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Screening Colonoscopy Uptake Among Adult Stroke Survivors: Findings from the 2022 BRFSS Data

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Abstract: Background/Objectives: Colorectal cancer (CRC) is the second leading cause of cancer-related deaths globally. Screening for cancer helps to prevent comorbid conditions among individuals with chronic medical conditions, such as stroke. The gold standard for CRC screening is colonoscopy. Stroke is the fifth leading cause of death in the United States and a leading cause of long-term disability. This study examined the prevalence of screening colonoscopy among individuals who reported ever having had a stroke (stroke survivors). **Methods**: The 2022 Behavioral Risk Factor Surveillance System (BRFSS) data were analyzed for the weighted prevalence and odds of screening colonoscopy uptake among adults aged 45 years and older, based on having had a stroke and socioeconomic status. **Results**: Almost 6% (n = 16,371) of the adults included in the analysis (N = 285,329) reported having had a stroke, and the weighted prevalence of screening colonoscopy for this group was 73.3% compared to 67.8% for those without stroke. Stroke survivors were 1.3 times more likely to have had a screening colonoscopy compared to those without a history of stroke. Higher odds of screening colonoscopy uptake were observed among stroke survivors that were older than 45–49 years old, with high school or greater than high school education. Stroke survivors that were multiracial and without health insurance coverage had lower odds of screening colonoscopy uptake compared to those that were white and had health insurance coverage, respectively. **Conclusions**: Though adult stroke survivors, compared to those without a stroke, are more likely to report having had a screening colonoscopy, differences in screening colonoscopy uptake were observed among subgroups of this population based on sociodemographic status. Tailored interventions are needed for increasing screening colonoscopy uptake among disadvantaged subgroups.

Keywords: colorectal cancer; screening; colonoscopy; stroke

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1. Introduction

Colorectal cancer (CRC) is the third most common cancer worldwide, with almost two million cases reported in 2022 [1]. In the same year, more than 904,000 deaths were reported worldwide for CRC [1]. In the United States (U.S.), about 152,810 new cases and 53,010 deaths from CRC were estimated for the year 2024 [2]. Timely screening reduces both CRC incidence and mortality [3,4]. Though there are different methods of screening

for CRC (including colonoscopy, sigmoidoscopy, fecal occult blood tests (FOBTs), fecal immunochemical tests (FITs) and stool DNA tests), colonoscopy remains the gold standard test [5] because it facilitates the removal of pre-cancerous polyps and the early detection of cancer [6].

Stroke is ranked as the second leading cause of death worldwide, with an annual mortality rate of about 5.5 million [7,8], and the fifth leading cause of death in the United States (U.S.) [9]. Stroke is also a leading cause of long-term disability [7]. Currently, there are about 610,000 new cases of stroke in the U.S. [10]. Stroke may be the first manifestation of occult cancer or may be an indicator of an increased cancer risk in later life [11,12]. Cancer may be identified within the first year after a stroke in 2% to 5% of all patients with ischemic stroke, and in a higher percentage of stroke patients without a clear cause (cryptogenic stroke) [11,12]. Cryptogenic stroke accounts for 30% to 40% of ischemic stroke [13]. Almost one-third of stroke patients aged 18 to 49 years have cryptogenic stroke [14]. Lung cancer and CRC are strongly associated with stroke [15]. A study in Japan reported the incidence of CRC as 16 per 10,000 person-years for the general population, and nearly 500 times more in patients presenting initially with stroke [16].

Several mechanisms explain the association between stroke and CRC. The vascular risk profiles of cancer patients are similar to those of stroke patients without cancer [17]. The most important mechanism by which cancer can cause stroke is through abnormal coagulation cascades [18]. Coagulation disorders, such as disseminated intravascular coagulation (DIC), are more likely to be seen in stroke patients with cancer than without cancer [18,19]. Elevated D-Dimer levels are observed in cancer patients with cryptogenic stroke compared to stroke patients without malignancy [20].

Adenocarcinomas are especially linked with clotting disorders and malignancy-associated stroke [18]. They increase the formation of thrombi through the production of mucin. Mucin is a high-molecular-weight glycosylated substance that is secreted by endothelial cells. Adenocarcinomas of the pancreas, colon, breast, lung, prostate and ovary can secrete this substance directly into the bloodstream, thereby creating a state of hypercoagulability [21]. Cell adhesion molecules (CAMs) on endothelial cells, platelets and lymphocytes may interact with mucin to induce the formation of thrombi containing many platelets [18].

Substances that promote coagulation, such as tissue factor (TF) and cancer pro-coagulant (CP), may be directly released by cancer cells [22]. TF binds to factor VII to potentiate the coagulation cascade and thrombi formation. TF is also thought to destabilize plaques in atherosclerosis [23]. CP is released by many cancers and is known to cleave factor X to Xa, ultimately resulting in the generation of thrombin [24]. Malignant cells also release pro-coagulant cytokines such as TNF-alpha, IL-1 and IL-6. These cytokines induce endothelial cells, monocytes and cancer cells to express TF, thereby potentiating the clotting cascade [25]. In addition, the activation of a natural anticoagulant in the body, Protein C, is inhibited by these cytokines [26]. Also, platelet activation is increased in cancer patients because of the increase in locally released cytokines and secreted proteins, as well as elevated levels of von-Willebrand factor [26].

Another common mechanism linking stroke and cancer is nonbacterial thrombotic endocarditis (NBTE) [27,28]. It is a rare condition that refers to a spectrum of non-infectious lesions of the heart valves that is most seen in advanced malignancy. Sterile platelet thrombi are deposited on heart valves (aortic and mitral), and these vegetations are easily dislodged with a greater tendency for embolism and extensive infarction. Patients with NBTE have more cerebral emboli and a greater number of brain lesions compared to those without NBTE [26,28].

Many cancers and stroke share similar risk factors, including smoking, obesity, metabolic syndrome and diabetes [11,29,30]. It is therefore important to screen individuals with stroke for underlying cancers. Few studies have generally examined adherence to guideline-recommended CRC screening in stroke survivors [31], but none has specifically assessed the uptake of screening colonoscopy among stroke populations. In this study, we examined the prevalence and likelihood of obtaining screening colonoscopy among individuals who reported having had a stroke (stroke survivors).

2. Materials and Methods

2.1. Data Source and Study Participants

The 2022 Behavioral Risk Factor Surveillance System (BRFSS) data were analyzed in this study. The BRFSS conducts more than 400,000 adult interviews each year through random-digit-dialed telephone surveys and collects data on residents in all 50 states, the District of Columbia and three U.S. territories regarding their health-related risk behaviors, chronic health conditions and use of preventive services [4,32]. The standards set by the American Association of Public Opinion Research (AAPOR) Response Rate Formula 4 are utilized for calculating BRFSS response rates [33]. In 2022, the survey response rates for all states, territories and Washington, D.C. ranged from 22.8% to 66.8%, with a median of 45.1% [33]. The study participants were adults aged 45 years and older residing in the U.S.

2.2. Measures

The prevalence of screening colonoscopy uptake was the dependent variable. This was the proportion of individuals aged 45 years and older who responded to the question of whether they had a colonoscopy within the past ten years. The prevalence of stroke was the independent variable. This was the proportion of individuals aged 45 years and older who responded to the question of whether they had been told that they had ever had a stroke. Sex, age, race, education and health insurance were the covariates.

2.3. Statistical Analysis

Descriptive statistics of the respondents related to colonoscopy utilization based on stoke status were generated using frequencies and proportions. The weighted percentages of respondents who reported having a colonoscopy based on stroke status were calculated using crosstabulations (Chi square and Fisher's exact tests). The data were weighted to adjust for non-coverage, non-response and for the generalization of results using a variable provided by the BRFSS [34]. Binary logistic regression was used to calculate the adjusted odds ratios (and the related 95% confidence intervals) of having a screening colonoscopy based on reported stroke status. Adjustments were made for sex, age, race, education and healthcare coverage. The significance level was set at $p < 0.05$, and all tests were two-sided. IBM SPSS version 28 (IBM Corp., Armonk, NY, USA) [35] was used for the analysis.

2.4. Ethical Considerations

The publicly accessible BRFSS data do not contain identifiable personal information. The process of BRFSS data collection and release is governed by appropriate rules, regulations and legislative authorizations [36].

3. Results

3.1. Characteristics of the Study Population

The characteristic distributions of the unweighted frequencies and percentages of the 285,329 adult respondents included in the final analysis are illustrated in Table 1. Most of the respondents were females (n = 154,778; 54.2%), white (n = 221,322; 77.6%), 60–69 years

(n = 84,721; 29.7%), had more than a high school education (n = 200,604; 70.3%) and had health insurance coverage (n = 267,076; 93.6%). Almost 6% (n = 16,371) reported having had a stroke, and 0.34% (n = 55) of this group had CRC. Among those without stroke (n = 267,995; 93.9%), 680 (0.25%) had CRC.

Table 1. Characteristics of the study participants based on stroke status: BRFSS 2022 data.

Variable	Stroke Status					
	Yes		No		Total	
	n = 16,371	%	n = 267,995	%	n = 285,329	%
Sex						
Male	7809	6.0	121,779	93.7	129,588	45.4
Female	8562	5.7	146,216	94.1	154,778	54.2
Refused	-	-	-	-	963	0.3
Age (Years)						
45–49	630	2.4	25,450	97.4	26,080	9.1
50–59	2405	3.7	62,073	96.0	64,478	22.6
60–69	4566	5.4	80,155	94.3	84,721	29.7
70–79	5237	7.4	65,184	92.3	70,421	24.7
80+	3340	10.2	29,098	89.2	32,438	11.4
Not Sure	193	3.1	6035	96.1	7191	2.5
Race						
White, NH	12,241	5.5	209,081	94.2	221,322	77.6
Black, NH	1673	7.9	19,357	91.8	21,030	7.4
Other, NH	672	6.3	9910	93.4	10,582	3.7
Multi, NH	400	8.6	4235	90.6	4635	1.6
Hispanic	835	4.5	17,491	95.0	18,326	6.4
Not Sure	550	6.4	7921	92.7	8471	3.0
Refused	-	-	-	-	963	0.3
Education						
<High School	1551	10.0	13,908	89.3	15,459	5.4
High School	4791	7.1	62,406	92.5	67,197	23.6
>High School	9964	5.0	190,640	94.8	200,604	70.3
Not Sure	65	5.8	1041	92.6	1106	0.4
Refused	-	-	-	-	963	0.3
Health Insurance						
Yes	15,396	5.7	251,680	93.9	267,076	93.6
No	349	4.1	8130	95.4	8479	3.0
Not Sure	626	7.0	8185	92.1	8811	3.1
Refused	-	-	-	-	963	0.3
CRC Status						
Yes	55	7.5	680	92.5	735	0.3
No	16,253	5.7	266,491	94.3	282,744	99.1
Not Sure	63	7.1	824	92.9	887	0.3
Refused	-	-	-	-	963	0.3

Note: NH, non-Hispanic; CRC, colorectal cancer.

3.2. Weighted Prevalence of Screening Colonoscopy Uptake Among U.S. Adults Based on Stroke Status

Table 2 and Figure 1 show the weighted proportions of respondents (prevalence) who reported having screening colonoscopy based on their stroke status. The weighted prevalence of screening colonoscopy was 73.3% among stroke survivors, compared to 67.8% among those without stroke. Statistically significant differences based on sociodemographic status were observed in the proportions of respondents who had undergone a colonoscopy. The prevalence of colonoscopy uptake was higher among female, white and older individuals, with higher levels of education and health insurance coverage.

Table 2. Weighted prevalence of screening colonoscopy uptake among U.S. adults based on stroke status: BRFSS 2022 data.

Variable	**Stroke Status**			
	Yes	**No**	**Total**	***p*-Value**
	%	**%**	**%**	
Overall	73.3	67.8		
Sex				<0.001
Male	72.8	66.3	66.6	
Female	73.9	69.1	69.4	
Age (Years)				<0.001
45–49	35.3	29.2	29.4	
50–59	61.0	59.3	59.4	
60–69	76.5	79.2	79.0	
70–79	83.9	85.4	85.2	
80+	77.4	77.1	77.1	
Race				<0.001
White, NH	76.6	72.3	72.5	
Black, NH	69.8	69.2	69.2	
Other, NH	61.9	53.6	54.0	
Multi, NH	66.4	64.3	64.6	
Hispanic	68.1	52.1	52.6	
Education				<0.001
<High School	63.1	52.1	53.0	
High School	70.8	66.2	66.5	
>High School	78.7	71.2	71.5	
Health Insurance				<0.001
Yes	75.0	69.9	70.2	
No	42.4	26.7	27.4	

3.3. Adjusted Odds of Screening Colonoscopy Uptake Among U.S. Adults with Stroke

The weighted and unweighted results of the adjusted binary logistic regression analysis are displayed in Table 3. Adjustments were made for sex, age, race, education and health insurance coverage. The weighted results show that stroke survivors were 1.309 times (confidence interval (C.I.) = 1.307, 1.311; $p < 0.001$) more likely to report having had a screening colonoscopy compared to those without stroke. Higher odds of screening colonoscopy uptake were observed among stroke survivors that were older than 45–49 years (odds ratio (OR) $\geq$ 2.814, C.I. = 2.793, 8.346; $p < 0.001$), with a high school or greater than high school

education (odds ratio (OR) ≥ 1.267, C.I. = 1.261, 1.968; $p < 0.001$). Stroke survivors that were multiracial (OR = 0.629, C.I. = 0.624, 0.635; $p < 0.001$) and without health insurance coverage (OR = 0.388, C.I. = 0.385, 0.392; $p < 0.001$) had lower odds of screening colonoscopy uptake compared to those that were white and had health insurance coverage, respectively. The unweighted results of the adjusted binary logistic regression analysis were similar to the weighted ones.

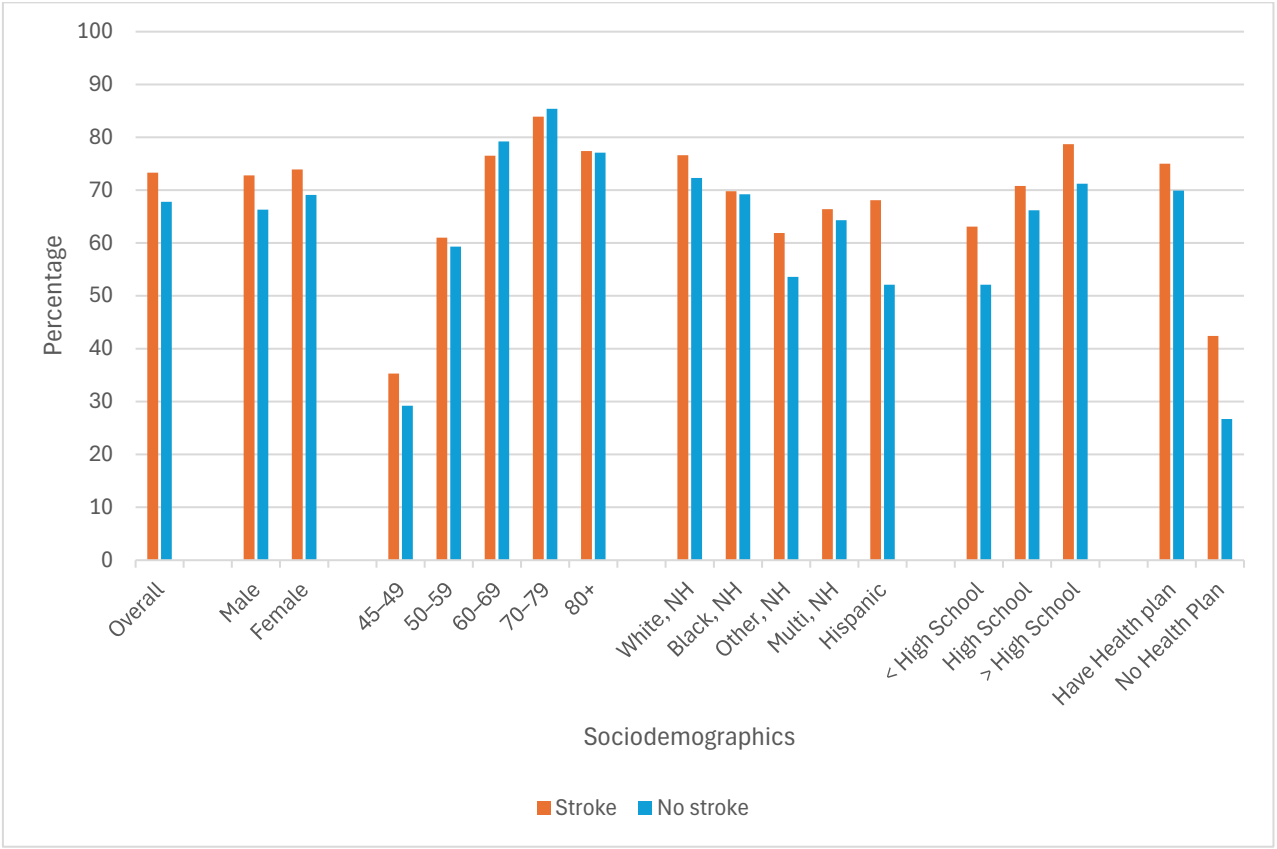


Figure 1. Weighted prevalence of screening colonoscopy uptake among U.S. Adults based on stroke status: BRFSS 2022 data.

Table 3. Adjusted odds of screening colonoscopy uptake among U.S. adults with stroke: BRFSS 2022 data.

	Weighted				Unweighted			
Variables	**aOR**	**Lower 95%CI**	**Upper 95%CI**	***p*-Value**	**aOR**	**Lower 95%CI**	**Upper 95%CI**	***p*-Value**
Stroke								
Yes	1.309	1.307	1.311	<0.001	1.226	1.181	1.272	<0.001
No	Ref.				Ref.			
Sex				<0.001				
Male	Ref.				Ref.			
Female	1.053	1.050	1.057		1.007	0.933	1.086	0.863
Age (Years)				<0.001				
45–49	Ref.				Ref.			
50–59	2.814	2.793	2.834		3.093	2.569	3.724	<0.001

Table 3. *Cont.*

	Weighted				Unweighted			
Variables	**aOR**	**Lower 95%CI**	**Upper 95%CI**	***p*-Value**	**aOR**	**Lower 95%CI**	**Upper 95%CI**	***p*-Value**
60–69	5.742	5.701	5.784		6.020	5.028	7.209	<0.001
70–79	8.801	8.735	8.868		8.346	6.957	10.013	<0.001
80+	5.870	5.823	5.917		6.127	5.082	7.386	<0.001
Race				<0.001				
White, NH	Ref.				Ref.			
Black, NH	0.875	0.871	0.879		0.933	0.825	1.055	0.269
Other, NH	0.545	0.541	0.549		0.691	0.580	0.824	<0.001
Multi, NH	0.629	0.624	0.635		0.671	0.535	0.842	<0.001
Hispanic	1.060	1.053	1.066		0.966	0.817	1.141	0.682
Education				<0.001				
<High School	Ref.				Ref.			
High School	1.267	1.261	1.273		1.328	1.168	1.509	<0.001
>High School	1.959	1.950	1.968		2.004	1.773	2.264	<0.001
Health Insurance				<0.001				
Yes	Ref.				Ref.			
No	0.388	0.385	0.392		0.355	0.283	0.447	<0.001

4. Discussion

Colorectal cancer (CRC) and stroke are among the top five causes of death in the U.S. [37]. Cancer and stroke share similar risk factors, such as smoking, obesity and diabetes. In addition, the association of stroke and cancer may be explained by several mechanisms, including abnormal coagulation cascades, the formation of thrombi from the interaction of endothelial cell adhesion molecules (CAMs) and mucin secreted by endothelial cells and the release of substances that promote hypercoagulation by cancer cells. More than 10% of persons with ischemic stroke are diagnosed with cancer within two years post-diagnosis [20,31,38], and CRC is one of the cancers most commonly linked to stroke [39].

For this cross-sectional study, we analyzed the 2022 BRFSS dataset to assess the prevalence of screening colonoscopy among U.S. adults aged 45 years and older, based on their stroke status and sociodemographic characteristics. Our findings revealed that 0.34% of the stroke population had CRC compared to 0.25% of those without stroke. The weighted prevalence of screening colonoscopy was 73.3% among stroke survivors, compared to 67.8% among those without stroke. Stroke survivors were 1.3 times more likely to report having had a screening colonoscopy compared to those without stroke, and higher odds of screening colonoscopy uptake were observed among stroke survivors that were older, with a high school or greater than high school education and health insurance coverage.

The only previous study identified in the existing literature to have assessed CRC screening in stroke survivors was authored by Simonetto et al. [31]. The findings from their study of the adherence to guideline-recommended cancer screening in stroke survivors [31] were similar to those from our present study. Stroke survivors were more likely than those without stroke to have had up-to-date CRC screening. However, the interactions for age group and gender were not significant. The study did not differentiate between the methods used for CRC screening, such as colonoscopy or stool-based tests. In addition,

the study examined the adherence to recommended screening guidelines for other cancer types in stroke survivors. Compared to persons without a stroke, survivors of stroke were more likely to adhere to recommended guidelines for lung cancer and were less likely to adhere to recommended guidelines for breast cancer.

Our findings may be explained by the higher utilization of healthcare services and more referrals to specialized care among persons with chronic medical conditions such as stroke [40]. This specialized care may include the use of preventive services. In addition, healthcare providers may increasingly recommend screening colonoscopy after stroke because of the strong association between stroke and cancer [31]. The occurrence of gastrointestinal bleeding as a potential side effect from prescribed antithrombotic medications [25] for stroke survivors may also explain the higher rate of colonoscopy performed for this population [31].

Study Limitations

The cross-sectional design of the BRFSS survey is a limitation of this study. Having stroke and receiving a colonoscopy may have occurred at different time points. For example, someone aged 60 years may be reporting a colonoscopy they received in their fifties, whereas their report of stroke may be a recent event. It is possible that they may not have had a colonoscopy after the occurrence of stroke. BRFSS surveys do not verify the clinical information provided by the respondents; therefore, recall bias is another possible limitation of this study. This bias may result in the overestimation or underestimation of the presented results. Despite these limitations, the large sample size and the use of weighting in the analysis contribute to the high validity and generalizability of this study.

5. Conclusions

Adult stroke survivors, compared to those without stroke, are more likely to report having had a screening colonoscopy. There were observed differences in screening colonoscopy uptake among subgroups of stroke survivors based on sociodemographic status. Policies and programs that target disadvantaged subgroups are needed to increase screening colonoscopy uptake. The findings from this project were presented at the 2024 International Cancer Education Conference in Lexington, KY, USA [41].

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Institutional Review Board Statement: Not applicable. Publicly accessible BRFSS data do not contain identifiable personal information. The process of BRFSS data collection and release are governed by appropriate rules, regulations and legislative authorizations [17].

Informed Consent Statement: Not applicable.

Data Availability Statement: The 2022 BRFSS dataset that was analyzed for this study may be accessed at https://www.cdc.gov/brfss/annual_data/annual_2022.html (accessed on 14 June 2024).

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