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# **Colorectal cancer screening practices among cancer survivors five years after diagnosis**

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1 **Background:** Colorectal cancer (CRC) has a high incidence worldwide, especially in high-  
2 income countries. In France, a national CRC screening program targeting residents aged 50-  
3 74 has been in place since 2009. Little is known about CRC screening practices in cancer  
4 survivors, even though some have an increased risk of developing a second cancer in the  
5 colorectum. This study aims to identify the barriers to CRC screening among cancer  
6 survivors.

7  
8 **Methods:** This cross-sectional study based on the French national VICAN survey included  
9 individuals diagnosed in 2010 with a cancer in one of 11 locations other than colorectum and  
10 interviewed five years after diagnosis about various health-related issues. Binary logistic  
11 regression was used to identify the factors associated with lack of up-to-date CRC screening  
12 in cancer survivors without cancer progression.

13  
14 **Results:** Of the 2,935 cancer survivors included in the study, 35.3% reported undergoing a  
15 screening test in the previous two years. The rate of up-to-date CRC screening rose to 49.3%  
16 in survivors aged 51-75. Among these, lack of CRC screening in the recommended timeframe  
17 was associated with obesity, current smoking, non-use of complementary medicine, perceived  
18 financial difficulties, and poor access to general practitioners.

19  
20 **Conclusions:** Barriers to CRC screening can be personal and/or institutional.

21  
22 **Keywords:** Screening, colorectal cancer, second cancer, cancer survivors.

23 **Introduction**

24

25 Colorectal cancer (CRC) has a high incidence worldwide, especially in high-income regions,  
26 which accounted for almost 55.0% of the world's CRC cases in 2012 (International Agency  
27 for Research on Cancer 2018; Ferlay 2015). In men, CRC has the third highest incidence of  
28 any cancer site, after prostate and lung cancer, and represents 10.9% of new cancer cases. In  
29 women, it has the second highest incidence of any cancer site, after breast cancer, and  
30 accounts for 9.5% of new cancer cases. CRC is the second cause of death by cancer for both  
31 sexes and all ages (9.2% of cancer deaths in 2018).(International Agency for Research on  
32 Cancer 2018)

33

34 The same tendencies have been observed in metropolitan France. In 2017, CRC represented  
35 11.2% of new cancer cases for both women and men, and CRC was the second cause of death  
36 by cancer (around 12.0% of all deaths by cancer).(Institut National Du Cancer 2018)

37

38 In the past decades, CRC population screening programs have been implemented around the  
39 world.(Navarro 2017) In France, a national CRC screening program targeting residents aged  
40 50-74 has been in place since 2009. This program, which is managed by local institutions  
41 based on national guidelines, targeted 16.8 million people in 2016-2017.(Institut National Du  
42 Cancer 2016, 2018) Every two years, targeted men and women are invited by a letter to  
43 undergo a fecal occult blood test (FOBT), followed by a colonoscopy in case of positive  
44 result. Their regular doctor then delivers the CRC screening kit. The FOBT is performed at  
45 home, and mailed free of charge to the laboratory. No specific recommendations on cancer  
46 screening have been formulated for cancer survivors in France.(Institut National Du Cancer  
47 2013)

48

49 In 2016-2017, the rate of participation in the French national CRC screening program was  
50 estimated at 33.5%.(Institut National Du Cancer 2018) This rate is lower than the EU's  
51 minimum and desired targets, set at 45% and 65%, respectively.(European Commission 2010)  
52 According to a review published in 2017, France is the European country with the third-  
53 lowest participation rate (34.3%), far below the highest participation rate recorded in the  
54 Netherlands (68.2%).(Navarro 2017) In some studies, participation in the French national  
55 CRC screening program is slightly higher in women and increases with age.(Institut National  
56 Du Cancer 2018; Santé Publique France 2018) In other studies, French residents who do not

57 undergo CRC screening most often live alone, have no complementary health scheme, or have  
58 given up care for financial reasons.(Institut National Du Cancer 2016; Goulard 2009; Fon  
59 Sing 2013) Regular doctors have also been found to play a key role in promoting CRC  
60 screening. Among women, participation in the French national CRC screening program has  
61 been shown to be higher in those who had previously undergone breast cancer and/or cervical  
62 cancer screening. Among men, smoking has been found to be a barrier to participation. A  
63 systematic review published in 2016 identified similar barriers to CRC screening, but found  
64 that women are less likely to undergo CRC screening.(Wools 2016)

65

66 Three million individuals are living with a cancer diagnosis in France today. The risk of  
67 developing a second cancer in survivors is higher by 36.0% on average than the risk of  
68 developing cancer in the general population.(Institut National Du Cancer 2015) A large  
69 number of cancer survivors aged 50-74 are at risk of developing a second cancer in the  
70 colorectum. In this context, it is essential that CRC prevention and screening be promoted as  
71 part of the cancer survivor's follow-up.

72

73 The risk of developing a second cancer varies depending on the site of the first cancer.(Institut  
74 National Du Cancer 2013, 2015; Curtis 2006) According to a SEER-based study, the excess  
75 absolute risk (EAR) of the second cancer being colorectal is higher in survivors of upper  
76 aerodigestive tract, lung, uterine, or non-Hodgkin lymphoma cancer; by contrast, survivors of  
77 prostate or melanoma cancer do not seem to be at risk of developing a second cancer in the  
78 colorectum.(Curtis 2006) Other studies have found that the EAR of the second cancer being  
79 colorectal is higher in male survivors of upper aerodigestive tract, esophagus, laryngeal, or  
80 lung cancer, but also in male survivors of prostate cancer; in addition, they have found that  
81 the EAR of the second cancer being colorectal is higher in female survivors with cervical  
82 cancer.(Institut National Du Cancer 2013, 2015) The increased risk of developing a second  
83 cancer in the colorectum may be due to shared risk factors, but also to the impact on non-  
84 cancerous cells of cancer treatments like radiation therapy.(Baxter 2005)

85

86 Despite the fact that cancer survivors have an increased risk of developing a second cancer in  
87 the colorectum, studies are lacking on CRC screening practices among cancer survivors. The  
88 few studies available on the topic describe cancer screening rates in cancer survivors, and/or  
89 assess the health beliefs that shape screening practices.(Corkum 2013; Mayer 2007; Trask  
90 2005; Shin 2011; Yang 2014) Generally, these studies do not specifically focus on CRC

91 screening, but are also concerned with breast, cervical, and prostate cancer screening. To our  
92 knowledge, no study has been conducted on CRC screening practices using a large  
93 representative sample of cancer survivors and covering a wide range of tumor sites. Our study  
94 aims to estimate the rate of up-to-date CRC screening among cancer survivors five years after  
95 diagnosis, and to identify the personal and institutional barriers to CRC screening in these  
96 survivors.

97 **Methods**

98

99 **The French national VICAN survey**

100 This cross-sectional study was based on the French national VICAN survey. In this national  
101 representative study, cancer survivors diagnosed in 2010 were followed up for a period of five  
102 years to assess their life conditions.)

103 Data were obtained from different sources:

- 104 - Patient interviews performed two and five years after diagnosis (2012/2015) to gather  
105 information on various health issues, including health condition, preventive health  
106 behaviors, etc.;
- 107 - The French national medico-administrative database (SNIIRAM), which records all  
108 care consumption data (generated inside and outside healthcare centers).

109 The VICAN survey focused on 12 types of cancer (breast, lung, colorectal, prostate, upper  
110 aerodigestive tract, bladder, kidney, thyroid, non-Hodgkin lymphoma, melanoma, cervical,  
111 and endometrial) accounting for the 4,174 cancer survivors who responded to the 5-year  
112 interview. Cancer survivors aged under 18 at diagnosis were excluded from the survey for  
113 legal reasons, and those aged over 82 at diagnosis were excluded because high attrition was  
114 expected. All participants provided written informed consent before participation. National  
115 ethics commissions approved the methodology of the VICAN survey.

116 Of the 13,046 cancer survivors invited to participate in the 5-year interview, 4,174 were  
117 finally included (32.0% crude response rate).

118 A weighting procedure was applied in order to ensure national representativeness in terms of  
119 gender, age, national insurance scheme, socioeconomic hardship, tumor site, and cancer  
120 progression since diagnosis. Cancer progression since diagnosis took into account the  
121 following criteria: metastasis (more than 12 months after cancer diagnosis) or second cancer,  
122 admission to a palliative care unit or treatment with chemotherapy, radiotherapy or targeted  
123 therapy (at least 24 months after cancer diagnosis) and death.(Bouhnik 2015)

124

125 **Self-reported CRC screening practices**

126 In the interview conducted five years after diagnosis, participants were asked the following  
127 question: “*Have you ever undergone a FOBT or a colonoscopy?*” The possible answers were:  
128 “*Yes, less than two years ago/Yes, more than two years ago/No, never.*” The two modalities  
129 (“*Yes, more than two years ago*” and “*No, never*”) were used to identify survivors who had

130 not undergone CRC screening in the recommended timeframe (two years). These survivors  
131 were defined as not up-to-date with CRC screening.

132

### 133 **Sample selection**

134 Three categories of survivors were excluded from the statistical analyses (Figure 1): 1)  
135 survivors of colorectal cancer, because they already received colonoscopies as part of their  
136 regular follow-up; 2) individuals with cancer progression since diagnosis (cancer metastasis,  
137 second cancer, chemotherapy/radiotherapy administered more than two years after cancer  
138 diagnosis, palliative care), in order to obtain a homogeneous population of survivors who  
139 might benefit from CRC screening; and 3) individuals with missing data (<0.5%) related to  
140 the main variable of the study. Three age groups were defined based on the age recommended  
141 by national guidelines for CRC screening (i.e., 50-74 in the general population). The limits of  
142 the age group targeted for CRC screening were moved upwards by one year to ensure that  
143 included patients had enough time to undergo screening. The resulting age groups were:  
144 26-50, 51-75, and 76-87.

145

### 146 **Statistical analyses**

147 Sensitivity analysis was used to address a potential bias related to the choice of the limits of  
148 the age groups. Univariate statistical analyses were performed using  $\chi^2$  tests for categorical  
149 variables and using Student's t-tests for continuous variables.

150 Then, for each age group, binary logistic regression models stratified by sex were used to  
151 identify factors independently associated with lack of up-to-date CRC screening. A backward  
152 stepwise process was used to select statistically significant factors in a multivariate model  
153 (probability threshold for inclusion in the model p-value=20%). Only variables remaining  
154 significantly associated with the outcome with a p-value $\leq$ 5% were kept in the final model.  
155 First order interactions were systematically checked. An all available cases analysis method  
156 was applied to handle rare missing values. Another sensitivity analysis was performed to  
157 assess the robustness of the factors associated with no CRC screening, by considering "no  
158 CRC screening during lifetime" as outcome, instead of "in the past 2 years". Results of  
159 sensitivity analyses are provided as Online supplementary tables.

160 All statistical tests were done using the STATA 12.0 software.

161

### 162 **Results**

163



164 The sample of 2,935 individuals aged 26-87 (weighted mean age at the time of the  
165 survey=59.4, SD=12.8) was mainly composed of female survivors and survivors aged 51-75  
166 (Online Supplementary Table 1). Most of the survivors aged over 51 had not completed high  
167 school and were retired at the time of the survey (Online Supplementary Table 1).

168

169 Five years after diagnosis, 35.3% of respondents (32.4% of women and 41.0% of men)  
170 reported undergoing a colonoscopy or a FOBT in the previous two years. The rate of up-to-  
171 date CRC screening was higher in the 51-75 age group (Figure 1). This rate was higher in  
172 men than in women ( $p<0.001$ ) for the pooled age groups; however, gender difference did not  
173 reach statistical significance for the age groups taken separately (Figure 1). CRC screening  
174 practices varied according to tumor site (Figure 2), but this variation did not reach statistical  
175 significance in the 51-75 age group after adjustment for age.

176

177 For cancer survivors eligible to participate in the national CRC screening program, the rate of  
178 up-to-date CRC screening was 49.3% [95%CI 46.5% to 52.1%]. A sensitivity analysis found  
179 a similar rate for survivors aged 50-74 (47.8%;  $n=1,762$ ) and for survivors aged 51-74  
180 (47.8%;  $n=1,658$ ).

181

### 182 **Factors associated with lack of up-to-date CRC screening five years after diagnosis**

183 In univariate analyses, different sociodemographic, economic, medical, and behavioral  
184 variables were associated with lack of up-to-date CRC screening in survivors aged 51-75  
185 (Table 1). The survivors more likely to report not being up-to-date with CRC screening were  
186 younger ( $p=0.016$ ), lived alone ( $p=0.019$ ), had perceived financial difficulties ( $p=<0.001$ ),  
187 had poor access to GPs ( $p=0.004$ ), were currently smoking ( $p=<0.001$ ), and/or did not use  
188 complementary medicine ( $p=0.050$ ). Socio-professional category and BMI were borderline  
189 significant.

190

191 The multivariate analysis (Table 2) confirmed that lack of up-to-date screening was  
192 significantly associated with perceived financial difficulties ( $p=0.004$ ) (only in women, at  
193 least “Tight/I have to be careful”: AOR (Adjusted Odd Ratio)=1.41 [95%CI 1.02 to 1.96]),  
194 poor access to GPs ( $p=0.010$ ) (only in men: AOR=1.61 [95%CI 1.06 to 2.46]), non-use of  
195 complementary medicine ( $p=0.026$ ) (only in women: AOR=1.54 [95%CI 1.10 to 2.14]),  
196 obesity ( $p=0.039$ ), and current smoking ( $p=<0.001$ ). It also tended to be associated with

197 young age. However, it was no longer significantly associated with living alone. None first  
198 interactions was significant.

199

200 The same multivariate model was applied to the other two age groups (26-50 and 76-87)  
201 (Online Supplementary Table 2, Online Supplementary Table 3). In both cases, age at the  
202 time of the survey was statistically significant. In the 26-50 group, lack of up-to-date  
203 screening decreased as age increased ( $p=0.038$ ), whereas in the 76-87 age group it increased  
204 as age increased ( $p=0.019$ ). Perceived financial difficulties were associated with a higher lack  
205 of up-to-date screening in women from the 51-75 age group, but with a lower lack of up-to-  
206 date screening in men younger than 51 (AOR=0.07 [95%CI 0.01 to 0.45]). Non-use of  
207 complementary medicine was only associated with lack of up-to-date CRC screening in  
208 younger women (AOR=2.11 [95%CI 1.19 to 3.75]).

209

210

## 211 **Discussion**

212

### 213 **Main finding of this study**

214 Five years after cancer diagnosis, and regardless of age, 35.3% of study participants reported  
215 undergoing a colonoscopy or a FOBT in the previous two years. In cancer survivors aged 51-  
216 75, this rate increased to 49.3%. This finding was expected, as individuals in this age group  
217 are automatically invited to participate in the French national CRC screening program. The  
218 49.3% rate of up-to-date CRC screening observed in survivors aged 51-75 was higher than the  
219 EU's minimum target set at 45%.(European Commission 2010) However, it was far below the  
220 EU's desired target (>65%).(European Commission 2010)

221

222 A high rate of up-to-date CRC screening was observed in prostate cancer survivors ( $n=377$ ).  
223 Conversely, half or less of the survivors of cervical, upper aerodigestive tract, breast, or lung  
224 cancer in our study reported undergoing CRC screening in the previous two years, even  
225 though they have an increased risk of developing a second cancer in the colorectum.(Institut  
226 National Du Cancer 2015; Curtis 2006; Institut National Du Cancer 2013)

227

228 We identified several personal barriers to CRC screening. An association was found between  
229 a BMI of 30 or greater and lack of up-to-date CRC screening. Survivors with perceived  
230 financial difficulties were less likely to report up-to-date CRC screening. Individuals who

231 continued smoking after receiving a cancer diagnosis were less likely to undergo CRC  
232 screening, despite an increased risk of developing a second cancer in the colorectum.  
233 Conversely, survivors who used complementary medicine had a higher rate of up-to-date  
234 CRC screening.

235 Institutional barriers to CRC screening were also identified. Poor access to GPs was  
236 associated with a lower rate of up-to-date CRC screening in male survivors.

237

### 238 **What is already known on this topic**

239 As expected, the rate of up-to-date CRC screening was lower in younger cancer survivors.

240 This is consistent with published studies, which found that young cancer survivors feel less  
241 concerned with the risk of developing a second cancer and are generally unaware of the  
242 importance of CRC screening.(Goulard 2009; Mayer 2007) This finding may be partly  
243 explained by the lack of national guidelines on screening for cancer survivors. Similarly, the  
244 rate of up-to-date CRC screening was lower in cancer survivors aged over 75. This is  
245 unsurprising, since for older cancer survivors the benefits of CRC screening have not been  
246 demonstrated. In fact, some authors recommend shared decision-making regarding CRC  
247 screening in this particular age group.(Gangarosa 2011)

248

249 Personal and institutional barriers to CRC screening identified in our study was consistent  
250 with the associations revealed in previous studies.

251 Obesity is sometimes accompanied by physiological sequela and non-healthy behaviors.

252 Obese survivors are known to avoid CRC screening due to feelings of low self-esteem, body  
253 image disorder, or embarrassment—though it should be noted that the association between  
254 BMI and CRC screening practices has been found to be inconsistent in the general  
255 population.(Seibert 2017; Maruthur 2012)

256 The association between smoking and poor cancer screening practices has been observed in  
257 the general population.(Fon Sing 2013; Wools 2016)

258 Unlike at-risk behaviors like smoking, healthy lifestyles are usually associated with proper  
259 cancer screening practices. This is consistent with published studies, which found that CRC  
260 patients who report using complementary medicines do so mainly to improve their general  
261 health and well-being.(Sewitch 2010)

262 Studies have shown that financial insecurity causes individuals to give up care and cancer  
263 screening, even in the French context where screening tests and additional medical exams are  
264 free of charge.(Goulard 2009) In fact, it may be that other costs associated with CRC

265 screening play a role in patients' decision not to undergo FOBT and/or colonoscopy.(Hoover  
266 2017)

267 Studies found lower rates of participation in screening programs among individuals with poor  
268 access to healthcare providers.(Wools 2016)

269

### 270 **What this study adds**

271 To our knowledge, this is the first study to investigate CRC screening practices in cancer  
272 survivors using a large national representative sample and covering 11 tumor sites. Our study  
273 took advantage of the wide range of sociodemographic, economic, medical, and behavioral  
274 data generated by the VICAN survey.

275

276 Several personal and institutional barriers to CRC screening were identified, which may be  
277 targeted in future recommendations for improving CRC screening in cancer survivors.

278 Our findings suggest that age thresholds for CRC screening should be adapted in function of  
279 the site of the first cancer, whenever this site is associated with an increased risk of  
280 developing CRC.

281 The lack of national guidelines on screening for cancer survivors is problematic given that a  
282 first cancer diagnosis increases the risk of developing a second cancer in most tumor sites  
283 (including the colorectum), particularly in individuals approaching the age of 50. Indeed,  
284 younger cancer survivors should be given information on the importance of developing  
285 regular CRC screening practices as early as possible: a cancer diagnosis could thus provide a  
286 teachable moment to improve preventive behaviors.(Bluethmann 2015)

287 The high rate of up-to-date CRC screening observed in prostate cancer survivors is surprising,  
288 because of all the tumor sites under examination, prostate has been shown to be associated  
289 with the lowest risk of developing a second cancer in the colorectum.(Institut National Du  
290 Cancer 2015; Curtis 2006; Institut National Du Cancer 2013) This finding may reflect an age  
291 effect, as prostate cancer generally affects older individuals who are known to undergo CRC  
292 screening more frequently. Information on the increased risk of developing CRC after a first  
293 cancer is quite new, and in the absence of specific medical recommendations, those who  
294 undergo CRC screening are not necessarily the ones who most need it.

295 Smoking cessation should be encouraged as part of a global screening and preventive  
296 program.

297 While the gender difference observed in our study is difficult to explain, it can be expected to  
298 increase given that, since 2018, gynecologists in France are authorized to distribute FOBT  
299 kits to their (female) patients.

300

### 301 **Limitations of this study**

302 Our study has some limitations that must be acknowledged. Overall, a selection bias within  
303 our population resulting in an over-estimation of CRC screening rate cannot be excluded, as  
304 more severely affected survivors might be under-represented in our sample. A weighting  
305 procedure was applied in order to ensure the representativeness of our sample, taking into  
306 account cancer progression since diagnosis. Information on CRC screening was self-reported,  
307 which means that memory or social desirability bias may have occurred. However, we found  
308 it necessary to use self-reported data because the CRC screening procedure is not currently  
309 registered in the French medico-administrative database. In addition, it is possible that some  
310 of the participants who reported undergoing a colonoscopy did so in the context of a medical  
311 examination, and not following CRC screening. Nevertheless, a large body of literature  
312 indicates that self-reported measures of FOBT or colonoscopy uptake are acceptable, and that  
313 rates of self-reported CRC screening are consistent with CRC screening rates observed in the  
314 general French population.(Institut National Du Cancer 2018; Baier 2000)

315

### 316 **Conclusions**

317

318 Our study conducted in a population of cancer survivors five years after diagnosis identified  
319 several personal and institutional barriers to CRC screening. A number of recommendations  
320 can be made based on our results. Cancer survivors and healthcare practitioners should be  
321 given appropriate information on the risk of developing a second cancer in the colorectum and  
322 on the importance of CRC screening practices. National guidelines should formulate  
323 recommendations for the preventive follow-up of cancer survivors, especially the most  
324 vulnerable (e.g. younger, smokers or obese survivors). Health agencies, healthcare providers,  
325 and researchers should consider the possibility of extending the national CRC screening  
326 program to younger cancer survivors. In order to reduce the negative impact of financial  
327 difficulties on CRC screening practices, a communication campaign should be launched to  
328 inform the general population and cancer survivors in particular about the free CRC screening  
329 tests. Lastly, CRC screening kits should be made available beyond medical consultations (for  
330 instance, in pharmacies) to reduce the difficulties associated with poor access to GPs.

331

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333

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337

338 **Compliance with Ethical Standards**

339

340 **Conflict of interest statement:** No conflict of interest was reported by the authors of this  
341 paper.

342 **Role of funding source:** This content is solely under the responsibility of the authors and  
343 does not necessarily represent the official position of the French National Cancer Institute  
344 (INCa). The INCa had no role in study design; analysis and interpretation of data; writing the  
345 research article and decision to submit it for publication.

346 **Ethical Approval:** Three national ethics commissions have approved the methodology of the  
347 VICAN survey: the CCTIRS (*Comité Consultatif sur le Traitement de l'Information en*  
348 *matière de Recherche dans le domaine de la Santé*, registration n°11-143), the ISP (*Institut*  
349 *thématique Santé Publique*, registration n°C11-63) and the CNIL (*Commission Nationale de*  
350 *l'Informatique et des Libertés*, registration n°911290).

351 **Informed Consent:** Informed consent was obtained from all individual participants included  
352 in the study.

353 **References**

354

355 Baier M, Calonge N, Cutter G, McClatchey M, Schoentgen S, Hines S, Marcus A, Ahnen D  
356 (2000) Validity of Self-Reported Colorectal Cancer Screening Behavior. *Cancer*  
357 *Epidemiol Prev Biomark* 9:229–232

358 Baxter NN, Tepper JE, Durham SB, Rothenberger DA, Virnig BA (2005) Increased risk of  
359 rectal cancer after prostate radiation: A population-based study. *Gastroenterology*  
360 128:819–824. <https://doi.org/10.1053/j.gastro.2004.12.038>

361 Bluethmann SM, Basen-Engquist K, Vernon SW, Cox M, Gabriel KP, Stansberry SA,  
362 Carmack CL, Blalock JA, Demark-Wahnefried W (2015) Grasping the ‘Teachable  
363 Moment’: Time Since Diagnosis, Symptom Burden and Health Behaviors in Breast,  
364 Colorectal and Prostate Cancer Survivors. *Psychooncology* 24:1250–1257.  
365 <https://doi.org/10.1002/pon.3857>

366 Bouhnik A-D, Bendiane M-K, Cortaredona S, Teyssier LS, Rey D, Berenger C, Seror V,  
367 Peretti-Watel P, Group members of the VICAN survey (2015) The labour market,  
368 psychosocial outcomes and health conditions in cancer survivors: protocol for a  
369 nationwide longitudinal survey 2 and 5 years after cancer diagnosis (the VICAN  
370 survey). *BMJ Open* 5:e005971. <https://doi.org/10.1136/bmjopen-2014-005971>

371 Corkum M, Hayden JA, Kephart G, Urquhart R, Schlievert C, Porter G (2013) Screening for  
372 new primary cancers in cancer survivors compared to non-cancer controls: a  
373 systematic review and meta-analysis. *J Cancer Surviv* 7:455–463.  
374 <https://doi.org/10.1007/s11764-013-0278-6>

375 Curtis RE, Freedman DM, Ron E, Ries LAG, Hacker DG, Edwards BK, Tucker MA,  
376 Fraumeni JF Jr. (eds) (2006) New malignancies among cancer survivors: SEER cancer  
377 registries, 1973-2000. National Cancer Institute. NIH Publ. N°05-5302. Bethesda, MD

378 European Commission (2010) European Guidelines for Quality Assurance in Colorectal  
379 Cancer Screening and Diagnosis - First Edition. Segnan N, Patnick J, von Karsa L  
380 (eds)

381 Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, Parkin DM, Forman D,  
382 Bray F (2015) Cancer incidence and mortality worldwide: Sources, methods and  
383 major patterns in GLOBOCAN 2012: Globocan 2012. *Int J Cancer* 136:E359–E386 .  
384 <https://doi.org/10.1002/ijc.29210>

385 Fon Sing M, Leuraud K, Duport N (2013) Characteristics of French people using organised  
386 colorectal cancer screening. Analysis of the 2010 French Health, Healthcare and  
387 Insurance Survey. *Prev Med* 57:65–68. <https://doi.org/10.1016/j.ypmed.2013.03.008>

388 Gangarosa LM (2011) New Guidelines for Cancer Screening in Older Patients. *AMA J Ethics*  
389 13:765–768. <https://doi.org/10.1001/virtualmentor.2011.13.11.ccas3-1111>.

390 Goulard H, Boussac-Zarebska M, Duport N, Bloch J (2009) Facteurs d’Adhésion au  
391 Dépistage Organisé du cancer colorectal : étude Fado-colorectal, France, décembre  
392 2006-avril 2007. *Bulletin épidémiologique hebdomadaire (BEH)*. Numéro thématique  
393 - Dépistage organisé du cancer colorectal en France. N°2-3

394 Hoover S, Subramanian S, Tangka FKL, Cole-Beebe M, Sun A, Kramer CL, Pacillio G  
395 (2017) Patients and caregivers costs for colonoscopy-based colorectal cancer  
396 screening: Experience of low-income individuals undergoing free colonoscopies. Eval  
397 Program Plann 62:81–86 . <https://doi.org/10.1016/j.evalprogplan.2017.01.002>

398 Institut National du Cancer (2013) Identifier et prévenir les risques de second cancer primitif  
399 chez l'adulte. Collection Etat des lieux et des connaissances. Boulogne-Billancourt

400 Institut National du Cancer (2015) Estimation du risque de second cancer en France - Etude à  
401 partir des registres des cancers du réseau Francim. Collection Les Données. 14 p

402 Institut National du Cancer (2016) Éthique et dépistage organisé du cancer colorectal -  
403 Analyse du dispositif français. Collection Appui à la décision

404 Institut National du Cancer (2018) Les cancers en France. Edition 2017. Collection Les  
405 Données

406 International Agency for Research on Cancer (2018) The Global Cancer Observatory.  
407 Colorectal cancer

408 International Agency for Research on Cancer (2018) The Global Cancer Observatory. World

409 Maruthur NM, Bolen S, Gudzone K, Brancati FL, Clark JM (2012) Body mass index and  
410 colon cancer screening: a systematic review and meta-analysis. Cancer Epidemiol  
411 Biomark Prev Publ Am Assoc Cancer Res Cosponsored Am Soc Prev Oncol 21:737–  
412 746. <https://doi.org/10.1158/1055-9965.EPI-11-0826>

413 Mayer DK, Terrin NC, Menon U, Kreps GL, McCance K, Parsons SK, Mooney KH (2007)  
414 Screening practices in cancer survivors. J Cancer Surviv Res Pract 1:17–26.  
415 <https://doi.org/10.1007/s11764-007-0007-0>

416 Navarro M, Nicolas A, Ferrandez A, Lanás A (2017) Colorectal cancer population screening  
417 programs worldwide in 2016: An update. World J Gastroenterol 23:3632–3642.  
418 <https://doi.org/10.3748/wjg.v23.i20.3632>

419 Santé Publique France (2018) Taux de participation au programme de dépistage organisé du  
420 cancer colorectal 2016-2017

421 Seibert RG, Hanchate AD, Berz JP, Schroy PC (2017) National Disparities in Colorectal  
422 Cancer Screening Among Obese Adults. Am J Prev Med 53:e41–e49 .  
423 <https://doi.org/10.1016/j.amepre.2017.01.006>

424 Sewitch MJ, Rajput Y (2010) A literature review of complementary and alternative medicine  
425 use by colorectal cancer patients. Complement Ther Clin Pract 16:52–56 .  
426 <https://doi.org/10.1016/j.ctcp.2009.10.001>

427 Shin DW, Kim Y-W, Oh JH, Kim SW, Chung K-W, Lee WY, Lee JE, Lee WC, Guallar E,  
428 Cho J (2011) Knowledge, attitudes, risk perception, and cancer screening behaviors  
429 among cancer survivors. Cancer 117:3850–3859. <https://doi.org/10.1002/cncr.25951>

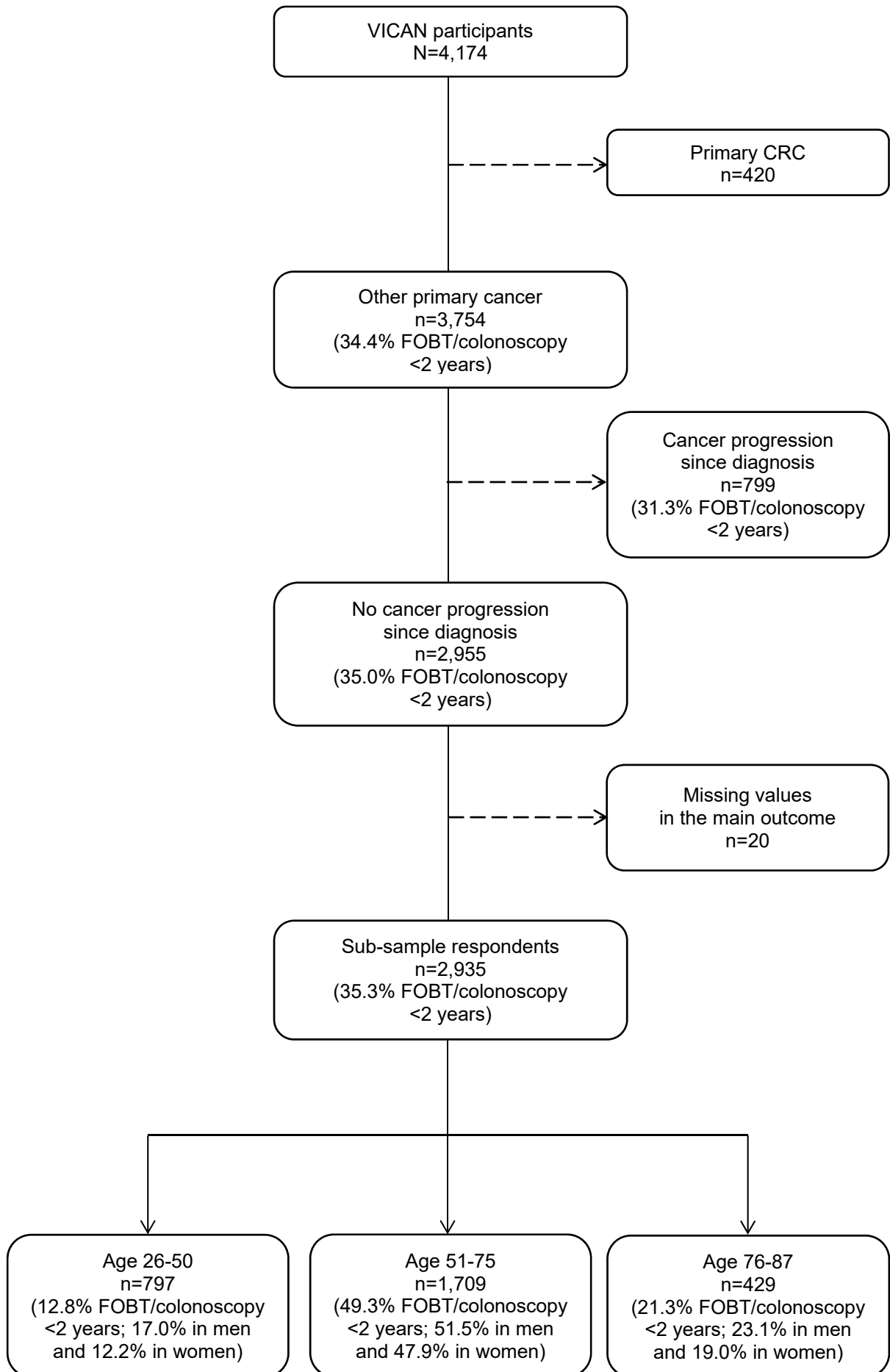


430 Trask PC, Rabin C, Rogers ML, Whiteley J, Nash J, Frierson G, Pinto B (2005) Cancer  
431 screening practices among cancer survivors. *Am J Prev Med* 28:351–356 .  
432 <https://doi.org/10.1016/j.amepre.2005.01.005>

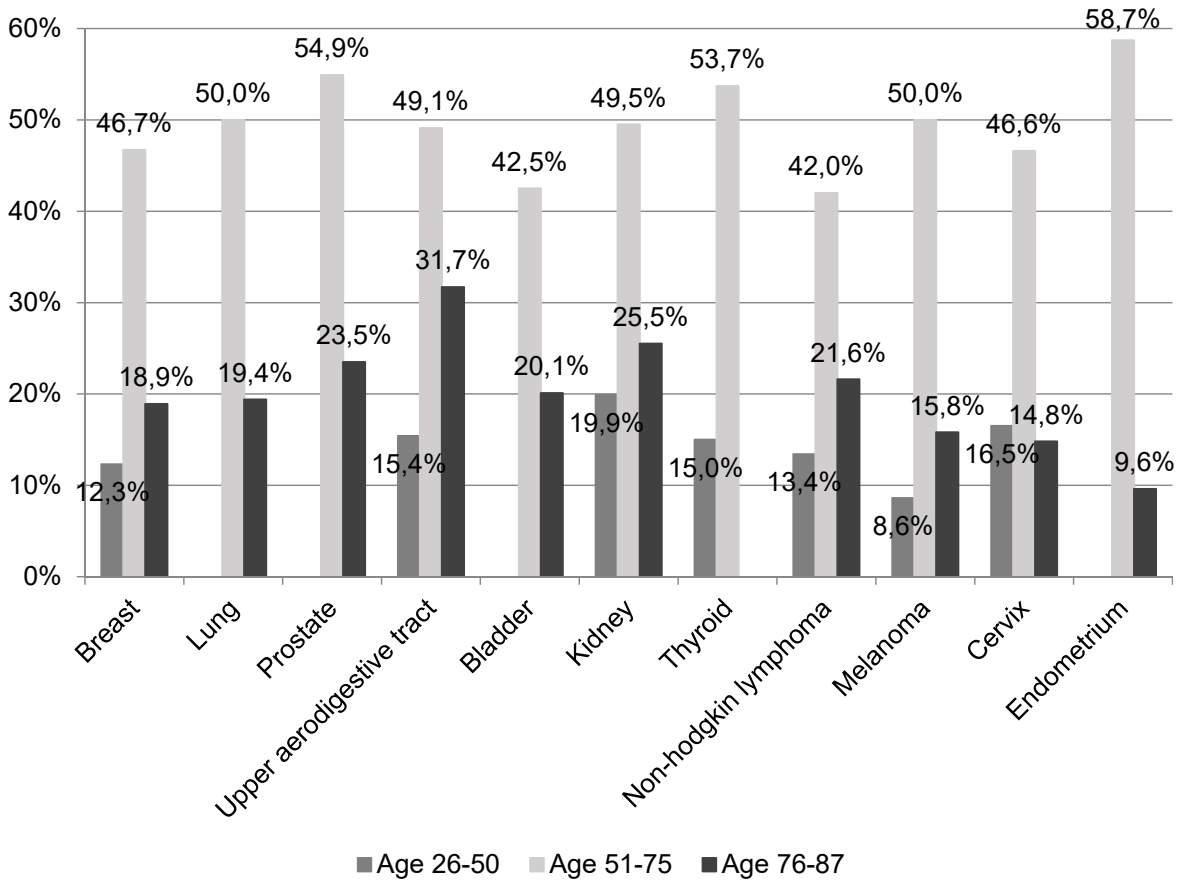
433 Wools A, Dapper EA, Leeuw JRJ de (2016) Colorectal cancer screening participation: a  
434 systematic review. *Eur J Public Health* 26:158–168.  
435 <https://doi.org/10.1093/eurpub/ckv148>

436 Yang YH (2014) A Path Analysis on Factors Influencing Second Primary Cancer Screening  
437 Practices in Stomach, Colon, and Breast Cancer Survivors. *J Korean Acad Nurs*  
438 44:139–148 . <https://doi.org/10.4040/jkan.2014.44.2.139>

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441 Figure 1: Flow chart of the study population



442

443 Figure 2: Prevalence of up-to-date CRC screening by age and cancer location

444 Note: N=2,935. Values are presented as weighted percentages. There were no survivors of  
 445 prostate, bladder, or endometrial cancer in the 26-50 age group, and no survivors of thyroid  
 446 cancer in the 76-87 age group.

447 Table 1: CRC screening practices among 51-75 survivors

	%	Up-to-date with CRC screening <sup>a</sup> (% in column) (n=842)	Not up-to-date with CRC screening <sup>b</sup> (% in column) (n=867)	p-value <sup>c</sup>
Gender				0.209
Male	38.0	39.7	36.3	
Female	62.0	60.3	63.7	
Age at the time of the survey, weighted mean (SD)	61.4	62.0 (7.5)	60.9 (7.5)	<b>0.016</b>
Living as a couple				<b>0.019</b>
Yes	75.1	76.9	73.4	
No	22.9	20.3	25.5	
Missing	2.0	2.8	1.1	
Level of education				0.592
< Less than high school degree	51.7	52.4	51.0	
≥ High school degree or more	48.1	47.3	48.9	
Missing	0.2	0.3	0.1	
Socio-professional category at the survey				0.058
Executive job	22.9	22.3	23.5	
Managerial job	17.2	16.7	17.6	
Unemployed	12.0	9.8	14.1	
Pensioner	46.9	49.9	44.0	
Missing	1.0	1.3	0.8	
Perceived financial status				<b>&lt;0.001</b>
Comfortable/Things are good	49.1	53.7	44.7	
Tight/I have to be careful	34.8	32.7	36.8	

Difficult/I can't manage without incurring debts	13.7	10.2	17.1	
Missing	2.4	3.4	1.4	
Household income by consumption unit (sample quartiles)				0.091
<1 <sup>st</sup> quartile	20.3	17.8	22.8	
1 <sup>st</sup> quartile - 3 <sup>rd</sup> quartile	46.0	48.0	44.0	
>3 <sup>rd</sup> quartile	25.9	26.4	25.4	
Missing	7.8	7.8	7.8	
Indicator of potential access to general practitioners (sample quartiles)				<b>0.004</b>
Low (<1 <sup>st</sup> quartile)	24.5	20.9	28.0	
Higher (>1 <sup>st</sup> quartile)	75.1	78.4	71.9	
Missing	0.4	0.7	0.1	
Prognosis of cancer				0.761
Good	77.7	78.2	77.2	
Middle	18.0	17.4	18.5	
Bad	4.3	4.4	4.3	
BMI				0.072
BMI<30	81.4	83.4	79.4	
BMI≥30	18.1	16.1	20.0	
Missing	0.5	0.5	0.6	
Currently smoking				<b>&lt;0.001</b>
Yes	14.6	10.0	19.1	
No	84.6	88.9	80.5	
Missing	0.7	1.1	0.4	
Use of complementary medicine				<b>0.050</b>
Yes	23.5	25.7	21.3	
No	74.4	71.4	77.4	
Missing	2.1	2.9	1.3	

448 *Note:* n=1,709. Values are presented as weighted percentages, unless otherwise noted.

449 Boldface indicates statistical significance ( $p \leq 0.05$ ).

450 <sup>a</sup>Up-to-date with CRC screening: cancer survivors who had undergone FOBT or colonoscopy  
451 in the previous two years.

452 <sup>b</sup>Not up-to-date with CRC screening: cancer survivors who had not undergone FOBT or  
453 colonoscopy in the previous two years.

454 <sup>c</sup>Calculated excluding missing values.

455 Table 2: Logistic regression model of lack of up-to-date CRC screening among 51-75  
 456 survivors

	All respondents			Men		Women	
	AOR	95%CI	p-value	AOR	95%CI	AOR	95%CI
<b>Personal factors</b>							
Gender <sup>a</sup>							
Male	1						
Female	1.06	0.82-1.38	0.655				
Age at the time of the survey (per 1 year increase)	0.98	0.97-1.01	0.064	0.99	0.96-1.02	0.98	0.96-1.00
Perceived financial status							
Comfortable/Things are good	1			1		1	
Tight/I have to be careful	1.27	0.98-1.63	0.065	1.06	0.71-1.57	<b>1.41</b>	<b>1.02-1.96</b>
Difficult/I can't manage without incurring debts	<b>1.76</b>	<b>1.20-2.58</b>	<b>0.004</b>	1.53	0.82-2.85	<b>1.89</b>	<b>1.17-3.05</b>
BMI							
BMI<30	1			1		1	
BMI≥30	<b>1.38</b>	<b>1.02-1.86</b>	<b>0.039</b>	1.23	0.80-1.89	1.49	0.97-2.28
Currently smoking							
Yes	<b>1.91</b>	<b>1.35-2.69</b>	<b>&lt;0.001</b>	<b>1.98</b>	<b>1.07-3.67</b>	<b>1.85</b>	<b>1.21-2.83</b>
No	1			1		1	
Use of complementary medicine							
Yes	1			1		1	
No	<b>1.39</b>	<b>1.04-1.86</b>	<b>0.026</b>	0.98	0.54-1.78	<b>1.54</b>	<b>1.10-2.14</b>
<b>Contextual factors</b>							
Indicator of potential access to general							



practitioners (sample quartiles)							
Low (<1 <sup>st</sup> quartile)	<b>1.43</b>	<b>1.09-1.88</b>	<b>0.010</b>	<b>1.61</b>	<b>1.06-2.46</b>	<b>1.38</b>	<b>0.96-1.97</b>
Higher (>1 <sup>st</sup> quartile)	<b>1</b>			<b>1</b>		<b>1</b>	

457 *Note:* n=1,645 after exclusion of 64 observations with missing values. Boldface indicates  
458 statistical significance ( $p \leq 0.05$ ).

459 <sup>a</sup>Variable not selected by the stepwise procedure and forced in the multivariate logistic  
460 regression.

461 Online Supplementary Table 1: Sociodemographic characteristics of the study population

	Age 26-50 (n=797)	Age 51-75 (n=1,709)	Age 76-87 (n=429)	p-value
Age at the time of the survey, weighted mean (SD)	44.4 (5.2)	61.4 (7.5)	79.5 (2.7)	<0.001
Gender				<0.001
Male	106 (13.3)	649 (38.0)	238 (55.5)	
Female	691 (86.7)	1060 (62.0)	191 (44.5)	
Living as a couple				0.171
Yes	557 (70.0)	1221 (71.4)	281 (65.6)	
No	240 (30.0)	486 (28.5)	147 (34.2)	
Missing	0 (0.0)	2 (0.1)	1 (0.2)	
Level of education				<0.001
< Less than high school degree	267 (33.5)	883 (51.7)	280 (65.2)	
≥ High school degree or more	530 (66.5)	823 (48.1)	149 (34.8)	
Missing	0 (0.0)	3 (0.2)	0 (0.0)	
Having a child				<0.001
Yes	671 (84.2)	1546 (90.5)	394 (91.7)	
No	126 (15.8)	159 (9.3)	34 (7.9)	
Missing	0 (0.0)	4 (0.2)	1 (0.4)	
Socio-professional category at the time of the survey				<0.001
Executive job	363 (45.6)	392 (22.9)	4 (0.9)	
Managerial job	286 (35.9)	294 (17.2)	0 (0.0)	
Unemployed	137 (17.2)	204 (12.0)	22 (5.0)	
Pensioner	3 (0.4)	801 (46.9)	396 (92.3)	
Missing	8 (0.9)	18 (1.0)	7 (1.8)	
Perceived financial status				<0.001
Comfortable/Things are good	352 (44.2)	840 (49.2)	215 (50.2)	
Tight/I have to be careful	295 (37.0)	594 (34.8)	158 (36.9)	

Difficult/I can't manage without incurring debts	<b>139 (17.5)</b>	<b>235 (13.7)</b>	<b>27 (6.3)</b>
Missing	<b>11 (1.3)</b>	<b>40 (2.4)</b>	<b>29 (6.6)</b>

462 *Note:* n=2,935. Values are presented as weighted percentages, unless otherwise noted.

463 **Boldface** indicates statistical significance ( $p \leq 0.05$ ).

464 Online Supplementary Table 2: Logistic regression model of lack of up-to-date CRC  
 465 screening among 26-50 survivors

	All respondents			Men		Women	
	AOR	95%CI	p-value	AOR	95%CI	AOR	95%CI
<b>Personal factors</b>							
Gender <sup>a</sup>							
Male	1						
Female	1.63	0.84-3.14	0.147				
Age at the time of the survey (per 1 year increase)	<b>0.93</b>	<b>0.87-0.99</b>	<b>0.038</b>	1.03	0.90-1.18	<b>0.92</b>	<b>0.86-0.99</b>
Perceived financial status							
Comfortable/Things are good	1			1		1	
Tight/I have to be careful	0.60	0.33-1.09	0.093	0.48	0.08-2.73	0.61	0.32-1.17
Difficult/I can't manage without incurring debts	<b>0.41</b>	<b>0.21-0.79</b>	<b>0.008</b>	<b>0.07</b>	<b>0.01-0.45</b>	0.59	0.28-1.25
BMI							
BMI < 30	1			1		1	
BMI ≥ 30	0.83	0.41-1.68	0.610	1.57	0.31-8.02	0.74	0.33-1.68
Currently smoking							
Yes	1.25	0.65-2.39	0.501	5.51	0.94-32.40	0.94	0.47-1.86
No	1			1		1	
Use of complementary medicine							
Yes	1			1		1	
No	<b>0.72</b>	<b>1.01-2.93</b>	<b>0.046</b>	12.21	0.05-1.71	<b>2.11</b>	<b>1.19-3.75</b>
<b>Contextual factors</b>							

Indicator of potential access to general practitioners (sample quartiles)							
Low (<1 <sup>st</sup> quartile)	<b>1.38</b>	<b>0.69-2.77</b>	<b>0.366</b>	<b>3.07</b>	<b>0.79-11.86</b>	<b>1.24</b>	<b>0.58-2.68</b>
Higher (>1 <sup>st</sup> quartile)	<b>1</b>			<b>1</b>		<b>1</b>	

466 *Note:* n=797. Boldface indicates statistical significance ( $p \leq 0.05$ ).

467 <sup>a</sup>Variable not selected by the stepwise procedure and forced in the multivariate logistic

468 regression.

469 Online Supplementary Table 3: Logistic regression model of lack of up-to-date CRC  
 470 screening among 76-87 survivors

	All respondents			Men		Women	
	AOR	95%CI	p-value	AOR	95%CI	AOR	95%CI
<b>Personal factors</b>							
Gender <sup>a</sup>							
Male	1						
Female	1.39	0.71-2.71	0.335				
Age at the time of the survey (per 1 year increase)	<b>1.18</b>	<b>1.03-1.36</b>	<b>0.019</b>	1.16	0.96-1.40	1.21	0.99-1.47
Perceived financial status							
Comfortable/Things are good	1			1		1	
Tight/I have to be careful	0.65	0.34-1.27	0.211	0.87	0.37-2.06	0.44	0.14-1.35
Difficult/I can't manage without incurring debts	0.50	0.16-1.52	0.220	0.45	0.12-1.73	0.50	0.06-4.31
BMI							
BMI < 30	1			1		1	
BMI ≥ 30	1.55	0.62-3.84	0.347	1.28	0.36-4.51	1.89	0.54-6.66
Currently smoking							
Yes	0.77	0.28-2.09	0.603	0.55	0.17-1.80	3.62	0.36-36.03
No	1			1		1	
Use of complementary medicine							
Yes	1			1		1	
No	1.02	0.39-2.63	0.970	1.59	0.43-5.86	0.62	0.13-2.87
<b>Contextual factors</b>							
<b>Indicator of potential access to general</b>							

practitioners (sample quartiles)							
Low (<1 <sup>st</sup> quartile)	<b>1.78</b>	<b>0.76-4.09</b>	<b>0.184</b>	<b>1.91</b>	<b>0.68-5.37</b>	<b>1.58</b>	<b>0.36-7.01</b>
Higher (>1 <sup>st</sup> quartile)	<b>1</b>			<b>1</b>		<b>1</b>	

471 *Note:* n=429. Boldface indicates statistical significance ( $p \leq 0.05$ ).

472 <sup>a</sup>Variable not selected by the stepwise procedure and forced in the multivariate logistic  
473 regression.

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Online Supplementary Table 4: Logistic regression model of lack of CRC screening during lifetime among 51-75 survivors

	All respondents			Men		Women	
	AOR <sup>a</sup>	p	95%CI	AOR <sup>a</sup>	95%CI <sup>b</sup>	AOR <sup>a</sup>	95%CI <sup>b</sup>
<b>Personal factors</b>							
<b>Gender</b>							
Men	1						
Women	1.23	0.178	0.91 – 1.66				
<b>Age at the survey (per 1 year increase)</b>	0.94	<0.001	0.92 – 0.96	0.96	0.93 – 0.99	0.93	0.91 – 0.96
<b>Perceived financial status</b>							
Easy/It's ok	1			1		1	
It's borderline, we have to be careful	1.14	0.395	0.85 – 1.53	0.92	0.55 – 1.52	1.24	0.86 – 1.80
You manage with difficulties/You can't manage without incurring debts	1.96	0.001	1.30 – 2.93	2.46	1.24 – 4.88	1.81	1.10 – 2.96
<b>BMI</b>							
BMI<30	1			1		1	
BMI≥30	1.20	0.314	0.84 – 1.72	1.00	0.58 – 1.73	1.34	0.84 – 2.16
<b>Current smoker</b>							
Yes	1.77	0.001	1.25 – 2.51	2.02	1.09 – 3.73	1.69	1.11 – 2.58
No	1			1		1	
<b>Use of complementary medicine</b>							
Yes	1			1		1	
No	1.89	<0.001	1.33 – 2.68	2.00	0.96 – 4.16	1.87	1.26 – 2.78
<b>Contextual factors</b>							
<b>Indicator of potential accessibility to general practitioners (sample quartiles)</b>							
Low (<1 <sup>st</sup> quartile)	1.01	0.956	0.74 – 1.38	1.56	0.71 – 1.89	0.95	0.64 – 1.42



Higher (>1<sup>st</sup>  
quartile)

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