**Title**

# The role of access to a regular primary care physician in mediating immigration-based disparities in colorectal screening: Application of multiple mediation methods

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## ABSTRACT

**Background:** Colorectal cancer screening participation is lower among recent immigrants than among Canadian-born individuals. We assessed whether this screening disparity is mediated by access to regular primary care physicians (PCP).

**Methods:** Pooling years 2003-2014 of the Canadian Community Health Survey, lifetime screening in respondents aged 50-75 years who immigrated in the previous 10 years (n=1,067) was compared to Canadian-born respondents (N=102,366). Regression- and inverse probability weighting-based methods were used to estimate the Total Effect (TE) and Controlled Direct Effect (CDE) of recent immigration on never having received either a stool- or endoscopic-based screening test. The proportion of the TE that would be eliminated if all had a PCP was computed using these estimates (Proportion Eliminated (PE) = [TE-CDE]/[TE-1]). Analyses were stratified by visible minority status, and adjusted for income, rurality, age, sex, marital status, education, and exposure to a provincially organized colorectal screening program.

**Results:** The prevalence of never having been screened was 71% and 57% in visible minority and white recent immigrants, respectively, and 46% in white Canadian-born respondents. If all had regular PCPs, there would be no reduction in the screening inequality between white recent immigrants and Canadian-born (null PE), and the inequality between visible minority immigrants and white Canadian-born may increase by 6% to 13%.

**Conclusions:** Ensuring all have regular PCPs may lead to greater screening gains among Canadian-born than recent immigrants.

**Impact:** Improving access to PCPs may increase colorectal screening overall, but not reduce immigration-based disparities screening. Alternative interventions to reduce this disparity should be explored.

## INTRODUCTION

In Canada, as in other developed nations,[1, 2] immigrants are less likely than Canadian-born residents to have ever been screened for colorectal cancer,[3, 4] which is currently the third most common cause of cancer death in the country.[5] The gap in lifetime screening between those born in Canada and those born abroad is of approximately 10%.[6] Since having never been screened is associated with later-stage at diagnosis and higher levels of colorectal cancer mortality,[7] immigrants are likely to bear a disproportionate amount of the burden of colorectal cancer, in part because they are under-screened. Immigration-based screening disparities beg two questions: how do these disparities come to exist; and what interventions can be leveraged to reduce them?

Known social determinants of colorectal screening include lack of available free time,[8] lack of high school graduation,[9] lower income,[3] rural residence,[10] and not being exposed to an organized screening program.[11] Beyond these determinants, one factor that is hypothesized to drive immigration-based inequalities in colorectal screening is the difficulty that many recent immigrants face in accessing primary health care services. In Canada, though immigrants granted permanent residency are entitled to universal health care coverage, linguistic, cultural and system-based barriers can make accessing health resources difficult.[12, 13] For example, recent immigrants are less likely than non-immigrants to have a primary care physician (PCP).[14] Since individuals without regular PCPs are less likely to be screened,[3] the disparity in access to regular PCPs may explain, at least in part, this disparity in colorectal screening.

Though improving regular PCP access has been identified as a potential area of intervention to increase screening among recent immigrants, this potential mediating pathway between recent immigration and screening has yet to be formally empirically assessed. The aim of this study was therefore to assess if having a regular PCP mediates the disparity in lifetime colorectal screening between recent immigrants and non-immigrants in Canada, and if so, assess what proportion of the disparity would be eliminated if all had a regular PCP (referred to as the Proportion Eliminated or "PE"). Since recent immigrants' cancer screening habits and beliefs, and overall interactions with the health care system, can vary across racial and ethnic identities,[15, 16] we wished to assess the Proportion Eliminated across visible minority and white sub-populations. We did so using multiple techniques to compare the stability of findings.

## MATERIALS AND METHODS

### Data and target population

Data from years 2003, 2005, 2007-2014 of the population-based, cross-sectional Canadian Community Health Study (CCHS) were used.[17] The CCHS questionnaire was administered in English and French (with the possibility of completing the interview in an alternative language when necessary [18]) via computer-assisted interviewing, either in-person or by telephone (40% and 60% of interviews, respectively [18]). Response rates ranged from 80.7% in 2003 [19] to 65.6% in 2014 [18], with sampling weights adjusted for non-response. This study's target population was adults aged 50-75 years, who were either white and Canadian-born or had immigrated to Canada recently (≤10 years), and had no known risk factors or symptoms of

colorectal cancer.[20] Excluded from this study were respondents who reported screening due to "family history of colorectal cancer," "follow-up of a problem", and "follow-up of colorectal cancer treatment" [17, 20], as well as longer-term immigrants (>10 years). The latter were excluded given their similar overall prevalence of never having been screened for colorectal cancer (45.6%, 95% CI: 44.4%, 47.1%) as Canadian-born respondents (46.3%, 95% CI: 45.8, 46.8%).

**Measures**

Figure 1 describes the hypothesized relations between the following measures (additional theory and literature on which are described in detail in the Supplement's eMethods 1):

*Outcome measure*

The CCHS questionnaire describes stool-tests and endoscopic examination (sigmoidoscopy, colonoscopy) and asks: "Have you ever had this test/either of these exams?" For immigrants, the question did not differentiate whether tests were conducted before or after arrival to Canada. Respondents were considered to have never been screened (Y=1) if they reported to have never had any of these tests. We focused on lifetime screening as most Canadians have in fact never been screened in their lifetime[6] and since having never been screened is associated with later-stage cancer at diagnosis and higher risk of mortality.[7]

*Exposure measure*

The exposure of interest (A) was recent immigration experience (A=1 for those who reported immigrating to Canada in the previous 10 years). A 10 year cut-off for recent immigration was

used to reflect the observed period it takes, on average, for new residents to feel a sense of familiarity in the Canadian setting, and to report similar income earnings as average Canadian residents.[21] To account for the intersecting experiences of recent immigration and racialization,[22] recent immigrants and non-immigrants were stratified by visible minority status (yes or no). The CCHS' derived variable for visible minority status captures whether respondents' self-reported cultural and racial background is other than "White". [23] Screening among white recent immigrants and visible minority recent immigrants was compared to screening among white Canadian-born respondents to isolate associations for joint exposure (visible minority status, recent immigration) and single exposure (recent immigration).

*Mediator measures*

The principal mediator of interest was access to a regular PCP. Respondents were considered to not have a regular PCP if they answered "No" to the question "Do you have a regular medical doctor?" And, as it is convention to consider other potential mediating factors in the analysis of direct and indirect effects,[24] we identified two factors in the literature to be treated as additional potential mediators in the analyses: household income and area of residence. These factors were excluded from TE analyses and included as potential confounders of the mediator-outcome association in CDE analyses. Household income was categorized as quartile groupings (highest income [Quartile 4] as reference). Since missing income data were not imputed in the CCHS before 2005, income for CCHS 2003 was imputed based on individuals' age, sex, education, marital status, immigration status, and sampling weight, using hot deck imputation in Stata 14 (*hotdeckvar*).[25] Area of residence was dichotomized (urban vs. rural). Urban classification in the CCHS is based on census population concentration ($n \geq 1{,}000$ inhabitants)

and density ($n \geq 400/km^2$). It includes urban core, urban fringe, secondary urban core, and suburban areas.[23]

*Covariate measures*

Covariates included were sex, age (50-65 years; 65-75 years), marital status (single; divorced, widowed, or separated; married or in a common-law relationship), educational attainment and exposure to a provincially organized colorectal screening program. Since lack of high school graduation is an important predictor of non-recent screening participation across white and visible minority groups at other cancer sites [9] and has previously been associated with lower likelihood of colorectal screening (with non-differential effect sizes for higher education groups, i.e., high school graduates, postsecondary attendees) [26], those who had not completed high school were compared to those who had a high school diploma or more formal education (including college attendance). Residents of Manitoba from 2007, Ontario from 2008, Saskatchewan from 2009, Nova Scotia from 2009, and New Brunswick from 2014 were considered exposed to a mail-out based organized colorectal screening program,[27] designed to promote screening. Exposure to these programs was included as a confounder (i.e. as a potential determinant of having a regular PCP, screening likelihood, and how immigration is experienced) and effect modifier (i.e. as a moderating factor of the associations between immigration experience and having a regular PCP, and between PCP access and screening).

**Analysis**

Estimating the proportion of the disparity would be eliminated if all had a regular PCP (the Proportion Eliminated or "PE"), requires an estimation of 1) the total adjusted association

(referred to as the total effect or "TE") between recent immigration experience and lifetime colorectal screening, and 2) the direct association between recent immigration and lifetime colorectal screening if all had a PCP (referred to as the controlled direct effect "CDE"). In a counterfactual framework,[28] if we assume having measured all mediator-outcome confounders, the CDE can be defined as the remaining immigration-based disparity in lifetime screening prevalence had all individuals been assigned (possibly counterfactually) a regular PCP.[29, 30] Measuring the CDE is particularly relevant when interested in assessing how a potential intervention on the mediator (here, assigning all a PCP) could influence a known inequality.[29, 30] If the inequality in access to regular PCPs according to immigration status does explain, at least in part, immigration-based inequalities in screening, we would expect to see a proportion of the inequality eliminated.

Multiple approaches have been proposed to estimate the TE and CDE. Some use regression modeling,[31, 32] whereas others combine regression modeling with inverse probability weighting techniques,[33] or use a purely inverse probability weighting approach.[24] The aim of using inverse probability weights is to create synthetic populations that are balanced in terms of the measured covariates, through which contrasts in average outcomes can be estimated.[24] In this study, we applied three methods (summarized in detail in other texts[32, 33][24] and in Table 1)—which, taken together, enable an assessment of the robustness of the findings. We describe the three methods here:

First, we used a regression-based product method (also referred to as the generalized product method[30]) proposed by VanderWeele and Vansteelandt,[32] which extends Baron and

Kenny's product method[31] to allow for effect estimation in the presence of exposure-mediator interaction [Method 1]. This method requires the specification of two Poisson regression models for the screening outcome—one with, the other without, the mediator measure and its product term with the exposure (these are the CDE, and TE models, respectively). Second, we used an inverse probability-weighted marginal structural model approach [Method 2], described by VanderWeele,[33] in which TE and CDE models (as in Method 1) are weighted using inverse probability weights for the exposure and mediator. These weights are constructed using propensity scores (predicted probabilities) for the exposure and mediator, given covariates and other mediator values, which are estimated using logistic models (details in Table 1 and the Supplement's eMethod 2). Lastly, we used an inverse probability weighted approach for marginal effect estimation [Method 3], described by VanderWeele,[24] in which screening prevalence is weighted (as in Method 2), and simple ratios of the average screening prevalence between the exposed and unexposed (for TE estimation), and between the exposed with a PCP and unexposed with a PCP (for CDE estimation) are computed. Inverse probability weights used in this method are also constructed using propensity scores for the exposure and mediator, estimated using logistic models (details in Table 1 and Supplement's eMethod 2). Estimates from IPW methods 2 and 3 can be interpreted as the average associations in the population, whereas method 1 associations are conditional on the strata of the variables in the models. With the TE and CDE, the proportion of the total effect explained by having a regular PCP (PE) was estimated on an excess relative risk scale (using prevalence ratio [PR] estimates) as follows: $(PR^{TE} - PR^{CDE)} / (PR^{TE} - 1)$.[24] Confidence intervals (95%) for CDE, TE, and PE were estimated using the bootstrap method (500 replications).[24] Analyses were conducted in R (version 3.4.1).[34]

*Assumptions and sensitivity analyses*

The analyses described above rely on two assumptions, the validity of which will be tested using sensitivity analyses. First, the validity of the CDE estimates (and consequently, of the PE estimates) relies on the assumption of controlled confounding for the mediator-outcome relationship.[35] We apply formulas derived by VanderWeele (2015)[36] to test the sensitivity of observed CDE estimates to unmeasured confounding of the mediator-outcome relationship. This approach estimates how large associations would have to be between an unmeasured factor and both the mediator and outcome for the true CDE estimates to be null (PR=1) despite non-null estimates, or to be equivalent or smaller to the observed TEs (yielding null or positive PEs).

Secondly, estimating CDE requires both theoretical positivity of the mediator (i.e. that all respondents have a non-null probability of having a regular PCP) and—when using inverse probability weighting—practical positivity for the exposure and mediator (i.e. that propensity scores for these factors are neither 0 nor 1 [0% or 100% probability]).[37] To assess this, we performed stratified, descriptive analyses of propensity scores for the exposure and mediator.[24]

The study protocol was approved by the Ethical Review Board of the Centre de Recherche du Centre Hospitalier de l'Université de Montréal.

## RESULTS

### Sample characteristics

Of the total sample (102,366 of whom were white Canadian-born respondents, 659 were recent-immigrants of visible minorities, and 408 of whom were white recent-immigrants), 47% had never been screened in their lifetime and 9% did not have a regular PCP. The prevalence of never having been screened was 71% and 57% in visible minority and white recent immigrants, respectively, and 46% in white Canadian-born respondents (Table 2). Approximately 9% of white Canadian-born respondents did not have a regular PCP, compared to 18% among both visible minority and white recent immigrants, respectively (Table 2). Overall, the proportion of those who had never been screened was higher among those who were younger than 60 years, not partnered, had lower income (quartiles 1 and 2), had not obtained a high school diploma, did not have a PCP, resided in rural settings, and were not exposed to a provincial organized screening program (Table 2).

**Associations between exposure, mediator, and outcome**

Overall, associations were observed between immigration status, having a regular PCP, and screening. Adjusting for all factors, recent immigrants were less likely to have a PCP (Table 3) and more likely to have never been screened (Table 4). However, associations between having a regular PCP and screening were heterogeneous across strata of immigration status. Expressed as prevalence differences (PD), the adjusted difference in screening between those with and without a PCP was larger among white Canadian-born respondents (PD = 19% [95% CI 17% to 20%], i.e. prevalence of approximately 44% among those with a PCP, 68% among those without) than among white immigrants (PD=4% [95% CI -15% to 24%], i.e. prevalence of approximately 54% among those with a regular PCP, 58% among those without) or among visible minority

immigrants (PD=8% [95% CI -10% to 27%], i.e. prevalence of approximately 71% among those with a PCP, 79% among those without) (data not in table).

**TE, CDE, and PE estimates**

The TE, CDE, and PE estimates were largely consistent across all three mediation methods (Table 5). Large CDE estimates (between PR=1.56 and 1.60 for visible minority recent immigrants, and between PR=1.24 to 1.27 for white recent immigrants, depending on the method used) suggest that even if inequalities in access to a regular PCP were eliminated, a large disparity in lifetime screening would remain for recent immigrants across visible minority status. Most CDE estimates were larger than TE estimates, yielding null PE estimates for white recent immigrants, and negative PE estimates (i.e. exacerbated inequalities under mediator intervention) for visible minority recent immigrants (between -6% and -13%, depending on the method used) (Table 2).

**Results of sensitivity analyses**

First, we found that the associations between the unmeasured factor and both the mediator and outcome would have to be at minimum PR = 2.5 for visible minority recent immigrants, and PR=1.8 for white recent immigrants for the true CDE estimates to be null (PR=1) despite non-null estimates; and would have to be at minimum PR=1.3 and PR=1.1 for visible minority and white recent immigrants, respectively, for true CDE estimates to be equivalent or smaller than observed TE estimates (yielding null or positive PE values) (Supplement's eTable 1 and eTable 2). These are larger estimates than those observed for low education and not being exposed to an organized screening program (Table 2, Table 3). Nonetheless, the potential for unmeasured

confounding remains. Second, analyses of propensity scores indicate good covariate balance between exposed and unexposed respondents after weighting, and of practical positivity for regular PCP access (Supplement's eTable 3, eTable 4). However, the requirement of practical positivity for recent immigration may be violated (i.e. propensity scores—even when truncated at the 10$^{th}$ percentile—were close to 0). Lack of practical positivity may lead to potential instability of the weighting methods. Lastly, results were largely consistent when accounting for effect modification by exposure to an organized screening program, with slightly attenuated direct effects (Supplement's eTable 5).

## DISCUSSION

The aim of this study was to assess whether having a regular PCP mediates the disparity in lifetime colorectal screening between recent immigrants and non-immigrants in Canada. In this sample, in which nearly half (47%) have never been screened, we observed large controlled direct effects between recent immigration and screening, as well as proportions eliminated that were either null or negative—indicating that improving access to regular PCPs may not reduce observed immigration-based screening inequalities. As the screening disparity between those with and without a regular PCP is larger among white Canadian-born respondents (PD=19%) than among recent immigrants (PD=8% and 4% among visible and white minority recent immigrants, respectively), having a PCP lead to larger increases in screening among Canadian-born individuals than among recent immigrants, thereby leaving the disparity untouched or exacerbated.

The observed associations between recent immigration and lifetime screening are consistent with those observed previously in Canada and North America.[1] These associations may be explained by recent immigrants' more limited knowledge of and trust in the efficacy of the screening tests and the medical system, discomfort with the test itself, or lower perceived susceptibility to cancer.[1, 38] Differences in effect sizes between white and visible minority recent immigrants may be explained by differences in ethno-cultural feelings of fatalism and helplessness with regards to colorectal cancer diagnosis and mortality[15] or in the acceptability of screening tests.[16] On a more distal level, systemic discrimination,[39] barriers to health care, and social stressors such as inadequate housing and precarious employment[40] are thought to explain, in part, why persons who immigrate to Canada —who, upon arrival are disproportionately healthy—see their health experience a decline in health over time, eventually converging with Canadian-born residents their age.[12] These distal factors may also explain why such strong associations are observed between immigration experience and screening. However, it should be noted that Canada's immigrant and visible minority populations are highly heterogenous, and explanations for the observed findings may not hold across all sub-groups.

Though having a regular PCP is an important enabling determinant of screening participation overall,[1] our findings suggest increasing access to PCPs may lead to greater gains in screening for Canadian-born individuals than for recent immigrants. Several factors may explain this observation. First, recent immigrants may not systematically receive screening recommendations from their regular PCPs—as is observed for patients of visible minorities or lower socioeconomic status in Canada.[41] Recent immigrants to Canada have also reported gaps in the cultural competency of health care providers, specifically with regards to cultural understandings

of health and health care,[42] and to language and communication.[43] These limitations of the Canadian health care system, in conjunction with general logistic and psychological barriers to colorectal screening (such as unreachable or inadequate resources, lower social support, fear, embarrassment or anxiety of the test, its required preparation—especially for endoscopic procedures—or of its result[44]) may explain why simply having a regular PCP may not be sufficient to ensure screening uptake.

The implication of these findings is that improving individuals' access to regular PCPs may improve screening participation overall (namely through large gains among Canadian-born individuals) but fail to reduce screening disparities according to recent immigration. We recommend that future studies explore alternative areas of intervention to both reduce these inequalities and increase screening uptake overall.

These findings are bound by certain limitations. First, the broad categories of white versus visible minority immigrants may obscure sub-group heterogeneity in the associations measured, as has been observed in previous studies [45]. These findings should therefore be interpreted as the average mediating role of PCPs in white and visible minority immigrants. Second, the cross-sectional data used required additional assumptions of the temporal ordering of associations between recent immigration, regular PCP access, and screening. Replication of these analyses using longitudinal data will be beneficial. Third, although we stated effect estimates in the causal language used in epidemiologic research, the validity of these assertions rely on the satisfaction of the causal assumptions underpinning each method.[24] Sensitivity analyses suggest that some residual confounding is likely present. Among the unmeasured factors in this study (and indeed,

in the CCHS) are concordance of individuals' and PCPs' gender identity or economic, linguistic, ethnic, or cultural background [46, 47]. Future mediation studies may benefit from incorporating the latter measures, as well as exploring downstream mediators such as knowledge and cultural beliefs around cancer or cancer prevention, and the frequency or recency of PCP visits. Lastly, since self-reported screening data tend to over-estimate recent screening (i.e. previous two year fecal occult blood test (FOBT) sensitivity is 77.4% and specificity is 89.8%),[48] and studies at other cancer sites have observed differential self-reported screening according to racial and ethnic subpopulations,[48] it is possible that the screening gaps between immigrants and non-immigrants observed in this study may be underestimated.

In sum, almost half of adults aged 50 to 75 years in Canada have never been screened for colorectal cancer, and the prevalence of having never been screened is even higher for recent immigrants. This study suggests that increasing individuals' access to regular PCPs may increase screening overall, but not eliminate immigration-based disparities in screening. Other levers will be necessary to decrease these inequalities.

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## References

1. Decker, K.M. and H. Singh, *Reducing inequities in colorectal cancer screening in North America.* J Carcinog, 2014. **13**: p. 12.
2. Arnold, M., O. Razum, and J.-W. Coebergh, *Cancer risk diversity in non-western migrants to Europe: an overview of the literature.* European journal of cancer, 2010. **46**(14): p. 2647-2659.
3. Sewitch, M.J., et al., *Adherence to colorectal cancer screening guidelines in Canada.* BMC Gastroenterol, 2007. **7**: p. 39.
4. Sewitch, M., et al., *Colorectal cancer screening in Canada: results of a national survey.* Chronic Dis Can, 2008. **29**(1): p. 9-21.
5. CCS, *Canadian Cancer Statistics 2017 - Special topic: Pancreatic cancer*. 2017, Canadian Cancer Society's Advisory Committee on Cancer Statistics: Ottawa, Ontario.
6. Blair, A., et al., *Area-level income disparities in colorectal screening in Canada: Evidence to inform future surveillance* Forthcoming [In Press]: Current Oncology.
7. O'Malley, A.S., et al., *Disparities despite coverage: Gaps in colorectal cancer screening among medicare beneficiaries.* Archives of Internal Medicine, 2005. **165**(18): p. 2129-2135.
8. Natale-Pereira, A., et al., *Barriers and facilitators for colorectal cancer screening practices in the Latino community: perspectives from community leaders.* Cancer Control, 2008. **15**(2): p. 157-65.
9. Selvin, E. and K.M. Brett, *Breast and Cervical Cancer Screening: Sociodemographic Predictors Among White, Black, and Hispanic Women.* American Journal of Public Health, 2003. **93**(4): p. 618-623.
10. McGregor, S.E., et al., *Low uptake of colorectal cancer screening 3 yr after release of national recommendations for screening.* Am J Gastroenterol, 2007. **102**(8): p. 1727-35.
11. Charters, T.J., E.C. Strumpf, and M.J. Sewitch, *Effectiveness of an organized colorectal cancer screening program on increasing adherence in asymptomatic average-risk Canadians.* BMC Health Serv Res, 2013. **13**: p. 449.
12. Batista, R., et al., *Primary Health Care Models Addressing Health Equity for Immigrants: A Systematic Scoping Review.* J Immigr Minor Health, 2016. **20**(1): p. 214-230.
13. Battaglini, A., et al., *Immigrant health in Canada: current state of knowledge, interventions and issues.* Glob Health Promot, 2014. **21**(1 Suppl): p. 40-5.
14. Claudia, S. and R. Nancy, *Experiencing Difficulties Accessing First-Contact Health Services in Canada.* Healthcare Policy, 2006. **1**(2): p. 103-119.
15. Lee, E.E., L. Fogg, and U. Menon, *Knowledge and beliefs related to cervical cancer and screening among Korean American women.* Western Journal of Nursing Research, 2008. **30**(8): p. 960-74.
16. Walsh, J.M.E., et al., *Barriers to colorectal cancer screening in Latino and Vietnamese Americans.* Journal of general internal medicine, 2004. **19**(2): p. 156-166.
17. *Canadian Community Health Survey*. 2012, Statistics Canada: Ottawa, Ontario.
18. *Canadian Community Health Survey (CCHS) Annual component - User guide: 2014 and 2013-2014 Microdata files*. 2015, Statistics Canada: Ottawa, Canada.
19. *CCHS Cycle 2.1 (2003), Public Use Microdata File Documentation*. 2003, Statistics Canada: Ottawa, Canada.

20. Haggar, F.A. and R.P. Boushey, *Colorectal cancer epidemiology: incidence, mortality, survival, and risk factors.* Clin Colon Rectal Surg, 2009. **22**(4): p. 191-7.
21. Dunn, J.R. and I. Dyck, *Social determinants of health in Canada's immigrant population: results from the National Population Health Survey.* Social science & medicine, 2000. **51**(11): p. 1573-1593.
22. Bauer, G.R., *Incorporating intersectionality theory into population health research methodology: Challenges and the potential to advance health equity.* Social Science & Medicine, 2014. **110**: p. 10-17.
23. *Canadian Community Health Survey (CCHS): Derived Variable (DV) Specifications*, in *Canadian Community Health Survey - Public Use Microdata File* 2014, Statistics Canada: Ottawa, Canada.
24. VanderWeele, T., *Explanation in causal inference: methods for mediation and interaction*. 2015: Oxford University Press.
25. StataCorp, *Stata Statistical Software: Release 14*. 2015, StataCorp LP: College Station, TX.
26. Zarychanski, R., et al., *Frequency of colorectal cancer screening and the impact of family physicians on screening behaviour.* Canadian Medical Association Journal, 2007. **177**(6): p. 593-597.
27. *Colorectal Cancer Screening in Canada: Environmental Scan*. 2015, Canadian Partnership Against Cancer: Toronto, Canada.
28. Richiardi, L., R. Bellocco, and D. Zugna, *Mediation analysis in epidemiology: methods, interpretation and bias.* International Journal of Epidemiology, 2013. **42**(5): p. 1511-1519.
29. VanderWeele, T.J. and W.R. Robinson, *On causal interpretation of race in regressions adjusting for confounding and mediating variables.* 2014. **25**(4): p. 473-84.
30. Naimi, A.I., J.S. Kaufman, and R.F. MacLehose, *Mediation misgivings: ambiguous clinical and public health interpretations of natural direct and indirect effects.* International Journal of Epidemiology, 2014. **43**(5): p. 1656-1661.
31. Baron, R.M. and D.A. Kenny, *The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations.* Journal of personality and social psychology, 1986. **51**(6): p. 1173.
32. VanderWeele, T.J. and S. Vansteelandt, *Odds ratios for mediation analysis for a dichotomous outcome.* American journal of epidemiology, 2010. **172**(12): p. 1339-1348.
33. VanderWeele, T.J., *Marginal structural models for the estimation of direct and indirect effects.* Epidemiology, 2009. **20**(1): p. 18-26.
34. R-CoreTeam, *R: A language and environment for statistical computing*, R.F.f.S. Computing, Editor. 2012: Vienna, Austria.
35. Naimi, A.I., et al., *Mediation Analysis for Health Disparities Research.* American Journal of Epidemiology, 2016. **184**(4): p. 315-324.
36. VanderWeele, T.J., *Mediation Analysis: A Practitioner's Guide.* Annual Review of Public Health, 2016. **37**(1): p. 17-32.
37. Westreich, D. and S.R. Cole, *Invited Commentary: Positivity in Practice.* American Journal of Epidemiology, 2010. **171**(6): p. 674-677.
38. Javanparast, S., et al., *How equitable are colorectal cancer screening programs which include FOBTs? A review of qualitative and quantitative studies.* Preventive Medicine, 2010. **50**(4): p. 165-172.

39. De Maio, F.G. and E. Kemp, *The deterioration of health status among immigrants to Canada.* Global Public Health, 2010. **5**(5): p. 462-478.
40. Guruge, S., B. Birpreet, and J.A. Samuels-Dennis, *Health Status and Health Determinants of Older Immigrant Women in Canada: A Scoping Review.* J Aging Res, 2015. **2015**: p. 393761.
41. Lofters, A., R. Ng, and R. Lobb, *Primary care physician characteristics associated with cancer screening: a retrospective cohort study in Ontario, Canada.* Cancer Med, 2015. **4**(2): p. 212-23.
42. Asanin, J. and K. Wilson, *"I spent nine years looking for a doctor": Exploring access to health care among immigrants in Mississauga, Ontario, Canada.* Social Science & Medicine, 2008. **66**(6): p. 1271-1283.
43. Stewart, M.J., et al., *Immigrant women family caregivers in Canada: implications for policies and programmes in health and social sectors.* Health & Social Care in the Community, 2006. **14**(4): p. 329-340.
44. Vernon, S.W., *Participation in Colorectal Cancer Screening: A Review.* Journal of the National Cancer Institute, 1997. **89**(19): p. 1406-1422.
45. Shen, S., et al., *Predictors of non-adherence to colorectal cancer screening among immigrants to Ontario, Canada: a population-based study.* Preventive Medicine, 2018. **111**: p. 180-189.
46. Franks, P. and K.D. Bertakis, *Physician Gender, Patient Gender, and Primary Care.* Journal of Women's Health, 2003. **12**(1): p. 73-80.
47. Saha, S., et al., *Patient-physician racial concordance and the perceived quality and use of health care.* Archives of Internal Medicine, 1999. **159**(9): p. 997-1004.
48. Lofters, A., M. Vahabi, and R.H. Glazier, *The validity of self-reported cancer screening history and the role of social disadvantage in Ontario, Canada.* BMC Public Health, 2015. **15**: p. 28.

**Table 1:** Summary of models required for the estimation of the controlled direct effect (CDE) and total effect (TE), in the three methods used in the study

| Method | Controlled direct effect (CDE) | Total effect (TE) |
|---|---|---|
| (1) Generalized Product Method | **Outcome model**<br>$\log(E[Y\|a,m\ c] = \theta_0 + \theta_1 A_i + \theta_2 M1 + \theta_3 AM1 + \theta' M_i + \theta' c$<br><br>CDE indicated by $(\theta_1 + \theta_3 m)$, where $m$ was set to $m=1$; all have physicians | **Outcome model**<br>$\log(E[Y\|a,m\ c] = \theta_0 + \theta_1 A_i + \theta' M_i + \theta' c$<br><br>TE indicated by $(\theta_1)$ |
| (2) Inverse probability weighting (IPW) Marginal Structural Model approach | **Propensity score models**<br>Logistic model for A=1 ~ 1 (p_A)<br>Logistic model for A=1 with $C_i$ (p_A1)<br>Logistic model for M1=1 with A (p_M)<br>Logistic model for M1=1 with A,$C_i$, all $M_i$ (p_M1)<br><br>**Weights for A**<br>If A=1: p_A/p_A1<br>If A=0: p_A/(1-p_A1)<br>**Weights for M1**<br>If M1=1: p_M/p_M1<br>If M1=0: p_M/(1-p_M1)<br><br>**Outcome model**<br>Where all are weighted using product of weights for A and for M1: $\log(E[Y\|a,m\ c] = \theta_0 + \theta_1 A_i + \theta_2 M1 + \theta_3 AM1 + \theta' M_i + \theta' c$<br><br>CDE indicated by $(\theta_1 + \theta_3 m)$, where $m$ was set to $m=1$; all have physicians | **Propensity score models**<br>Logistic model for A=1 ~ 1 (p_A)<br>Logistic model for A=1 with $C_i$ (p_A1)<br><br>**Weights for A**<br>If A=1: p_A/p_A1<br>If A=0: p_A/(1-p_A1)<br><br>**Outcome model**<br>Where all are weighted using weights for A:<br>$\log(E[Y\|a,m\ c] = \theta_0 + \theta_1 A_i + \theta' M_i + \theta' c$<br><br>TE indicated by $(\theta_1)$ |
| (3) Inverse probability weighted (IPW) Average Marginal Effect approach | **Propensity score models**<br>Logistic model for A=1 with $C_i$ (p_A1)<br>Logistic model for M1=1 with A, $C_i$, all $M_i$ (p_M1)<br><br>**Weights for A**<br>If A=1: 1 /p_A1<br>If A=0: 1/(1-p_A1)<br>**Weights for M1**<br>If M1=1: 1/p_M1<br>If M1=0: 1/(1-p_M1)<br><br>**Estimation**<br>CDE is estimated by the ratio of weighted (using product of weights for A and M1) screening prevalence in those with A=1 and M1=1 over those with A=0 and M1=1:<br>$Y_{A=1, M1=1, weighted} / Y_{A=0, M1=1, weighted}$ | **Propensity score model**<br>Logistic model for A=1 with $C_i$<br><br>**Weights for A**<br>If A=1: 1/p_A1<br>If A=0: 1/(1-p_A1)<br><br>**Estimation**<br>TE is estimated by the ratio of weighted screening prevalence in those with A=1 over those with A=0:<br>$Y_{A=1, weighted} / Y_{A=0, weighted}$ |

[a] A= exposure (recent immigration). M1=mediator (not having a primary care physician). $M_i$ describes the additional mediators, here M2-M4 are quartile groupings 1,2,3 of household income, and M5 stands for rural residence. $C_i$ represent covariates, which include sex, age, marital status, education, and exposure to an organized screening program.

**Table 2**: Prevalence of having never been screened and not having a primary care physician across demographic, social, and economic population characteristics among respondents aged 50-75 years to the 2003-2014 waves of the Canadian Community Health Survey (n=659 visible minority recent-immigrants, n=408 white recent-immigrants, n=102,366 white Canadian-born respondents)

| Characteristics | Overall | % Without a Primary care physician (95% CI) | % Never Screened (95% CI) |
|---|---|---|---|
| | 100 | 9.3 | 47.0 |
| **Recent immigration** | | | |
| No | 99.2 | 9.0 (8.7, 9.4) | 46.3 (45.8, 46.8) |
| Yes | 0.9 | 18.2 (13.8, 23.7) | 67.9 (62.6, 72.7) |
| **Visible minority status** | | | |
| No | 93.6 | 9.0 (8.7, 9.3) | 46.3 (45.7, 46.8) |
| Yes | 6.4 | 14.4 (12.0. 17.2) | 57.6 (54.7, 60.5) |
| **Immigration/visible minority** | | | |
| Recent Immigrant, Visible Minority (n=659) | 0.61 | 18.4 (13.0, 25.4) | 71.0 (65.0, 76.3) |
| Recent Immigrant, White (n=408) | 0.38 | 17.6 (13.0, 23.4) | 56.8 (46.5, 66.4) |
| Canadian-born, Visible Minority (n=5241) | 4.82 | 11.7 (10.4, 13.2) | 48.9 (46.0, 51.7) |
| Canadian-born, White (n=102,366) | 94.20 | 8.9 (8.6, 9.3) | 46.2 (45.7, 46.7) |
| **Primary care physician** | | | |
| Yes | 90.7 | | 44.7 (44.1, 45.2) |
| No | 9.3 | | 69.8 (67.9, 71.6) |
| **Sex** | | | |
| Men | 49.9 | 7.6 (7.2, 8.0) | 47.1 (46.2, 47.9) |
| Women | 50.1 | 11.1 (10.5, 11.6) | 46.9 (46.2, 47.6) |
| **Age (years)** | | | |
| 50-59 | 52.8 | 7.2 (6.8, 7.6) | 54.9 (54.0, 55.8) |
| 60-75 | 47.2 | 11.3 (10.5, 12.0) | 38.1 (37.5, 38.8) |
| **Marital status** | | | |
| Married/Common Law | 73.6 | 7.8 (7.4, 8.2) | 45.4 (44.7, 46.0) |
| Divorced/Widowed/Separated | 18.6 | 11.3 (10.5, 12.0) | 49.5 (48.3, 50.8) |
| Single | 7.8 | 19.8 (18.4, 21.3) | 47.0 (46.5, 47.6) |
| **Education** | | | |
| ≥High School | 80.5 | 9.1 (8.0, 9.5) | 45.8 (45.2, 46.5) |
| <High School | 19.5 | 10.2 (9.6, 10.9) | 51.9 (50.8, 53.0) |
| **Organized screening** | | | |
| Yes | 39.6 | 7.4 (6.9, 8.0) | 35.2 (34.2, 36.1) |
| No | 60.4 | 10.6 (10.2, 11.1) | 55.8 (54.1, 55.4) |
| **Income quartiles** | | | |
| Quartile 1 | 19.0 | 12.0 (11.2, 12.8) | 51.6 (50.6, 52.7) |
| Quartile 2 | 20.4 | 9.6 (8.9, 10.4) | 45.0 (43.9, 46.1) |
| Quartile 3 | 30.4 | 9.1 (8.4, 9.8) | 46.3 (45.2, 47.5) |
| Quartile 4 | 30.2 | 7.7 (7.2, 8.3) | 46.1 (45.0, 47.2) |
| **Rural** | | | |
| Yes | 25.9 | 9.3 (8.8, 9.9) | 49.2 (45.6, 46.9) |
| No | 74.1 | 9.3 (8.9, 9.8) | 46.3 (45.6, 46.9) |

**Table 3**: Covariate-adjusted models for recent immigration (A) and not having a primary care physician (M1), stratified by visible minority status (n=659 visible minority, n=408 white), with white Canadian-born respondents (n=102,366) as reference category, in the Canadian Community Health Survey 2003-2014

| | **Stratified, covariate-adjusted models for recent immigration (A)** | | **Stratified, covariate-adjusted models for not having a primary care physician (M1)** | |
|---|---|---|---|---|
| | Visible minority recent immigrants vs. White Canadian-born | White recent immigrants vs. White Canadian-born | Visible minority recent immigrants vs. White Canadian-born | White recent immigrants vs. White Canadian-born |
| Characteristics | Recent immigration PR[b] (95% CI) | Recent immigration PR[b] (95% CI) | Not having a primary care physician PR[b] (95% CI) | Not having a primary care physician PR[b] (95% CI) |
| **Recent immigration** [a] | | | | |
| Yes | | | 1.40 (1.14, 1.82) | 2.86 (2.22, 3.63) |
| No | | | 1 | 1 |
| **Sex** | | | | |
| Men | 1.16 (1.07, 1.26) | 0.91 (0.82, 1.00) | 1.58 (1.54, 1.61) | 1.57 (1.54, 1.61) |
| Women | 1 | 1 | 1 | 1 |
| **Age** | | | | |
| 50-59 | 2.15 (1.98, 2.32) | 1.52 (1.38, 1.69) | 1.65 (1.61, 1.68) | 1.65 (1.61, 1.68) |
| 60-75 | 1 | 1 | 1 | 1 |
| **Marital Status**[a] | | | | |
| Mar./Com. Law | 1 | 1 | 1 | 1 |
| Div./Widow. | 0.63 (0.57, 0.70) | 0.63 (0.55, 0.72) | 1.55 (1.51, 1.60) | 1.56 (1.50, 1.60) |
| Single | 0.41 (0.35, 0.49) | 0.40 (0.32, 0.50) | 2.41 (2.34, 2.49) | 2.42 (2.36, 2.47) |
| **Education** | | | | |
| ≥High School | 1 | 1 | 1 | 1 |
| <High School | 1.06 (0.97, 1.17) | 0.25 (0.20, 0.30) | 1.13 (1.10, 1.15) | 1.13 (1.10, 1.16) |
| **Organized screening** | | | | |
| Yes | 1 | 1 | 1 | 1 |
| No | 1.23 (1.13, 1.33) | 0.88 (0.79, 0.97) | 1.25 (1.22, 1.28) | 1.25 (1.22, 1.28) |
| **Income Quartiles** | | | | |
| Quartile 1 | | | 1.13 (1.09, 1.17) | 1.13 (1.09, 1.17) |
| Quartile 2 | | | 1.02 (0.99, 1.05) | 1.02 (0.99, 1.05) |
| Quartile 3 | | | 1.01 (0.97, 1.04) | 1.01 (0.98, 1.04) |
| Quartile 4 (highest) | | | 1 | 1 |
| **Rural** | | | | |
| Yes | | | 1.19 (1.17, 1.22) | 1.19 (1.17, 1.22) |
| No | | | 1 | 1 |

[a] "Mar" indicates married; "Com. Law" indicates Common law relationship status; "Div." indicates divorced, "Widow." indicates widowed.
[b] Stratified PR values represent stratified prevalence risk ratios estimated via Poisson log-linear regression models. Models were adjusted for age, sex, marital status, educational attainment, exposure to a provincial organized screening program, income quartile, rural residence

**Table 4:** Covariate-adjusted models for having never been screened (Y), stratified by visible minority status (n=659 visible minority, n=408 white), with white Canadian-born respondents (n=102,366) as reference category, in the Canadian Community Health Survey 2003-2014

| | **Stratified, covariate-adjusted models for having never been screened (Y)** | |
|---|---|---|
| | Visible minority recent immigrants vs. White Canadian-born | White recent immigrants vs. White Canadian-born |
| Characteristics | Having never been screened $PR_{11}$[b] (95% CI) | Having never been screened $PR_{10}$[b] (95% CI) |
| **Recent Immigration (A)**[a] | | |
| Yes | 1.16 (0.92, 1.41) | 1.01 (0.75, 1.27) |
| No | 1 | 1 |
| **Primary care physician (M1)** | | |
| Yes | 1 | 1 |
| No | 1.41 (1.36, 1.44) | 1.42 (1.36, 1.47) |
| **Product terms** | | |
| A*M1 | 1.33 (1.07, 1.60) | 1.23 (0.93, 1.53) |
| **Sex** | | |
| Men | 1.02 (1.00, 1.04) | 1.02 (1.00, 1.04) |
| Women | 1 | 1 |
| **Age** | | |
| 50-59 | 1.40 (1.39, 1.42) | 1.41 (1.39, 1.42) |
| 60-75 | 1 | 1 |
| **Marital Status**[a] | | |
| Mar./Com. Law | 1 | 1 |
| Div./Widow. | 1.08 (1.06, 1.11) | 1.08 (1.06, 1.11) |
| Single | 1.12 (1.09, 1.15) | 1.12 (1.09, 1.15) |
| **Education** | | |
| ≥High School | 1 | 1 |
| <High School | 1.13 (1.11, 1.15) | 1.13 (1.11, 1.15) |
| **Organized screening** | | |
| Yes | 1 | 1 |
| No | 1.66 (1.64, 1.68) | 1.66 (1.64, 1.68) |
| **Income Quartiles** | | |
| Quartile 1 | 1.04 (1.02, 1.07) | 1.04 (1.02, 1.07) |
| Quartile 2 | 0.96 (0.93, 0.98) | 0.96 (0.93, 0.99) |
| Quartile 3 | 0.94 (0.92, 0.97) | 0.94 (0.91, 0.97) |
| Quartile 4 (highest) | 1 | 1 |
| **Rural** | | |
| Yes | 1.03 (1.01, 1.05) | 1.03 (1.01, 1.05) |
| No | 1 | 1 |

[a] "Mar" indicates married; "Com. Law" indicates Common law relationship status; "Div." indicates divorced, "Widow." Indicates widowed.

[b] PR values represent stratified prevalence ratios estimated via Poisson log-linear regression models. Models were adjusted for age, sex, marital status, educational attainment, exposure to a provincial organized screening program, income quartile, rural residence and product terms.

**Table 5:** Estimated total effect of recent immigration (exposure) on lifetime screening, and controlled direct effect when access to a primary care physician (mediator) is held fixed, stratified by visible minority status (n=659 visible minority, n=408 white), with white Canadian-born respondents (n=102,366) as reference category, in the Canadian Community Health Survey 2003-2014

| **Population Strata** | **Approach** | **Total Effect (TE)** PR (95% CI) | **Controlled Direct Effect (CDE)** PR (95% CI) | **Proportion Eliminated (PE)** $(PR^{TE} - PR^{CDE}) / (PR^{TE} - 1)$ % (95% CI) |
|---|---|---|---|---|
| Visible minority recent immigrants vs. White Canadian-born | (1) Generalized Product Method approach[a] | 1.51 (1.28, 1.65) | 1.56 (1.48, 1.63) | -9% (-15%, -4%) |
| | (2) IPW Marginal Structural Model approach[b] | 1.54 (1.41, 1.69) | 1.58 (1.50, 1.68) | -6% (-12%, -2%) |
| | (3) IPW Average Marginal Effect approach[c] | 1.53 (1.44, 1.61) | 1.60 (1.51, 1.70) | -13% (-20%, -6%) |
| White recent immigrants vs. White Canadian-born | (1) Generalized Product Method approach[a] | 1.24 (1.08, 1.40) | 1.24 (1.12, 1.35) | -2% (-29%, 24%) |
| | (2) IPW Marginal Structural Model approach[b] | 1.31 (1.15, 1.48) | 1.32 (1.18, 1.47) | 1% (-21%, 24%) |
| | (3) IPW Average Marginal Effect approach[c] | 1.25 (1.13, 1.37) | 1.27 (1.12, 1.42) | -10% (-51%, 36%) |

NOTE: IPW = Inverse probability weighted, PR= Prevalence Ratio.

[a] The generalized product method, proposed by VanderWeele and Vansteeladnt (2009), extends Baron and Kenny's (1986) product method to allow for effect estimation in the presence of exposure-mediator interaction. Note that when exposure-mediator interaction is not accounted for, effects were the following for visible minority recent immigrants (ref. White, Canadian-born): TE = 1.51 (1.38, 1.66), the CDE = 1.49 (1.42, 1.56), and the PE = 3.8% (1%, 7%); and for white recent immigrants (ref. white Canadian-born) they were TE=1.24 (1.08, 1.40), CDE= 1.18 (1.08, 1.29), PE = 26% (15%, 43%).

[b] The inverse probability-weighted marginal structural model approach, proposed by VanderWeele (2009), fits inverse-probability-weighted TE and CDE models (on outcome Y) such that the exposed and unexposed are balanced in terms of measured covariates (for CDE, TE estimation) and primary care physician values (for CDE estimation).

[c] The IPW Average Marginal Effect approach estimates CDE by computing the ratio between i) the average prevalence of lifetime screening in recent immigrants with physicians (who are weighted to be balanced in terms of measured covariates and mediators with those born in Canada) and ii) the average prevalence of lifetime screening in Canadian-born respondents with physicians (who are weighted to be balanced in terms of measured covariates and mediators with recent immigrants). Similarly, the TE is estimated by computing ratio between i) the average prevalence of lifetime screening in recent immigrants (weighted to be balanced in terms of measured covariates with those born in Canada) and ii) the average prevalence of lifetime screening in Canadian-born respondents (weighted to be balanced in terms of measured covariates).

## Figure legend

**Figure 1:** Directed Acyclic Graph (DAG) of the assumed direction of associations between study measures. One-way arrows indicate assumed direction of associations between the exposure of the study (A, recent immigration/visible minority status), the principal mediator (M1, access to a primary care physician), the outcome (Y, lifetime colorectal cancer screening), other assumed mediators (M2-M5) and covariates (C). The asterisk (*) is used to indicate that certain assumptions underly the assumed direction of the arrow from exposure to an organized screening program to recent immigration (A). These assumptions are that 1) recent immigration entails a set of experiences, some of which are mutable and can vary according to the country of arrival's integration policies, and 2) organized screening programs (which represent a provincial investment in health promotion and health service accessibility—or least, the promotion of service and screening awareness) could shape recent immigrants' experiences in navigating a new health system.

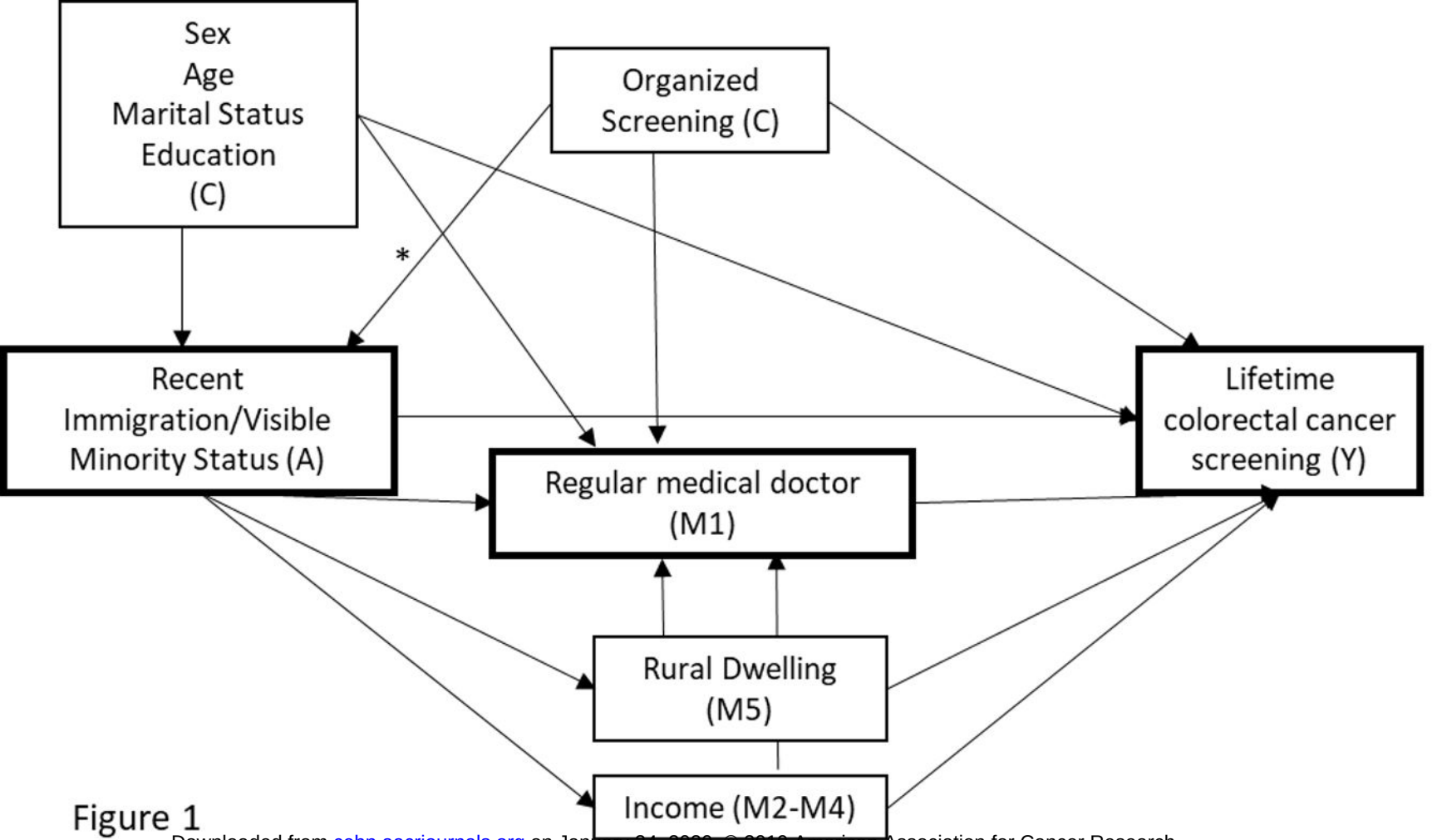


Figure 1

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# The role of access to a regular primary care physician in mediating immigration-based disparities in colorectal screening: Application of multiple mediation methods

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