Use of Colorectal Cancer Screening Among People With Mobility Disability

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Goals: We aimed to assess use of colorectal cancer screening (CRCS) as per United States Preventive Task Force guidelines among people with mobility disability using a nationally representative data set.

Background: Individuals with mobility disability have decreased access to health care services, but the impact of mobility disability on CRCS has not been investigated.

Study: Data from the 2013 National Health Interview Survey were used to estimate sociodemographic characteristics of adults with mobility disability, prevalence of CRCS, and odds of CRCS given mobility disability among Americans aged 50 to 75.

Results: In total, 56.8% of the entire sample (n = 81,953,585) were up-to-date with CRCS. Mobility disability was not associated with CRCS status on univariable analysis but was significantly associated after adjustment for covariates including age and comorbidities, with an inverse relationship between the degree of mobility disability and odds of CRCS. Odds ratio for CRCS given progressively severe disability were 0.78 (0.66 to 0.93), 0.71 (0.53 to 0.94), 0.65 (0.31 to 1.19).

Conclusions: The present study indicates reduced CRCS among people with mobility disability and highlights the need for CRCS to be especially targeted toward this group. Future research should identify the specific systemic, social, and/or physical barriers to CRCS for this subgroup so that they can be addressed.

Key Words: aging, disabled persons, epidemiology, screening, cancer, colorectal neoplasms

(*J Clin Gastroenterol* 2018;52:789–795)

Colorectal cancer (CRC) is the second leading cause of cancer-related death in the United States[1] and and the third-leading cause worldwide.[2] Colorectal cancer screening (CRCS) is an effective tool to reduce the number of deaths from CRC. The US Preventive Services Task Force (USPSTF) and the Centers for Disease Control and Prevention (CDC) recommend CRCS for adults between ages 50 and 75 using colonoscopy, sigmoidoscopy, or fecal occult blood testing (FOBT).[3] However, CRCS is underutilized by American adults, with only 65% of eligible adults being up-to-date with CRCS in 2012.[4,5] Further, traditionally underserved populations, such as people in lower socioeconomic positions,[6] those in rural areas,[7,8] immigrants,[6,9] the homeless,[10] and racial minorities[9,11–13] experience particularly low rates of CRCS.[9,13,14]

People with disabilities experience barriers to accessing primary health care services, including preventive cancer screening.[15–22] A complex set of reasons, including inaccessible architecture; providers' low prioritization of medical needs unrelated to the disability; and inaccessible or inconvenient transportation are responsible for this finding.[22,23] Insufficient family and staff awareness of preventative screening needs for people with disabilities is another reason.[24] One study found that clinics frequently have insufficient numbers of staff members who can provide extra assistance with screening activities to people with disabilities.[23]

To our knowledge, there has been no nationally representative analysis of CRCS among people with mobility disability in the United States using current data. We aimed to measure CRCS rates in this population using the same methodology as performed by CDC when measuring CRCS rates in the general population.[5]

MATERIALS AND METHODS

Data Source

We analyzed data from the 2013 National Health Interview Survey (NHIS),[25] extracting all variables from the Sample Adult Core file. NHIS is an annual cross-sectional household interview survey performed by the National Center for Health Statistics (NCHS) at the CDC. The data are provided for public use and do not require Institutional Review Board approval before analysis. The study uses a multistage area probability design to permit representation of the civilian, noninstitutionalized United States population.[26,27] Sample weights adjusted for age, sex, race, and ethnicity[27] were applied to create nationally representative estimates.

Study Population

We restricted the population to individuals between ages 50 to 75, in accordance with CDC/USPSTF guidelines.[28] Individuals who mentioned having ever had colon cancer were excluded from the sample (unweighted n = 89). Those whose answers to "have you ever had a colonoscopy?"; "have

Received for publication February 24, 2017; accepted March 31, 2017.
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T.J.M. acknowledges support in part through a Patient-Centered Outcomes Research Institute (PCORI) Award 1IP2PI000797-01. This research was supported in part by Grant 1 R49 CE002096-01 from the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention to the Center for Injury Epidemiology and Prevention at Columbia University. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the National Institutes of Health and Centers for Disease Control and Prevention. Benjamin Lebwohl acknowledges support from The National Center for Advancing Translational Sciences, National Institutes of Health (UL1 TR000040).

The authors declare that they have nothing to disclose.
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Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website, www.jcge.com.

DOI: 10.1097/MCG.0000000000000835

you ever had a sigmoidoscopy?"; and "have you ever had a blood stool test, using a home test kit?" were not ascertained due to incomplete interviews were excluded from the sample (unweighted n = 258). Those who had colonoscopy, flexible sigmoidoscopy (FS), and FOBT all for nonscreening reasons ("because of a problem," "follow-up test of an earlier test or screening examination" "other reason") (unweighted n = 59) were also excluded from the analysis.

Exposure: Physical Capacity

Mobility disability was operationalized based on a validated, ordinal measure of self-reported physical capacity developed by Freedman et al[29] through the National Health and Aging Trends Study (NHATS). The original measure by Freedman et al[29] assesses physical capacity using 6 pairs of more challenging and less challenging physical tasks. NHIS only collects data on the 6 less challenging tasks. Thus, a 4-level physical capacity scale using the 6 less challenging tasks was created, replicating the physical capacity scale developed by Gell et al.[30] This 4-level physical capacity scale was created using the following tasks: (1) walking a quarter of a mile—about 3 city blocks; (2) climbing 10 steps without resting; (3) lifting or carrying something as heavy as 10 pounds such as a full bag of groceries; (4) stooping, bending, or kneeling; (5) reaching up over (one's) head; and (6) using (one's) fingers to grasp or handle small objects. Those who answered "not at all difficult," "only a little difficult," "somewhat difficult," or "very difficult" were categorized as able to do the task; those who responded "can't do at all" were categorized as unable to do the activity. Those who refused to answer, answered "do not do this activity," "don't know," or whose answer was not ascertained due to incompletion of the study were excluded from the study (unweighted n = 523). The 4 levels of physical capacity, ranging from highest physical capacity to lowest physical capacity, were: able to perform all 6 tasks; able to perform 4 to 5 tasks; able to perform 2 to 3 tasks; and able to perform 0 to 1 tasks. The data set was restricted to respondents who had responses for all 6 variables.

Outcome: CRCS

Participants were asked in separate questions whether they had ever had a colonoscopy, sigmoidoscopy, or FOBT. Short descriptions of colonoscopy, sigmoidoscopy, and FOBT were provided. Those who affirmed receipt of any of these screenings provided the date of the examination and reported the amount of time that had elapsed since the last screening. The reason for each screening was recorded as well. NHIS uses a variety of methods to calculate time-since-event; the most recently implemented method (from 2005) was used in this analysis.[27]

The binary outcome of being up-to-date with CRCS was designed according to current CDC/USPSTF guidelines.[28] Individuals were considered up-to-date with CRCS if they filled at least one of the following 3 criteria: had screening colonoscopy within the last 10 years; had screening sigmoidoscopy within the past 5 years and screening FOBT within the past 3 years; and/or had screening FOBT within the past 1 year. Individuals who answered "no" to "have you ever had a colonoscopy?" and "have you ever had a sigmoidoscopy?" and "have you ever had a blood stool test, using a home test kit?," or whose colonoscopy, FS, and/or FOBT were all not within the timeframe recommended by CDC/USPSTF guidelines comprised the comparator group, that is, not up-to-date with CRCS. Those who selected "because of a routine examination" as the reason for having one of these examinations were considered to have received screening according to USPSTF guidelines.

Covariates

Race and Ethnicity

A 4-level race category was created: white; black/African American only; Asian only; and "other" (ie, American Indian/Alaska Native only, multiple race, or race group not releasable due to confidentiality reasons). Hispanic ethnicity was operationalized into a separate binary category, with the following groups included in the "Hispanic" category: multiple Hispanic; Puerto Rico; Mexican; Mexican American; Cuban/Cuban American; Dominican (Republic); Central or South American; Other Latin American, type not specified; Other Spanish; Hispanic/Latino/Spanish, nonspecific type; Hispanic/Latino/Spanish, type refused; Hispanic/Latino/Spanish, type not ascertained.

Obesity

Given the documented effect of obesity on access to CRCS,[19,31,32] obesity was dichotomized as per World Health Organization guidelines[33] into nonobese [body mass index (BMI) < 29.9] versus obese (BMI ≥ 30.0).

Health Insurance

A binary variable assessed whether or not participants were covered by a health insurance plan. Those who were insured reported having health insurance from private health insurance, Medicare, Medicaid, State Children's Health Insurance Program, a state-sponsored health plan, other government plans, and/or military plans at the time of the interview. A minority of individuals had missing data (0.1%), which were coded as "unknown" and were combined with "no health insurance" for all analyses.

Regular Source of Health Care

A binary variable assessed whether or not participants received health care from a regular source. Those who indicated they did not have a source of regular health care, or that they usually received health care from a hospital emergency room, hospital outpatient department, or no one particular place most often were categorized as not having a regular source of health care. Those who answered "is there a place you usually go to when you are sick or need advice about your health?" with "yes" or "there is >1 place" were categorized as having a regular source of health care if the health care was received at a clinic or health center; doctor's office or HMO; or some other place. Missing data (0.0096%) were coded as "unknown." Because of low cell count, these data were combined with "no regular source of health care" for all analyses.

Comorbidities

Selection of the chronic conditions was informed by the recommendations of the US Department of Health and Human Services Interagency Workgroup on multiple chronic conditions and Office of the Assistant Secretary for Health[34] on standardizing definition of chronic conditions. Data on only 10 of the groups' 20 listed chronic conditions were available in the NHIS data set. However, asthma was not included due to a high amount of missing data in the variable (88.7%).

Following the approach of Ward and Schiller[35] and Ward et al[36] a 3-level (0 to 1, 2 to 3, 4 +) multiple chronic conditions

variable was constructed. The exposure variable was not included in the count of chronic conditions. Participants who affirmed ever being told by a doctor or health professional that he or she had hypertension; coronary heart disease; stroke; diabetes; cancer or a malignancy of any kind; arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia; hepatitis; or chronic obstructive pulmonary disease were considered to have a chronic condition. Reporting weak or failing kidneys during the past 12 months was considered a proxy for having chronic kidney disease.[34] A minority of individuals had missing data, which were coded as "unknown" and included in the analyses.

Statistical Analyses

SAS version 9.4[37] was used for all analyses. Cluster, strata, and weight variables were applied to account for NHIS's complex survey design for calculation of proportions; averages; univariable and multivariable odds ratios (OR); and for all statistical tests. Statistical analyses were performed from December 2014 to May 2015.

The χ^2 tests were used to test differences between proportions. Univariable analyses of each covariate's relationship with the outcome were performed to calculate OR and 95% confidence intervals (CI). Multivariable survey logistic regression was used to assess the relationship between CRCS and mobility disability, controlling for age, sex, education, health insurance, employment status, BMI, and comorbidities. Covariates were selected a priori and all were included in the multivariable model. All statistical tests were 2-sided and α was set to 0.05 for all analyses.

RESULTS

The weighted sample size was 81,953,585 individuals aged 50 to 75 years. The mean age in the sample was 60.4 years. Sociodemographic characteristics and other covariate information for the overall sample are presented in Table 1. Both weighted and unweighted sample sizes are presented. Three of the 8 covariates had missing data: 0.2% of data on health insurance status were missing; 0.0096% of data on regular source of health care were missing; and 2.9% of data on comorbidities were missing.

The present study used being up-to-date with any CRCS as per USPSTF guidelines as the primary outcome. Secondary outcome information stratified by type of CRCS (colonoscopy, FS, and FOBT) received are presented in the Appendix (Appendix Table 1, Supplemental Digital Content 1, http://links.lww.com/JCG/A323). Weighted and unweighted sample sizes, percentages, and the results of univariable analyses examining the relationship of sociodemographic characteristics and predictors of the primary outcome are presented in Table 1.

Table 2 describes the relationships between physical capacity, being up-to-date with any CRCS, and the other

TABLE 1. Sociodemographic Characteristics and the Proportion of Respondents Aged 50-75 Up-to-Date With CRCS

	Sample		Proportion Up-to-Date With CRCS		
Characteristic	**N**	**n (%)*,†**	**N**	**n (%)*,†**	***P*‡**
Overall	12,431	81,953,585 (100.0)	58,956	39,485,786 (48.2)	—
Age (y)					
Mean (SE) = 60.4 (0.1)*					
50-59	5657	40,401,994 (49.3)	2196	15,929,679 (39.4)	**< 0.0001**
60-69	4809	30,296,535 (37.0)	2555	16,737,838 (55.2)	—
70-75	1965	11,255,056 (13.7)	1144	6,818,269 (60.6)	—
Sex					
Male	6789	42,336,625 (51.7)	3219	20,151,249 (47.6)	0.27
Female	5642	39,616,960 (48.3)	2676	19,334,537 (48.8)	—
Race					
White	9613	67,979,681 (82.9)	4604	33,020,315 (48.6)	0.10
Black	1885	8,604,766 (10.5)	900	4,162,079 (48.4)	—
Asian	599	3,869,689 (4.7)	258	1,686,447 (43.6)	—
Other	334	1,499,449 (1.8)	133	616,945 (41.1)	—
Ethnicity					
Non-Hispanic	10,935	73,958,229 (90.2)	5381	36,888,390 (49.9)	**< 0.0001**
Hispanic	1496	7,995,356 (9.8)	514	2,597,396 (32.5)	—
Obesity					
Nonobese	8160	54,341,925 (66.3)	3855	26,087,083 (48.0)	0.69
Obese	4271	27,611,660 (33.7)	2040	13,398,703 (48.5)	—
Health insurance					
No/unknown	1421	8,856,274 (10.8)	237	1,514,362 (17.5)	**< 0.0001**
Yes	11,010	73,097,311 (89.2)	5658	37,971,424 (51.9)	—
Regular source of health care					
No/unknown	1448	8,429,501 (10.3)	272	1,429,483 (17.0)	**< 0.0001**
Yes	10,983	73,524,084 (89.7)	5623	38,056,303 (51.8)	—
No. comorbidities					
0-1	7130	48,890,656 (59.7)	3719	25,552,812 (52.3)	**< 0.0001**
2-3	4079	25,889,642 (31.6)	2845	18,013,511 (69.6)	—
4 +	815	4,764,023 (5.8)	573	3,409,165 (71.6)	—
Unknown	407	2,409,264 (2.9)	243	1,450,193 (60.2)	

*Weighted values.
†Proportions use weighted values.
‡Boldface indicates statistical significance ($P < 0.05$).
CRCS indicates colorectal cancer screening.

TABLE 2. Sociodemographic Characteristics and Screening Status by Level of Physical Capacity

Characteristic	P†	Level of Physical Capacity [n (%)]*			
		Able to Perform All 6 Tasks (Highest Physical Capacity)	Able to Perform 4-5 Tasks	Able to Perform 2-3 Tasks	Able to Perform 0-1 Tasks (Lowest Physical Capacity)
Total		73,411,683 (89.6)	5,792,355 (7.1)	2,192,252 (2.7)	557,295 (0.7)
Up-to-date with CRCS					
No	0.48	37,846,226 (89.1)	3,125,522 (7.4)	1,172,225 (2.8)	323,826 (0.8)
Yes		35,565,457 (90.1)	2,666,833 (6.8)	1,020,027 (2.6)	233,469 (0.6)
Age (y)					
Mean (SE)*		60.2 (0.1)	62.3 (0.3)	62.3 (0.5)	62.7 (1.0)
50-59	**< 0.0001**	37,036,855 (91.7)	2,289,594 (5.7)	857,293 (2.1)	218,252 (0.5)
60-69		26,904,765 (88.8)	2,253,413 (7.4)	909,307 (3.0)	229,050 (0.8)
70-75		9,470,063 (84.1)	1,249,348 (11.1)	425,652 (3.8)	109,993 (1.0)
Sex					
Female	**< 0.0001**	36,976,586 (87.3)	3,717,057 (8.8)	1,308,078 (3.1)	334,904 (0.8)
Male		36,435,097 (92.0)	2,075,298 (5.2)	884,174 (2.2)	222,391 (0.6)
			Race		
White	**< 0.0001**	61,232,013 (90.1)	4,726,864 (7.0)	1,529,795 (2.3)	491,009 (0.7)
Black		7,313,478 (85.0)	731,698 (8.5)	512,241 (6.0)	47,349 (0.6)
Asian		3,598,134 (93.0)	176,780 (4.6)	83,300 (2.2)	11,475 (0.3)
Other		1,268,058 (84.6)	157,013 (10.5)	66,916 (4.5)	7,462 (0.5)
Ethnicity					
Non-Hispanic	0.33	66,287,325 (89.6)	5,196,671 (7.0)	2,001,359 (2.7)	472,874 (0.6)
Hispanic		7,124,358 (89.1)	595,684 (7.5)	190,893 (2.4)	84,421 (1.1)
Obesity					
Nonobese	**< 0.0001**	50,228,304 (92.4)	2,784,596 (5.1)	1,020,671 (1.9)	308,354 (0.6)
Obese		23,183,379 (84.0)	3,007,759 (10.9)	1,171,581 (4.2)	248,941 (0.9)
Health insurance					
No/unknown	**< 0.0001**	8,083,070 (91.3)	645,318 (7.3)	82,365 (0.9)	45,521 (0.5)
Yes		65,328,613 (89.4)	5,147,037 (7.0)	2,109,887 (2.9)	511,774 (0.7)
Regular source of health care					
No/unknown	0.38	7,580,326 (89.9)	637,392 (7.6)	157,202 (1.9)	54,581 (0.6)
Yes		65,831,357 (89.5)	5,154,963 (7.0)	2,035,050 (2.8)	502,714 (0.7)
No. comorbidities					
0-1	**< 0.0001**	47,194,158 (96.5)	1,279,579 (2.6)	347,834 (0.7)	69,085 (0.1)
2-3		21,533,588 (83.2)	3,081,630 (11.9)	997,708 (3.9)	276,716 (1.1)
4 +		2,657,246 (55.8)	1,172,305 (24.6)	750,406 (15.8)	184,066 (3.9)
Unknown		2,026,691 (84.1)	258,841 (10.7)	96,304 (4.0)	27,428 (1.1)

*Weighted values.
†Boldface indicates statistical significance ($P < 0.05$).
CRCS indicates colorectal cancer screening.

covariates. Weighted sample sizes, proportions, and the results of bivariate analyses are presented. Age, sex, race, obesity, health insurance status, and comorbidity status were all highly associated with physical capacity ($P < 0.0001$ for each variable). Physical capacity was not associated with CRCS status on univariable analysis ($P = 0.13$). Similarly, neither ethnicity ($P = 0.33$) nor having a regular source of health care ($P = 0.38$) was associated with physical capacity.

Decreased physical capacity was more common among the older than the younger adults in the sample. The distribution of the 3 age groups in the lowest 3 levels of physical capacity were quite similar to each other but different from the distribution of age group in the highest physical capacity level. The mean age of the category of highest physical capacity (60.2 y, SE = 0.1) was 2 years below the mean ages of the 3 categories of lower physical capacity [able to perform 4 to 5 tasks, 62.3 (0.3); able to perform 2 to 3 tasks 62.3 (0.5); able to perform 0 to 1 task, 62.7 (1.0)].

A similar pattern was observed with comorbidities (Fig. 1, number of comorbidities by level of physical capacity); as physical capacity declined, comorbidities increased. Those with the highest physical capacity primarily had 0 to 1 comorbidities

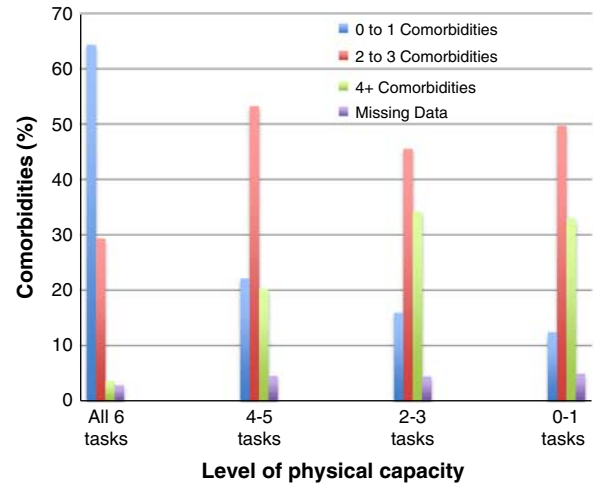

FIGURE 1. Number of comorbidities by level of physical capacity.

(64.3%), 29.3% had 2 to 3 comorbidities, and only a minority (3.6%) had 4 + comorbidities. In contrast, a minority of those in the other 3 physical capacity categories had 0 to 1 comorbidities (22.1%, 15.9%, and 12.4%, respectively). Approximately half of those in the lower physical capacity categories had 2 to 3 comorbidities (53.2%, 45.5%, and 49.7%, respectively).

Table 3 presents OR and 95% CI for the unadjusted and adjusted association of physical capacity with CRCS status. Overall, 48.2% were up-to-date with any CRCS. On univariable analysis, age category was significantly associated with any CRCS, with 48.1% of 50 to 59 year olds, 43.5% of 60 to 69 year olds, and 70.0% of 70 to 75 year olds receiving any CRCS ($P < 0.0001$). Ethnicity, obesity, health insurance status, having a regular source of health care, and number of comorbidities were also significantly associated with CRCS status. Race ($P = 0.10$), sex ($P = 0.27$), and obesity ($P = 0.69$) were not significantly associated with the outcome (data not shown).

On the unadjusted analysis, physical capacity was unrelated to CRCS status ($P = 0.48$). After adjusting for age, sex, race, ethnicity, obesity, health insurance, having a regular source of health care, and level of comorbidities, physical capacity was significantly associated with CRCS ($P = 0.0046$). The odds of CRCS decreased with decreasing physical capacity. Those able to perform 0 to 1 tasks were the least likely to have been screened for CRC in comparison with those able to perform all 6 tasks (OR, 0.65; 95% CI, 0.35-1.19), though this stratum did not meet statistical significance. Those able to perform 2 to 3 tasks (OR, 0.71; 95% CI, 0.53-0.94) and 4 to 5 tasks (OR, 0.78; 95% CI, 0.66-0.93) had similarly significantly decreased odds of CRCS.

When the chronic conditions variable was removed from the multivariable model, the *P*-value for the physical capacity exposure variable rose to 0.04 (results not presented). When age was removed in addition to the chronic conditions variable, the *P*-value for the physical capacity variable increased to 0.34. This increase of the *P*-value past the level of statistical significance did not occur with removal of any other individual variable from the regression model or combined removal of the chronic conditions variable with another variable.

DISCUSSION

An association between mobility disability, operationalized as physical capacity, and CRCS status as per USPSTF guidelines was the main outcome of this study. Our results indicate that when adjusted for potential confounders, reduced level of physical capacity is significantly associated with reduced odds of CRCS.

These results are congruent with other disparities in receipt of primary preventive screening,[17–19,22–24,38–49] including CRCS,[23,43] among people with disabilities. These results also demonstrate that disparities in access to these services increase with increasing disability severity, as previously discussed by Anderson et al.[8]

The results indicate that level of physical capacity is significantly associated with CRCS status only when adjusted for potential confounders. This pattern of negative confounding may be explained by the phenomenon of lower physical capacity with higher age and number of comorbidities but increased rates of CRCS among older patients with multiple comorbidities (Table 3).[50,51] Lowest level of physical capacity (able to perform only 0 to 1 tasks) was not found to be associated with CRCS status. However, these nonsignificant results may be due to the low cell count for this stratum of physical capacity (n = 557,295) in comparison with the cell counts for the other levels of physical capacity (able to perform 2 to 3 tasks, n = 2,192,252; able to perform 4 to 5 tasks, n = 5,792,355; able to perform 6 tasks, n = 73,411,683). The effect of relatively small cell count may similarly explain why the 2 to 3 comorbidities level was a significant predictor of CRCS (n = 25,889,642, $P < 0.0001$), whereas >4 comorbidities (n = 4,764,023, $P = 0.13$) was not significantly associated with the outcome.

The literature on access to cancer screening among people with disabilities focuses on women with mobility or intellectual disabilities, identifying inequalities in access to preventive cervical and breast cancer screening.[19,22,38,41,44,47,48,52,53] The literature examining CRCS among people with disabilities is less robust than the literature on screening for cervical or breast cancer for women with disabilities.[21] For example, previous studies on CRCS among people with disabilities used case-based methods,[43] Medicare data,[13] or use older data[42,54] whose collection preceded the present popularity of colonoscopy.[5,55] One such study[7] focused on urban/rural disparities, used an age range of 50 to 64 (even though the guidelines call for screening until age 75), and used a broad definition of disability. Colonoscopy questions asked by Miller et al[20] were limited by the authors' data set, which lacked information on the upper age limit and the timeframe of CRCS. Miller and colleagues also used a broad classification of disability, following Altman and Bernstein[56] Wei et al[17] focused on women, was limited to individuals younger than 65, and did not distinguish between screening and diagnostic colonoscopy. Although some studies have examined CRCS in people with spinal cord injuries,[57] this group is not the same as people with mobility disability, which may have been acquired in a number of ways. Given the high morbidity and mortality associated with CRC and the pattern of differential access to preventive health services among people with disabilities, our finding raises the concern that mobility disability decreases the likelihood of receiving potentially life-saving screening.

Overall CRCS proportions reported in Table 1 are lower than those previously reported. This may be because the present study used exclusion criteria more restrictive than those in the literature; previous analyses operationalized up-to-date with CRCS according to whether or not the colonoscopy, FS, or FOBT occurred within the USPSTF timeframe guidelines but did not exclude diagnostic tests.[4,5,9,58] We restricted analysis only to those who had

TABLE 3. Unadjusted and Adjusted Associations of Physical Capacity and Sociodemographic Variables With CRCS Status

	Unadjusted	Adjusted
Level of Physical Capacity	**OR (95% CI)**	**OR (95% CI)**
Able to perform all 6 tasks (highest physical capacity)	1.0	1.0
Able to perform 4-5 tasks	0.91 (0.77-1.07)	0.78 (0.66-0.93)
Able to perform 2-3 tasks	0.93 (0.72-1.19)	0.71 (0.53-0.94)
Able to perform 0-1 tasks (lowest physical capacity)	0.77 (0.46-1.28)	0.65 (0.35-1.19)

Adjusted for age, sex, race, ethnicity, obesity, health insurance, regular source of health care, and comorbidities.

CI indicates confidence interval; CRCS, colorectal cancer screening; OR, odds ratio.

colonoscopy, FS, and/or FOBT for screening (as opposed to diagnostic, other, or unknown) reasons. Proportions of adults between 50 and 75 who received CRCS according to exclusion criteria used in previous literature (ie, operationalizing up-to-date with CRCS without conditioning on reason for colonoscopy, FS, or FOBT) are consistent with trends reported previously in the literature[58] and are presented in the Appendix (Appendix Table 2, Supplemental Digital Content 2, http://links.lww.com/JCG/A324).

Limitations

The limitations of this study are worthy of attention. First, the NHIS study population does not include those in long-term care facilities.[26] Older adults in these facilities may be more likely to have mobility disability than those residing in noninstitutional settings. This study thus could not determine whether adults with mobility disability who reside in institutional settings experience disparities in CRCS. Second, this study's exclusion criteria relied on self-report for receipt of, timing of, and reason for colonoscopy, FS and/or FOBT. Errors in these reports could not be accounted for in this analysis. Next, educational level could not be controlled for as a potential confounder[58,59] because the sample weight required for this variable was different from the sample weight for the other variables used in this study; using the education variable would have resulted in incorrect results.

The categorical variable for comorbidities used in this analysis introduces limitations. The variables that informed the count are solely informed by self-reported data, making misclassification likely.[60] Further, studying comorbidity via a categorical assessment of number of comorbidities is less informative than studying the interactions unique to each individual chronic condition.[60] Finally, CRCS may not be offered to certain individuals with numerous comorbidities due to limited life expectancy associated with their comorbidities. Thus, our results may reflect decreased screening due to limited life expectancy, not physical capacity status.

Because of the constraints of available variables in NHIS, our measurement of physical capacity relied on Gell and colleagues'[30] adaptation of a validated scale. Using the original measure by Freedman et al[29] would have resulted in more sensitive operationalization of mobility disability. Restricting the analysis only to those who answered the 6 variables that were used to construct the physical capacity variable may have introduced bias into the results as well. Those who completed the questions about physical ability may have sociodemographic characteristics and/or likelihood of experiencing primary preventive care different from those who were disinclined to answer all of these questions. The cross-sectional design of NHIS makes it difficult to assess if physical capacity status preceded the beginning of eligibility for CRCS.

CONCLUSIONS

In conclusion, we found that decreased physical capacity was independently associated with reduced CRCS. Understanding the pattern of CRCS among people with disabilities has implications for targeting cancer screening at especially vulnerable groups. It is important to examine rates of cancer screening in specific subgroups of persons with disabilities because of the different barriers to care affecting each subgroup.[21,22] For example, the barriers to care and unique needs of older adults with mobility disability requiring CRCS are entirely different from those experienced by younger individuals with intellectual disability who require mammography or Pap smears. The present study calls attention to the need for CRCS to be especially targeted toward individuals with lower physical capacity. Future research should identify the specific systemic, social, and/or physical barriers to CRCS for this subgroup so that they can be addressed. Given the need to carefully articulate subgroups and the complexity of operationalizing mobility disability,[29] future research must ensure use of validated and sensitive measures of disability in its operationalization.

REFERENCES

1. Centers for Disease Control and Prevention. Colorectal cancer statistics. 2014. Available at: www.cdc.gov/cancer/colorectal/statistics/. Accessed October 29, 2014.
2. World Cancer Research Fund International. Colorectal cancer statistics. 2015. Available at: www.wcrf.org/int/cancer-facts-figures/data-specific-cancers/colorectal-cancer-statistics. Accessed December 31, 2015.
3. US Preventive Services Task Force. Recommendation summary. 2014. Available at: www.uspreventiveservicestaskforce.org/Page/Topic/recommendation-summary/colorectal-cancer-screening. Accessed October 29, 2014.
4. Shapiro JA, Seeff LC, Thompson TD, et al. Colorectal cancer test use from the 2005 National Health Interview Survey. *Cancer Epidemiol Biomarkers Prev*. 2008;17:1623–1630.
5. Klabunde CN, Joseph DA, King JB, et al. Vital signs: colorectal cancer screening test use—United States, 2012. Centers for Disease Control and Prevention. 2013.
6. Frederiksen BL, Jorgensen T, Brasso K, et al. Socioeconomic position and participation in colorectal cancer screening. *Br J Cancer*. 2010;103:1496–1501.
7. Horner-Johnson W, Dobbertin K, Lee JC, et al. Rural disparities in receipt of colorectal cancer screening among adults ages 50-64 with disabilities. *Disabil Health J*. 2014;7:394–401.
8. Anderson AE, Henry KA, Samadder NJ, et al. Rural vs urban residence affects risk-appropriate colorectal cancer screening. *Clin Gastroenterol Hepatol*. 2013;11:526–533.
9. Klabunde CN, Cronin KA, Breen N, et al. Trends in colorectal cancer test use among vulnerable populations in the United States. *Cancer Epidemiol Biomarkers Prev*. 2011;20:1611–1621.
10. Asgary R, Garland V, Jakubowski A, et al. Colorectal cancer screening among the homeless population of New York City shelter-based clinics. *Am J Public Health*. 2014;104:1307–1313.
11. Suzuki R, Wallace PM, Small E. Race, health-related quality of life and colorectal dancer screening rates in the National Health Interview Survey. *Am J Health Behav*. 2015;39:132–139.
12. Collazo TH, Jandorf L, Thelemaque L, et al. Screening colonoscopy among uninsured and underinsured urban minorities. *Gut Liver*. 2015;9:502–508.
13. Schenck AP, Peacock SC, Klabunde CN, et al. Trends in colorectal cancer test use in the medicare population, 1998-2005. *Am J Prev Med*. 2009;37:1–7.
14. Jacob BJ, Baxter NN, Moineddin R, et al. Social disparities in the use of colonoscopy by primary care physicians in Ontario. *BMC Gastroenterol*. 2011;11:102.
15. Kroll T, Jones GC, Kehn M, et al. Barriers and strategies affecting the utilisation of primary preventive services for people with physical disabilities: a qualitative inquiry. *Health Soc Care Community*. 2006;14:284–293.
16. Hwang K, Johnston M, Tulsky D, et al. Access and coordination of health care service for people with disabilities. *J Disabil Policy Stud*. 2009;20:28–34.
17. Wei W, Findley PA, Sambamoorthi U. Disability and receipt of clinical preventive services among women. *Womens Health Issues*. 2006;16:286–296.

18. Coyle CP, Santiago MC. Healthcare utilization among women with physical disabilities. *Medscape Womens Health*. 2002;7:2.
19. Bussiere C, Sicsic J, Pelletier-Fleury N. The effects of obesity and mobility disability in access to breast and cervical cancer screening in France: results from the national health and disability survey. *PLoS One*. 2014;9:e104901.
20. Miller NA, Kirk A, Alston B, et al. Effects of gender, disability, and age in the receipt of preventive services. *Gerontologist*. 2014; 54:473–487.
21. Merten JW, Pomeranz JL, King JL, et al. Barriers to cancer screening for people with disabilities: a literature review. *Disabil Health J*. 2015;8:9–16.
22. Andresen EM, Peterson-Besse JJ, Krahn GL, et al. Pap, mammography, and clinical breast examination screening among women with disabilities: a systematic review. *Womens Health Issues*. 2013;23:e205–e214.
23. Angus J, Seto L, Barry N, et al. Access to cancer screening for women with mobility disabilities. *J Cancer Educ*. 2012;27:75–82.
24. Hanna LM, Taggart L, Cousins W. Cancer prevention and health promotion for people with intellectual disabilities: an exploratory study of staff knowledge. *J Intellect Disabil Res*. 2011;55:281–291.
25. National Center for Health Statistics. National Health Interview Survey 2013 data release. 2013.
26. Centers for Disease Control and Prevention/National Center for Health Statistics. About the National Health Interview Survey. 2012. Available at: www.cdc.gov/nchs/nhis/about_nhis.htm. Accessed December 25, 2014.
27. National Center for Health Statistics. Survey description, National Health Interview Survey, 2013. 2014. Available at: www.cdc.gov/nchs/nhis/quest_data_related_1997_forward.htm. Accessed May 4, 2015.
28. US Preventive Services Task Force. Final recommendation statement colorectal cancer: screening. 2014. Available at: www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/colorectal-cancer-screening. Accessed December 25, 2014.
29. Freedman VA, Kasper JD, Cornman JC, et al. Validation of new measures of disability and functioning in the National Health and Aging Trends Study. *J Gerontol A Biol Sci Med Sci*. 2011;66A:1013–1021.
30. Gell NM, Rosenberg DE, Demiris G, et al. Patterns of technology use among older adults with and without disabilities. *Gerontologist*. 2015;55:412–421.
31. Rosen AB, Schneider EC. Colorectal cancer screening disparities related to obesity and gender. *J Gen Intern Med*. 2004;19:332–338.
32. Ferrante JM, Ohman-Strickland P, Hudson SV, et al. Colorectal cancer screening among obese versus non-obese patients in primary care practices. *Cancer Detect Prev*. 2006;30: 459–465.
33. World Health Organization. BMI classification. 2015. Available at: http://apps.who.int/bmi/index.jsp?introPage = intro_3.html. Accessed January 13, 2015.
34. Goodman RA, Posner SF, Huang ES, et al. Defining and measuring chronic conditions: imperatives for research, policy, program, and practice. *Prev Chronic Dis*. 2013;10:E66.
35. Ward BW, Schiller JS. Prevalence of multiple chronic conditions among US adults: estimates from the National Health Interview Survey, 2010. *Prev Chronic Dis*. 2013;10:E65.
36. Ward BW, Schiller JS, Goodman RA. Multiple chronic conditions among US adults: a 2012 update. *Prev Chronic Dis*. 2014;11:E62.
37. SAS (Computer Program). *Version 94*. Cary, NC: SAS Institute Inc.; 2013.
38. Armour BS, Thierry JM, Wolf LA. State-level differences in breast and cervical cancer screening by disability status: United States, 2008. *Womens Health Issues*. 2009;19:406–414.
39. Cobigo V, Ouellette-Kuntz H, Balogh R, et al. Are cervical and breast cancer screening programmes equitable? The case of women with intellectual and developmental disabilities. *J Intellect Disabil Res*. 2013;57:478–488.
40. Courtney-Long E, Armour B, Frammartino B, et al. Factors associated with self-reported mammography use for women with and women without a disability. *J Women's Health*. 2011; 20:1279–1286.
41. Davies N, Duff M. Breast cancer screening for older women with intellectual disability living in community group homes. *J Intellect Disabil Res*. 2001;45(pt 3):253–257.
42. Diab ME, Johnston MV. Relationships between level of disability and receipt of preventive health services. *Arch Phys Med Rehabil*. 2004;85:749–757.
43. Fischer LS, Becker A, Paraguya M, et al. Colonoscopy and colorectal cancer screening in adults with intellectual and developmental disabilities: review of a series of cases and recommendations for examination. *Intellect Dev Disabil*. 2012; 50:383–390.
44. Horner-Johnson W, Dobbertin K, Andresen EM, et al. Breast and cervical cancer screening disparities associated with disability severity. *Womens Health Issues*. 2014;24:e147–e153.
45. Iezzoni LI, McCarthy EP, Davis RB, et al. Mobility impairments and use of screening and preventive services. *Am J Public Health*. 2000;90:955–961.
46. Lofters A, Guilcher S, Glazier RH, et al. Screening for cervical cancer in women with disability and multimorbidity: a retrospective cohort study in Ontario, Canada. *CMAJ Open*. 2014;2:E240–E247.
47. Parish SL, Swaine JG, Son E, et al. Receipt of mammography among women with intellectual disabilities: medical record data indicate substantial disparities for African American women. *Disabil Health J*. 2013;6:36–42.
48. Smeltzer SC. Preventive health screening for breast and cervical cancer and osteoporosis in women with physical disabilities. *Fam Community Health*. 2006;29(suppl):35s–43s.
49. Wilkinson JE, Cerreto MC. Primary care for women with intellectual disabilities. *J Am Board Fam Med*. 2008;21: 215–222.
50. Gross CP, McAvay GJ, Krumholz HM, et al. The effect of age and chronic illness on life expectancy after a diagnosis of colorectal cancer: implications for screening. *Ann Intern Med*. 2006;145:646–653.
51. Wilson JAP. Colon cancer screening in the elderly: when do we stop? *Trans Am Clin Climatol Assoc*. 2010;121:94–103.
52. Swaine JG, Parish SL, Luken K. Breast and cervical cancer screening for women with intellectual disabilities. *Health Soc Work*. 2013;38:183–186.
53. Reidy M, Denieffe S, Foran S. Cancer screening in women with intellectual disabilities: an Irish perspective. *J Intellect Disabil*. 2014;18:51–60.
54. Ramirez A, Farmer GC, Grant D, et al. Disability and preventive cancer screening: results from the 2001 California Health Interview Survey. *Am J Public Health*. 2005;95: 2057–2064.
55. Cram P, Fendrick AM, Inadomi J, et al. The impact of a celebrity promotional campaign on the use of colon cancer screening: the Katie Couric effect. *Arch Intern Med*. 2003;163: 1601–1605.
56. Altman BBA, Bernstein A. *Disability and Health in the United States, 2001-2005*. Hyattsville, MD: National Center for Health Statistics; 2008.
57. Johnston MV, Diab ME, Chu BC, et al. Preventive services and health behaviors among people with spinal cord injury. *J Spinal Cord Med*. 2005;28:43–54.
58. Shapiro JA, Klabunde CN, Thompson TD, et al. Patterns of colorectal cancer test use, including CT colonography, in the 2010 National Health Interview Survey. *Cancer Epidemiol Biomarkers Prev*. 2012;21:895–904.
59. Chiu CJ, Chiu CJ, Wray LA. Physical disability trajectories in older Americans with and without diabetes: the role of age, gender, race or ethnicity, and education. *Gerontologist*. 2011; 51:51–63.
60. Newman A. Comorbidity and multimorbidity. In: Newman AB, Cauley JA, eds. *The Epidemiology of Aging*. New York, NY: Springer Netherlands; 2013:131.