How effective are colorectal cancer screening programs at increasing the rate of screening in asymptomatic average-risk groups in Canada?

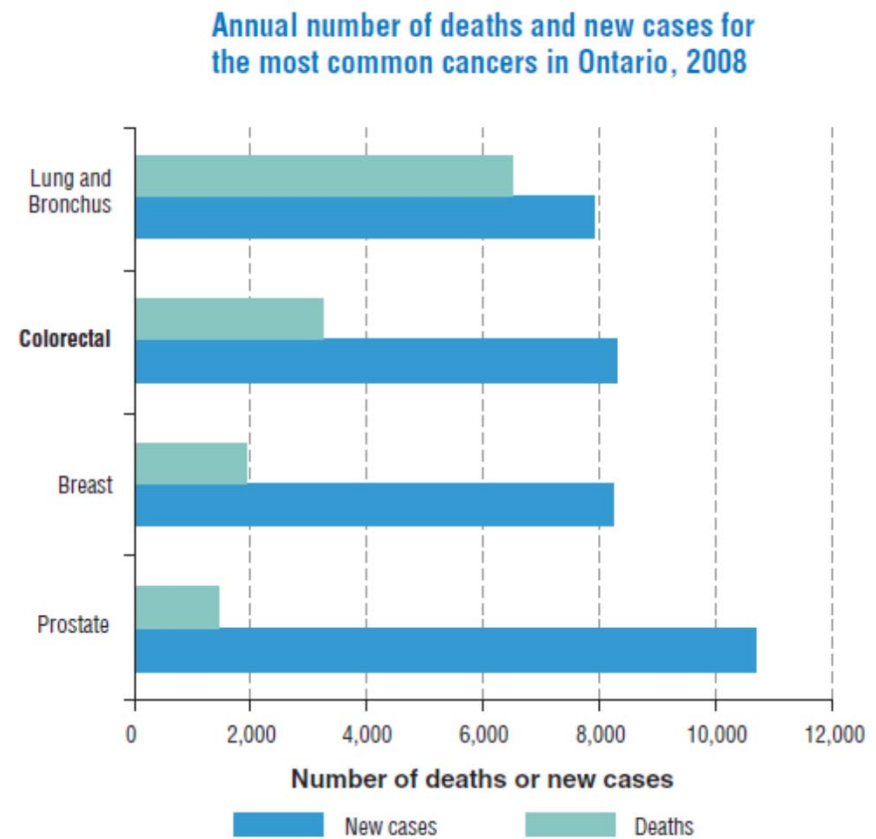Thomas Charters, MSc Candidate[1]

Erin Strumpf, PhD[1,2]

Maida Sewitch, PhD[1]

[1]McGill University Dept. of Epidemiology, Biostatistics and Occupational Health

[2]McGill University Dept. of Economics

Colorectal Cancer in Canada

- CRC constitutes the third highest cancer incidence in Canada and the second highest cancer related mortality (Canadian Cancer Society, 2010)

- Males:
  - Incidence: 62 per 100 000
  - Death : 25 per 100 000

- Females:
  - Incidence: 41 per 100 000
  - Death : 16 per 100 000

Annual number of deaths and new cases for the most common cancers in Ontario, 2008

Lung and Bronchus	
Colorectal	
Breast	
Prostate	

0   2,000   4,000   6,000   8,000   10,000   12,000

Number of deaths or new cases

■ New cases   ■ Deaths

(Cancer Care Ontario, 2008)

Screening in Canada

- Screening Recommendations
  - Commonly have individuals ≥50 screen biennially with gFOBT with Endoscopy follow Up
  - Canadian Task Force on Preventive Healthcare (2001)
  - National Committee on Colorectal Cancer Screening (2002)
  - Canadian Association of Gastroenterology (2004)

Screening in Canada

- 1992: 6% of those aged 50-74 reported FOBT
  - (Cancer Care Ontario, 2006)

- 2003: Screening guidelines adherence low (15.1% FOBT adherence, 30.1% total screening adherence)
  - (Sewitch et al., 2007)

- 2008: Screening adherence 23% FOBT, 40% combined
  - Significant Increases from 2005 observed in Newfoundland, New Brunswick and Ontario (not all provinces represented)
  - (Wilkins & Shields, 2008)

ColonCancerCheck

- Asymptomatic Average Risk Population
  - ≥50 years
  - No symptoms or other bowel disorder (crohn's, colitis)
  - No Family History
- gFOBT Biennial Screening
  - Sensitivity: 50%(repeated); Specificity: 96-98%(repeated)
  - No drug/dietary restrictions except Vit. C.
  - Acceptable: complete at home and mail to CCO
- Follow-Up Colonoscopy or Flexible Sigmoidoscopy
  - (Guidice & Meuser, 2008)
- Formally Launched March 14 2008

ColonCancerCheck

- Central role of Primary Care Provider (PCP)
- Five Year Media/Educational Campaign
- FOBT kits to pharmacies or TeleHealth Ontario for those without PCP
- Registry for invitations and result letters
- Sets and upholds quality assurance standards
- Additional funding for hospitals
- Development of group targeting strategies
    - (Cancer Care Ontario, 2010)

Colon Cancer Check

YOU'RE NOT SEE-THROUGH,
SO TALK TO YOUR HEALTH CARE PROVIDER
ABOUT SCREENING FOR COLON CANCER

Study Rationale

- Previous research:
  - CRC screening has increased significantly in several provinces between 2005 -2008 including Ontario (CCHS)
  - OHIP claims data indicates increases in FOBT in 2007-8 (29.7%) from 2005-6(19.9%). 62% with positive result had endoscopy within 6 months
  - Most research has focused on proportions screened over time and predictors of screening
- Objective:
  - Evaluate the effectiveness of *ColonCancerCheck* in increasing the proportion of average risk individuals screened in a causal framework

Methods

- Data source: Canadian Community Health Survey
  - 2003(cycle 2.1), 2005(cycle 3.1), 2007, 2008, 2009 Pooled
  - Nationally representative survey Canadians ≥12 excluding those on Indian Reserves, Crown Lands, Armed Forces, Institutions, or remote regions.
- Complex stratified cluster sampling design, unequal probabilities of selection with multiple stages of selection
  - (Statistics Canada, 2009)
- Bootstrap Re-sampling Method
  - Sample n-1 clusters within each stratum with replacement
  - Form 500 replicates to recalculate survey weights with post- stratification on demographic information to correct for unequal probabilities of selection
    - (Statistics Canada, 2010)
- Pooled BS Weights rescaled proportionally for average population
    - Consistent with (Korn & Graubard , 1999)

Methods

- Difference-in-Differences (DD)
- $Y = \beta 0 + \beta 1 * Group + \beta 2 * Time + \beta 3 * Group * Time + \varepsilon$

	Intervention Group	Control Group
Pre-Intervention		
Post-Intervention		

- $\beta 3 = [\hat{E}(Y_{igt}|T=1, G=1) - \hat{E}(Y_{igt}|T=1, G=0)] - [\hat{E}(Y_{igt}|T=0, G=1) - \hat{E}(Y_{igt}|T=0, G=0)]$
- Allows the isolation of proportion of those screened not due to fixed province (Group) differences or temporal trends (Time).
- Assumptions
  - Groups comparable in pre-intervention period, parallel slopes
  - Program is the only significant difference between groups at time of intervention, no differential period effects besides intervention

Methods

- Regression Discontinuity Design
- Exploits threshold age of initiation (50) common to programs to create comparable treatment and control groups

$$Y_i = \beta 0 + \beta 01 * Age_i + \beta 0p * Age_i^p \ldots + \rho * Th_i + \beta 1 * Age_i * Th_i + \beta p * Age_i^p * Th_i + \beta 3 * covar_{igt} + \varepsilon_i$$
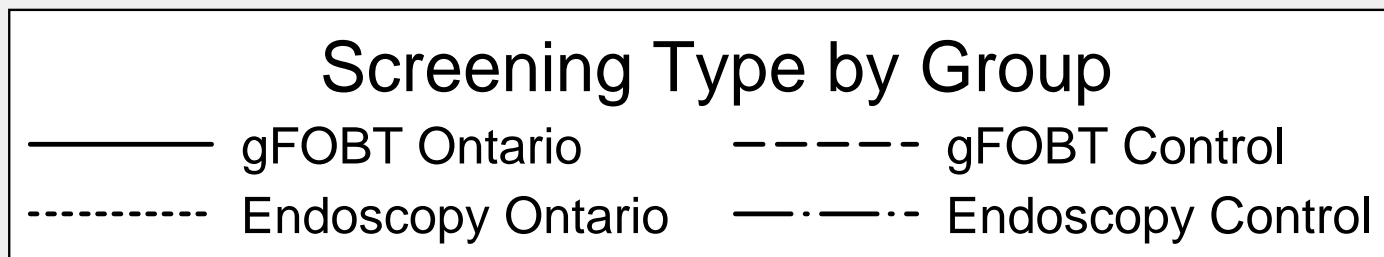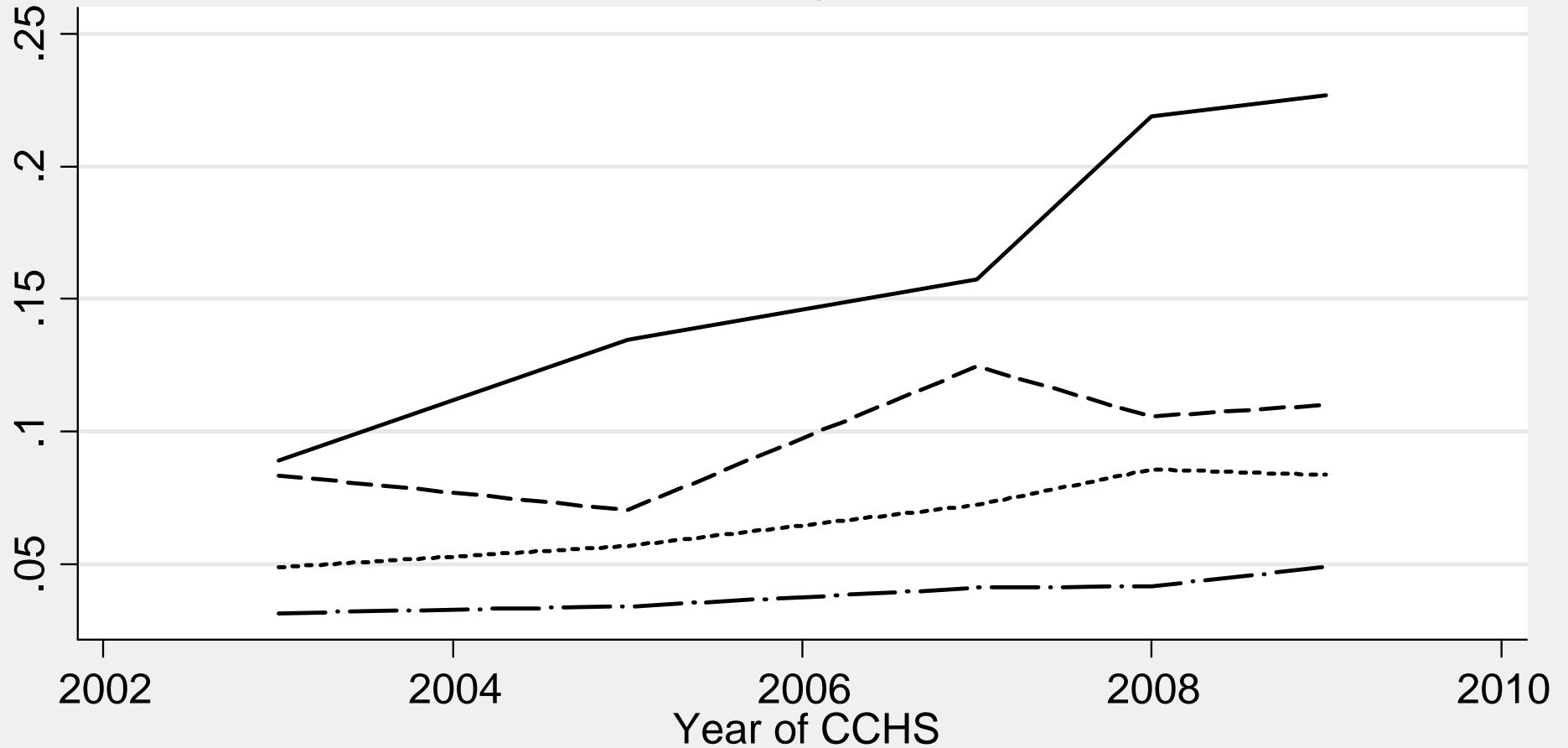
- Assumptions
  - $P[Th_i|x_i]$ is discontinuous at x_0 due to Intervention only*
  - Individuals close to threshold are similar
  - Individuals cannot manipulate or select into treatment
- *Violated in accessing role of *CCC*, so expand into difference-in-difference-indifferences style analysis

$$Y_{igt} = \beta 0 + \beta 1 * Group_g + \beta 2 * Time_t + \beta 3 * Th_i + \beta 4 * Group * Time_{gt} + \beta 5 * Group * Th_{ig} + \beta 6 * Time * Th_{it} + \beta 7 * Group * Time * Th_{igt} + \beta 8 * Age_i + \beta 9 * Age_i * Th_i + \beta 10 * covar_{igt} + \varepsilon_{igt}$$

Sample Characteristics

- Ages 50-74
- Asymptomatic Average Risk Population
  - Excluded if report screening due to family history
  - Excluded if report screening as part of treatment
  - Excluded if report having colitis or crohn's disease
- Restricted to provinces answering optional module of questions concerning CRC screening
- Territories Restricted due to Poor Representation
- Complete Case Analysis

Past Year Screening by Year and Group

Year of CCHS

Screening Type by Group

—— gFOBT Ontario   – – – gFOBT Control

······· Endoscopy Ontario   –·–· Endoscopy Control

CCHS Cycles 2.1, 3.1, 2007, 2008, 2009

Difference in Differences Models

Outcome		DD*				DD**			
		Mrg	95% CI		p	Mrg	95% CI		p
gFOBT	Post Intervention	0.073	0.052	0.095	0.000	0.074	0.053	0.095	0.000
	Interv Group	0.082	0.059	0.104	0.000	0.064	0.041	0.086	0.000
	Group*Time	0.050	0.030	0.070	0.000	0.052	0.032	0.071	0.000
Endoscopy	Post Intervention	0.022	0.008	0.037	0.003	0.023	0.009	0.038	0.002
	Interv Group	0.018	0.005	0.031	0.006	0.009	-0.004	0.022	0.182
	Group*Time	0.007	-0.007	0.021	0.301	0.009	-0.005	0.023	0.207

CCHS 2003, 2005, 2007, 2008, 2009.

*: main effects controlled for year and province indicators

**: main effects controlled for year, province, sex, age category, geography, self rated health, having MD, reporting flu shot, physical activity index, smoking status, ethnicity, education, income, #GP consultations past year

Results shown are average marginal effects calculated from multivariate logistic regression model. Complete case analysis used.

# Difference in Difference in Differences (DDD)

- $Y = \beta_0 + \beta_1 *Group + \beta_2 *Time + \beta_3 *Var + \beta_4 *Group*Time + \beta_5 *Group*Var + \beta_6 *Time*Var + \beta_7 *Group*Time*Var + \varepsilon$

Outcome		DDD*			
		Mrg Effect	95% CI		p
gFOBT	G*T*MD	0.008	-0.095	0.111	0.883
	G*T*Age65-74	0.028	-0.008	0.065	0.127
	G*T*PhysInactive	0.007	-0.029	0.042	0.720
	G*T*Flu-Shot	0.010	-0.031	0.052	0.623
Endoscopy	G*T*MD	0.065	-0.007	0.137	0.077
	G*T*Age65-74	0.002	-0.022	0.027	0.853
	G*T*PhysInactive	-0.003	-0.027	0.022	0.835
	G*T*Flu-Shot	-0.007	-0.035	0.021	0.628

CCHS 2003, 2005, 2007, 2008, 2009.

*: main effects controlled for year, province, sex, age category, geography, self rated health, having MD, reporting flu shot, physical activity index, smoking status, ethnicity, education, income, #GP consultations past year

Results shown are average marginal effects calculated from multivariate logistic regression model. Complete case analysis used.
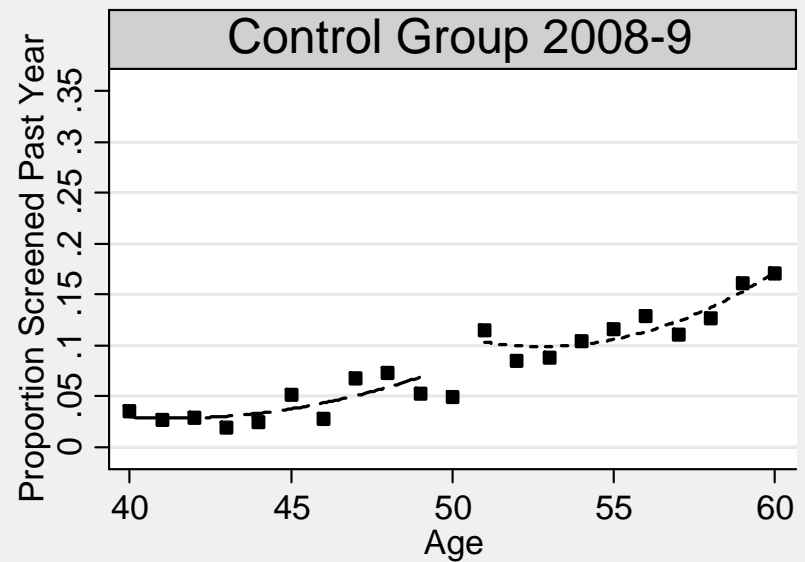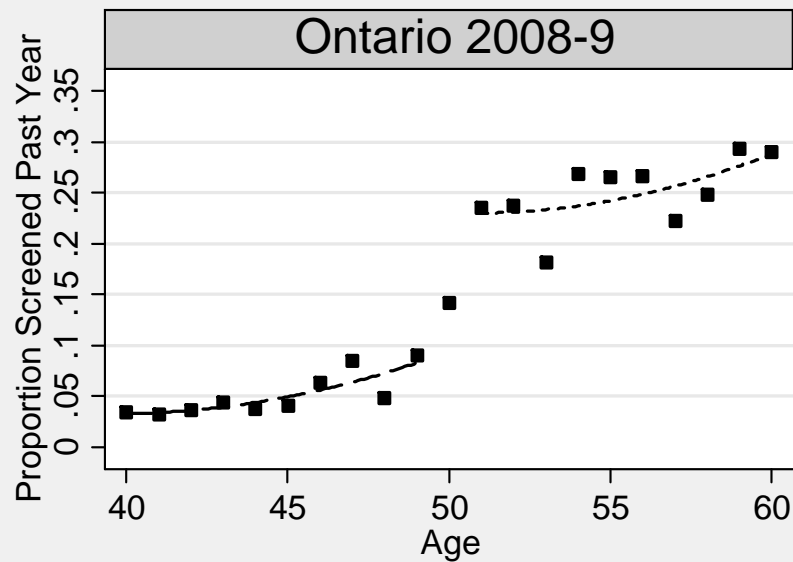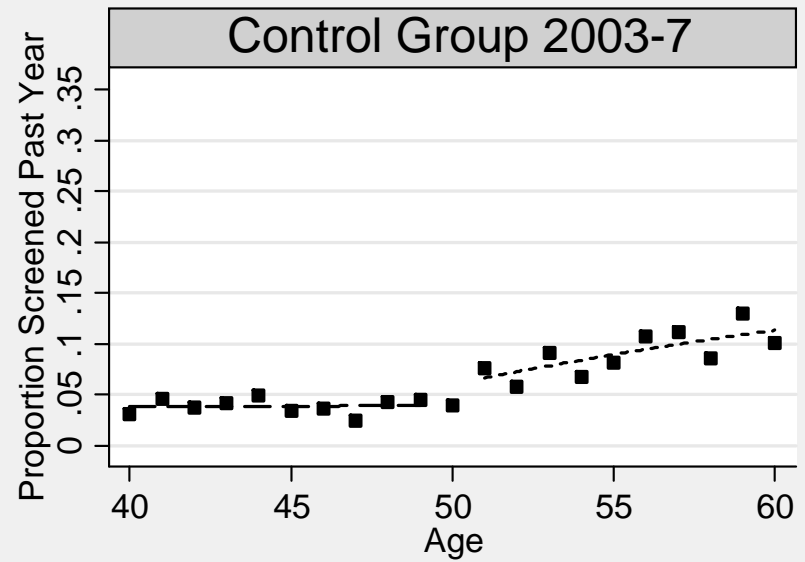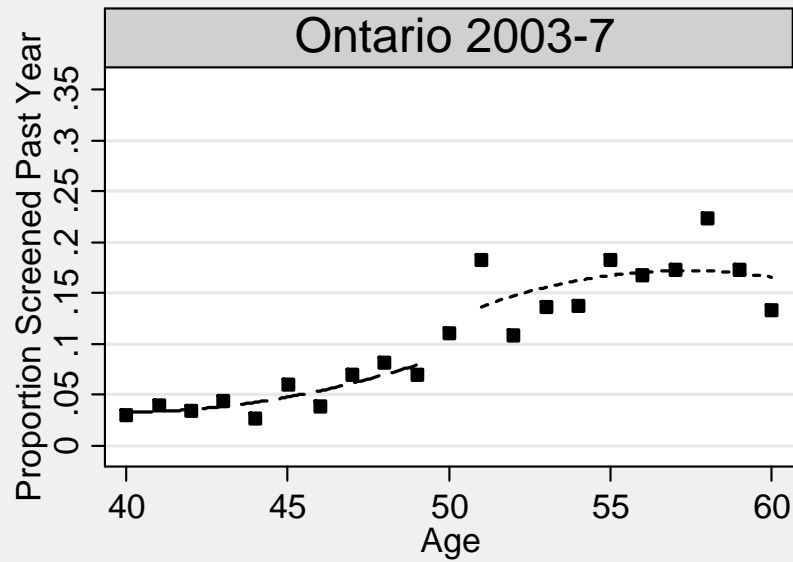
RDD-Expansion

Outcome	Model	Mrg Effect	95% CI		p	Bandwidth
gFOBT	1	0.0104	-0.0245	0.0453	0.558	40-60
	2	0.0119	-0.0225	0.0463	0.499	40-60
	3	0.0456	-0.0040	0.0953	0.072	45-55
	4	0.0451	-0.0035	0.0938	0.069	45-55
Endoscopy	1	-0.0067	-0.0283	0.0149	0.544	40-60
	2	-0.0063	-0.0278	0.0152	0.566	40-60
	3	-0.0103	-0.0396	0.0189	0.489	45-55
	4	-0.0097	-0.0386	0.0192	0.510	45-55

CCHS 2003, 2005, 2007, 2008, 2009
Models 1 and 3: main effects controlled for year and province
 Models 2 and 4: main effects controlled for year, province, sex, age category, geography, self rated health, having MD, reporting flu shot, physical activity index, smoking status, ethnicity, education, income, #GP consultations past year
Models 1-2: linear age term, Models 3-4: squared age term
Results shown are average marginal effects calculated from multivariate logistic regression model. Complete case analysis used

Limitations

Province	2003	2005	2007	2008	2009
Newfoundland and Labrador	•	•	•	•	•
Prince Edward Island		•	•	•	•
Nova Scotia		•		•	•
New Brunswick		•		•	•
Quebec				•	
Ontario	○	•	•	•	•
Manitoba				•	
Saskatchewan	○		•	•	•
Alberta				•	
British Columbia	•			•	

○   *Indicates not all health regions were surveyed for this province.*

- ## Suitability of Control Group
  - Different Pre-intervention Screening Trends
  - Unbalanced panel of control provinces
  - Number of provinces and years do not allow adjustment for province-specific time trends
  - Membership of control group disproportionately represents Eastern Canada, which typically has lower screening rates

Limitations

- Unmeasured Interactions
  - DD falsification analysis (pseudo-treatment year)
  - DDD analyses to test for potential interactions

- Risk of endogeneity of policy adoption
  - Conditions which brought about policy have independent effect on subsequent policy outcomes
  - National screening guidelines for consistency
  - Federal transfers to provinces, guarantees for reasonable access to care, harmonized training of health professionals
  - Avoids greatest disparities by excluding territories
  - Upcoming programs in Alberta and Manitoba

Bias Check 1: DD Before Intervention

Outcome		DD* Mrg Effect	95% CI		p	DD** Mrg Effect	95% CI		p
Combined	2007	**0.076**	**0.040**	**0.113**	**0.000**	**0.077**	**0.042**	**0.112**	**0.000**
	Treatment Group	**0.090**	**0.064**	**0.115**	**0.000**	**0.067**	**0.041**	**0.093**	**0.000**
	Group*Time	0.008	-0.031	0.048	0.675	0.008	-0.031	0.046	0.689
FOBT	2007	**0.086**	**0.053**	**0.120**	**0.000**	**0.088**	**0.055**	**0.120**	**0.000**
	Treatment Group	**0.084**	**0.060**	**0.109**	**0.000**	**0.069**	**0.044**	**0.094**	**0.000**
	Group*Time	-0.019	-0.055	0.017	0.295	-0.020	-0.056	0.015	0.256
Endoscopy	2007	-0.001	-0.022	0.020	0.959	0.000	-0.020	0.021	0.989
	Treatment Group	**0.019**	**0.004**	**0.034**	**0.015**	0.010	-0.005	0.025	0.198
	Group*Time	0.022	-0.001	0.045	0.065	0.022	-0.001	0.045	0.061

CCHS 2003, 2005 (pre-intervention), 2007 (post-intervention).
*: main effects controlled for year and province indicators
**: main effects controlled for year, province, sex, age category, geography, self rated health, having MD, reporting flu shot, physical activity index, smoking status, ethnicity, education, income, #GP consultations past year
Results shown are average marginal effects calculated from multivariate logistic regression model. Complete case analysis used.

Bias Check 2: DD Alternate Outcome (Flu shot)

Outcome		DD*				DD**			
		Mrg Effect	95% CI		p	Mrg Effect	95% CI		p
Flu shot	Post Intervention	0.066	0.036	0.096	0.000	0.074	0.045	0.103	0.000
	Treatment Group	0.273	0.250	0.295	0.000	0.259	0.237	0.281	0.000
	Group*Time	-0.015	-0.045	0.014	0.305	-0.015	-0.044	0.013	0.291

CCHS 2003, 2005, 2007, 2008, 2009.

*: main effects controlled for year and province indicators

**: main effects controlled for year, province, sex, age category, geography, self rated health, having MD, reporting flu shot, physical activity index, smoking status, ethnicity, education, income, #GP consultations past year

Results shown are average marginal effects calculated from multivariate logistic regression model. Complete case analysis used.

Limitations

- Time of Program Initiation
  - Manitoba and Alberta 2008 had pilot programs in place which may distort results in this year
  - Official launch Mar 2008 but attributes of program likely in place at earlier time
  - Data from CCHS 2008 may be for events prior to launch
- Inaccuracy of self-reported outcomes
  - FOBT sensitivity 82%, specificity 78%; tendency to under-report (Rauscher et al., 2008)
- *ColonCancerCheck* roll-out is ongoing and aspects of the program yet to be implemented.

Strengths

- DD distinguishes causal effect:
  - Control for temporal trends (shown to increase)
  - Confounders common to both treatment groups
  - Reduce bias due to differences between provincial healthcare systems
- DD Reduces measurement error
- RDD approximates random sampling
  - Greater internal validity
  - Reduces risk of confounding

Strengths

- Canadian Community Health Survey
  - Relatively consistent over time
  - Detailed screening data
  - Detailed information on relevant health and socio-demographic data
  - Covered all of Canada over large time range
- Repeated cross-sections vs. panel data
  - Avoid problem of loss to follow-up
  - More representative of community level changes
  - Alleviates variance miscalculation by correlation of residuals

Conclusions

- Some evidence suggests *ColonCancerCheck* increases past-year screening in asymptomatic average risk adults up to absolute increase of 5.2 percentage points.
- Effect of *ColonCancerCheck* seen mostly through FOB testing
- Results reinforce previous research on importance of PCP
- Insufficient evidence to state that dynamics of demographic predictors of screening have been altered upon introduction of *ColonCancerCheck*
- Convincing evidence of program effect at the threshold
- More consistent data on screening in provinces would lead to more robust analysis and greater confidence in results

Acknowledgements

FUNDING

- Research Supported by CIHR Canada Graduate Scholarship
- Research Supported by QICSS Grant Matching Award

ADVICE AND SUPPORT

- Sam Harper
- Jay Kaufman
- Danielle Forest (QICSS)
- Marie Eve-Gagnon (QICSS)

References

- Canadian Cancer Society. (May 19 2010). Colorectal Cancer Statistics Retrieved July 10, 2010, from http://www.cancer.ca/Canada-wide/About%20cancer/Cancer%20statistics/Stats%20at%20a%20glance/Colorectal%20cancer.aspx?sc_lang=en
- Canadian Partnership Against Cancer. (2009). *The System Performance Initiative: The First Year Report*. Toronto: Retrieved from http://www.cancerview.ca/idc/groups/public/documents/webcontent/system_performance_pdf.pdf.
- Canadian Task Force on Preventive Health Care. (2001). Colorectal cancer screening: Recommendation statement from the Canadian Task Force on Preventive Health Care. *Canadian Medical Association Journal, 165*(2), 206-208.
- Cancer Care Ontario. (2006). *Ontario FOBT Project Final Report*. Toronto: Retrieved from http://www.cancercare.on.ca/common/pages/UserFile.aspx?fileId=13608.
- Cancer Care Ontario. (2008). *Insight on Cancer: News and Information on Colorectal Cancer and Screening in Ontario*. Toronto: Retrieved from http://www.cancercare.on.ca/common/pages/UserFile.aspx?fileId=34627.
- Cancer Care Ontario. (2010). *Colon Cancer Check 2008 Program Report*. Toronto: Retrieved from http://www.cancercare.on.ca/common/pages/UserFile.aspx?fileId=75573.
- CancerCare Manitoba. (2010). *Cancer in Manitoba Incidence and Mortality 2007 Annual Statistical Report* Winnipeg.
- Guidice, L. D., & Meuser, J. (2008). Colorectal Cancer Screening, from http://www.health.gov.on.ca/en/pro/programs/coloncancercheck/screeningresearch.aspx
- Hewitson, P., Glasziou, P., Watson, E., Towler, B., & Irwig, L. (2008). Cochrane systematic review of colorectal cancer screening using the fecal occult blood test (hemoccult): an update. *American Journal of Gastroenterology, 103*(6), 1541-1549.
- Leddin, D., Hunt, R., Champion, M., Cockeram, A., Flook, N., Gould, M., . . . Canadian Digestive Health Foundation. (2004). Canadian Association of Gastroenterology and the Canadian Digestive Health Foundation: Guidelines on colon cancer screening. *Canadian Journal of Gastroenterology*, 18(2), 93-99.
- National Committee on Colorectal Cancer Screening. (2002). *Recommendations for population-based colorectal cancer screening*. Retrieved from http://www.phac-aspc.gc.ca/publicat/ncccs-cndcc/ccsrec-eng.php
- Rauscher, GH, Johnson TP, Cho YI, et al. Accuracy of self-reported cancer screening histories: a meta-analysis. *Cancer Epidemiology Biomarkers & Prevention*. 2008; 17(4):748-757.
- Ries, L. A. G., Wingo, P. A., Miller, D. S., Howe, H. L., Weir, H. K., Rosenberg, H. M., . . . Edwards, B. K. (2000). The annual report to the nation on the status of cancer, 1973–1997, with a special section on colorectal cancer. *Cancer, 88*(10), 2398-2424.
- Sewitch, M.J., Fournier, C., Ciampi, A., Dyachenko, A. (2007). Adherence to colorectal cancer screening guidelines in Canada*. BMC Gastroenterology*, 7, 39.
- Statistics Canada (2010). *Canadian Community Health Survey (CCHS)-Annual Component User Guide 2009 Microdata Files*. Retrieved Sept 1 2010 From: http://www.statcan.gc.ca/cgi-bin/af-fdr.cgi?l=eng&loc=http://www.statcan.gc.ca/imdb-bmdi/document/3226_D7_T9_V7-eng.pdf&teng=CCHS%202009%20User%20Guide&tfra=ESCC%202009%20Guide%20de%20l'utilisateur
- Statistics Canada (2010). *Canadian Community Health Survey (CCHS).* Retrieved Sept 1 2010, from http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&lang=en&db=imdb&adm=8&dis=2.
- Korn E.L., & Graubard, B.I. (1999). *Analysis of Health Surveys.* New York: Wiley. p 278-301.
- Winawer, S. J. (1999). Natural history of colorectal cancer. *The American Journal of Medicine, 106*(1, Supplement 1), 3-6. doi: Doi: 10.1016/s0002-9343(98)00338-6
- Wilkins, K., & Shields, M. (2009). Colorectal cancer testing in Canada--2008. *Health Reports*, 20(3), 21-30.