



Colorectal cancer screening: results from the World Trade Center Health Registry cohort

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Abstract

Purpose Little is known about colorectal cancer screening in 9/11 World Trade Center (WTC)-exposed populations. We utilized survey data from the WTC Health Registry (WTCHR) to examine associations between enrollees' characteristics and colorectal cancer (CRC) screening.

Methods We studied 22,061 enrollees aged 50–75 who completed the WTCHR follow-up survey in 2015–2016. Those with a history of CRC were excluded. Screening was defined as a self-reported, routine colonoscopy or sigmoidoscopy during the 12-month period prior to the survey. Multivariable log binomial regression identified factors associated with screening in the 12 months preceding the survey. We also stratified by age group.

Results Of 22,061 enrollees, 23% were screened, with largely similar rates across age groups. Higher screening percentages were seen in selected groups including non-Hispanic Black enrollees (26.4%), males (24.3%), those married/living with a partner (24.1%), those with a higher household income (\geq \$150 k, 25.4%), those who received services from the WTC Health Program (25.6%), and those with greater perceived social support (24.4%). On multivariable analyses, non-Hispanic Black enrollees [adjusted relative risk (aRR) = 1.30, 95% confidence interval (CI) 1.19–1.42] were significantly more likely to report screening, even after stratifying by age group. Hispanic enrollees, those with a higher household income, those with increased perceived social support, and those with diagnosed medical conditions under 70 years old were also associated with screening.

Conclusion We found that non-Hispanic Black compared with non-Hispanic White enrollees were more likely to obtain screening for CRC. Continued efforts to promote health and wellness of WTC-exposed population is essential.

Keywords Colorectal cancer · Cancer screening · World Trade Center (WTC) · WTC disaster · Rescue and recovery worker

Introduction

Colorectal cancer (CRC) screening is a means of secondary prevention through early detection thereby decreasing rates of colorectal cancer as well as mortality [1]. In the United States, CRC is the fourth most common cancer; however, it is the second most common cause of cancer death with rates generally increasing with age [2]. CRC incidence and mortality rates also vary by race and ethnicity. The incidence rate in non-Hispanic Black individuals is 41.7 per 100,000 compared with 35.7 in non-Hispanic White individuals with increased mortality rates also seen in non-Hispanic Black individuals [3].

Overall, the incidence of CRC has decreased, especially since the early 2000s, with contributing factors including increased screening for CRC cancers and use of colonoscopy, which allows for the early identification of polyps

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before their natural progression to CRC [4, 5]. While the United States Preventive Services Task Force (USPSTF) recommends several methods for CRC screening, endoscopic screening with colonoscopy remains the most common [6, 7]. Screening rates vary depending on information source. According to 2021 estimates from the National Health Interview survey, over 71% of those aged 50–75 years old were up to date on screening with 63.9% receiving their screening via sigmoidoscopy or colonoscopy [8]. More recently, the 2022 crude prevalence based on the Behavioral Risk Factor Surveillance System was estimated to be 66.9% of those 45–75 years old were up to date on their colorectal cancer screening [9]. These screening rates are unequal and disparities exist, especially amongst persons without insurance, with lower educational attainment, and with lower incomes [10]. Additionally, rates are lower in specific racial and ethnicity groups, including Hispanic individuals with similar rates seen between non-Hispanic Black and non-Hispanic white individuals [10].

Cancer has been a concern among the population exposed to the terrorist attacks of 11 September 2001, on the World Trade Center (WTC) in New York City (NYC), due to the potential exposures that may have occurred to various carcinogens present [11–16]. To better understand the use of endoscopic screening (colonoscopy and sigmoidoscopy) for CRC in a WTC-exposed population, our goal was to describe the screening activity along with examine the enrollees' sociodemographic characteristics, medical history, health-care utilization, level of social support, and WTC exposure that may be associated with rates of screening for CRC.

Methods

Data source and study population

The detailed methodological descriptions of the WTC Health Registry (WTCHR) have been previously published [17–19]. In brief, the WTCHR was established in July 2002, and it enrolled more than 70,000 individuals who were exposed to the WTC disaster based on exposure criteria including exposure to dust and debris, proximity to the disaster site after the WTC towers collapsed, and involvement of the subsequent clean-up efforts [18]. Its enrollees consisted of workers/volunteers who were involved in rescue and recovery efforts as well as community members who lived or worked in the nearby area and were followed up through periodic surveys since enrollment starting with the Wave 1 survey in 2003–2004 [18]. Thus far, four follow-up surveys have been completed. WTC exposure information was collected at Wave 1 and Wave 2 (2006–2007). For our current study, Wave 4 (2015–2016) was utilized as it asked questions that pertained to CRC screening.

The questions at Wave 4 specific to CRC screening were “In the last 12 months, did you have a colonoscopy or sigmoidoscopy?” and “What was the main reason you had your most recent colonoscopy or sigmoidoscopy?” These questions were adapted from the ones in the 2010 National Health Interview Survey' Cancer Control Supplement [20]. Thus, CRC screening in this study was defined as a colonoscopy or sigmoidoscopy in the past 12 months preceding the Wave 4 survey with additional exclusions as below.

The study sample was limited to Wave 4 enrollees who were aged 50 to 75 years at the time of the survey ($n = 24,517$), which corresponds to the USPSTF recommended screening guidelines for CRC at that time [21]. We excluded enrollees who had self-reported CRC ($n = 199$), did not complete the screening colonoscopy/sigmoidoscopy question ($n = 802$), and had missing reason for having reason for CRC screening other than routine screening ($n = 1,455$) (Fig. 1). The final sample in our analyses includes 22,061 enrollees.

The Institutional Review Board (IRB) at the New York City Department of Health and Mental Hygiene approved this study with a data use agreement enacted for data sharing with Icahn School of Medicine at Mount Sinai. The overall registry protocols were evaluated and approved by the IRBs from the Centers for Disease Control and Prevention and New York City Department of Health and Mental Hygiene.

Independent variables

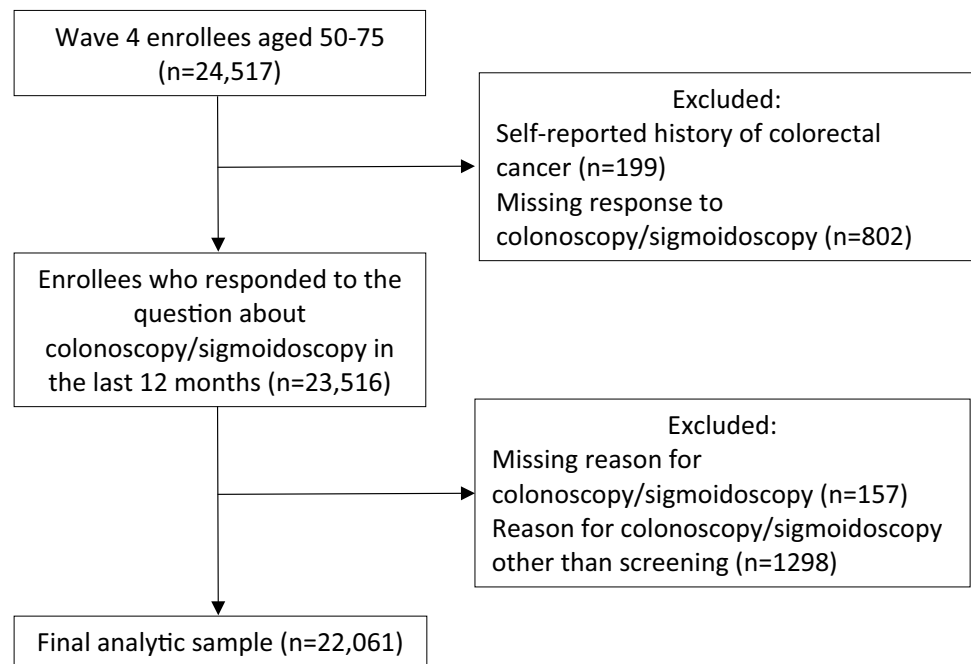
Sociodemographic characteristics

Sociodemographic variables were self-reported and included age at Wave 4 grouped as follows: 50–59, 60–69, and 70–75 years old. They additionally included race and ethnicity (Hispanic and Non-Hispanic White, Black, Asian, other race), sex, marital status (never married; divorced, separated, or widowed; and married/living with partner), and household annual income ($\leq \$50$ K, $\$50$ K to $< \$100$ K, $\$100$ K to $< \$150$ K, $\geq \$150$ K). Of note, insurance status was not included in our analysis given 92% of enrollees reported having health insurance at any point in preceding 12 months prior to the Wave 4 survey.

Health care utilization and medical history

The use of services from the WTC Health Program's (WTCHP) clinics was obtained from self-report on the Wave 4 survey.

The co-morbidities encompassed a self-reported medical history of hypertension, hypercholesterolemia, angina, heart attack, coronary heart disease, stroke, diabetes mellitus, asthma, chronic bronchitis, emphysema or chronic obstructive pulmonary disease, reactive airways dysfunction

Fig. 1 Selection of study sample

syndrome, sarcoidosis, pulmonary fibrosis, asbestosis, sleep apnea, gastroesophageal reflux disease, thyroid problems, peripheral neuropathy, rheumatoid arthritis, or other autoimmune disorder. Enrollees were considered to have a history of a medical condition if any of these were reported on Wave 4.

Perceived social support

Level of perceived social support was measured using the five-item version of the Modified Social Support Survey (MSSS-5) [22]. The sum of responses to each of the 5 questions with a five-point scale from none (0) to all of the time (4), including whether they perceived someone was available when needed to take them to the doctor, have a good time together, hug them, preparing meals, and understanding their problems, were grouped into none to little (0–5 points), some (6–10), most (11–15) and all of the time (16–20).

Risk factors for CRC

Risk factors for CRC were defined based on the literature of known CRC risk factors [23]. These included personal history of colorectal health issues and family (close and distant relatives) history of colon cancer. History of colon health issues included self-reported irritable bowel syndrome, Crohn's disease or colitis, polyposis, or Lynch syndrome. Additionally, level of physical activity (very or somewhat active versus not very or not at all active), body mass index (BMI), and alcohol use (we used binge drinking in the last 30 days, ≥ 5 drinks for men and ≥ 4 for women in one

setting), and smoking status (current, former or never) was obtained.

WTC exposure

Lastly, WTC exposure was defined, using data collected in Wave 1 and Wave 2, based on the sum of 11 exposure items, and grouped into: none/low (0–2), medium (3–4) and high (≥ 5 exposure items) [24]. The 11 exposure items were: (1) being inside one of the towers that collapsed on 9/11, (2) experiencing 3 or more traumatic events (watching the planes hit the towers, the towers fall, people jumping, people hurt, or people fleeing), (3) having the fear that one would be physically harmed, (4–6) having a relation/friend/co-worker killed on 9/11, (7) being exposed to the dust cloud, (8) experiencing property damage or loss, (9) obtaining a physical injury, (10) having to leave one's home for a minimum of 24 h, and (11) job loss due to 9/11.

Statistical analysis

Descriptive analyses first assessed the distribution of the variables of interest by CRC screening among the overall study population. Next, log binomial regression was utilized to assess factors that may be associated with CRC screening. A log binomial regression model was selected given its robustness as compared to a Poisson regression in the setting of a large sample size with a model that converges [25]. As a sensitivity analysis, we additionally ran the adjusted full model using a Poisson regression, and the results were largely similar. Adjusted relative risk (aRR) estimated the

association between the independent variables and CRC screening in the overall study sample and by age group on multivariable analyses [26]. All statistical tests were two-sided, and the statistical significance was indicated if the 95% confidence interval (CI) did not contain the null value of 1 or if a *p* value was less than 0.05.

Results

From the 24,517 Wave 4 enrollees aged 50–75 years, 22,061 (90%) did not self-report a history of colon cancer, answered the question related to whether they had a colonoscopy/sigmoidoscopy in the last 12 months, and if they did have an endoscopic exam, it was for screening purposes (Fig. 1).

Table 1 shows the distribution of the study sample and percentages of CRC screening by enrollees' characteristics. Twenty-three percent of included enrollees reported having had a CRC screening colonoscopy/sigmoidoscopy in the last 12 months of the Wave 4 survey. Screening was more likely to be reported in non-Hispanic Black enrollees (26.4%; crude relative risk (RR) = 1.18, 95% CI 1.10–1.27), males (24.3%; RR = 1.17, 95% CI 1.10–1.24), those married/living with a partner (24.1%, RR = 1.32, 95% CI 1.21–1.44) or divorced/separated/widowed (21.8%, RR = 1.20, 95% CI 1.09–1.32), and those with a higher annual income. Additionally, receiving services from the WTCHP clinics (25.6%, RR = 1.15, 95% CI 1.09–1.22) and having perceived social support at least some of the time (some of the time- 21.5%, RR = 1.23 95% CI 1.10–1.38; most of the time- 23.5%, RR = 1.35 95% CI 1.21–1.50; and all of the time- 24.4%, RR = 1.40 95% CI 1.26–1.54) were significantly associated with CRC screening in our study sample. Enrollees with medical conditions and with an increasing number of CRC risk factors were more likely to have been screened.

Table 2 shows the CRC screening rates stratified by age group as well as for each individual CRC risk factor. The CRC screening rates were similar across all three age groups: 22.4% for ages 50–59, 23.5% for ages 60–69, and 23.8% for ages 70–75. Comparatively, higher rates were seen for those who reported a close family history of colon cancer (27.6% for ages 50–59 years old, 28.4% for ages 60–69 years old, and 31.4% for ages 70–75 years old). Of those aged 60–69, 50% were screened who reported a history of health conditions in the colon compared to 23.7% in those aged 50–59 and 25.0% in those aged 70–75.

On multivariable analysis of the overall study sample, compared with non-Hispanic White enrollees, increased CRC screening was associated with being non-Hispanic Black (aRR = 1.30, 95% CI 1.19–1.42), non-Hispanic other race (aRR = 1.21, 1.05–1.39), or Hispanic (aRR = 1.16, 95% CI 1.06–1.26) (Table 3). More males reported CRC screening compared to females (aRR = 1.13, 95% CI

1.06–1.20). Other associated variables included being married/living with a partner (aRR = 1.13, 95% CI 1.03–1.25); being divorced, separated/widowed (aRR = 1.13, 95% CI 1.02–1.26); having a household income of \geq \$150,000 (aRR = 1.16, 95% CI 1.06–1.27); having increased perceived social support; and receipt of services from the WTCHP (aRR = 1.11, 95% CI 1.04–1.18). Additionally, having diagnosed medical conditions (aRR = 1.27, 95% CI 1.17–1.38) or more than one risk factor for colorectal cancer were significantly associated with reporting CRC screening. Interestingly, those with a high level of WTC exposure were 1.12 times more likely to be screened compared to those with a low level of WTC exposure (95% CI 1.04–1.22).

When stratified by age group, only enrollees that reported being non-Hispanic Black remained statistically significantly associated with CRC screening across all age groups. The association between CRC and a high household income was seen exclusively in those under 70. The associations with perceived social support were significant in those aged 50–59 as well as in those aged 60–69 for higher levels of perceived social support only. Receipt of services from the WTCHP also was significantly associated with a report of CRC screening in those 50–59 years of age.

Discussion

In the present study, we evaluated factors that may be associated with colonoscopy or sigmoidoscopy for CRC screening in the preceding 12 months prior to the Wave 4 survey in WTCHP enrollees. We found an association in the overall study population between CRC screening and perceived social support. Additionally, non-Hispanic Black enrollees had increased CRC screening rates, which was seen in the overall study sample as well as with stratification by age group.

While social support encompasses many components, it can generally be thought of as access to a network of individuals and resources [27]. For CRC screening, previous studies have found physician recommendation as well as having a primary care physician to be important [28–31]. The WTCHP clinics provide a number of resources, including annual monitoring and cancer screenings for those eligible and treatment of WTC certified conditions [32]. In this current study, we found self-reported CRC screening was associated with ever having received services from a WTCHP clinic suggesting that the program may provide another support layer or opportunity for enrollees to discuss and obtain CRC screening. We additionally found that perceived social support, especially in the younger age group, was an important predictor of CRC screening in this population. A 2009 report of the Health Information National Trends Survey showed that social integration, as defined as

Table 1 Characteristics of study sample and percentage of enrollees aged 50–75 who reported colorectal cancer screening in the preceding 12 months prior to the survey

	<i>n</i> (col. %)	<i>n</i> (%) screened	Crude RR (95% CI)
Total	22,061 (100.0)	5,072 (23.0)	
Sociodemographic			
Age, years			
50–59	10,755 (48.8)	2,405 (22.4)	1.00
60–69	8,923 (40.4)	2,099 (23.5)	1.05 (1.00–1.11)
70–75	2,383 (10.8)	568 (23.8)	1.07 (0.98–1.15)
Race/ethnicity			
Non-Hispanic white	15,718 (71.2)	3,519 (22.4)	1.00
Non-Hispanic black	2,322 (10.5)	613 (26.4)	1.18 (1.10–1.27)
Hispanic	2,315 (10.5)	561 (24.2)	1.08 (1.00–1.17)
Asian	1,005 (4.6)	202 (20.1)	0.90 (0.79–1.02)
Non-Hispanic, other race	701 (3.2)	177 (25.3)	1.13 (0.99–1.29)
Sex			
Male	13,779 (62.5)	3,350 (24.3)	1.17 (1.10–1.24)
Female	8,282 (37.5)	1,722 (20.8)	1.00
Marital status			
Married/living with partner	14,914 (67.6)	3,593 (24.1)	1.32 (1.21–1.44)
Divorced, separated or widowed	4,255 (19.3)	928 (21.8)	1.20 (1.09–1.32)
Never married	2,632 (11.9)	479 (18.2)	1.00
Missing	260 (1.2)	72 (27.7)	
Household income, \$			
< 50,000	4,424 (20.1)	928 (21.0)	1.00
50,000 to < 100,000	6,447 (29.2)	1,458 (22.6)	1.08 (1.00–1.16)
100,000 to < 150,000	4,666 (21.2)	1,087 (23.3)	1.11 (1.03–1.20)
≥ 150,000	5,035 (22.8)	1,281 (25.4)	1.21 (1.13–1.31)
Missing	1,489 (6.7)	318 (21.4)	
Health care utilization			
Ever received services from WTCHP			
Yes	4,909 (22.3)	1,256 (25.6)	1.15 (1.09–1.22)
No	16,426 (74.5)	3,653 (22.2)	1.00
Unknown	726 (3.3)	163 (22.5)	
Perceived social support			
None to a little of the time	2,033 (9.2)	355 (17.5)	1.00
Some of the time	3,411 (15.5)	733 (21.5)	1.23 (1.10–1.38)
Most of the time	6,324 (28.7)	1,488 (23.5)	1.35 (1.21–1.50)
All of the time	9,639 (43.7)	2,350 (24.4)	1.40 (1.26–1.54)
Unknown	654 (3.0)	146 (22.3)	
Medical history			
Any history of physician diagnosed medical conditions ^a			
Yes	18,606 (84.3)	4,431 (23.8)	1.28 (1.19–1.38)
No/unknown	3,455 (15.7)	641 (18.6)	1.00
Number of risk factors for colorectal cancer ^b			
None/unknown	1,910 (8.7)	398 (20.8)	1.00
One	7,095 (32.2)	1,517 (22.2)	1.07 (0.97–1.17)
Two	8,309 (37.7)	1,933 (23.3)	1.12 (1.01–1.23)
Three to six	4,747 (21.5)	1,166 (24.6)	1.18 (1.07–1.30)
WTC-related			
Enrollee type			
WTC rescue/recovery workers	10,589 (48.0)	2,528 (23.9)	1.08 (1.03–1.13)
Community members	11,472 (52.0)	2,544 (22.2)	1.00

Table 1 (continued)

	<i>n</i> (col. %)	<i>n</i> (%) screened	Crude RR (95% CI)
Level of 9/11 exposure			
Low	10,633 (48.2)	2,394 (22.5)	1.00
Medium	5,815 (26.4)	1,373 (23.6)	1.05 (0.99–1.11)
High	2,714 (12.3)	662 (24.4)	1.08 (1.01–1.17)
Unknown	2,899 (13.1)	643 (22.2)	0.99 (0.91–1.07)

RR relative risk, CI confidence interval, WTC_{HP} World Trade Center Health Program, WTC World Trade Center, NH non-Hispanic

^aMedical condition included any of the following conditions reported at Wave 4: hypertension, hypercholesterolemia, angina, heart attack, coronary heart disease, stroke, diabetes mellitus, asthma, chronic bronchitis, emphysema or COPD, reactive airways dysfunction syndrome, sarcoidosis, pulmonary fibrosis, asbestosis, sleep apnea, gastroesophageal reflux disease, thyroid problems, peripheral neuropathy, rheumatoid arthritis, or other autoimmune disorder

^bRisk factors included personal history of colon issues, family history of colon cancer, physical activity, BMI (body mass index), alcohol use, and/or smoking

Table 2 Colorectal cancer screening by colorectal cancer risk factors and age groups

	Total <i>n</i> (% screened)			
	Overall	Age at Wave 4 survey		
		50–59 years	60–69	70–75
Total	22,061 (23.0)	10,755 (22.4)	8,923 (23.5)	2,383 (23.8)
Self-reported health conditions in colon ^a				
Yes	82 (31.7)	38 (23.7)	24 (50.0)	20 (25.0)
No	21,979 (23.0)	10,717 (22.4)	8,899 (23.5)	2,363 (23.6)
Family history of colon cancer				
Close	2,169 (28.4)	947 (27.6)	970 (28.4)	252 (31.4)
Distant	1,603 (24.6)	858 (24.1)	609 (25.8)	136 (22.8)
None	17,905 (22.2)	8,755 (21.7)	7,195 (22.7)	1,955 (22.8)
Unknown	384 (21.1)	195 (19.0)	149 (21.5)	40 (30.0)
Physical activity				
Very or somewhat active	15,965 (23.5)	7,791 (22.9)	6,394 (23.9)	1,780 (24.8)
Not very active/not active at all	5,870 (21.5)	2,884 (20.8)	2,416 (22.6)	570 (20.7)
Unknown	226 (24.3)	80 (25.0)	113 (23.9)	33 (24.2)
BMI				
Obese (BMI ≥ 30)	7,382 (23.5)	3,939 (22.4)	2,843 (24.5)	600 (26.0)
Overweight (25 to 29)	8,554 (23.6)	4,136 (23.3)	3,427 (23.8)	991 (23.9)
Under/normal weight (< 25)	5,566 (21.6)	2,440 (21.0)	2,420 (21.9)	706 (22.1)
Unknown	559 (21.1)	240 (17.9)	233 (24.0)	86 (22.1)
Alcohol binge drinking in last 30 days				
Yes	4,141 (25.3)	2,574 (24.6)	1,358 (26.1)	209 (28.7)
No	17,920 (22.5)	8,181 (21.7)	7,565 (23.1)	2,174 (23.4)
Smoking status				
Former or current smoker	8,875 (23.1)	3,735 (22.6)	3,946 (23.2)	1,194 (24.6)
Never	12,772 (23.0)	6,825 (22.4)	4,811 (23.8)	1,136 (23.1)
Unknown	414 (19.6)	195 (13.4)	166 (23.5)	53 (22.6)

BMI body mass index

^aIncluded IBS, Crohn or colitis, polyposis or lynch syndrome

Table 3 Adjusted relative risk (ARR) and 95% confidence intervals (CI) for association between predictors and screening for colorectal cancer by age at Wave 4 ($n=22,061$)

	Full model		Age: 50–59 years ($n=10,755$)	60–69 ($n=8,923$)	70–75 ($n=2,383$)
	ARR	95% CI	ARR (95% CI)	ARR (95% CI)	ARR (95% CI)
Sociodemographic					
Age, years					
50–59	1.00				
60–69	1.08	1.02–1.14			
70–75	1.07	0.98–1.17			
Race/ethnicity					
Non-Hispanic white	1.00		1.00	1.00	1.00
Non-Hispanic black	1.30	1.19–1.42	1.27 (1.12–1.44)	1.32 (1.16–1.50)	1.34 (1.03–1.75)
Hispanic	1.16	1.06–1.26	1.27 (1.00–1.27)	1.18 (1.03–1.36)	1.19 (0.88–1.59)
Asian	1.01	0.88–1.16	0.96 (0.77–1.18)	1.00 (0.82–1.23)	1.29 (0.89–1.87)
Non-Hispanic, other race	1.21	1.05–1.39	1.18 (0.96–1.47)	1.33 (1.08–1.64)	0.91 (0.80–1.59)
Sex					
Female	1.00		1.00	1.00	1.00
Male	1.13	1.06–1.20	1.08 (0.99–1.19)	1.16 (1.06–1.27)	1.21 (1.00–1.46)
Marital status					
Never married	1.00		1.00	1.00	1.00
Married/living with partner	1.13	1.03–1.25	1.10 (0.96–1.26)	1.18 (1.01–1.39)	1.12 (0.80–1.59)
Divorced, separated/widowed	1.13	1.02–1.26	1.12 (0.97–1.30)	1.16 (0.98–1.37)	1.10 (0.78–1.54)
Household income, \$					
< 50,000	1.00		1.00	1.00	1.00
50,000 to < 100,000	1.03	0.95–1.11	1.02 (0.90–1.15)	1.06 (0.94–1.19)	0.93 (0.75–1.15)
100,000 to < 150,000	1.06	0.97–1.15	1.04 (0.91–1.19)	1.09 (0.96–1.24)	0.97 (0.74–1.26)
≥ 150,000	1.16	1.06–1.27	1.15 (1.01–1.31)	1.15 (1.01–1.31)	1.30 (0.99–1.69)
Health care utilization					
Ever received services from WTCHP					
Yes	1.11	1.04–1.18	1.13 (1.04–1.24)	1.08 (0.98–1.20)	1.05 (0.86–1.29)
No	1.00		1.00	1.00	1.00
Perceived social support					
None to a little of the time	1.00		1.00	1.00	1.00
Some of the time	1.18	1.04–1.33	1.23 (1.03–1.47)	1.11 (0.92–1.33)	1.23 (0.86–1.82)
Most of the time	1.29	1.15–1.45	1.34 (1.13–1.59)	1.25 (1.05–1.48)	1.25 (0.86–1.82)
All of the time	1.32	1.17–1.48	1.37 (1.60–1.62)	1.26 (1.06–1.50)	1.29 (0.88–1.86)
Medical history					
Any history of physician diagnosed medical conditions ^a					
Yes	1.27	1.17–1.38	1.27 (1.14–1.41)	1.29 (1.13–1.48)	1.16 (0.88–1.53)
No/unknown	1.00		1.00	1.00	1.00
Number of risk factors for colorectal cancer ^b					
None/unknown	1.00		1.00	1.00	1.00
One	1.05	0.95–1.17	1.00 (0.86–1.15)	1.12 (0.95–1.33)	1.09 (0.73–1.62)
Two	1.13	1.02–1.25	1.08 (0.94–1.25)	1.15 (0.98–1.36)	1.26 (0.86–1.86)
Three or more	1.22	1.10–1.36	1.22 (1.05–1.42)	1.19 (1.00–1.42)	1.40(0.94–2.09)
WTC-related					
Enrollee type					
WTC rescue/recovery workers	1.01	0.95–1.07	1.08 (0.98–1.18)	0.94 (0.85–1.03)	1.03 (0.86–1.23)
Community members	1.00		1.00	1.00	1.00
Level of 9/11 exposure					
Low	1.00		1.00	1.00	1.00

Table 3 (continued)

	Full model		Age: 50–59 years (<i>n</i> = 10,755)	60–69 (<i>n</i> = 8,923)	70–75 (<i>n</i> = 2,383)
	ARR	95% CI	ARR (95% CI)	ARR (95% CI)	ARR (95% CI)
Medium	1.05	0.99–1.12	1.12 (1.02–1.22)	1.00 (0.90–1.10)	0.96 (0.79–1.18)
High	1.12	1.04–1.22	1.05 (0.93–1.18)	1.22 (1.09–1.38)	1.10 (0.84–1.43)
Unknown	1.01	0.93–1.10	1.00 (0.89–1.13)	1.07 (0.94–1.22)	0.84 (0.63–1.11)

WTCHP World Trade Center Health Program, WTC World Trade Center, NH Non-Hispanic

^aMedical condition included any of the following conditions reported at Wave 4: hypertension, hypercholesterolemia, angina, heart attack, coronary heart disease, stroke, diabetes mellitus, asthma, chronic bronchitis, emphysema or COPD, reactive airways dysfunction syndrome, sarcoidosis, pulmonary fibrosis, asbestosis, sleep apnea, gastroesophageal reflux disease, thyroid problems, peripheral neuropathy, rheumatoid arthritis, or other autoimmune disorder

^bRisk factors included personal history of colon issues, family history of colon cancer, physical activity, BMI, alcohol use, and/or smoking

marital status and social support, was positively associated with CRC screening [33]. A 2016 review further highlighted that spousal support was an important motivator in obtaining CRC screening, whereas friends or family members had varying impacts depending on their experiences [34]. Others evaluating specific racial and ethnic groups found social support to be a largely positive factor for obtaining CRC screening [35–38]. A recent study of African American men showed that family and community were an important factor when promoting CRC screening [37]. However, differences have been observed, such as in a 2017 study of Chinese Americans, in which social support was negatively associated with screening via colonoscopy [35]. This highlights the importance of targeted, culturally adapted interventions that address the unique barriers and perceptions of CRC screening within each population.

Our study showed that non-Hispanic Black enrollees reported more CRC screening uptake compared with non-Hispanic White enrollees. This varies from recent screening estimates where the rates are similar between these two groups [10]. Of note, previous estimates that more reflect the time of this survey completion showed slightly lower rates of CRC screening in Black individuals compared to white. Data from the 2010 Behavioral Risk Factor Surveillance System showed a rate of 62% for white individuals compared with 59% for Black individuals [39]. This may in part reflect the overall uniqueness of the WTCHP and be accounted for in study sample differences [40]. The characteristics of the New York City population may also be contributing. The New York City Community Health Survey showed a higher rate of colonoscopy uptake in non-Hispanic Black individuals (71.1%) compared with non-Hispanic white individuals (68.2%) during the 2015–2016 time period [41]. We also found increased rates in the Hispanic group, which mirrors certain groups of Hispanic individuals depending on country of origin in this survey for the same time period [41]. Whereas, rates for Hispanic individuals are lower overall in national estimates [8, 39]. Additionally, similar findings

for Black individuals have been seen in healthcare systems in which patients have a more equalized availability of care, including the Veterans Health Administration and the Health Center Program [42, 43]. This association was seen before and after adjustment for socioeconomic factors. A study of the 2018 Behavioral Risk Factor Surveillance System data found a disparity in CRC screening that improved, and even became positive for the non-Hispanic Black group, after adjustment for social determinants of health and behavioral factors [44]. Thus, our findings may also point to unique aspects of the WTCHP clinics that potentially play a role in mitigation of these factors [40]. While this current study did not assess individuals' frequency of WTCHP clinics use, the clinics do provide a variety of services screening for cancer to 9/11-exposed individuals who are qualified [45]. Of note, we discuss race/ethnicity as a social context, and the incidence rate of CRC using national data collected from 2012 to 2016 was about 20% higher for non-Hispanic Blacks than for non-Hispanic whites [4]. Given the continued disparities in CRC by racial minorities and the complexities of individual's screening behaviors, further work is needed to understand how our results translate into CRC outcomes among this population [39, 46–48].

Our study had several limitations. First, the self-report survey format of this study may be subject to recall bias. Enrollees may be more likely to report screening for CRC if they had a memorable experience or received the screening recently. However, previous work in the WTC-exposed population has shown a high sensitivity for self-reported cancer diagnosis, and thus an important procedure such as a colonoscopy or sigmoidoscopy, is less likely to be misreported [49]. Second, our study evaluated screening in the previous year, and thus likely underreported screening rates due to enrollees not being due for a colonoscopy/sigmoidoscopy or having received a different type of screening test. Per the USPSTF guidelines, a screening colonoscopy is recommended every 10 years and sigmoidoscopy every 5–10 years if fecal immunochemical testing is performed with other

screening methods available [21]. Estimates of the percentage of the United States population that is up-to-date on CRC screening using the Behavioral Risk Factor Surveillance System are around 68.8%; whereas, ours was 25.7% for screening colonoscopy/sigmoidoscopy in the preceding 12 months of the Wave 4 survey in WTCHR enrollees [50]. Additionally, the survey was limited to self-reported sigmoidoscopy and colonoscopy. While colonoscopy is a common method for CRC screening, this likely narrows the scope of this current study to holistically evaluate screening practices in this study sample [51]. However, our study adds value to existing knowledge because it provides a snapshot of screening rates among the WTC-exposed population. Finally, other factors that we did not have the data to examine may have influenced screening rates in this study, such as cultural differences, health literacy, and individual enrollee factors.

Further work is needed to understand the overall screening rate in this population and how it compares with the national rates. An investigation regarding whether screening rates translate into lower rates of CRC, specifically for those racial and ethnic groups that have traditionally elevated risk, is warranted. This study provides the groundwork for such research as well as helps to understand which enrollees may be at greatest risk for not undergoing CRC screening.

Conclusion

Our study showed that non-Hispanic Black enrollees reported more CRC screening uptake compared with non-Hispanic White enrollees. Our findings also suggest health-care access and social support to be important contributors to CRC screening in our population. This highlights the importance of increased awareness of CRC screening and helps identify potential target populations for increased resource allocation.

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Data availability World Trade Center Health Registry (WTCHR) Data may be made available following review of applications to the WTCHR. The data are not publicly available due to privacy or ethical restrictions.

Declarations

Competing interests The authors declare that they have no competing interests.

Ethical approval Our study was approved by the Institutional Review Board (IRB) at the New York City Department of Health and Mental Hygiene with a data use agreement enacted for data sharing with Icahn School of Medicine at Mount Sinai.

Consent to participate Informed consent was obtained from all individual enrollees included in this study.

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