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Journal: European journal of cancer prevention : the official journal of the European Cancer Prevention Organisation (ECP)

Year: 2013 Sep

Issue: 22

Volume: 5

Pages: 425-30

DOI: 10.1097/CEJ.0b013e32835f3b87

Obesity and Overweight Associated with Lower Rates of Colorectal Cancer Screening in Switzerland

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Word count

Abstract: 250 words	Text: 2809 words	Number of references: 35
Number of tables: 3	Number of figures: 1 appendix figure	

Running head: Predictors of Colorectal Cancer Screening

Conflict of interest statement: An investigator-initiated unrestricted research grant from Pfizer (Switzerland) was provided for data collection and analysis. Pfizer had no role in the study design, the choice of statistical analyses, or the preparation of the manuscript. None of the authors have additional individual financial disclosures.

Abstract

Background: Screening for colorectal cancer (CRC) is associated with reduced CRC mortality, but low screening rates have been reported in several settings.

Objective: To assess predictors of low CRC screening in Switzerland.

Design & Participants: Retrospective cohort of a random sample of 940 patients aged 50–80 years followed for 2 years from 4 Swiss University primary care settings. Patients with illegal residency status and history of CRC or colorectal polyps were excluded.

Main measures: We abstracted socio-demographic data of patients and physicians, patient health status and indicators derived from RAND's Quality Assessment Tools from medical charts. We defined CRC screening as colonoscopy in last 10 years, flexible sigmoidoscopy in last 5 years, or fecal occult blood testing in last 2 years. We used bivariate and multivariate logistic regression analyses.

Key results: Of 940 patients (mean age 63.9 years, 42.7% women), 316 (33.6%) had CRC screening. In multivariate analysis, birthplace in a country outside of Western Europe and North America (OR 0.65, 95% CI 0.45-0.97), male gender of the physician in charge (OR 0.67, 95% CI 0.50-0.91), BMI 25.0-29.9 kg/m^2 (OR 0.66, CI 0.46-0.96) and ≥30.0 kg/m^2 (OR 0.61, CI 0.40-0.90) were associated with lower CRC screening rates.

Conclusion: Obesity, overweight, birthplace outside of Western Europe and North America, and male gender of the physician in charge were associated with lower CRC screening rates in Swiss University primary care settings. Physician perception of obesity and its impact on their recommendation for CRC screening might be a target for further research.

Keywords: Colorectal Cancer; Cancer Screening; Obesity

Background

According to the World Health Organization (WHO), colorectal cancer (CRC) is the fourth leading cause of cancer death worldwide. CRC screening using biennial fecal occult blood testing has been shown to reduce CRC related mortality by about 14% [1]. Screening colonoscopy every 10 years, flexible sigmoidoscopy every 5 years, or annual fecal occult blood testing (FOBT) have been recommended by United States (U.S.) Guidelines [2] and a European Panel [3] for patients older than 50. Several studies also support cost effectiveness of CRC screening [4,5]. However, reported screening rates stay around 55% in the U.S. [6,7] and around 45% in European countries [8].

In search for a better understanding of these low rates, recent studies examined the factors associated with CRC screening. Socio-economic factors such as white ethnicity, male gender, lower age, higher education level and higher household income, and insurance coverage, were found to be associated with higher CRC screening rates in several studies in the U.S. and Canada [9–12]. Whereas presence of a chronic condition increased odds for CRC screening in one study [11], no association with the number of chronic conditions was found in another [12]. A recent review on the relationship between obesity and cancer screening found a complex pattern of positive and negative associations between CRC screening and weight status throughout the literature [13]. Several studies found that annual influenza vaccine was associated with higher CRC screening rates [9,11]. The main reasons not to perform FOBT screening were patient unawareness and physicians not recommending it [10].

Outside of Northern America, publications on correlates of CRC screening are rare. A recent Spanish study found higher education level, periodic screening for breast and cervical cancer in women, and knowledge about CRC and CRC screening to increase odds for initial participation in a population-based screening program [14]. One study from Hong Kong found that physician factors such as experience, academic appointment and agreement with CRC screening were associated with higher screening rates [15]. However, we found no studies assessing the factors associated with CRC screening in European countries without population-based screening program, such as Switzerland.

The aim of this study was to assess patient and physician factors associated with lower rate of CRC screening, in University primary care settings in Switzerland, a country without a population-based screening program.

Methods

Study design and patients

The study design was previously published [16]. Briefly, this retrospective cohort study aimed to assess the quality of preventive care and control of cardiovascular risk factors, and included a random sample of all patients aged 50 to 80 years old, followed up by primary care physicians (PCPs) in 4 Swiss University primary care settings in Basel, Geneva, Lausanne and Zurich during 2005 and 2006. We limited the sample to this age group in order to have a high enough prevalence of examined preventive indicators and eligibility for cancer screening. From the initial random sample of 1889 patients, we excluded patients whose medical charts could not be found (54), patients with emergency visits or nurse appointment only (125), those followed up in specialized clinics only (117) or for less than one year (591), because of a possible lack of adequate time to provide preventive care (Appendix Figure 1). For this study, we also excluded 12 patients known for CRC or colorectal polyps at the beginning of the review period, as the focus was to assess cancer screening in average risk patients and not to follow up. In addition, we excluded 50 patients with irregular residency status, as insurance coverage is not guaranteed for these patients. The final sample consisted of 940 abstracted medical charts. A similar sample size was used in previous studies on quality of care based on chart abstraction [17,18]. The Institutional Review Board approved the study protocol at each site.

Chart abstraction

Based on previous studies on factors associated with CRC screening [9,10,15], we examined the following indicators: patient demographic characteristics, including age, gender, civil status, birthplace and occupation; characteristics of the physician in charge (defined as the physician with whom the patient had the most visits over the review period), including gender, position, and number of visits. BMI was calculated as reported body-weight in kilograms divided by squared height in meters, or directly abstracted from the medical chart. As a surrogate to patient health status, we calculated the Charlson combined age-comorbidity index [19,20] from reported comorbid conditions and the patient's age. As this index only captures a limited list of conditions that have a potential impact on survival, we abstracted the number of prescribed medications over the two years review period.

As previously described [16], patient data were abstracted from medical charts by trained medical students using a questionnaire form similar to previous studies [17,18,21]. The questionnaire assessed the 33 selected indicators for chronic and preventive care derived from RAND's Quality Assessment Tool System [21], as well as other covariates (demographics, co-morbid conditions) based on the chart abstraction form from the Translating Research Into Action For Diabetes Study [22]. Performed CRC screening was defined as documented colonoscopy in the last 10 years, flexible sigmoidoscopy or double contrast barium enema in the last 5 years, or fecal occult blood testing in the last 2 years, based on the U.S. Preventive Services Task Force 2002 recommendation statement [23]. We considered any procedure or test regardless of their indication, as data on indications was not always available. We used the 2002 recommendation statement instead of the 2008 statement [2] to measure compliance with guidelines at the time of the review period (2005–2006). Patients who refused CRC screening (n=22) were grouped with those not screened, even though screening was offered by the physician, as this information might not be systematically documented in medical charts and therefore not adequately captured by chart. To measure physician-initiated care, we repeated the analysis categorizing these patients with the performed CRC screening group in a secondary analysis.

As chart abstraction might underestimate quality of care by 5% to 10% compared to clinical vignettes and standardized patients [24], inter-rater reliability was assessed by repeating the chart abstraction on a random sample of patients (n=45) to detect a significant kappa value [16,25]. For CRC screening, the kappa value was 0.85. Influenza immunization indicators were validated with an external administrative register at Lausanne, as previously reported [16]. For 230 patients, no BMI value could be abstracted or calculated from medical charts; we imputed these missing values by the Gaussian normal regression imputation method from known values of patient's age, gender, weight and height. We report median, lower and upper quartile of BMI before and after imputation, and proportion of imputed BMI values for each BMI category. We categorized age of the patients in three life decades, and categorized birthplace as Switzerland or foreign country, further divided into Western European and North American countries, defined as country in the child and adult mortality stratum A according to the Annex 1 of the WHO 2003 World Health Report [26], and outside of Western Europe and North America, mortality strata B – E. We dichotomized continuous variables without normal distribution, i.e. Charlson combined age-comorbidity index, the number of prescribed medications, and the number of visits to the physician in charge, according to the median, and report interquartile ranges (IQR).

Statistical analyses

We used descriptive statistics and bivariate analyses to characterize the sample, and performed multivariate logistical regression to analyze the predictors of adequate CRC screening. Results are reported as percentages with 95% binomial exact confidence intervals (CI). To account for clustering within each of the four University setting, we treated each site as a fixed effect. Multivariate logistic regression analysis was repeated in sensitivity analyses using measured BMI without imputation, and number of prescribed medications in addition to Charlson index.

We used Stata software (version 12.1, Stata Corp., College Station, Texas) for all statistical analyses.

Results

Patient description

Table 1 shows characteristics of the 940 included patients. Mean age was 63.9 years (standard deviation 8.8), and 402 patients (42.7%) were women. Median BMI was 27.9 (lower quartile: 24.9, upper quartile: 31.2) before imputation and 28.2 kg/m^2 (IQR 24.8 – 32.1) after imputation. Most of the care was delivered by residents (89.5% vs. 10.5% by senior residents or attending physicians) and 55.1% of patients were followed by female physicians. Annual influenza vaccination was delivered to 22.3% of patients, whereas 77.7% did not receive vaccination.

Colorectal cancer screening rates

Table 2 shows CRC screening rates and describes screening methods. Only 316 (33.6%) of patients eligible for CRC screening had adequate CRC screening. Refusal of CRC screening was documented in 22 patients (2.3%). Fifty six percent had a colonoscopy, 41.3% had FOBT alone or combined with endoscopy, and only 3.6% had flexible sigmoidoscopy alone. Double contrast barium enema was not used for any patient.

Results of bivariate and multivariate logistical regression analyses are reported in Table 3. In bivariate analyses, being overweight (BMI 25.0 to 29.9 kg/m^2) and obese (BMI $\geq$30.0 kg/m^2) were associated with lower CRC screening rates (OR 0.64, CI 0.46 – 0.90, and OR 0.61, CI 0.43 – 0.88, respectively; p for trend = 0.007). Male gender of the physician in charge (OR 0.70, CI 0.53 – 0.93) was also negatively associated with CRC screening. Place of birth in a country outside of Western Europe and North America was only borderline significant (OR 0.73, 95% CI 0.53 – 1.00).

In multivariate logistic regression analysis, being overweight (OR 0.66, CI 0.46 – 0.96) or obese (OR 0.61, CI 0.40 – 0.90), and male gender of the physician in charge (OR 0.67, 95% CI 0.50 –

0.91; p for trend = 0.011) remained significantly associated with lower screening rates, and place of birth outside of Western Europe and North America became significant (OR 0.65, 95% CI 0.45 – 0.97).

The proportion of imputed BMI values was considerably higher in normal and overweight than in obese patients (23% and 34% vs. 13% respectively). A sensitivity analysis using measured BMI without imputation confirmed the association of CRC screening with obesity (OR 0.63, 95% CI 0.51 – 0.99) and birthplace in a country outside of Western Europe and North America, but not with overweight and physician gender. Including the total number of medications in addition to Charlson combined age-comorbidity index did not significantly change the results. In a secondary analysis considering CRC screening proposed by the physician rather than performed screening, being overweight and obese (OR 0.65, 95% CI 0.45 – 0.93 and OR 0.62, 95% CI 0.42 – 0.91), and male gender of the physician in charge (OR 0.67, 95% CI 0.50 – 0.91) were associated with CRC screening, but not with place of birth in a country outside of Western Europe and North America.

Discussion

We found that only about one in three patients followed up in Swiss University primary care settings were screened for CRC. This relatively low CRC screening rate is comparable to those reported in some underserved populations in the U.S. [27]. We found three characteristics to be associated with lower CRC screening rates: being overweight or obese, male gender of the physician in charge, and being born in a country outside of Western Europe and North America. None of the other measured socio-demographic factors (patient gender, occupation, civil status), nor patient health status estimated by the Charlson combined age-comorbidity index reached statistical significance.

As previously hypothesized [16], the absence of a population-based CRC screening program, or the lack of systematic performance monitoring in Switzerland, might explain these low CRC screening rates. This hypothesis is also supported by findings of a Canadian study, where higher CRC screening rates were found in regions with recent implementation of a CRC screening program [11]. Also, influenza vaccination has been shown to be associated with higher CRC screening rates [9,11], but was not significant in our study, possibly due to the small sample size.

The negative association between BMI and CRC screening has been reported in previous studies [28], but a recent review article by Fagan *et al.* showed a mixed pattern of association between weight status and CRC screening without a clear trend towards a positive or negative association throughout the literature [13]. The authors hypothesized that factors associated with CRC screening might differ according to race and gender of the studied population. Overweight persons might be less health conscious and therefore less demanding of health care. However, previous studies have shown that lack of recommendation by the physician is the most frequent reason to skip CRC screening, instead of patients not asking or refusing it [10]. Also, physicians might have been less likely to recommend CRC screening to overweight and obese patients, either because they think that these patients would not want screening or because of higher priority on other medical conditions. However, in the latter case, one would expect the same to be true for patients with higher Charlson combined age-comorbidity index. This potential stigmatization of overweight and obese patients by their physicians has been documented [29,30].

Female gender of the physician in charge has been associated with higher rates of screening mammographies and cervical smears [31]. However, physician gender was not associated with CRC screening in previous studies [15]. Female physicians might be more sensitized to cancer prevention through their participation as patients in regional, population-based breast cancer screening programs in Switzerland, and well-implemented screening for cervical cancer, whereas no such program exists for cancer in men.

Our finding that CRC screening is associated with birthplace outside of Western Europe and North America is consistent with previous studies that found ethnicity to be associated with CRC screening [9–12]. These studies also found other socio-demographic factors such as gender and educational level, to be predictors of CRC screening that did not reach statistical significance in our results. This might be due to the relatively small sample size. A recent review by Naylor *et al.* suggests that patient education and physician training in communication with patients of low health literacy are paths for improving adherence to CRC screening in ethnic minorities [32].

Our study has several limitations. A first limitation was the potential underreporting in medical charts of data such as patient refusal of screening. Process-based quality scores using abstraction of medical charts have been found to underestimate the quality of care compared to clinical vignettes and standardized patients by 5% and 10%, respectively [24]. Second, we considered any initial sigmoidoscopy in the last 5 years or colonoscopy in the last 10 years as CRC screening, because of lack of complete data on the indication, and excluded follow-up colonoscopies for CRC or adenomatous polyps only. We therefore cannot exclude that some of these endoscopic procedures were conducted for symptomatic indications, such as rectal bleeding. Third, our results rely on imputed BMI and sensitivity analysis confirmed the association between CRC screening and obesity only, but not for overweight and physician gender. This might be due to loss of power in the statistical model (n=688) and potential underreporting of BMI in normal weight and overweight, but not for obese patients. Fourth, our sample in University primary care settings might not be representative of the general Swiss population. In fact, our sample had a high proportion of patients with migratory background (51%) and men (57%), and a higher prevalence of obesity than in the general Swiss population (32% in our sample vs. 13% in the general Swiss population aged 55-74 years) [33]. Our model was adjusted for these characteristics. Fifth, most of the care was delivered by residents in postgraduate training. Similar to our study, a previous report on CRC screening showed no difference in screening rates between physicians with or without completed postgraduate training [15], but we did not find studies directly comparing screening rates between community-based PCPs and University-based residents within a health care system with universal coverage. Sixth, it was not possible to measure patient and physician knowledge and beliefs regarding CRC and CRC screening, as this study was based on a retrospective review of medical charts. Seventh, due to the relatively small sample size, the absence of statistical significance has to be interpreted with caution, as the study might not have enough power to detect associations in subgroups.

These results may be important for clinical practice, as obesity has been suggested as a risk factor for colorectal cancer [34,35]. Physician perception of obesity and its impact on their recommendation for CRC screening might be a target for further research. A population-based CRC screening program and a systematic performance monitoring might help improve the rate of CRC screening.

Acknowledgements

Research funding for the collection and analysis of these data was provided by an investigator-initiated unrestricted grant from Pfizer (Switzerland). Preliminary results were presented at the Society of General Internal Medicine 34th Annual Meeting in Phoenix, AZ, USA, and at the Swiss Society of General Internal Medicine 79th Annual Conference in Lausanne, Switzerland, under the title of “Obesity and overweight are negative predictors of colorectal cancer screening in a health care system combining fee for service and universal coverage”.

References

[1] Heresbach D, Manfredi S, D'Halluin PN, Bretagne JF, Branger B. Review in depth and meta-analysis of controlled trials on colorectal cancer screening by faecal occult blood test. *Eur J Gastroenterol Hepatol* 2006;**18**:427–433.

[2] U.S. Preventive Services Task Force. Screening for Colorectal Cancer: U.S. Preventive Services Task Force Recommendation Statement. *Ann Intern Med* 2008;**149**:638–677.

[3] Arditi C, Peytremann-Bridevaux J, Burnand B, Eckardt VF, Bytzer P, Agréus L, et al. (2009) Appropriateness of colonoscopy in Europe (EPAGE II). Screening for colorectal cancer. *Endoscopy*;**41**:200–208.

[4] Pignone M, Saha S, Hoerger T, Mandelblatt J. Cost-Effectiveness Analyses of Colorectal Cancer Screening: A Systematic Review for the U.S. Preventive Services Task Force. *Ann Intern Med* 2002;**137**:96–104.

[5] Sekiguchi M, Matsuda T, Tamai N, Sakamoto T, Nakajima T, Otake Y, et al. (2012). Cost-effectiveness of total colonoscopy in screening of colorectal cancer in Japan. *Gastroenterol Res Pract* 2012;2012:728454 [epub ahead of print].

[6] American Cancer Society. *Colorectal Cancer Facts & Figures 2011-2013.* Atlanta: American Cancer Society, 2011.

[7] Fagan HB, Myers RE, Daskalakis C, Sifri R, Mainous AG, Wender R. Race/Ethnicity, gender, weight status, and colorectal cancer screening. *J Obes* 2011;**2011**:314619.

[8] Pox C, Schmiegel W, Classen M. Current status of screening colonoscopy in Europe and in the United States. *Endoscopy* 2007;**39**:168–173.

[9] Zimmermann RK, Nowalk MP, Tabbarah M, Grufferman S. Predictors of colorectal cancer screening in diverse primary care practices. *BMC Health Serv Res* 2006;**6**:116.

[10] Wee CC, McCarthy EP, Phillips RS. Factors associated with colon cancer screening: the role of patient factors and physician counseling. *Prev Med* 2005;**41**:23–29.

[11] Sewitch MJ, Fournier C, Ciampi A, Dyachenko A. Adherence to colorectal cancer screening guidelines in Canada. *BMC Gastroenterol* 2007;**7**:39.

[12] Phillips KL, Smith ML, Ahn S, Ory MG, Hochhalter AK. Correlates of Initiating Colorectal Cancer Screening Beginning at Age 50*. J Community Health* 2012 [epub ahead of print]

[13] Fagan HB, Wender R, Myers RE, Petrelli N. Obesity and Cancer Screening according to Race and Gender. *J Obes* 2011;**2011**:218250.

[14] García M, Borràs JM, Milà N, Espinàs J a, Binefa G, Fernández E, et al. (2011). Factors associated with initial participation in a population-based screening for colorectal cancer in Catalonia, Spain: a mixed-methods study. *Prev Med* **52**:265–267.

[15] Wong MC, Lam AT, Li DK, Lau DK, Griffiths SM, Sung JJ. Factors associated with practice of colorectal cancer screening among primary care phyicians in a Chinese polpulation: A cross-sectional study. *Cancer Epidemiol* 2009;**33**:201–206.

[16] Collet TH, Salamin S, Zimmerli L, Kerr EA, Clair C, Picard-Kossovsky M, et al. (2011). The Quality of Primary Care in a Country with Universal Health Care Coverage. J Gen Intern Med **26**:724–730.

[17] Kerr EA, Smith DM, Hogan MM, Hofer TP, Krein SL, Bermann M, et al. (2003). Building a better quality measure: are some patients with "poor quality" actually getting good care? *Med Care* **41**:1173–1182.

[18] Asch SM, McGlynn EA, Hogan MM, Hayward RA, Shekelle P, Rubenstein L, et al. (2004). Comparison of quality of care for patients in the Veterans Health Administration and patients in a national sample. *Ann Intern Med* **141**:938–945.

[19] Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a Combined Comorbidity Index. *J Clin Epidemiol* 1994;**47**:1245–1251.

[20] De Groot V, Beckermann H, Lankhorst GJ, Bouter LM. How to measure comorbidity: a critical review of available methods. *J Clin Epidemiol* 2003;**56**:221–229.

[21] McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, et al. (2003). The Quality of Health Care Delivered to Adults in the United States. *N Engl J Med* **348**:2635–2645.

[22] Kerr EA, Gerzoff RB, Krein SL, Selby JV, Piette JD, Curb JD, et al. (2004). Diabetes Care Quality in the Veterans Affairs Health Care System and Commercial Managed Care: The TRIAD Study. *Ann Intern Med* **141**:272–281.

[23] U.S. Preventive Services Task Force. Screening for colorectal cancer: recommendation and rationale. *Ann Intern Med* 2002;**137**:129–131.

[24] Peabody JW, Luck J, Glassman P, Dresselhaus TR, Lee M. Comparison of vignettes, standardized patients, and chart abstraction: a prospective validation study of 3 methods for measuring quality. *JAMA* 2000;**283**:1715–1722.

[25] Sim J, Wright CC. The kappa statistic in reliability studies: use, interpretation, and sample size requirements. *Phys Ther* 2005;**85**:257–268.

[26] World Health Organization (2003). List of Member States by WHO region and mortality stratum. In: World Health Organization. *The World health report: 2003: shaping the future*. Geneva: World Health Organization, pp.182-183

[27] Doubeni CA, Jambaulikar GD, Fouayzi H, Robinson SB, Gunter MJ, Field TS, et al. (2012). Neighborhood socioeconomic status and use of colonoscopy in an insured population--a retrospective cohort study. *PloS one* 2012, **7**:e36392.

[28] Ferrante JM, Ohman-Strickland P, Hudson SV, Hahn K a, Scott JG, Crabtree BF. Colorectal cancer screening among obese versus non-obese patients in primary care practices. *Cancer Detect Prev* 2006;**30**:459–465.

[29] Sikorski C, Luppa M, Kaiser M, Glaesmer H, Schomerus G, König H-H, et al. (2011). The stigma of obesity in the general public and its implications for public health-a systematic review. *BMC Public Health* **11**:661.

[30] Wee CC, McCarthy EP, Davis RB, Phillips RS. Screening for cervical and breast cancer: is obesity an unrecognized barrier to preventive care? *Ann Intern Med* 2000;**132**:697–704.

[31] Lurie N, Slater J, McGovern P, Ekstrum J, Quam L, Margolis K. Preventive care for women. Does the sex of the physician matter? *N Engl J Med* 1993;**329**:478–482.

[32] Naylor K, Ward J, Polite BN. Interventions to improve care related to colorectal cancer among racial and ethnic minorities: a systematic review. *J Gen Intern Med* 2012;**27**:1033–1046.

[33] Schneider H, Venetz W, Berardo Gallani C. *Overweight and obesity in Switzerland; Part 1: Cost burden of adult obesity in 2007.* Basel: Swiss Federal Office of Public Health, 2009.

[34] Gunter MJ, Leitzmann MF. Obesity and colorectal cancer: epidemiology, mechanisms and candidate genes. *J Nutr Biochem* 2006;**17**:145–156.

[35] Liu Z, Brooks RS, Ciappio ED, Kim SJ, Crott JW, Bennett G, et al. (2012). Diet-induced obesity elevates colonic TNF-α in mice and is accompanied by an activation of Wnt signaling: a mechanism for obesity-associated colorectal cancer. *J Nutr Biochem* **23**:1207-1213.

Tables

Table 1: Patient characteristics			N=940
Age (years, n, %)			
50 – 59 years		345	36.7%
60 – 69 years		359	38.2%
70 – 80 years		236	25.1%
Gender (n, %)			
female		402	42.7%
Civil Status (N=931, n, %)			
married		490	52.6%
divorced or separated		214	23.0%
single		133	14.3%
widowed		94	10.1%
Birth place (N=930, n, %)			
Switzerland		453	48.7%
Other country, within Western Europe and North America*		194	20.9%
Other country, outside of Western Europe and North America*		283	30.4%
Occupation (N=921, n, %)			
employed		251	27.3%
retired		364	39.5%
freelance, at home, or in education		112	12.2%
social aid		109	11.8%
unemployed		85	9.2%
Body mass index† (n, %)			
<18.5 kg/m^2		14	1.5%
18.5 – 24.9 kg/m^2		230	24.5%
25.0 – 29.9 kg/m^2		391	42.6%
≥30.0 kg/m^2		305	32.4%
Charlson combined age-comorbidity index			
median, interquartile range		3	2 - 5
Number of prescribed medications			
median, interquartile range		4	2 - 6
Physician in charge‡			
position (N=931, n, %)	resident	833	89.5%
	senior resident	78	8.4%
	attending / faculty	20	2.1%
gender (N=939, n, %)	female	517	55.1%
number of visits (median, interquartile range)		6	4-9
Annual Influenza vaccination (n, %)			
done		210	22.3%
not done		730	77.7%

* Defined as countries in the child and adult mortality stratum A based on World Health Organization (WHO) mortality estimates [26].

† Two hundred and thirty missing values were imputed from patient age, gender, height and weight. The median body mass index (BMI) was 28.2 kg/m^2 (interquartile range 24.8 – 32.1) before imputation and 27.9 kg/m^2 (interquartile range 24.9 – 31.3) after imputation.

‡ Physician in charge is defined as the physician the patient had the most visits to.

Table 2: Colo-Rectal Cancer (CRC) screening

		N=940
CRC screening (n, %)		
not done *	624	66.4%
done	316	33.6%
Screening method (N=315, n, %)		
fecal occult blood test	130	41.3%
colonoscopy†	173	54.9%
flexible sigmoidoscopy‡	12	3.8%
double contrast barium enema	0	0%

* Including 22 (2%) patients who had refused CRC screening.

† In 47 patients with FOBT or sigmoidoscopy and subsequent colonoscopy, the latter was considered follow-up, not screening.

‡ Nine patients screened with FOBT and sigmoidoscopy grouped with FOBT.

Table 3: Factors associated with colorectal cancer screening

	Bivariate OR (95% CI)		Multivariable adjusted OR§ (95% CI)	
Age				
50 – 59 years	1 (ref.)		1 (ref.)	
60 – 69 years	1.45	(1.06 – 1.99)	1.29	(0.87 – 1.88)
70 – 80 years	1.18	(0.82 – 1.68)	0.90	(0.55 – 1.57)
Gender				
female	1 (ref.)		1 (ref.)	
male	1.04	(0.79 – 1.37)	1.01	(0.72 – 1.41)
Civil status				
married	1 (ref.)		1 (ref.)	
divorced or separated	1.02	(0.73 – 1.44)	0.94	(0.66 – 1.37)
widowed	1.34	(0.85 – 2.11)	1.19	(0.72 – 1.95)
single	1.05	(0.70 – 1.58)	0.94	(0.60 – 1.47)
Birth place				
Switzerland	1 (ref.)		1 (ref.)	
Other country, within Western Europe and North America*	1.02	(0.72 – 1.46)	1.02	(0.70 – 1.49)
Other country, outside of Western Europe and North America*	0.73	(0.53 – 1.00)	0.65	(0.45 – 0.97)
Occupation				
employed	1 (ref.)		1 (ref.)	
retired	1.28	(0.91 – 1.79)	1.32	(0.83 – 2.09)
freelance, at home or in education	0.78	(0.48 – 1.28)	1.00	(0.55 – 1.81)
social aid	1.10	(0.68 – 1.77)	1.10	(0.65 – 1.86)
unemployed	1.11	(0.66 – 1.86)	1.13	(0.62 – 2.06)
Body mass index[b]				
<18.5 kg/m^2	0.56	(0.17 – 1.83)	0.32	(0.09 – 1.17)
18.5 – 24.9 kg/m^2	1 (ref.)		1 (ref.)	
25 – 29.9 kg/m^2	0.64	(0.46 – 0.90)	0.66	(0.46 – 0.96)
≥30 kg/m^2	0.61	(0.43 – 0.88)	0.61	(0.40 – 0.90)
Charlson combined age-comorbidity index				
≤ 3 points	1 (ref.)		1 (ref.)	
> 3 points	0.85	(0.65 – 1.11)	0.80	(0.58 – 1.11)
Physician in charge‡				
position resident	1 (ref.)		1 (ref.)	
senior resident	1.05	(0.65 – 1.71)	1.25	(0.74 – 2.11)
attending /faculty	1.32	(0.53 – 3.28)	1.33	(0.50 – 3.57)
gender female	1 (ref.)		1 (ref.)	
male	0.70	(0.53 – 0.93)	0.67	(0.50 – 0.91)
≤ 6 visits during 2 years follow-up	1 (ref.)			
> 6 visits during 2 years follow-up	1.18	(0.90 – 1.55)	1.15	(0.86 – 1.55)
Annual Influenza vaccination				
done	1 (ref.)		1 (ref.)	
not done	0.74	(0.4 – 1.01)	0.84	(0.58 – 1.20)

* Defined as countries in the child and adult mortality stratum A based on World Health Organization (WHO) mortality estimates [26].

† Two hundred and thirty missing values were imputed from patient age, gender, height and weight.

‡ Physician in charge is defined as the physician the patient had the most visits to.

§ Adjusted for age, gender, civil status, occupation, birth place, BMI, Charlson combined age-comorbidity index, annual influenza vaccination, number of visits to the physician in charge, and function, gender and age of the physician in charge, using a multilevel generalized linear model and treating each site as a random effect. N=897 due to missing values.

Appendix

Appendix Figure 1: Flowchart from the electronic administrative data to the final sample