of eligible participants in the

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Pilot, we used CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT to determine eligibility of potential control participants.

Propensity scores that modeled the probability of belonging to the Pilot group were calculated for each participant in the entire group (Pilot and control). The variables in this model included age (as a continuous measure), sex, co-morbidity, median neighborhood income quintile, health region, immigration status, and FOBT from 2 to 5 years prior.^{28 29} Pilot participants were matched to controls in a 1:1 fashion based on propensity scores using a caliper width of 0.25. This methodology was implemented to balance the distribution of participant-level variables between the Pilot and control groups.

<u>Response to mailed invitation</u>: For our primary outcome, we defined response to the mailed invitation as in Study 1, a record of FOBT regardless of result, within 6 months of the index date. For our secondary outcome, response was defined as a record of either FOBT or colonoscopy within 6 months of the index date. For the purposes of this study, controls were assigned the same index date as their matched counterpart in the Pilot group.

BMJ Open

Analysis: Standard differences between the Pilot participants and controls were calculated for the variables included in the propensity score. Important differences between the 2 groups were defined by a standardized difference exceeding 0.1.^{29 30} In the primary analysis, we compared the number and proportion in the Pilot and control groups responding to the mailed invitation with FOBT using McNemar's test.²⁹ We determined the number of invitations mailed in order to screen one additional person with FOBT. We repeated the above analyses using our secondary outcome in order to determine if observed differences in FOBT uptake could be attributed to differences in colonoscopy uptake (i.e., participants had CRC screening but chose colonoscopy over FOBT). As the matching only accounted for participant-level variables, we repeated our analyses using conditional logistic regression in order to adjust for physician covariates (age, sex, practice type and size).

RESULTS

Study 1: Factors associated with response to the mailed invitation

There were 11,311 eligible patient participants associated with the 102 family physicians in the Pilot cohort. Nine participants were excluded, as we were unable to determine their health region and/or income quintile; this left 11,302 participants for the analysis. The majority of participants were 50 to 59 years of age, 52% were women, 48% had no or low co-morbidity and 14% had completed an FOBT from 2 to 5 years prior to the mailing. Two thirds of participants had a male physician, approximately half were part of

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

a primary care team reimbursed via an enhanced fee-for-service arrangement and just under half were enrolled in larger practices (>1800 enrolled patients) (Table 1).

2503 (22%) completed an FOBT within 6 months of mailing. In the multivariate regression, the strongest participant factor associated with FOBT completion was prior FOBT use (2 to 5 years prior vs. > 5 years or never: OR 2.8, 95% C.I.: 2.5 to 3.3, p < 0.0001). Other significant factors associated with FOBT completion included older participant age, greater co-morbidity, and having a female physician (Table 2).

Study 2: Evaluation of the effectiveness of mailed invitations

Of the 11,302 participants in Study 1, 10,652 were successfully matched to 10,652 controls using propensity scores. Standardized differences for the participant characteristics included in the propensity score were all <0.1, indicating that the two cohorts were well matched for measurable potential confounders (Table 3).

Pilot participants were significantly more likely than controls to complete FOBT alone (2387 (22%) versus 854 (8%), p<0.0001) and FOBT or colonoscopy (2664 (25%) vs. 1191 (11%), p<0.0001) within 6 months of mailing. The association between the mailed invitation and CRC screening participation (either FOBT alone or FOBT or colonoscopy) remained after adjusting for physician level characteristics (Table 4).

BMJ Open

DISCUSSION

In the current study, we have demonstrated that physician-linked mailed invitations are both feasible and effective in the context of a large organized, population-based screening program; only 7 letters would need to be sent in order to screen one additional person. Furthermore, we have found that older participants, those with greater comorbidity, those who have previously been screened and those with female physicians were more likely to respond to this type of invitation. Our findings are of particular interest to other jurisdictions planning or who already have organized CRC screening.

In other published studies of mailed invitations, an FOBT kit is often included with the invitation. Three studies done outside organized screening programs have found physician-linked invitations superior to non-linked invitations; 2 of these studies included an FOBT kit,^{31 32} and the third study did not.³³ Other studies have examined mailed invitations with FOBT kits in the context of primary care practices in the USA.³⁴⁻³⁶ While the results from these trials were largely supportive of mailed invitations, kit inclusion can make it difficult to separate the convenience of receiving the FOBT kit directly by mail from the impact of an invitation from one's own physician.

Our study demonstrates the effectiveness and feasibility of physician-linked invitations in the context of a large organized CRC screening program with an estimated target population of over 3 million persons. Implementation in this context confers challenges in

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

terms of technological infra-structure, privacy and regulatory issues. There are 2 studies (from the United Kingdom³⁷ and Italy³⁸) that have reported on mailed invitations in the context of organized colorectal cancer screening programs and found them to be effective. Both studies included FOBT kits and one studied the impact of physician endorsement specifically.³⁷ Our findings are important because they support a potentially more cost-effective approach that avoids wasting kits that are mailed but not used.

Our results highlight the critical role of physician recommendation, a finding supported by others. For example, in the NHS Bowel Cancer Screening Programme (BCSP) currently, the primary care physician receives the result but is not directly involved in the mailed invitation or the actual screening. Recently, a randomized controlled trial conducted in the context of the BCSP showed that an endorsement letter from the primary care provider increased participation by 6%.³⁷ In 2 studies from Australia, endorsement improved initial participation^{31 32} and over 4 successive screening rounds.³²

Uptake of FOBT in Ontario is lower than some organized CRC screening programs in other countries. For example, 30% of Ontarians were up-to-date with FOBT in 2008-9³⁹ compared to 52% participation in the United Kingdom program by October 2008,⁴⁰ 54% in the Italian program in 2007,⁴¹ and 54% in the New Zealand pilot program in 2012.⁴²

BMJ Open

However, in the latter countries, there is very little, if any, opportunistic CRC screening using colonoscopy whereas Ontario's program operates in a hybrid environment where opportunistic colonoscopy is available as the initial screening test in persons at average risk. It has been noted that uptake of FOBT may be lower in settings, such as Ontario's or Australia's,⁴³ where opportunistic screening is available.⁴⁴ The findings from the current study indicate that physician-linked invitations for CRC screening can be effective in increasing uptake of FOBT in programs that operate in the context of opportunistic colonoscopy for average risk screening.

Our study has several limitations. First, we are unable to determine family history using Ontario administrative data. A second limitation is that a single generic letter was used. Tailored letters with key messages for specific subgroups may be more effective¹⁶ – an approach that may be relevant in Ontario as we did find that response to the letter appeared to differ in various subgroups. Additionally, while our findings are promising, there are challenges to adoption by other population-based screening programs, including the need for a centralized database that links patients to their physicians. Finally, implementation of this strategy in population-based screening is predicated on physician acceptability and agreement. While we have found that this approach is acceptable in principle to many Ontario physicians,⁴⁵ processes to confirm individual physician agreement have not been determined for the entire CCC program which comprises an estimated 7000 primary care physicians.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

CONCLUSIONS

In summary, we have demonstrated that physician-linked mailed invitations for CRC screening, even without the inclusion of an FOBT kit, can have substantial effect on participation in an organized CRC screening program and that it is technically feasible to centrally organize and mail physician-linked invitations on a large scale. Organized screening programs, which often use unlinked invitations, should consider adopting this approach given its demonstrated effectiveness and feasibility.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Peter Austin PhD for his expert statistic advice. They also wish to acknowledge the support of the Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and CCO. The opinions, results and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and CCO is intended or should be inferred.

FUNDING STATEMENT

This study was conducted with funding support from the Ontario Institute for Cancer Research and CCO's Health Services Research Network, which is independent of the ColonCancerCheck program. This work was also supported in part by a grant from the Canadian Institutes for Health Research (grant # CST-85478). Dr. Tinmouth was supported by a Canadian Institutes of Health Research New Investigator Award during the period of this study.

AUTHOR CONTRIBUTION:

Authors contributed substantially to each of the following areas: -conception and design (JT, LFP, LR) or analysis and interpretation of data (JT, NB, LFP, LR, RS, LY)

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

-drafting the article (JT) or revising it critically for important intellectual content (JT, NB,

LFP, LR, RS, LY)

-final approval of the version to be published (JT, NB, LFP, LR, RS, LY)

COMPETING INTERESTS STATEMENT

Dr. Tinmouth is the Lead Scientist for the ColonCancerCheck program and Dr.

Rabeneck oversees the ColonCancerCheck program in her capacity as the Vice-

President, Cancer Prevention and Control at CCO. None of the other authors have any

conflicts of interest to report.

DATA SHARING STATEMENT

Under Ontario's privacy legislation, neither Cancer Care Ontario nor ICES are permitted to share individual level data from the submitted work.

BMJ Open

REFERENCES

1.	Canadian Cancer Society's Steering Committee on Cancer Statistics. Canadian
	Cancer Statistics 2013. Toronto, ON: Canadian Cancer Society, 2013.

- 2. Mandel JS, Church TR, Bond JH, et al. The effect of fecal occult-blood screening on the incidence of colorectal cancer. *N Engl J Med* 2000;343(22):1603-7.
- 3. Hardcastle JD, Chamberlain JO, Robinson MH, et al. Randomised controlled trial of faecal-occult-blood screening for colorectal cancer. *Lancet* 1996;348(9040):1472-7.
- 4. Kronborg O, Fenger C, Olsen J, et al. Randomised study of screening for colorectal cancer with faecal-occult-blood test. *Lancet* 1996;348(9040):1467-71.
- Atkin WS, Edwards R, Kralj-Hans I, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. *Lancet* 2010;375(9726):1624-33.
- 6. Segnan N, Armaroli P, Bonelli L, et al. Once-Only Sigmoidoscopy in Colorectal Cancer Screening: Follow-up Findings of the Italian Randomized Controlled Trial—SCORE J Natl Cancer Inst 2011;103(17):1310-22
- 7. Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. *N Engl J Med* 2012;366(25):2345-57.
- 8. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. *Cancer* 2004;104(5 Suppl):1201-13.
- 9. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Secondary Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Feb 9 2009. http://appliedresearch.cancer.gov/icsn/colorectal/screening.html.
- 10. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program Feb 2, 2012. <u>http://health.gov.on.ca/en/public/programs/coloncancercheck/</u>.
- 11. Pignone M, Campbell MK, Carr C, et al. Meta-analysis of dietary restriction during fecal occult blood testing. *Eff Clin Pract* 2001;4(4):150-6.
- 12. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012.
- 13. HealthForceOntario. Family Practice Models. Secondary Family Practice Models May 3 2013.

http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideOntario/PractisingInOntario/family_practice_models.aspx.

14. Ontario Ministry of Health and Long-Term Care. Bulletin 4482: ColonCancerCheck Physician Incentives. . Secondary Bulletin 4482: ColonCancerCheck Physician

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Incentives. July 22, 2008. http://www.health.gov.on.ca/en/pro/programs/ohip/bulletins/4000/bul4482. pdf.

- 15. Khalid-de Bakker C, Jonkers D, Smits K, et al. Participation in colorectal cancer screening trials after first-time invitation: a systematic review. *Endoscopy* 2011;43(12):1059-86.
- 16. Rawl SM, Skinner CS, Perkins SM, et al. Computer-delivered tailored intervention improves colon cancer screening knowledge and health beliefs of African-Americans. *Health Educ Res* 2012;27(5):868-85.
- Alharbi O, Rabeneck L, Sutradhar R, et al. A population-based analysis of outpatient colonoscopy in adults assisted by an anesthesiologist. *Anesthesiology* 2009;111(4):734-40.
- 18. Robles SC, Marrett LD, Clarke EA, et al. An application of capture-recapture methods to the estimation of completeness of cancer registration. *J Clin Epidemiol* 1988;41(5):495-501.
- 19. Alter DA, Naylor CD, Austin P, et al. Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction. *N Engl J Med* 1999;341(18):1359-67.
- 20. Singh SM, Paszat LF, Li C, et al. Association of socioeconomic status and receipt of colorectal cancer investigations: a population-based retrospective cohort study. *Can Med Assoc J* 2004;171(5):461-5.
- 21. Anonymous. Ontario's Local Health Integration Networks. Secondary Ontario's Local Health Integration Networks May 30 2013. <u>http://www.lhins.on.ca/home.aspx</u>.
- 22. Anonymous. The Johns Hopkins University ACG Case-Mix System. Secondary The Johns Hopkins University ACG Case-Mix System 2012. http://www.acg.jhsph.edu/.
- 23. Austin PC, van Walraven C, Wodchis WP, et al. Using the Johns Hopkins Aggregated Diagnosis Groups (ADGs) to predict mortality in a general adult population cohort in Ontario, Canada. *Med Care* 2011;49(10):932-9.
- 24. Ray JG, Vermeulen MJ, Schull MJ, et al. Results of the Recent Immigrant Pregnancy and Perinatal Long-term Evaluation Study (RIPPLES). *Can Med Assoc J* 2007;176(10):1419-26.
- 25. Glazier RH, Klein-Geltink J, Kopp A, et al. Capitation and enhanced fee-for-service models for primary care reform: a population-based evaluation. *Can Med Assoc J* 2009;180(11):E72-E81.
- 26. Dahrouge S, Hogg WE, Russell G, et al. Impact of remuneration and organizational factors on completing preventive manoeuvres in primary care practices. *Can Med Assoc J* 2012;184(2):E135-43.
- 27. Liang K, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika* 1986;73:13-22.

ge 25 of 75	BMJ Open
	Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening
	28. D'Agostino RB, Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. <i>Stat Med</i> 1998;17(19):2265-81.
	29. Austin PC. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. <i>Multivariate Behav Res</i> 2011;46(3):399-424.
	30. Normand ST, Landrum MB, Guadagnoli E, et al. Validating recommendations for coronary angiography following acute myocardial infarction in the elderly: a matched analysis using propensity scores. <i>J Clin Epidemiol</i> 2001;54(4):387-98.
	31. Cole SR, Young GP, Byrne D, et al. Participation in screening for colorectal cancer based on a faecal occult blood test is improved by endorsement by the primary care practitioner. J Med Screen 2002;9(4):147-52.
	32. Zajac IT, Whibley AH, Cole SR, et al. Endorsement by the primary care practitioner consistently improves participation in screening for colorectal cancer: a longitudinal analysis. <i>J Med Screen</i> 2010;17(1):19-24.
	 Grazzini G, Castiglione G, Isu A, et al. Colorectal cancer screening by fecal occult blood testing: results of a population-based experience. <i>Tumori</i> 2000;86(5):384-8.
	34. Myers RE, Sifri R, Hyslop T, et al. A randomized controlled trial of the impact of targeted and tailored interventions on colorectal cancer screening. <i>Cancer</i> 2007;110(9):2083-91.
	35. Sequist TD, Zaslavsky AM, Marshall R, et al. Patient and physician reminders to promote colorectal cancer screening: a randomized controlled trial. <i>Arch Intern Med</i> 2009;169(4):364-71.
	36. Walsh JM, Salazar R, Terdiman JP, et al. Promoting use of colorectal cancer screening tests. Can we change physician behavior? J Gen Intern Med 2005;20(12):1097-101.
	37. Hewitson P, Ward AM, Heneghan C, et al. Primary care endorsement letter and a patient leaflet to improve participation in colorectal cancer screening: results of a factorial randomised trial. <i>Br J Cancer</i> 2011;105(4):475-80.
	38. Giorgi Rossi P, Grazzini G, Anti M, et al. Direct mailing of faecal occult blood tests for colorectal cancer screening: a randomized population study from Central Italy. <i>J Med Screen</i> 2011;18(3):121-7.
	39. Cancer Quality Council of Ontario. Colorectal Cancer Screening: Participation Secondary Colorectal Cancer Screening: Participation. 2013. <u>http://www.csqi.on.ca/cms/one.aspx?portalld=258922&pageId=273238 -</u> .UijqNMakrmQ.
	40. Logan RF, Patnick J, Nickerson C, et al. Outcomes of the Bowel Cancer Screening Programme (BCSP) in England after the first 1 million tests. <i>Gut</i> 2012;61(10):1439-46.
	41. Parente F, Boemo C, Ardizzoia A, et al. Outcomes and cost evaluation of the first two rounds of a colorectal cancer screening program based on

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

immunochemical fecal occult blood test in northern Italy. *Endoscopy* 2013;45(1):27-34.

- 42. New Zealand Ministry of Health. Bowel Screening Pilot January to June 2012 results. Secondary Bowel Screening Pilot January to June 2012 results 26 April 2013. <u>http://www.health.govt.nz/our-work/diseases-and-conditions/cancerprogramme/bowel-cancer-programme/bowel-screening-pilot/bowelscreening-pilot-results/bowel-screening-pilot-january-june-2012-results.</u>
- 43. Zajac IT, Flight I, Turnbull D, et al. Self-reported bowel screening rates in older Australians and the implications for public health screening programs. *Australas Med J* 2013;6(8):411-7.
- 44. Moss SM, Ancelle-Park R, Brenner H. Evaluation and interpretation of screening outcomes. In: Patnick J, Segnan N, von Karsa L, eds. European guidelines for quality assurance in colorectal cancer screening and diagnosis. Luxembrourg: International Agency for Research on Cancer 2010.
- 45. Tinmouth J, Ritvo P, McGregor SE, et al. ColonCancerCheck Primary Care Invitation Pilot project: family physician perceptions. *Can Fam Physician* 2012;58(10):e570-7.

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Tables.

Table 1. Patient participant and physician characteristics for Study 1

	FOBT within 6 months	No FOBT within 6 months	Total
	(n=2,503)	(n=8,799)	(n=11,302)
Patient participants			
Age group in years, No. (%)			
50-59	1,279 (51%)	5,384 (61%)	6,663 (59%)
60-69	894 (36%)	2,637 (30%)	3,531 (31%)
70-74	330 (13%)	778 (9%)	1,108 (10%)
Sex, No. (%)			
Female	1,299 (52%)	4,554 (52%)	5,853 (52%)
Male	1,204 (48%)	4,245 (48%)	5,449 (48%)
Co-morbidity*, No. of ADGs (%)			
0	257 (10%)	1,279 (15%)	1,536 (14%)
1-2	828 (33%)	3,044 (35%)	3,872 (34%)
3-4	712 (28%)	2,241 (25%)	2,953 (26%)
5-6	393 (16%)	1,224 (14%)	1,617 (14%)
7+	313 (13%)	1,011 (11%)	1,324 (12%)
Median neighborhood income quintile, No. (%)			
Rural	394 (16%)	1,431 (16%)	1,825 (16%)
Low Urban	360 (14%)	1,375 (16%)	1,735 (15%)
2	402 (16%)	1,418 (16%)	1,820 (16%)
3	429 (17%)	1,430 (16%)	1,859 (16%)
4	432 (17%)	1,552 (18%)	1,984 (18%)
High Urban	486 (19%)	1,593 (18%)	2,079 (18%)
Health region, No. (%)			
Erie St.Clair	125 (5%)	337 (4%)	462 (4%)
South West	284 (11%)	823 (9%)	1,107 (10%)
Waterloo Wellington	76 (3%)	251 (3%)	327 (3%)
Hamilton Niagara	289 (12%)	976 (11%)	1,265 (11%)
Central West	138 (6%)	482 (5%)	620 (5%)
Mississauga Halton	22 (1%)	120 (1%)	142 (1%)
Toronto Central	111 (4%)	392 (4%)	503 (4%)
Central	24 (1%)	177 (2%)	201 (2%)
Central East	361 (14%)	1,282 (15%)	1,643 (15%)
South East	162 (6%)	697 (8%)	859 (8%)
Champlain	219 (9%)	676 (8%)	895 (8%)
North Simcoe-Muskoka	77 (3%)	188 (2%)	265 (2%)
North East	291 (12%)	1,118 (13%)	1,409 (12%)
North West	324 (13%)	1,280 (15%)	1,604 (14%)

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Recent immigrant, No. (%)	23 (1%)	88 (1%)	111 (1%)
FOBT 2 to 5 years prior to mailing, No. (%)	643 (26%)	905 (10%)	1,548 (14%)
Physician			
Median age in years (IQR)	52 (45-59)	53 (46-59)	52 (45-59)
Sex, No. (%)			
Female	936 (37%)	3,044 (35%)	3,980 (35%)
Male	1,567 (63%)	5,755 (65%)	7,322 (65%)
Training location, No. (%)			
Outside Canada	312 (12%)	1,196 (14%)	1,508 (13%)
In Canada	2,191 (88%)	7,603 (86%)	9,794 (87%)
Practice type, No. (%)	4 000 (400/)	4.000 (400()	5 0 4 0 (4 7 0 ()
FHG	1,082 (43%)	4,266 (48%)	5,348 (47%)
FHO/FHN FHO/FHN-FHT	432 (17%) 881 (35%)	1,456 (17%) 2,620 (30%)	1,888 (17%) 3,501 (31%)
Other PEM	108 (4%)	457 (5%)	565 (5%)
	100 (470)	401 (070)	000 (070)
Practice size (enrolled patients), No. (%)			
>1800 patients	1,105 (44%)	4,104 (47%)	5,209 (46%)
Age-eligible rate of colonoscopy quintile, No. (%)			
Low	485 (19%)	1,619 (18%)	2,104 (19%)
2	548 (22%)	1,940 (22%)	2,488 (22%)
3	637 (25%)	2,279 (26%)	2,916 (26%)
4	477 (19%)	1,696 (19%)	2,173 (19%)
High	356 (14%)	1,265 (14%)	1,621 (14%)
Age-eligible rate of FOBT quintile, No. (%)			
Low	487 (19%)	1,888 (21%)	2,375 (21%)
2	504 (20%)	1,886 (21%)	2,390 (21%)
3	533 (21%)	1,890 (21%)	2,423 (21%)
4	522 (21%)	1,680 (19%)	2,202 (19%)
High	457 (18%)	1,455 (17%)	1,912 (17%)
Age-eligible rate of annual physical exams quintile, No. (%)			
Low	496 (20%)	2,009 (23%)	2,505 (22%)
2	490 (20%)	1,625 (18%)	2,115 (19%)
3	472 (19%)	1,638 (19%)	2,110 (19%)
4	509 (20%)	1,686 (19%)	2,195 (19%)
High	536 (21%)	1,841 (21%)	2,377 (21%)

Page 29 of 75

BMJ Open

Tinmouth et al.

Physician-linked mailed invitations for colorectal cancer screening

Age-eligible rate of influenza vaccine quintile, No. (%)			
Low	548 (22%)	1,997 (23%)	2,545 (23%)
2	549 (22%)	1,765 (20%)	2,314 (20%)
3	435 (17%)	1,930 (22%)	2,365 (21%)
4	485 (19%)	1,770 (20%)	2,255 (20%)
High	486 (19%)	1,337 (15%)	1,823 (16%)

*Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

Other PEM = other patient enrolled model of care

FOBT = fecal occult blood test

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 2. Multivariate logistic regression analysis using Generalized Estimating Equations for the characteristics of participants and physicians associated with completing an FOBT within 6 months of the mailing date.

Participants	Odds ratio (95% C.I.)	P-value
Age group, years		
50-59	0.6 (0.5, 0.8)	<.0001
60-69	0.8 (0.7, 1.0)	NS
70-74	Reference	N/A
Sex		
Female	0.9 (0.9, 1.0)	NS
Male	Reference	N/A
Co-morbidity*, No. of ADGs		
0	0.7 (0.6, 0.8)	0.0002
1-2	0.9 (0.7, 1.0)	NS
3-4	1.0 (0.9, 1.2)	NS
5-6	1.0 (0.9, 1.2)	NS
7+	Reference	N/A
Median neighborhood income quintile		
Rural	0.9 (0.7, 1.1)	NS
Low Urban	0.9 (0.7, 1.0)	NS
2	1.0 (0.8, 1.1)	NS
3	1.0 (0.9, 1.1)	NS
4	0.9 (0.8, 1.1)	NS
High Urban	Reference	N/A
Health region		
Erie St.Clair	1.3 (0.9, 1.8)	NS
South West	0.9 (0.6, 1.4)	NS
Waterloo Wellington	0.8 (0.6, 1.2)	NS
Hamilton Niagara	0.9 (0.6, 1.2)	NS
Central West	1.0 (0.7, 1.4)	NS
Mississauga Halton	0.6 (0.3, 1.2)	NS
Toronto Central	0.8 (0.6, 1.2)	NS
Central	0.5 (0.4, 0.7)	0.0004
South East	0.8 (0.5, 1.3)	NS
Champlain	1.0 (0.7, 1.4)	NS
North Simcoe-Muskoka	0.9 (0.6, 1.4)	NS
North East	1.1 (0.7, 1.5)	NS
North West	0.7 (0.5, 1.0)	0.03
Central East	Reference	N/A
Recency of immigration		
Remote or non-immigrant	1.0 (0.6, 1.6)	NS
Recent immigrant	Reference	N/A
Prior FOBT Use		
2 to 5 years prior to mailing	2.8 (2.5, 3.3)	<.0001

BMJ Open

> 5 years or never	Reference	
Physician		
Increasing age (per year)	1.0 (1.0, 1.0)	NS
Sex		
Female	1.3 (1.0, 1.5)	0.02
Male	Reference	N/A
Training location		
In Canada	0.9 (0.7, 1.2)	NS
Outside Canada	Reference	N/A
Practice type		
FHG	0.9 (0.7, 1.1)	NS
FHO/FHN	0.8 (0.6, 1.1)	NS
Other PEM	0.7 (0.4, 1.0)	0.05
FHO/FHN-FHT	Reference	N/A
Practice size (enrolled patients)		
≤ 1800 patients	1.1 (0.9, 1.3)	NS
> 1800 patients	Reference	N/A
Age-eligible rate of colonoscopy quintile	Reference	N/A
Low	1.1 (0.8, 1.5)	NS
2	1.2 (1.0, 1.6)	NS
3		NS
3	1.0 (0.8, 1.2)	NS
	1.0 (0.8, 1.3)	
High	Reference	N/A
Age-eligible rate of FOBT quintile	0.0 (0.0 1.2)	NO
2	0.9 (0.6, 1.3)	NS
3	0.9 (0.7, 1.2)	NS
4	1.1 (0.8, 1.4)	NS
High	0.9 (0.7, 1.3)	NS
Low	Reference	N/A
Age-eligible rate of annual physical exams		
quintile		
2	1.4 (0.9, 2.0)	NS
3	1.3 (0.9, 1.8)	NS
4	1.3 (0.9, 1.8)	NS
High	1.1 (0.8, 1.5)	NS
Low	Reference	N/A
Age-eligible rate of influenza vaccine quintile		
2	1.0 (0.8, 1.2)	NS
3	0.8 (0.6, 1.0)	0.02
4	0.9 (0.7, 1.2)	NS
High	1.3 (1.0, 1.7)	NS
Low	Reference	N/A

*Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Other PEM = other patient enrolled model of care NS = not significant N/A - not applicable For beer terrien only FOBT = fecal occult blood test



BMJ Open

Table 3. Characteristics of the 2 cohorts matched by propensity score in Study 2

Age group in years, No. (%) 6,248 (59%) 6,324 (59%) 0.01 50-59 3,342 (31%) 3,316 (31%) 0.01 70-74 1,062 (10%) 1,012 (10%) 0.02 Sex, No. (%) Female 5548 (52%) 5477 (51%) 0.01 Male 5,104 (48%) 5,175 (49%) 0.01 Co-morbidity**, No. of ADGs (%) 0 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,538 (14%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) No. (%) Rural 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1.699 (16%) 0.01 0.01 0.01 4 1,825 (17%) 1,889 (18%) 0.02 0.02 0.01 0.01 2 1,698 (16%) 1,728 (16%) 0.02 0.01 0.01 0.01 0.02 2 1,698 (16%) 1,728 (16%)		Pilot participants	Control participants	Standardized Difference*
Age group in years, No. (%) 6,248 (59%) 6,324 (59%) 0.01 50-59 3,342 (31%) 3,316 (31%) 0.01 70-74 1,062 (10%) 1,012 (10%) 0.02 Sex, No. (%) Female 5548 (52%) 5477 (51%) 0.01 Male 5,104 (48%) 5,175 (49%) 0.01 Co-morbidity**, No. of ADGs (%) 0 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,538 (14%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) No. (%) Rural 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1.699 (16%) 0.01 0.01 0.01 4 1,825 (17%) 1,889 (18%) 0.02 0.02 0.01 0.01 2 1,698 (16%) 1,728 (16%) 0.02 0.01 0.01 0.01 0.02 2 1,698 (16%) 1,728 (16%)		(n=10,652)	(n=10.652)	
50-59 6,248 (59%) 6,324 (59%) 0.01 60-69 3,342 (31%) 3,316 (31%) 0.01 70-74 1,062 (10%) 1,012 (10%) 0.02 Sex, No. (%) Female 5548 (52%) 5477 (51%) 0.01 Male 5,104 (48%) 5,175 (49%) 0.01 Co-morbidity**, No. of ADGs (%) 0 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3.44 2,764 (26%) 2,835 (27%) 0.02 5-6 7.4 1,536 (14%) 1,473 (14%) 0.02 2.435 (27%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 3.43 3.716 (35%) 0.01 Median neighborhood income quintile, No. (%) 1,628 (15%) 1,689 (18%) 0.02 2 1,698 (16%) 1,728 (16%) 0.02 Low Urban 1,622 (15%) 1,899 (18%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 3 1,728 (16%) 1,623 (15%) 0.02 2 1,698 (16	Participants			
60-69 3,342 (31%) 3,316 (31%) 0.01 70-74 1,062 (10%) 1,012 (10%) 0.02 Sex, No. (%) Female 5548 (52%) 5477 (51%) 0.01 Male 5,104 (48%) 5,175 (49%) 0.01 Co-morbidity**, No. of ADGs (%) 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) Rural 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.02 2 1,698 (16%) 0.01 4 1,831 (17%) 1,728 (16%) 0.01 4 1,831 (17%) 0.02 2 1,698 (16%) 1,692 (16%) 0.02 1 0.01 4 0.01 4 1,831 (17%) 1,728 (16%) 0.02	Age group in years, No. (%)			
70-74 1,062 (10%) 1,012 (10%) 0.02 Sex, No. (%) Female 5548 (52%) 5477 (51%) 0.01 Male 5,104 (48%) 5,175 (49%) 0.01 Co-morbidity**, No. of ADGS (%) 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) Rural 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.01 3 1,728 (16%) 0.01 3 1,728 (16%) 1,681 (16%) 0.01 4 1,831 (17%) 0.02 Low Urban 1,942 (18%) 1,902 (18%) 0.02 14igh Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (50-59	6,248 (59%)	6,324 (59%)	0.01
Sex, No. (%) Female 5548 (52%) 5477 (51%) 0.01 Male 5,104 (48%) 5,175 (49%) 0.01 Co-morbidity**, No. of ADGs (%) 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.01 3 1,728 (16%) 1,728 (16%) 0.01 4 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.01 3 1,728 (16%) 1,728 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 0 <td>60-69</td> <td>3,342 (31%)</td> <td>3,316 (31%)</td> <td>0.01</td>	60-69	3,342 (31%)	3,316 (31%)	0.01
Female 5548 (52%) 5477 (51%) 0.01 Male 5,104 (48%) 5,175 (49%) 0.01 Co-morbidity**, No. of ADGs (%) 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 3 1,726 (16%) 1,611 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 2 1,698 (16%) 1,902 (18%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 4 1,811 (17%) 1,753 (16%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 Warerloo Wellington <t< td=""><td>70-74</td><td></td><td>1,012 (10%)</td><td>0.02</td></t<>	70-74		1,012 (10%)	0.02
Male 5,104 (48%) 5,175 (49%) 0.01 Co-morbidity**, No. of ADGs (%) 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) 1,628 (15%) 1,699 (16%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 3 1,728 (16%) 1,689 (16%) 0.01 3 1,728 (16%) 1,681 (16%) 0.01 4 1,825 (17%) 1,889 (18%) 0.02 2 1,698 (16%) 1,728 (16%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 4 1,728 (16%) 1,681 (16%) 0.01 4 1,728 (16%) 1,902 (18%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Cerital West 620 (6%)	Sex, No. (%)			
Co-morbidity**, No. of ADGs (%) 1 <th1< th=""> <th< td=""><td>Female</td><td>5548 (52%)</td><td>5477 (51%)</td><td>0.01</td></th<></th1<>	Female	5548 (52%)	5477 (51%)	0.01
0 1,462 (14%) 1,425 (13%) 0.01 1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 3 1,728 (16%) 1,681 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) 1 1,107 (10%) 1,114 (10%) 0 South West 1,107 (10%) 1,114 (10%) 0 0 Maetrolo Wellington 327 (3%) 343 (3%) 0.01 Health region, No. (%) 1,245 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02	Male	5,104 (48%)	5,175 (49%)	0.01
1-2 3,647 (34%) 3,716 (35%) 0.01 3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,825 (17%) 1,889 (18%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 3 1,728 (16%) 1,691 (16%) 0.01 4 1,831 (17%) 1,728 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 <	Co-morbidity**, No. of ADGs (%)			
3-4 2,764 (26%) 2,835 (27%) 0.02 5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) 1,825 (17%) 1,889 (18%) 0.02 Rural 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 3 1,728 (16%) 1,681 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%)	0	1,462 (14%)	1,425 (13%)	0.01
5-6 1,536 (14%) 1,473 (14%) 0.02 7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) 1,825 (17%) 1,889 (18%) 0.02 Rural 1,628 (15%) 1,699 (16%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.01 3 1,728 (16%) 1,616 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 0 0 Toronto Central 503 (5%) 478 (4%)	1-2	3,647 (34%)	3,716 (35%)	0.01
7+ 1,243 (12%) 1,203 (11%) 0.01 Median neighborhood income quintile, No. (%) 0.01 Rural 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.01 3 1,728 (16%) 1,728 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 904 (8%)		2,764 (26%)	2,835 (27%)	0.02
Median neighborhood income quintile, No. (%) Image: Constraint of the system Image: Constraint of the system <thimage: constraint="" of="" system<="" th="" the=""> Im</thimage:>	5-6	1,536 (14%)	1,473 (14%)	0.02
No. (%) Image: Second Sec	7+	1,243 (12%)	1,203 (11%)	0.01
Rural 1,825 (17%) 1,889 (18%) 0.02 Low Urban 1,628 (15%) 1,699 (16%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 3 1,728 (16%) 1,681 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 203 (5%) 478 (4%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 904 (8%) 0 0 North Simcoe-Muskoka 265 (2%) 242 (2%)	0			
Low Urban 1,628 (15%) 1,699 (16%) 0.02 2 1,698 (16%) 1,728 (16%) 0.01 3 1,728 (16%) 1,681 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01				
2 1,698 (16%) 1,728 (16%) 0.01 3 1,728 (16%) 1,681 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East		1,825 (17%)		
3 1,728 (16%) 1,681 (16%) 0.01 4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) 0.01 Erie St.Clair 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North East <td>Low Urban</td> <td>1,628 (15%)</td> <td>1,699 (16%)</td> <td>0.02</td>	Low Urban	1,628 (15%)	1,699 (16%)	0.02
4 1,831 (17%) 1,753 (16%) 0.02 High Urban 1,942 (18%) 1,902 (18%) 0.01 Health region, No. (%) 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 1111 (1%) 105 (1%) 0.01	2	1,698 (16%)	1,728 (16%)	0.01
High Urban1,942 (18%)1,902 (18%)0.01Health region, No. (%)Erie St.Clair462 (4%)423 (4%)0.02South West1,107 (10%)1,114 (10%)0Waterloo Wellington327 (3%)343 (3%)0.01Hamilton Niagara1,265 (12%)1,290 (12%)0.01Central West620 (6%)580 (5%)0.02Mississauga Halton142 (1%)144 (1%)0Toronto Central503 (5%)478 (4%)0.01Central East1,643 (15%)1,702 (16%)0.02South East859 (8%)891 (8%)0.01Champlain895 (8%)904 (8%)0North Simcoe-Muskoka265 (2%)242 (2%)0.01North Kest954 (9%)954 (9%)0Recent immigrant, No. (%)111 (1%)105 (1%)0.01FOBT 2 to 5 years prior to mailing, No.1,476 (14%)1,240 (12%)0.07	3	1,728 (16%)	1,681 (16%)	0.01
Health region, No. (%) 462 (4%) 423 (4%) 0.02 South West 1,107 (10%) 1,114 (10%) 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North Simcoe-Muskoka 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01	4	1,831 (17%)	1,753 (16%)	0.02
Erie St.Clair462 (4%)423 (4%)0.02South West1,107 (10%)1,114 (10%)0Waterloo Wellington327 (3%)343 (3%)0.01Hamilton Niagara1,265 (12%)1,290 (12%)0.01Central West620 (6%)580 (5%)0.02Mississauga Halton142 (1%)144 (1%)0Toronto Central503 (5%)478 (4%)0.01Central East1,643 (15%)1,702 (16%)0.02South East859 (8%)891 (8%)0.01Champlain895 (8%)904 (8%)0North Simcoe-Muskoka265 (2%)242 (2%)0.01North West954 (9%)954 (9%)0Recent immigrant, No. (%)111 (1%)105 (1%)0.01FOBT 2 to 5 years prior to mailing, No.1,476 (14%)1 240 (12%)0.07	High Urban	1,942 (18%)	1,902 (18%)	0.01
South West 1,107 (10%) 1,114 (10%) 0 Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North West 954 (9%) 954 (9%) 0 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01	Health region, No. (%)			
Waterloo Wellington 327 (3%) 343 (3%) 0.01 Hamilton Niagara 1,265 (12%) 1,290 (12%) 0.01 Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 201 (2%) 209 (2%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North West 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01	Erie St.Clair	462 (4%)	423 (4%)	0.02
Hamilton Niagara1,265 (12%)1,290 (12%)0.01Central West620 (6%)580 (5%)0.02Mississauga Halton142 (1%)144 (1%)0Toronto Central503 (5%)478 (4%)0.01Central201 (2%)209 (2%)0.01Central East1,643 (15%)1,702 (16%)0.02South East859 (8%)891 (8%)0.01Champlain895 (8%)904 (8%)0North Simcoe-Muskoka265 (2%)242 (2%)0.01North West954 (9%)954 (9%)0Recent immigrant, No. (%)111 (1%)105 (1%)0.01FOBT 2 to 5 years prior to mailing, No.1,476 (14%)1 240 (12%)0.07	South West	1,107 (10%)	1,114 (10%)	0
Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central East 201 (2%) 209 (2%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 FOBT 2 to 5 years prior to mailing, No. 1,476 (14%) 1 240 (12%) 0.07	Waterloo Wellington	327 (3%)	343 (3%)	0.01
Central West 620 (6%) 580 (5%) 0.02 Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central 201 (2%) 209 (2%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 FOBT 2 to 5 years prior to mailing, No. 1,476 (14%) 1 240 (12%) 0.07	Hamilton Niagara	1,265 (12%)	1,290 (12%)	0.01
Mississauga Halton 142 (1%) 144 (1%) 0 Toronto Central 503 (5%) 478 (4%) 0.01 Central 201 (2%) 209 (2%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 FOBT 2 to 5 years prior to mailing, No. 1,476 (14%) 1 240 (12%) 0.07	Central West	620 (6%)	580 (5%)	0.02
Toronto Central503 (5%)478 (4%)0.01Central201 (2%)209 (2%)0.01Central East1,643 (15%)1,702 (16%)0.02South East859 (8%)891 (8%)0.01Champlain895 (8%)904 (8%)0North Simcoe-Muskoka265 (2%)242 (2%)0.01North East1,409 (13%)1,378 (13%)0.01North West954 (9%)954 (9%)0Recent immigrant, No. (%)111 (1%)105 (1%)0.01FOBT 2 to 5 years prior to mailing, No.1,476 (14%)1 240 (12%)0.07	Mississauga Halton			0
Central 201 (2%) 209 (2%) 0.01 Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01 FOBT 2 to 5 years prior to mailing, No. 1 476 (14%) 1 240 (12%) 0 07				0.01
Central East 1,643 (15%) 1,702 (16%) 0.02 South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 FOBT 2 to 5 years prior to mailing, No. 1,476 (14%) 1 240 (12%) 0.07	Central			0.01
South East 859 (8%) 891 (8%) 0.01 Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01 FOBT 2 to 5 years prior to mailing, No. 1 476 (14%) 1 240 (12%) 0 07	Central East	. ,		
Champlain 895 (8%) 904 (8%) 0 North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01 FOBT 2 to 5 years prior to mailing, No. 1 476 (14%) 1 240 (12%) 0 07	South East			0.01
North Simcoe-Muskoka 265 (2%) 242 (2%) 0.01 North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01 FOBT 2 to 5 years prior to mailing, No. 1 476 (14%) 1 240 (12%) 0 07		· · · ·		
North East 1,409 (13%) 1,378 (13%) 0.01 North West 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01 FOBT 2 to 5 years prior to mailing, No. 1 476 (14%) 1 240 (12%) 0 07				0.01
North West 954 (9%) 954 (9%) 0 Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01 FOBT 2 to 5 years prior to mailing, No. 1 476 (14%) 1 240 (12%) 0 07			. ,	
Recent immigrant, No. (%) 111 (1%) 105 (1%) 0.01 FOBT 2 to 5 years prior to mailing, No. 1 476 (14%) 1 240 (12%) 0 07			. ,	
FOBT 2 to 5 years prior to mailing, No. 1 476 (14%) 1 240 (12%) 0 07				
		1,476 (14%)	1,240 (12%)	0.07

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Median age in years (IQR)	52 (45-59)	52 (47-58)	N/A
Sex, No. (%)			
Female	3,875 (36%)	3,335 (31%)	N/A
Male	6,777 (64%)	7,317 (69%)	IN/A
Practice type, No. (%)			
FHG	4,854 (46%)	4,885 (46%)	
FHO/FHN	1,859 (17%)	1,718 (16%)	N1/A
FHO/FHN-FHT	3,374 (32%)	3,027 (28%)	N/A
Other PEM	565 (5%)	1,022 (10%)	
Practice size (enrolled patients), No.			
(%)			
>1800 patients	5,366 (50%)	5,026 (47%)	N/A

*Standardized differences for physician level variables not reported as propensity scores were estimated using patient level characteristics only

**Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

Other PEM = other patient enrolled model of care

FOBT = fecal occult blood test

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 4. Association between mailed invitation and FOBT completion or mailed invitation and FOBT or colonoscopy completion after adjusting for physician factors.

	FOBT completion		FOBT or Colonoscopy completion		
	Odds ratio (95% C.I.)	P-value	Odds ratio (95% C.I.)	P-value	
lailed invitation					
Yes (Pilot)	3.3 (3.1, 3.6)	<.0001	2.7 (2.5, 2.9)	<.0001	
No (Controls)	Reference	N/A	Reference	N/A	
ncreasing age (per year)	1.0 (1.0, 1.0)	NS	1.0 (1.0, 1.0)	0.03	
Sex, No. (%)					
Female	1.0 (0.9, 1.1)	NS	1.0 (0.9, 1.1)	NS	
Male	Reference	N/A	Reference	N/A	
Practice type, No. (%)					
FHG	0.7 (0.6, 0.8)	<.0001	0.7 (0.7, 0.8)	<.0001	
FHO/FHN	0.8 (0.7, 0.9)	<.0001	0.8 (0.7, 0.9)	<.0001	
Other PEM	0.8 (0.7, 1.0)	0.03	0.8 (0.7, 1.0)	NS	
FHO/FHN-FHT	Reference	N/A	Reference	N/A	
Practice size (enrolled patients)					
≤ 1800 patients	1.2 (1.1, 1.3)	0.0004	1.2 (1.1, 1.3)	<.0001	
> 1800 patients	Reference	N/A	Reference	N/A	

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Figure Legends

Figure 1. Mock-up of physician-linked invitation used in the Pilot.

TITLE PAGE

Title: Using pPhysician-linked mailed invitations to be screened in an organized colorectal cancer screening program: effectiveness and factors associated with response.

Short tile: Physician-linked invitations for colorectal cancer screening

Authors:

Jill Tinmouth^{1,3,5,6} Nancy N. Baxter^{3,5,7} Lawrence F. Paszat^{2,3,4} Linda Rabeneck^{1,3,4,5,6} Rinku Sutradhar^{3,4} Lingsong Yun³

Affiliations: Departments of Medicine¹ and Radiation Oncology², Sunnybrook Health Sciences Centre, Toronto, Canada; Institute for Clinical Evaluative Sciences, Toronto, Canada³; Dalla Lana School of Public Health, University of Toronto, Toronto, Canada⁴; Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Canada⁵; Cancer Care Ontario, Toronto, Canada⁶; Department of General Surgery and Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Canada⁷.

Corresponding Author Information:

Jill Tinmouth MD PhD FRCPC Sunnybrook Health Sciences Centre 2075 Bayview Ave Rm HG40 Toronto ON M4N 3M5 416 480-5910 t 416 480-4845 f jill.tinmouth@sunnybrook.ca

Email addresses of authors:

Nancy N. Baxter Lawrence F. Paszat Linda Rabeneck Rinku Sutradhar Lingsong Yun BaxterN@smh.toronto.on.ca lawrence.paszat@ices.on.ca Linda.Rabeneck@cancercare.on.ca Rinku.Sutradhar@ices.on.ca Lingsong.Yun@ices.on.ca

Word count: <u>3211_3159</u> (main text), 26<u>32</u> (abstract)

Formatted: Not Highlight

	Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening	
Number of Tables: 4		
Number of Figures: 1		
Number of References: <u>4945</u>		Formatted: Highlight
Key words: Mailed invitations, o	olorectal cancer, organized screening	

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

ABSTRACT

<u>Objectives</u>: A central tenet of organized cancer screening is that all persons in a target population are invited. The aims of this study were to identify participant and physician factors associated with response to mailed physician-linked invitations (Study 1) and to evaluate their effectiveness in an organized colorectal (CRC) screening program (Study 2).

<u>Design and setting</u>: Two studies (Study 1 – cohort design and Study 2 – matched cohort design, <u>of comprising</u> Study 1 participants and a matched control group) conducted in context of Ontario's organized province-wide CRC screening program.

<u>Participants</u>: 102 family physicians and 11,302 associated eligible patients from a technical evaluation ("the Pilot") of large scale mailed invitations for CRC screening were included. Matched controls were randomly selected using propensity scores from among eligible patients associated with family physicians in similar practice types as the Pilot physicians.

Intervention: Physician-linked mailed invitation to have CRC screening. <u>Outcomes</u>: Uptake of fecal occult blood test (FOBT) within 6 months of mailed invitation (primary) and uptake of FOBT or colonoscopy within 6 months of mailed invitation (secondary).

<u>Results</u>: Factors significantly associated with uptake of FOBT included prior FOBT use, older participant age, greater participant co-morbidity and having a female physician. In

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

the matched analysis, Pilot participants were more likely to complete an FOBT (22% vs. 8%, p<0.0001) or an FOBT or colonoscopy (25% vs. 11%, p <0.0001) within 6 months of mailed invitation than matched controls. The number needed to invite to screen one additional person was 7.

Conclusions: Centralized large scale mailing of physician-linked invitations is both feasible and effective in an the context of organized CRC screening program.

1	
2 3 4	Tinmouth et al.
5 6	Physician-linked mailed invitations for colorectal cancer screening
7 8	ARTICLE SUMMARY
9 10	Strengths and limitations of this study:
$\begin{array}{c} 10\\ 11\\ 12\\ 13\\ 14\\ 15\\ 16\\ 17\\ 18\\ 19\\ 20\\ 21\\ 22\\ 23\\ 24\\ 25\\ 26\\ 27\\ 28\\ 29\\ 30\\ 31\\ 32\\ 33\\ 435\\ 36\\ 37\\ 38\\ 39\\ 40\\ 41\\ 42\\ 43\\ 44\\ 546\\ 47\\ 48\\ 49\\ 50\\ 51\\ 52\\ 35\\ 45\\ 56\\ 57\\ 58\\ 59\end{array}$	

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

INTRODUCTION

Colorectal cancer (CRC) is the 3rd-most common cancer and the 4ththe second leading cause of cancer-related death <u>among men and the third among women worldwidein</u> <u>Canada.¹REF.</u> Fecal occult blood testing (FOBT)²⁻⁴ and flexible sigmoidoscopy⁵⁻⁷ have been shown to decrease CRC mortality in randomized controlled trials.

Given these data, organized CRC screening programs⁸ are being implemented worldwide.⁹ On April 1 2008, Ontario launched <u>ColonCancerCheck (CCC)</u>, Canada's first organized province-wide CRC screening program, <u>ColonCancerCheck (CCC)</u>.¹⁰ <u>CCC has a dual strategy: t</u>hrough the primary care physician, FOBT is offered to people at average risk for CRC and colonoscopy to those at increased risk based on family history. The CCC program uses a non-rehydrated guaiac FOBT (Hema-Screen, Immmunostics, Inc., NJ, USA) requiring <u>3 stool</u> samples from <u>3</u> separate stools. <u>While</u> there is data to suggest that dietary restriction may be unnecessary,¹¹ Tthe program recommends avoiding only recommended dietary restriction is to avoid vitamin C for 3 days prior to and during the collection period in order to minimize false negative results.

Approximately 75% of Ontario residents received their care via a patient enrolled model (PEMs) of care at the time of the study (2009).¹² PEMs comprise teams of family physicians who provide their enrolled patients with comprehensive health care and extended hours.¹³ PEMs vary in terms of structure, services provided and remuneration

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

(varying from enhance fee-for-service to blended capitation). All Ontario physicians are remunerated for preventive care such as CRC screening however, PEM physicians are incented to a greater degree than those who are not in PEMs. Specifically, PEM physicians receive a \$7/patient fee for "FOBT dDistribution and cGounseling", a \$6.86/patient fee for "CRC SScreening mManagement" and an annual "Colorectal cGancer SScreening pPreventive cGare bBonus" (\$220 to \$4000) depending on the proportion of enrolled patients who are up-to-date with FOBT (15-70%). The physician is entitled to the CRC SScreening mManagement fee if the enrolled patient attends an appointment to discuss CRC screening, has declined the test verbally or in writing or if there has been no response after 2 written notices and a telephone call from the physician.¹⁴

A central tenet of organized screening programs is that all persons in the target population be invited to participate.⁸ Implementation of this aspect of organized screening varyvaries: invitations may be sent with an FOBT kit, can include physician recommendation or may incorporate tailored messaging.¹⁵ ¹⁶ Some of these approaches, such as incorporation of physician recommendation, present significant implementation challenges for organized screening programs such as Ontario's.

In 2009, the CCC program <u>conducted undertook</u> the CCC Invitation Pilot (the "Pilot"), an evaluation that tested the technical feasibility of a centralized approach to sending physician-linked mailed invitations for CRC screening. In this paper, we describe the

Formatted: No underline

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

structure and the implementation of the Pilot. In addition, we report on participant and physician factors associated with response to mailed physician-linked invitations and on the effectiveness of these invitations in <u>an-Ontario's</u> organized CRC screening program.

METHODS

The CCC Invitation Pilot – Implementation and Evaluation

The Pilot was conducted by CCC CCC program conducted the Pilot in November 2009 in order to develop and test the technical infrastructure required for large scale centralized physician linked mailed invitations in Ontario. For the Pilot, ilnvitation letters were generated by the CCC program on behalf of 102 family physicians and sent to all their eligible enrolled patients. Just over 11,000 eligible patient participants were sent mailed invitations requesting they visit their family physician to obtain an FOBT kit or, if appropriate based on family history, a referral for colonoscopy. In this paper, we report on 2 studies using this cohort. Study 1 examines participant and physician factors associated with response to the mailed invitation among those who were sent the mailed invitation. Study 2 evaluates the effectiveness of the mailed invitation by comparing uptake of CRC screening among Study 1 participants compared to a matched control group. Ethics approval was obtained from the research ethics boards at Sunnybrook Health Sciences Centre and the Institute for Clinical Evaluative Sciences (ICES) and permission to use the Pilot data was obtained from Cancer Care Ontario's (CCO) Data

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Access Committee. All analyses were conducted using SAS v.9 (SAS Institute, Cary, NC). A p-value of 0.05 was used to determine statistical significance.

Data Sources

The Pilot study was conducted at ICES, which houses the administrative health records for all 12.43.5 million Ontarians. CCC program databases were linked to the ICES administrative databases using an encrypted version of the provincial health insurance number.

The ICES databases used include the Canadian Institute of Health Information (CIHI) databases, the Ontario Health Insurance Program (OHIP) Claims History Database, the Registered Persons Database (RPDB), the Ontario Cancer Registry, the ICES Physician Database, and the Client Agency Program Enrollment (CAPE) registry. The CIHI, OHIP, RPDB and the Ontario Cancer Registry and the ICES Physician Database have been are previously described elsewhere.^{17 18} The CAPE registry tracks patients enrolled to physicians who participate in PEMs and is a centralized electronic record of the linkage between specific patients and their physicians.,

<u>Since its inception, t</u>The CCC program has collected data <u>related to the FOBT kits</u> administered by the CCC program, including the results of these tests, on CRC screening since its inception using Laboratory Reporting Tool (LRT) and comprises data

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

related to the FOBT kits administered by the CCC program, including the results of these tests.

Study 1: Factors associated with response to the mailed invitation

<u>Cohort Definition</u>: For the Pilot, a convenience sample of physicians participating in PEM-type practices was recruited via CCO's Provincial Primary Care Cancer Network. Patients enrolled to these physicians, aged 50 to 74 years without a history of CRC and who were due for CRC screening (without a health administrative data record of recent FOBT (previous two years) or lower GI investigation including flexible sigmoidoscopy and colonoscopy (previous 5 years)), were eligible. For the Pilot mailing, CCC generated lists of patient participants eligible for CRC screening for each participating physician using CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT. All persons who were sent an invitation were included in the cohort, regardless of whether the letter was returned to the sender.

<u>The Mailing</u>: Invitations were mailed in November 2009. The date of mailing was the index date. The letters were compiled centrally by the CCC program but were physician-linked; patient participants were sent a letter from their own physician, as indicated by their name at the bottom of the letter in an italicized font (Figure 1). The letter asked participants to visit their family physician for screening; it did not include an FOBT kit. The letter was accompanied by a CRC screening information brochure and sent in an

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

envelope with the family physician name in the front upper left corner. For the purposes of the study, Pilot physicians were <u>not</u> compensated <u>for study participation</u>, <u>however</u>, they were able to apply the letter towards meeting the requirements for the <u>an equivalent</u> amount to the CRC <u>s</u>Creening <u>m</u>Management fee (\$6.86 per eligible enrolled patient) as Ontario PEM physicians are eligible for this fee for contacting the patient by mail regarding CRC screening.

<u>Response to Mailed Invitation</u>: We used a broad definition of response to the mailed invitation: any record of FOBT in either OHIP or in LRT within 6 months of the index date, regardless of result (including rejected kits). Up to 10% of FOBT done in the province are captured only <u>through in</u> OHIP, which does not have data on test results. We were not able to measure response in persons at increased risk of CRC as we do not have family history data available in the administrative databases.

<u>Participant and Physician Factors</u>: We characterized participants by age group, sex, comorbidity, median neighborhood income, ^{19 20}, health region, ²¹, immigration status, and prior FOBT. <u>-CWe measured comorbidity was measured</u> by counting the number of Aggregated Diagnosis Groups (ADGs) <u>using in the prior 12 months according to</u> the Johns Hopkins ACG® Case-Mix System in the prior 12 months.²² <u>This system has been</u> shown to<u>M</u> accurately predict mortality in a general population ambulatory cohort in Ontario was accurately predicted using this system.²³ -We used date of registration in

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

the RPDB as a proxy measure for immigration status; participants were considered recent immigrants if their date of registration was within 5 years of the index date.²⁴

Physicians were characterized according to age, sex, training location (attended Canadian medical schoolCanada vs. outside of Canada), practice type, size of practice, age-eligible rate of colonoscopy or FOBT over prior 2 years as well as the age-eligible rate of annual physical exams or influenza vaccinations in the prior year. -All participating physicians were in PEMs; practice types included family health groups (FHGs, enhanced fee-for-service models), family health organizations or networks (FHO/FHNs, blended capitation models), FHO/FHN with family health team (FHO/FHN-FHT, interprofessional team model with a blended capitation fee structure) and other PEMs.²⁵ -We measured practice size as the number of enrolled patients stratified in a binary fashion (≤1800 vs. >1800 enrolled patients) as larger practice sizes have been shown to be associated with poorer preventative care.²⁶ For the remaining physician characteristics, we identified all enrolled and non-enrolled patients aged 50-74 years in their practices as of the index date. Age-eligible FOBT and colonoscopy rates were obtained for each Pilot physician by calculating the proportion of their age-eligible patients who had had an FOBT or colonoscopy in the 2 years prior to the index date. Similarly, we calculated their rates of age-eligible annual physical exams or influenza vaccine in the year prior to the index date. -These variables were derived in order to

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

estimate physician adherence to CRC screening and preventive medicine practices at baseline.

<u>Analysis</u>: The number and proportion of persons in the cohort who responded to the mailed invitation within 6 months were determined overall and by participant and physician characteristics. Multivariate logistic regression modeling was used to identify participant and physician factors associated with response to the mailed invitation. In order to account for potential clustering of participants within physicians, Generalized Estimating Equations (GEE)²⁷ were used in the model.

Study 2: Evaluation of the effectiveness of mailed invitations

<u>Overview and study participants</u>: This was a matched double cohort analysis, comparing uptake of FOBT in those who were sent a mailed invitation (Pilot cohort) to a matched control group who were not sent a mailed invitation. -The control group comprised patients who were enrolled to PEM physicians who had not participated in the Pilot. Control participants received "usual care" fromer the CCC program in terms of screening promotion. As such, they received were eligible for screening via their primary care physician who wasere eligible for the same financial incentives as the Pilot physicians. Control participants were not sent a centralized physician-linked invitation from the CCC program although their physicians could send them a mailed invitation at their own discretion.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

The Pilot cohort comprised all members of the cohort described in Study 1 for whom a matched control could be identified. We identified potential controls as follows: 1) Pilot physicians were matched to non-Pilot physicians who were also practicing in PEMs in a 1:5 ratio using physician age, sex, size and practice type; 2) individuals enrolled to the selected control physicians were retained if they met the same inclusion/exclusion criteria as those in the intervention cohort (aged 50 to 74 years with no prior CRC who were due for CRC screening). As with the identification of eligible participants in the Pilot, we used CAPE, Ontario Cancer Registry, OHIP, CIRT and LRT to determine eligibility of potential control participants.

Propensity scores that modeled the probability of belonging to the Pilot group were calculated for each participant in the entire group (Pilot and control). The variables in this model included age (as a continuous measure), sex, co-morbidity, median neighborhood income quintile, health region, immigration status, and FOBT from 2 to 5 years prior.²⁸²⁹ Pilot participants were matched to controls in a 1:1 fashion based on propensity scores using a caliper width of 0.25. This methodology was implemented to balance the distribution of participant-level variables between the Pilot and control groups.

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Response to mailed invitation: For our primary outcome, we defined response to the mailed invitation as in Study 1, a record of FOBT regardless of result, within 6 months of the index date. For our secondary outcome, response was defined as a record of either FOBT or colonoscopy within 6 months of the index date. For the purposes of this study, controls were assigned the same index date as their matched counterpart in the Pilot group.

<u>Analysis</u>: Standard differences between the Pilot participants and controls were calculated for the variables included in the propensity score. Important differences between the 2 groups were defined by a standardized difference exceeding 0.1.^{29 30} In the primary analysis, we compared the number and proportion in the Pilot and control groups responding to the mailed invitation with FOBT using McNemar's test.²⁹ -We determined the number of invitations mailed in order to screen one additional person with FOBT. -We repeated the above analyses using our secondary outcome in order to determine if observed differences in FOBT uptake could be attributed to differences in colonoscopy uptake (i.e., participants had CRC screening but chose colonoscopy over FOBT). As the matching only accounted for participant-level variables, we repeated our analyses using conditional logistic regression in order to adjust for physician covariates (age, sex, practice type and size).

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

RESULTS

Study 1: Factors associated with response to the mailed invitation

There were 11,311 eligible patient participants associated with the 102 family physicians in the Pilot cohort. Nine participants were excluded<u>excluded</u>, as we were unable to determine their health region and/or income quintile; this left 11,302 participants for the analysis. The majority of participants were 50 to 59 years of age, 52% were women, 48% had no or low co-morbidity and 14% had completed an FOBT from 2 to 5 years prior to the mailing. Two thirds of participants had a male physician, approximately half were part of a primary care team reimbursed via an enhanced fee-for-service arrangement and just under half were enrolled in larger practices (>1800 enrolled patients) (Table 1).

2503 (22%) completed an FOBT within 6 months of mailing. In the multivariate regression, the strongest participant factor associated with FOBT completion was prior FOBT use (2 to 5 years prior vs. > 5 years or never: OR 2.8, 95% C.I.: 2.5 to 3.3, p < 0.0001). Other significant factors associated with FOBT completion included older participant age, greater co-morbidity, and having a female physician (Table 2).

Study 2: Evaluation of the effectiveness of mailed invitations

Of the 11,302 participants in Study 1, 10,652 -were successfully matched to 10,652 controls using propensity scores. Standardized differences for the participant

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

characteristics included in the propensity score were all <0.1, indicating that the two cohorts were well matched for measurable potential confounders (Table 3).

Pilot participants were significantly more likely than controls to complete FOBT alone (2387 (22%) versus 854 (8%), p<0.0001) and FOBT or colonoscopy (2664 (25%) vs. 1191 (11%), p<0.0001) within 6 months of mailing. The association between the mailed invitation and CRC screening participation (either FOBT alone or FOBT or colonoscopy) remained after adjusting for physician level characteristics (Table 4).

DISCUSSION

In the current study, we have demonstrated that physician-linked mailed invitations are both feasible and effective in the context of a large organized, population-based screening program; only 7 letters would need to be sent in order to screen one additional person. -Furthermore, we have found that older participants, those with greater comorbidity, those who have previously been screened and those with female physicians were more likely to respond to this type of invitation. Our findings are of particular interest to other jurisdictions planning or who already have organized CRC screening.

In other published studies of mailed invitations, an FOBT kit is often included with the invitation. Three studies done outside organized screening programs have found physician-linked invitations superior to non-linked invitations; 2 of these studies included

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

an FOBT kit,^{31 32} and the third study did not.³³ Other studies have examined mailed invitations with FOBT kits in the context of primary care practices in the USA.³⁴⁻³⁶ While the results from these trials were largely supportive of mailed invitations, kit inclusion can make it difficult to separate the convenience of receiving the FOBT kit directly by mail from the impact of an invitation from one's own physician.

Our study demonstrates the effectiveness and feasibility of physician-linked invitations in the context of a large organized CRC screening program with an estimated target population of over 3 million persons. Implementation in this context confers challenges in terms of technological infra-structure, privacy and regulatory issues. There are 2 studies (from the United Kingdom³⁷ and Italy³⁸) that have reported on mailed invitations in the context of organized colorectal cancer screening programs and found them to be effective. Both studies included FOBT kits and one studied the impact of physician endorsement specifically.³⁷ Our findings are important because they support a potentially more cost-effective approach that avoids wasting kits that are mailed but not used.

Our results highlight the critical role of physician recommendation, a finding supported by others. -For example, in the NHS Bowel Cancer Screening Programme (BCSP) currently, the primary care physician receives the result but is not directly involved in the mailed invitation or the actual screening. Recently, a randomized controlled trial

BMJ Open

conducted in the context of the BCSP showed that an endorsement letter from the primary care provider increased participation by 6%.³⁷—In 2 studies from Australia, endorsement improved initial participation^{31 32} and over 4 successive screening rounds.³²

Uptake of FOBT in Ontario is lower than some organized CRC screening programs in other countries. For example, 30% of Ontarians were up-to-date with FOBT in 2008-9³⁹ compared to 52% participation in the United Kingdom program by October 2008,⁴⁰ 54% in the Italian program in 2007,⁴¹ and 54% in the New Zealand pilot program in 2012.⁴² However, in the latter countries, there is very little, if any, opportunistic CRC screening using colonoscopy whereas Ontario's program operates in a hybrid environment where opportunistic colonoscopy is available as the initial screening test in persons at average risk. It has been noted that uptake of FOBT may be lower in settings, such as Ontario's or Australia's,⁴³ where opportunistic screening is available.⁴⁴ The findings from the current study indicate that physician-linked invitations for CRC screening can be effective in increasing uptake of FOBT in programs that operate in the context of opportunistic colonoscopy for average risk screening.

Our study has several limitations. As mentioned above<u>First</u>, we are unable to determine family history using Ontario administrative data. A second limitation is that a single generic letter was used. Tailored letters with key messages for specific subgroups may

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

be more effective;¹⁶ __an approach that may be relevant in Ontario as we did find that response to the letter appeared to differ in various subgroups. Additionally, while our findings are promising, there are challenges to widespread implementationadoption by in other population-based screening programs, including the requirement need for a centralized database that links patients to their physicians. Finally, implementation of this strategy in population_based screening is predicated on physician acceptability and agreement. While we have found that this approach is acceptable in principle to many Ontario physicians,⁴⁵ processes to confirm individual physician agreement have not been determined for the entire CCC program which comprises an estimated 7000 primary care physicians.

CONCLUSIONS

In summary, we have demonstrated that physician-linked mailed invitations for CRC screening, even without the inclusion of an FOBT kit, can have substantial effect on participation in an organized CRC screening program and that it is technically feasible to centrally organize and mail physician-linked invitations on a large scale. Organized screening programs, which often use unlinked invitations, should consider adopting this approach given its demonstrated effectiveness and feasibility.

ACKNOWLEDGEMENTS

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

The authors would like to acknowledge Peter Austin PhD for his expert statistic advice. They also wish to acknowledge the support of the Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and CCO. The opinions, results and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by Institutes for Clinical Evaluative Sciences, the Ontario Ministry of Health and Long Term Care and CCO is intended or should be inferred.

COMPETING INTERESTS STATEMENT

Dr. Tinmouth is the Lead Scientist for the ColonCancerCheck program and Dr. Rabeneck oversees the ColonCancerCheck program in her capacity as the Vice-President, Cancer Prevention and Control at CCO. None of the other authors have any conflicts of interest to report.

FUNDING STATEMENT

This study was conducted with the-funding support of from the Ontario Institute for Cancer Research and CCO's Health Services Research Network, which is independent of the ColonCancerCheck program, provided funding for this work. This work was also supported in part by a grant from the Canadian Institutes for Health Research (grant # CST-85478). -Dr. Tinmouth was supported by a Canadian Institutes of Health Research New Investigator Award during the period of this study. Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

AUTHOR CONTRIBUTION:

Authors contributed substantially to each of the following areas:

-conception and design (JT, LFP, LR) or analysis and interpretation of data (JT, NB,

LFP, LR, RS, LY)

-drafting the article (JT) or revising it critically for important intellectual content (JT, NB,

LFP, LR, RS, LY)

-final approval of the version to be published (JT, NB, LFP, LR, RS, LY)

BMJ Open

 in prevention of colorectal cancer: a multicentre randomised controlled trial. Lancet 2010;375(9726):1624-33. Segnan N, Armaroli P, Bonelli L, et al. Once-Only Sigmoidoscopy in Colorectal Cancer Screening: Follow-up Findings of the Italian Randomized Controlled Trial—SCORE J Natl Cancer Inst 2011;103(17):1310-22 Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. N Engl J Med 2012;366(25):2345-57. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. Cancer 2004;104(5 Suppl):1201-13. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Secondary Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Feb 9 2009. http://appliedresearch.cancer.gov/icsn/colorectal/screening.html. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Feb 2, 2012. http://health.gov.on.ca/en/public/programs/coloncancercheck/. Pignone M, Campbell MK, Carr C, et al. Meta-analysis of dietary restriction during fecal occult blood testing. Eff Clin Pract 2001;4(4):150-6. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012. HealthForceOntario. Family Practice Models. Secondary Family Practice Models May 3 2013. http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideO ntario/PractisingInOntario/family practice_models.aspx. Ontario Ministry of Health and Long-Term Care. Bulletin 4482: ColonCancerCheck Physician Incentives Seco	REFERENCES	
 the incidence of colorectal cancer. <i>N Engl J Med</i> 2000;343(22):1603-7. 3. Hardcastle JD, Chamberlain JO, Robinson MH, et al. Randomised controlled trial of faecal-occult-blood screening for colorectal cancer. <i>Lancet</i> 1996;348(9040):1472-7. 4. Kronborg O, Fenger C, Olsen J, et al. Randomised study of screening for colorectal cancer with faecal-occult-blood test. <i>Lancet</i> 1996;348(9040):1467-71. 5. Atkin WS, Edwards R, Kralj-Hans I, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. <i>Lancet</i> 2010;375(9726):1624-33. 6. Segnan N, Armaroli P, Bonelli L, et al. Once-Only Sigmoidoscopy in Colorectal Cancer Screening: Follow-up Findings of the Italian Randomized Controlled Trial—SCORE <i>J Natl Cancer Inst</i> 2011;103(17):1310-22 7. Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. <i>N Engl J Med</i> 2012;366(25):2345-57. 8. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. <i>Cancer</i> 2004;104(5 Suppl):1201-13. 9. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Feb 9 2009. http://appliedresearch.cancer.gov/icsn/colorectal/screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Feb 2, 2012. http://health.gov.on.ca/en/public/programs/coloncancercheck/. 11. Pignone M, Campbell MK, Carr C, et al. Meta-analysis of dietary restriction during facal occult blood testing. <i>Eff Clin Pract</i> 2001;4(4):150-6. 12. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012. 13.	1. Canadian Cancer Society's S Cancer Statistics 2013	B. Toronto, ON: Canadian Cancer Society, 2013.
 Kronborg O, Fenger C, Olsen J, et al. Randomised study of screening for colorectal cancer with faecal-occult-blood test. <i>Lancet</i> 1996;348(9040):1467-71. Atkin WS, Edwards R, Kralj-Hans I, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. <i>Lancet</i> 2010;375(9726):1624-33. Segnan N, Armaroli P, Bonelli L, et al. Once-Only Sigmoidoscopy in Colorectal Cancer Screening: Follow-up Findings of the Italian Randomized Controlled Trial—SCORE <i>J Natl Cancer Inst</i> 2011;103(17):1310-22 Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. <i>N Engl J Med</i> 2012;366(25):2345-57. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. <i>Cancer</i> 2004;104(5 Suppl):1201-13. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Secondary Inventory of Colorectal Cancer Screening Program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program Feb 2, 2012. http://health.gov.on.ca/en/public/programs/Coloncancercheck/. Pignone M, Campbell MK, Carr C, et al. Meta-analysis of dietary restriction during fecal occult blood testing. <i>Eff Clin Pract</i> 2001;4(4):150-6. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012. HealthForceOntario. Family Practice Models. Secondary Family Practice Models May 3 2013. http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/Physici	the incidence of color 3. Hardcastle JD, Chamberlain faecal-occult-blood sc	rectal cancer. <i>N Engl J Med</i> 2000;343(22):1603-7. JO, Robinson MH, et al. Randomised controlled trial of creening for colorectal cancer. <i>Lancet</i>
 Atkin WS, Edwards R, Kralj-Hans I, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. <i>Lancet</i> 2010;375(9726):1624-33. Segnan N, Armaroli P, Bonelli L, et al. Once-Only Sigmoidoscopy in Colorectal Cancer Screening: Follow-up Findings of the Italian Randomized Controlled Trial—SCORE <i>J Natl Cancer Inst</i> 2011;103(17):1310-22 Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. <i>N Engl J Med</i> 2012;366(25):2345-57. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. <i>Cancer</i> 2004;104(5 Suppl):1201-13. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Secondary Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Feb 9 2009. http://appliedresearch.cancer.gov/icsn/colorectal/screening.html. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Feb 2, 2012. <u>http://health.gov.on.ca/en/public/programs/coloncancercheck/.</u> Pignone M, Campbell MK, Carr C, et al. Meta-analysis of dietary restriction during fecal occult blood testing. <i>Eff Clin Pract</i> 2001;4(4):150-6. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012. HealthForceOntario. Family Practice Models. Secondary Family Practice Models May 3 2013. http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideOn Intario/PractisinglnOntario/family practice_models.aspx. Ontario	4. Kronborg O, Fenger C, Olse	n J, et al. Randomised study of screening for colorectal
 Cancer Screening: Follow-up Findings of the Italian Randomized Controlled Trial—SCORE J Natl Cancer Inst 2011;103(17):1310-22 7. Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. N Engl J Med 2012;366(25):2345-57. 8. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. Cancer 2004;104(5 Suppl):1201-13. 9. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Secondary Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Feb 9 2009. http://appliedresearch.cancer.gov/icsn/colorectal/screening.html. 10. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Feb 2, 2012. http://health.gov.on.ca/en/public/programs/coloncancercheck/. 11. Pignone M, Campbell MK, Carr C, et al. Meta-analysis of dietary restriction during fecal occult blood testing. Eff Clin Pract 2001;4(4):150-6. 12. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012. 13. HealthForceOntario. Family Practice Models. Secondary Family Practice Models May 3 2013. http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideO ntario/PractisingInOntario/family_practice_models.aspx. 14. Ontario Ministry of Health and Long-Term Care. Bulletin 4482: ColonCancerCheck Physician Incentives Secondary Bulletin 4482: ColonCancerCheck Physician 	5. Atkin WS, Edwards R, Kralj- in prevention of color	Hans I, et al. Once-only flexible sigmoidoscopy screening ectal cancer: a multicentre randomised controlled trial.
 Schoen RE, Pinsky PF, Weissfeld JL, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. <i>N Engl J Med</i> 2012;366(25):2345-57. Miles A, Cockburn J, Smith RA, et al. A Perspective from Countries Using Organized Screening Programs. <i>Cancer</i> 2004;104(5 Suppl):1201-13. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Secondary Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Feb 9 2009. http://appliedresearch.cancer.gov/icsn/colorectal/screening.html. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program. Feb 2, 2012. http://health.gov.on.ca/en/public/programs/coloncancercheck/. Pignone M, Campbell MK, Carr C, et al. Meta-analysis of dietary restriction during fecal occult blood testing. <i>Eff Clin Pract</i> 2001;4(4):150-6. Glazier RH, Zagorski BM, Rayner J. Comparison of Primary Care Models in Ontario by Demographics, Case Mix and Emergency Department Use, 2008/09 to 2009/10. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences, 2012. HealthForceOntario. Family Practice Models. Secondary Family Practice Models May 3 2013. http://www.healthforceontario.ca/Work/OutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsideOntario/PhysiciansOutsid	Cancer Screening: Fol	low-up Findings of the Italian Randomized Controlled
 Screening Programs. <i>Cancer</i> 2004;104(5 Suppl):1201-13. 9. International Cancer Screening Network. Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Secondary Inventory of Colorectal Cancer Screening Activities in ICSN Countries, May 2008. Feb 9 2009. http://appliedresearch.cancer.gov/icsn/colorectal/screening.html. 10. Anonymous. Colon Cancer Check: Ontario's colorectal cancer screening program. Secondary Colon Cancer Check: Ontario's colorectal cancer screening program Feb 2, 2012. 		

Field Code Changed

2 3 4	
5 6	
7 8	http://www.health
9	<u>pdf</u> . 15. Khalid-de Bakker C, Jon
10 11	screening trials after
12	2011;43(12):1059-8
13	16. Rawl SM, Skinner CS, Pe
14	improves colon can
15	Americans. <i>Health</i> 17. Alharbi O, Rabeneck L, S
16 17	outpatient colonos
18	Anesthesiology 200
19	18. Robles SC, Marrett LD, (
20	methods to the est
21	Epidemiol 1988;41(
22	19. Alter DA, Naylor CD, Au
23	invasive cardiac pro infarction. <i>N Engl J</i>
24 25	20. Singh SM, Paszat LF, Li C
26	colorectal cancer in
27	study. Can Med Ass
28	21. Anonymous. Ontario's L
29	Local Health Integra
30	http://www.lhins.o
31 32	22. Anonymous. The Johns Johns Hopkins Univ
33	http://www.acg.jhs
34	23. Austin PC, van Walraver
35	Aggregated Diagno
36	population cohort i
37	24. Ray JG, Vermeulen MJ,
38 39	and Perinatal Long- 2007;176(10):1419
39 40	25. Glazier RH, Klein-Geltin
41	models for primary
42	, Assoc J 2009;180(1
43	26. Dahrouge S, Hogg WE, F
44	factors on completi
45 46	Med Assoc J 2012;1
40 47	27. Liang K, Zeger SL. Longit Biometrika 1986;73
48	biometrika 1980,75
49	
50	
51	
52 53	
53 54	
55	
56	
57	
58	
59 60	
00	

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

http://www.health.gov.on.ca/en/pro/programs/ohip/bulletins/4000/bul4482. odf.

- .5. Khalid-de Bakker C, Jonkers D, Smits K, et al. Participation in colorectal cancer screening trials after first-time invitation: a systematic review. *Endoscopy* 2011;43(12):1059-86.
- L6. Rawl SM, Skinner CS, Perkins SM, et al. Computer-delivered tailored intervention improves colon cancer screening knowledge and health beliefs of African-Americans. *Health Educ Res* 2012;27(5):868-85.
- Alharbi O, Rabeneck L, Sutradhar R, et al. A population-based analysis of outpatient colonoscopy in adults assisted by an anesthesiologist. *Anesthesiology* 2009;111(4):734-40.
- Robles SC, Marrett LD, Clarke EA, et al. An application of capture-recapture methods to the estimation of completeness of cancer registration. J Clin Epidemiol 1988;41(5):495-501.
- 19. Alter DA, Naylor CD, Austin P, et al. Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction. N Engl J Med 1999;341(18):1359-67.
- 20. Singh SM, Paszat LF, Li C, et al. Association of socioeconomic status and receipt of colorectal cancer investigations: a population-based retrospective cohort study. Can Med Assoc J 2004;171(5):461-5.
- 21. Anonymous. Ontario's Local Health Integration Networks. Secondary Ontario's Local Health Integration Networks May 30 2013. http://www.lhins.on.ca/home.aspx.
- 22. Anonymous. The Johns Hopkins University ACG Case-Mix System. Secondary The Johns Hopkins University ACG Case-Mix System 2012. http://www.acg.jhsph.edu/.
- 23. Austin PC, van Walraven C, Wodchis WP, et al. Using the Johns Hopkins Aggregated Diagnosis Groups (ADGs) to predict mortality in a general adult population cohort in Ontario, Canada. *Med Care* 2011;49(10):932-9.
- 24. Ray JG, Vermeulen MJ, Schull MJ, et al. Results of the Recent Immigrant Pregnancy and Perinatal Long-term Evaluation Study (RIPPLES). *Can Med Assoc J* 2007;176(10):1419-26.
- Glazier RH, Klein-Geltink J, Kopp A, et al. Capitation and enhanced fee-for-service models for primary care reform: a population-based evaluation. Can Med Assoc J 2009;180(11):E72-E81.
- 26. Dahrouge S, Hogg WE, Russell G, et al. Impact of remuneration and organizational factors on completing preventive manoeuvres in primary care practices. Can Med Assoc J 2012;184(2):E135-43.
- 27. Liang K, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika* 1986;73:13-22.

BMJ Open

Physician-linked mailed invitations for colorectal cancer sc
28. D'Agostino RB, Jr. Propensity score methods for bias reduction in the compare of a treatment to a non-randomized control group. <i>Stat Med</i> 1998;17(19):2265-81.
 1998,17(19).2203-61. 19. Austin PC. An Introduction to Propensity Score Methods for Reducing the Eff of Confounding in Observational Studies. <i>Multivariate Behav Res</i> 2011;46(3):399-424.
30. Normand ST, Landrum MB, Guadagnoli E, et al. Validating recommendations coronary angiography following acute myocardial infarction in the elderl matched analysis using propensity scores. J Clin Epidemiol 2001;54(4):38
31. Cole SR, Young GP, Byrne D, et al. Participation in screening for colorectal car based on a faecal occult blood test is improved by endorsement by the primary care practitioner. J Med Screen 2002;9(4):147-52.
32. Zajac IT, Whibley AH, Cole SR, et al. Endorsement by the primary care practit consistently improves participation in screening for colorectal cancer: a longitudinal analysis. J Med Screen 2010;17(1):19-24.
 Grazzini G, Castiglione G, Isu A, et al. Colorectal cancer screening by fecal occ blood testing: results of a population-based experience. <i>Tumori</i> 2000;86(5):384-8.
34. Myers RE, Sifri R, Hyslop T, et al. A randomized controlled trial of the impact targeted and tailored interventions on colorectal cancer screening. <i>Canc</i> 2007;110(9):2083-91.
35. Sequist TD, Zaslavsky AM, Marshall R, et al. Patient and physician reminders promote colorectal cancer screening: a randomized controlled trial. Arch Intern Med 2009;169(4):364-71.
36. Walsh JM, Salazar R, Terdiman JP, et al. Promoting use of colorectal cancer screening tests. Can we change physician behavior? J Gen Intern Med 2005;20(12):1097-101.
37. Hewitson P, Ward AM, Heneghan C, et al. Primary care endorsement letter a patient leaflet to improve participation in colorectal cancer screening: re of a factorial randomised trial. <i>Br J Cancer</i> 2011;105(4):475-80.
38. Giorgi Rossi P, Grazzini G, Anti M, et al. Direct mailing of faecal occult blood t for colorectal cancer screening: a randomized population study from Cer Italy. J Med Screen 2011;18(3):121-7.
39. Cancer Quality Council of Ontario. Colorectal Cancer Screening: Participation Secondary Colorectal Cancer Screening: Participation. 2013. <u>http://www.csqi.on.ca/cms/one.aspx?portalld=258922&pageld=273238</u>
<u>.UijqNMakrmQ</u> . O. Logan RF, Patnick J, Nickerson C, et al. Outcomes of the Bowel Cancer Screen Programme (BCSP) in England after the first 1 million tests. <i>Gut</i> 2012;61(10):1439-46.
1. Parente F, Boemo C, Ardizzoia A, et al. Outcomes and cost evaluation of the f

Physician-linked mailed invitations for colorectal cancer screening

Tinmouth et al.

immunochemical fecal occult blood test in northern Italy. Endoscopy 2013;45(1):27-34. 42. New Zealand Ministry of Health. Bowel Screening Pilot January to June 2012 results. Secondary Bowel Screening Pilot January to June 2012 results 26 April 2013. http://www.health.govt.nz/our-work/diseases-and-conditions/cancer-programme/bowel-cancer-programme/bowel-screening-pilot/bowel-screening-pilot-results/bowel-screening-pilot-january-june-2012-results. 43. Zajac IT, Flight I, Turnbull D, et al. Self-reported bowel screening rates in older Australians and the implications for public health screening programs. Australas Med J 2013;6(8):411-7. 44. Moss SM, Ancelle-Park R, Brenner H. Evaluation and interpretation of screening outcomes. In: Patnick J, Segnan N, von Karsa L, eds. European guidelines for quality assurance in colorectal cancer screening and diagnosis. Luxembrourg: International Agency for Research on Cancer 2010. 45. Tinmouth J, Ritvo P, McGregor SE, et al. ColonCancerCheck Primary Care Invitation Pilot project: family physician perceptions. Can Fam Physician 2012;58(10):e570-7.

creeni, Jancer 2010. Join Cancer Check . Joins. Can Fam Physica.

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Tables.

Table 1. Patient participant and physician characteristics for Study 1

	FOBT within 6 months	No FOBT within 6 months	Total
	(n=2,503)	(n=8,799)	(n=11,302)
Patient participants			
Age group in years, No. (%)			
50-59	1,279 (51%)	5,384 (61%)	6,663 (59%)
60-69	894 (36%)	2,637 (30%)	3,531 (31%)
70-74	330 (13%)	778 (9%)	1,108 (10%)
Sex, No. (%)			
Female	1,299 (52%)	4,554 (52%)	5,853 (52%)
Male	1,204 (48%)	4,245 (48%)	5,449 (48%)
Co-morbidity*, No. of ADGs (%)			
0	257 (10%)	1,279 (15%)	1,536 (14%)
1-2	828 (33%)	3,044 (35%)	3,872 (34%)
3-4	712 (28%)	2,241 (25%)	2,953 (26%)
5-6	393 (16%)	1,224 (14%)	1,617 (14%)
7+	313 (13%)	1,011 (11%)	1,324 (12%)
Median neighborhood income quintile, No. (%)			
Rural	394 (16%)	1,431 (16%)	1,825 (16%)
Low Urban	360 (14%)	1,375 (16%)	1,735 (15%)
2	402 (16%)	1,418 (16%)	1,820 (16%)
3	429 (17%)	1,430 (16%)	1,859 (16%)
4	432 (17%)	1,552 (18%)	1,984 (18%)
High Urban	486 (19%)	1,593 (18%)	2,079 (18%)
Health region, No. (%)			
Erie St.Clair	125 (5%)	337 (4%)	462 (4%)
South West	284 (11%)	823 (9%)	1,107 (10%)
Waterloo Wellington	76 (3%)	251 (3%)	327 (3%)
Hamilton Niagara	289 (12%)	976 (11%)	1,265 (11%)
Central West	138 (6%)	482 (5%)	620 (5%)
Mississauga Halton	22 (1%)	120 (1%)	142 (1%)
Toronto Central	111 (4%)	392 (4%)	503 (4%)
Central	24 (1%)	177 (2%)	201 (2%)
Central East	361 (14%)	1,282 (15%)	1,643 (15%)
South East	162 (6%)	697 (8%)	859 (8%)
Champlain	219 (9%)	676 (8%)	895 (8%)
North Simcoe-Muskoka	77 (3%)	188 (2%)	265 (2%)
North East	291 (12%)	1,118 (13%)	1,409 (12%)
North West	324 (13%)	1,280 (15%)	1,604 (14%)

Tinmouth et al.	
Physician-linked mailed invitations for colorectal cancer screening	

		Tin	mouth et al.
	Physician-linked mailed invi		
	,		U U
	1		
Recent immigrant, No. (%)	23 (1%)	88 (1%)	111 (1%)
FOBT 2 to 5 years prior to mailing, No. (%)	643 (26%)	905 (10%)	1,548 (14%)
Physician			
Median age in years (IQR)	52 (45-59)	53 (46-59)	52 (45-59)
Sex, No. (%)		. ,	
Female	936 (37%)	3,044 (35%)	3,980 (35%)
Male	1,567 (63%)	5,755 (65%)	7,322 (65%)
Training location, No. (%)			
Outside Canada	312 (12%)	1,196 (14%)	1,508 (13%)
In Canada	2,191 (88%)	7,603 (86%)	9,794 (87%)
Practice type, No. (%)			
FHG	1,082 (43%)	4,266 (48%)	5,348 (47%)
FHO/FHN	432 (17%)	1,456 (17%)	1,888 (17%)
FHO/FHN-FHT	881 (35%)	2,620 (30%)	3,501 (31%)
Other PEM	108 (4%)	457 (5%)	565 (5%)
Practice size (enrolled patients), No.			
(%)			
>1800 patients	1,105 (44%)	4,104 (47%)	5,209 (46%)
Age-eligible rate of colonoscopy			
quintile, No. (%)			
	495 (100/)	1 610 (199/)	2 104 (109/)
Low 2	485 (19%) 548 (22%)	1,619 (18%) 1,940 (22%)	2,104 (19%) 2,488 (22%)
3	637 (25%)	2,279 (26%)	2,916 (26%)
4	477 (19%)	1,696 (19%)	2,173 (19%)
High	356 (14%)	1,265 (14%)	1,621 (14%)
		, (,-)	,
Age-eligible rate of FOBT quintile, No. (%)			
Low	487 (19%)	1,888 (21%)	2,375 (21%)
2	504 (20%)	1,886 (21%)	2,390 (21%)
3	533 (21%)	1,890 (21%)	2,423 (21%)
4	522 (21%)	1,680 (19%)	2,202 (19%)
High	457 (18%)	1,455 (17%)	1,912 (17%)
Age-eligible rate of annual physical exams quintile, No. (%)			
Low	496 (20%)	2,009 (23%)	2,505 (22%)
2	490 (20%)	1,625 (18%)	2,115 (19%)
3	472 (19%)	1,638 (19%)	2,110 (19%)
4	509 (20%)	1,686 (19%)	2,195 (19%)
High	536 (21%)	1,841 (21%)	2,377 (21%)
Tiigii	556 (2178)	1,041 (2170)	2,311 (2170)

BMJ Open

Tinmouth et al.	
Physician-linked mailed invitations for colorectal cancer screening	

Age-eligible rate of influenza vaccine quintile, No. (%)			
Low	548 (22%)	1,997 (23%)	2,545 (23%)
2	549 (22%)	1,765 (20%)	2,314 (20%)
3	435 (17%)	1,930 (22%)	2,365 (21%)
4	485 (19%)	1,770 (20%)	2,255 (20%)
High	486 (19%)	1,337 (15%)	1,823 (16%)
*Co-morbidity scored using number of Aggr FHG = family health group FHO/FHN = family health organizations or r Other PEM = other patient enrolled model of FOBT = fecal occult blood test	regated Diagnosis Groups (AD networks of care		ase Mix System

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 2. Multivariate logistic regression analysis using Generalized Estimating Equations for the

characteristics of participants and physicians associated with completing an FOBT within 6 months of the mailing date.

Participants	Odds ratio (95% C.I.)	P-value
Age group, years		
50-59	0.6 (0.5, 0.8)	<.0001
60-69	0.8 (0.7, 1.0)	NS
70-74	Reference	N/A
Sex		
Female	0.9 (0.9, 1.0)	NS
Male	Reference	N/A
Co-morbidity*, No. of ADGs		
0	0.7 (0.6, 0.8)	0.0002
1-2	0.9 (0.7, 1.0)	NS
3-4	1.0 (0.9, 1.2)	NS
5-6	1.0 (0.9, 1.2)	NS
7+	Reference	N/A
Median neighborhood income quintile		
Rural	0.9 (0.7, 1.1)	NS
Low Urban	0.9 (0.7, 1.0)	NS
2	1.0 (0.8, 1.1)	NS
3	1.0 (0.9, 1.1)	NS
4	0.9 (0.8, 1.1)	NS
High Urban	Reference	N/A
Health region		
Erie St.Clair	1.3 (0.9, 1.8)	NS
South West	0.9 (0.6, 1.4)	NS
Waterloo Wellington	0.8 (0.6, 1.2)	NS
Hamilton Niagara	0.9 (0.6, 1.2)	NS
Central West	1.0 (0.7, 1.4)	NS
Mississauga Halton	0.6 (0.3, 1.2)	NS
Toronto Central	0.8 (0.6, 1.2)	NS
Central	0.5 (0.4, 0.7)	0.0004
South East	0.8 (0. <u>5</u> 4, <u>1.3</u> 0.7)	NS
Champlain	1.0 (0.7, 1.4)	NS
North Simcoe-Muskoka	0.9 (0.6, 1.4)	NS
North East	1.1 (0.7, 1.5)	NS
North West	0.7 (0.5, 1.0)	0.03
Central East	Reference	N/A
Recency of immigration		
Remote or non-immigrant	1.0 (0.6, 1.6)	NS
Recent immigrant	Reference	N/A
Prior FOBT Use		
2 to 5 years prior to mailing	2.8 (2.5, 3.3)	<.0001

Physician-linked mailed invitations for colorectal cancer screening

Tinmouth et al.

(1.0, 1.0) (1.0, 1.5) eference (0.7, 1.2) eference (0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	NS 0.02 N/A NS N/A NS 0.05
(1.0, 1.5) eference (0.7, 1.2) eference (0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	0.02 N/A NS N/A NS NS 0.05
(1.0, 1.5) eference (0.7, 1.2) eference (0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	N/A NS N/A NS NS 0.05
(0.7, 1.2) eference (0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	N/A NS N/A NS NS 0.05
(0.7, 1.2) eference (0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	N/A NS N/A NS NS 0.05
(0.7, 1.2) eference (0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	NS N/A NS NS 0.05
(0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	N/A NS NS 0.05
(0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	N/A NS NS 0.05
(0.7, 1.1) (0.6, 1.1) (0.4, 1.0) eference	NS NS 0.05
(0.6, 1.1) (0.4, 1.0) eference	NS 0.05
(0.6, 1.1) (0.4, 1.0) eference	NS 0.05
(0.4, 1.0) eference	0.05
eference	
	N/A
(0,0,1,0)	
(0.9, 1.3)	NS
eference	N/A
(0.8, 1.5)	NS
(1.0, 1.6)	NS
(0.8, 1.2)	NS
(0.8, 1.3)	NS
eference	N/A
(0.6, 1.3)	NS
(0.7, 1.2)	NS
(0.8, 1.4)	NS
(0.7, 1.3)	NS
eference	N/A
(0.9, 2.0)	NS
(0.9, 1.8)	NS
(0.9, 1.8)	NS
(0.8, 1.5)	NS
eference	N/A
	IN/A
	NS
(0.8.1.2)	
	0.02
(0.6, 1.0)	NS
(0.6, 1.0) (0.7, 1.2)	NS N/A
	0 (0.8, 1.2) 3 (0.6, 1.0) 9 (0.7, 1.2) 3 (1.0, 1.7) teference

*Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

<text> Other PEM = other patient enrolled model of care NS = not significant N/A - not applicable FOBT = fecal occult blood test

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

2
3
1
4
5
6
7
1
8
a
9
10
11
40
12
13
1/
14
15
16
17
17
18
19
20
21
22
22
$\begin{array}{c} 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 11 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 11 \\ 2 \\ 11 \\ 10 \\ 11 \\ 10 \\ 2 \\ 12 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ $
24
25
25
26
27
21
28
29
20
30
31
32
52
33
34
35
35
36
37
201
38
39
40
41
42
43
44
45
10
46
47
48
40
49
50
E1
21
52
53
55
54
55
EC
49 50 51 52 53 54 55 56 57 58 59
57
58
50
59
~~

60

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 3. Characteristics of the 2 cohorts matched by propensity score in Study 2

	Pilot participants	Control	Standardized
	(n=10,652)	participants (n=10.652)	Difference*
Participants			
Age group in years, No. (%)			
50-59	6,248 (59%)	6,324 (59%)	0.01
60-69	3,342 (31%)	3,316 (31%)	0.01
70-74	1,062 (10%)	1,012 (10%)	0.02
Sex, No. (%)			
Female	5548 (52%)	5477 (51%)	0.01
Male	5,104 (48%)	5,175 (49%)	0.01
Co-morbidity**, No. of ADGs (%)			
0	1,462 (14%)	1,425 (13%)	0.01
1-2	3,647 (34%)	3,716 (35%)	0.01
3-4	2,764 (26%)	2,835 (27%)	0.02
5-6	1,536 (14%)	1,473 (14%)	0.02
7+	1,243 (12%)	1,203 (11%)	0.01
Median neighborhood income quintile,			
No. (%)			
Rural	1,825 (17%)	1,889 (18%)	0.02
Low Urban	1,628 (15%)	1,699 (16%)	0.02
2	1,698 (16%)	1,728 (16%)	0.01
3	1,728 (16%)	1,681 (16%)	0.01
4	1,831 (17%)	1,753 (16%)	0.02
High Urban	1,942 (18%)	1,902 (18%)	0.01
Health region, No. (%)			
Erie St.Clair	462 (4%)	423 (4%)	0.02
South West	1,107 (10%)	1,114 (10%)	0
Waterloo Wellington	327 (3%)	343 (3%)	0.01
Hamilton Niagara	1,265 (12%)	1,290 (12%)	0.01
Central West	620 (6%)	580 (5%)	0.02
Mississauga Halton	142 (1%)	144 (1%)	0
Toronto Central	503 (5%)	478 (4%)	0.01
Central	201 (2%)	209 (2%)	0.01
Central East	1,643 (15%)	1,702 (16%)	0.02
South East	859 (8%)	891 (8%)	0.01
Champlain	895 (8%)	904 (8%)	0
North Simcoe-Muskoka	265 (2%)	242 (2%)	0.01
North East	1,409 (13%)	1,378 (13%)	0.01
North West	954 (9%)	954 (9%)	0
Recent immigrant, No. (%)	111 (1%)	105 (1%)	0.01
FOBT 2 to 5 years prior to mailing, No.		. ,	
(%)	1,476 (14%)	1,240 (12%)	0.07
Physician			

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Median age in years (IQR)	52 (45-59)	52 (47-58)	N/A
Sex, No. (%)			
Female	3,875 (36%)	3,335 (31%)	N/A
Male	6,777 (64%)	7,317 (69%)	IN/A
Practice type, No. (%)			
FHG	4,854 (46%)	4,885 (46%)	
FHO/FHN	1,859 (17%)	1,718 (16%)	N/A
FHO/FHN-FHT	3,374 (32%)	3,027 (28%)	IN/A
Other PEM	565 (5%)	1,022 (10%)	
Practice size (enrolled patients), No.			
(%)			
>1800 patients	5,366 (50%)	5,026 (47%)	N/A

*Standardized differences for physician level variables not reported as propensity scores were estimated using patient level characteristics only

i β π.. Jris Joint Jo **Co-morbidity scored using number of Aggregated Diagnosis Groups (ADGs) using the Johns Hopkins Case Mix System

FHG = family health group

FHO/FHN = family health organizations or networks

Other PEM = other patient enrolled model of care

FOBT = fecal occult blood test

BMJ Open

Tinmouth et al. Physician-linked mailed invitations for colorectal cancer screening

Table 4. Association between mailed invitation and FOBT completion or mailed invitation and FOBT or colonoscopy completion after adjusting for physician factors.

	FOBT completion		FOBT or Colonoscop	y completion
	Odds ratio (95% C.I.)	P-value	Odds ratio (95% C.I.)	P-value
Mailed invitation				
Yes (Pilot)	3.3 (3.1, 3.6)	<.0001	2.7 (2.5, 2.9)	<.0001
No (Controls)	Reference	N/A	Reference	N/A
Increasing age (per year)	1.0 (1.0, 1.0)	NS	1.0 (1.0, 1.0)	0.03
Sex, No. (%)				
Female	1.0 (0.9, 1.1)	NS	1.0 (0.9, 1.1)	NS
Male	Reference	N/A	Reference	N/A
Practice type, No. (%)				
FHG	0.7 (0.6, 0.8)	<.0001	0.7 (0.7, 0.8)	<.0001
FHO/FHN	0.8 (0.7, 0.9)	<.0001	0.8 (0.7, 0.9)	<.0001
Other PEM	0.8 (0.7, 1.0)	0.03	0.8 (0.7, 1.0)	NS
FHO/FHN-FHT	Reference	N/A	Reference	N/A
Practice size (enrolled patients)				
≤ 1800 patients	1.2 (1.1, 1.3)	0.0004	1.2 (1.1, 1.3)	<.0001
> 1800 patients	Reference	N/A	Reference	N/A
FHG = family health group FHO/FHN = family health organizatior Other PEM = other patient enrolled m FOBT = fecal occult blood test	ns or networks odel of care			
FHO/FHN = family health organization Other PEM = other patient enrolled m	ns or networks odel of care			

Tinmouth et al.

Figure Legends

Figure 1. Mock-up of physician-linked invitation used in the Pilot.

<text>

1		
2		
3		
4		
5		
6		
7		
8	Colon Cancer Check Contrôle Cancer Colorectal	Goncer care action cancer
9	Controlecancer colorectar	ontario ontario
10		
11	From the office of Dr. George Black	
12		
13	Lawren Harris	June 1, 2009
	456 Superior Street	
14	Lindsay ON K2L 3M4	
15		
16	Dear Lawren Harris:	
17		
18	You have received this letter because it is time to be screened for col	
19	as of April 1 st , 2009 show that you have never had a fecal occult blood to know when you had your last FOBT. All adults between the ages of 50 a	
20	average risk for colon cancer should do a FOBT every two years.	ind / Fyou's who are at
21	If your parent, brother, sister or child has had colon cancer, your risk is have a colonoscopy.	ngher and you should
22	nave a coronoscopy.	
23	Please call my office to set up an appointment to talk about your risl	k for colon cancer and
24	which test is right for you.	
25	If you have recently completed colon cancer screening, please disregard	this letter.
26		
27	I look forward to hearing from you soon.	
	Dr. George Black	
28	705-555-1212	
29		
30	GET THE FACTS. GET CHECKED	
31		•
32	• Colon cancer is the second most common cause of cancer death in O	ntario
	• Colon cancer can develop without any early warning signs.	
33		
33 34	 If it is caught early enough, 9 out of every 10 people can be cured. Regular screening is the best way to catch colon cancer early. 	
34	 If it is caught early enough, 9 out of every 10 people can be cured. Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. 	
34 35	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. 	
34 35 36	• Regular screening is the best way to catch colon cancer early.	
34 35 36 37	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. 	
34 35 36	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colored	
34 35 36 37	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	ancer Care Ontario. If for any
34 35 36 37 38 39	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Care an</i>	ancer Care Ontario. If for any
34 35 36 37 38 39 40	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	ancer Care Ontario. If for any
34 35 36 37 38 39 40 41	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	ancer Care Ontario. If for any
34 35 36 37 38 39 40 41 42	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	ancer Care Ontario. If for any
34 35 36 37 38 39 40 41 42 43	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	ancer Care Ontario. If for any
34 35 36 37 38 39 40 41 42 43 44	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	ancer Care Ontario. If for any
34 35 36 37 38 39 40 41 42 43 44	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	ancer Care Ontario. If for any
34 35 36 37 38 39 40 41 42 43 44 45 46	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	ancer Care Ontario. If for any
34 35 36 37 38 39 40 41 42 43 44	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47	Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. <i>For more information please visit <u>www.coloncancercheck.ca</u> This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorece CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Ca reason you do not wish to receive future correspondence from the program, simply call </i>	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 51 52 53 54 55	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 51 52 53 54 55	 Regular screening is the best way to catch colon cancer early. The FOBT is a simple test that can be done at home. For more information please visit www.coloncancercheck.ca This letter has been sent on my behalf by ColonCancerCheck (CCC), Ontario's colorec CCC is a collaborative initiative of the Ministry of Health and Long-Term Care and Careason you do not wish to receive future correspondence from the program, simply call Information Line at 1-866-662-9233 during business hours. 	neer Care Ontario. If for any the ColonCancerCheck

Tinmouth at al Dh	veision linked meile	linvitation to be correct	d improved untoko in	an arganized colorected	oonoon corooning
I mmouth et al., I h	ysician-mikeu maneu	i mvitation to be screen	cu mipi oves uptake m	an organized colorectal	cancer screening

		BMJ Open		
Tinmouth et	al., Physic	cian-linked mailed invitation to be screened improves uptake in ar program.	organized colore	ectal cancer screening
	Item No	Recommendation	Page	Comment
Title and	1	(<i>a</i>) Indicate the study's design with a commonly used term in the	1, 3	
abstract		title or the abstract (b) Provide in the abstract an informative and balanced summary of	3	
		what was done and what was found	5	
Introduction				
Background/ratio nale	2	Explain the scientific background and rationale for the investigation being reported	07-Jun	
Objectives	3	State specific objectives, including any prespecified hypotheses	7, first paragraph	
Methods				
Study design	4	Present key elements of study design early in the paper	7, paragraph 2	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection		
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up		
		Case-control study —Give the eligibility criteria, and the sources and	⊅ara⊴ra¤h n/a	
		methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls		
		<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants		
		(b) Cohort study—For matched studies, give matching criteria and		
		number of exposed and unexposed Case-control study —For matched studies, give matching criteria	paragraph n/a	
** • • •		and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9, 10 & 11	
Data sources/	8*	For each variable of interest, give sources of data and details of	8, 9, 10 & 11	
measurement		methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group		
Bias	9	Describe any efforts to address potential sources of bias	11, paragraph 2	
a	10		& 13, paragraph	
Study size	10	Explain how the study size was arrived at	5, paragraph 1	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		
Statistical	12	e	11, paragraph 2	
methods		for confounding (b) Describe any methods used to examine subgroups and	& 13, paragraph n/a	
		interactions (c) Explain how missing data were addressed	14, first	
		(c) Explain now missing data were addressed	paragraph	
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed	n/a	all patients followed through administrative data, therefore no loss f f/u
		<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	n/a	
		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	n/a	
Dogult-		(\underline{e}) Describe any sensitivity analyses	n/a	
Results Participants	13*	(a) Report numbers of individuals at each stage of study—eg	14, first & last	
i ancipants	15.	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	paragraphs	
		(b) Give reasons for non-participation at each stage	14, first & last paragraphs	
			paragraphs	

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

D	1.4.9	(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	Table 1 & Table 3
		confounders	
		(b) Indicate number of participants with missing data for each variable of interest	15, first paragraph
		(c) Cohort study—Summarise follow-up time (eg, average and total	all followed up
	1.5%	amount)	for 6 months
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	15, 2nd paragraph & 16 1st paragraph
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study-Report numbers of outcome events or	n/a
Main results	16	summary measures (<i>a</i>) Give unadjusted estimates and, if applicable, confounder-	15, 2nd
		adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were	paragraph, Tabl
		included (b) Report category boundaries when continuous variables were	Tables 2 & 4
		categorized (c) If relevant, consider translating estimates of relative risk into	n/a
Other analyses	17	absolute risk for a meaningful time period Report other analyses done—eg analyses of subgroups and	n/a
-	1/	interactions, and sensitivity analyses	11/ a
Discussion	10		16
Key results Limitations	18 19	Summarise key results with reference to study objectives Discuss limitations of the study, taking into account sources of	16, paragraph 1 18, 2nd
Emitations	17	potential bias or imprecision. Discuss both direction and magnitude of any potential bias	paragraph
Interpretation	20	Give a cautious overall interpretation of results considering	17 & 18
		objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	
Generalisability	21	Discuss the generalisability (external validity) of the study results	18, last paragrap
Other informati			• •
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	