

Identification of the Cervical Cancer Screening Patterns among Black Caribbean Women Using Dendrogram and Decision Tree

Anny D. Rodriguez¹, Emir Veledar², Patria Rojas³, Richard Tardanico⁴, Vukosava Pekovic¹, Nasar U. Ahmed^{1*}

¹Department of Epidemiology, Robert Stempel College of Public Health and Social Work, Florida International University, Miami, USA

²Department of Biostatistics, Robert Stempel College of Public Health and Social Work, Florida International University, Miami, USA

³Department of Health Promotion and Disease Prevention, Robert Stempel College of Public Health and Social Work, Florida International University, Miami, USA

⁴Department of Global and Sociocultural Studies, Steven J. Green School of International & Public Affairs, Florida International University, Miami, USA

Email: *ahmendn@fiu.edu

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Abstract

Cervical cancer is a preventable yet significant cause of cancer-related deaths among women worldwide, particularly affecting socioeconomically disadvantaged groups and racial/ethnic minorities. Studies have found African American women to have higher incidence and prevalence of cervical cancer when compared to Caucasian women, but few studies have investigated the subgroups within the Black diaspora and their disparities, including Black Caribbean women. This study focuses on Black Caribbean women and the disparities in cervical cancer outcomes within this population and to identify barriers to screening and examine screening behaviors to develop culturally sensitive interventions. Data from 124 Black Caribbean women were analyzed, considering demographics, cervical cancer knowledge, screening practices, and healthcare-seeking behaviors. Two clustering methods, dendrograms and classification and regression trees, were performed to visualize and understand patterns in screening behaviors. The findings revealed disparities in screening rates based on age and country of birth, with older women and US-born participants having higher screening rates. Healthcare provider recommendations played a crucial role in screening adherence. The study emphasizes the need for culturally tailored screening programs and awareness campaigns to address knowledge gaps and cultural beliefs affecting screening behaviors. Improving knowledge, understanding cultural beliefs, and enhancing patient-provider relationships are essential in reducing the disparity in cervical cancer outcomes among Black Caribbean women in South Florida and similar populations.

Keywords

Cervical Cancer, Screening, Barriers, Clustering

1. Introduction

Cervical cancer is one of the most preventable cancers and is among the top leading causes of cancer-related deaths among women worldwide, with an estimated 530,000 new cases and 270,000 deaths annually (Small Jr. et al., 2017; Olusola et al., 2019). In the United States, cervical cancer ranks fourth most common cancer among women, with an estimated 13,800 new cases in 2020 (Fontham et al., 2020). It has been well documented that cervical cancer screening is very effective for early detection and have improved overall health outcomes, including treatments. Since the introduction and use of cervical cancer screening techniques in the 1950s, there has been a 75% decline in late-stage cervical cancer mortality. However, due to low screening rates among socioeconomically disadvantaged groups, including racial and ethnic minorities, there had higher late-stage diagnoses rates and higher mortality rates when compared with their counterparts (Tsikouras et al., 2016; Burd, 2003; Akinlotan et al., 2017).

Screening for cervical cancer involves either a Papanicolaou (Pap) test or Human papillomavirus (HPV) test. United States Preventive Services Task Force (USPSTF), the American College of Obstetricians and Gynecologists (ACOG), and the American Cancer Society (ACS) are recommending women of average risk to receive either test at age 21 unless recommended earlier by their physician (United States Preventive Services Task Force, 2018; American College of Obstetricians and Gynecologists, 2016; American Cancer Society, 2021; Tsikouras et al., 2016). Frequency of test recommendations vary by each of the governing bodies, including the screening type (United States Preventive Services Task Force, 2018; American College of Obstetricians and Gynecologists, 2016; American Cancer Society, 2021). Both the USPSTF and the ACOG recommend that women undergo a Pap test once every three years or as recommended by their physician, and the ACS recommends HPV testing once every five years (United States Preventive Services Task Force, 2018; American College of Obstetricians and Gynecologists, 2016; American Cancer Society, 2021).

Previous studies have found disparities in cervical cancer mortality between Caucasians and African Americans. Although the cervical cancer incidence rate was only 15% higher (9.0 vs. 7.2 per 100,000), the mortality rate was much higher, 200%, in African American women as compared with Caucasian women (Olusola et al., 2019; Maguire et al., 2017; Moore de Peralta et al., 2017). The screening plays a crucial role in the cancer burden. Even with low screening rates, Black women had higher late-stage cervical cancer incidence rates than Caucasian women (Maguire et al., 2017; Moore de Peralta et al., 2017). Furthermore, research on cancer risks among Black Caribbean women living in the U.S.

were shown to have higher morbidity and mortality for cervical cancer compared to overall rates in African American women (Barreto-Coelho et al., 2019; Pinheiro et al., 2016; Amuta-Jimenez et al., 2022). To address the cervical cancer morbidity and mortality disparities, early detection plays the central role.

In fact, among Black women in the US, Black Caribbean women receive cervical cancer screenings with much lower prevalence than US-born African Americans (Barreto-Coelho et al., 2019; Pinheiro et al., 2016; Ebu et al., 2014). Many studies concluded that mainly due to the low screening rates, they have higher rates of late-stage diagnosis, delayed treatment, and higher mortality for cervical cancer (Pinheiro et al., 2016; Ebu et al., 2014; Endeshaw et al., 2018). The reasons for these disparities among Black women are not well-understood.

Traditionally, most studies on Black women have treated them as a homogeneous population without recognizing any cultural differences among the varying subgroups within the Black community (Siegel, Miller, & Jemal, 2020; Ford & Kelly, 2005). Very little research has been done to address ethnic diversity among Black women and that may help explain differential high rate of cancer burden between US-born Black women and Caribbean-born Black women. There is a gap in knowledge, and it is imperative to provide insight to determining the best approach for creating culturally sensitive cervical cancer screening programs to reduce the disparity. There is a need for understanding the whole decision process of receiving cervical screening amongst Black Caribbean women to examine screening barriers, healthcare practice patterns and health seeking behaviors. The purpose of this study is to identify the clustering the perceived barriers to cervical cancer screenings and examine the patterns of the screening receiving process to explore point of interventions appropriate for the Black Caribbean women of Broward County, Florida.

2. Methods

2.1. Measures

Secondary data from a cross-sectional survey was used for this study. The survey consisted of 105 true/false, structured multiple-choice and open-ended questions. The questionnaire was developed based on literature, focus groups, and validated questions from national surveys. The questionnaires were self-administered, and no personally identifiable information was collected.

Prior to enrolling, participants were asked about their ancestry and their background, those who either had Black Caribbean ancestry and/or identified as a Black Caribbean were enrolled.

For this study, the following sections were analyzed: demographic and socio-economic factors, social support system, overall cervical cancer knowledge, barriers to cervical cancer screening, and overall cervical cancer screening practices. To facilitate the analyses, response options for some variables were collapsed. For place of birth, grouping each of the islands based on their geographical grouping: USA, Lucayan Antilles (the Bahamas and Turks & Caicos), Great-

er Antilles (Cuba, Jamaica, Haiti, the Dominican Republic, and Puerto Rico), Lesser Antilles (British Virgin Islands, US Virgin Islands, Guadeloupe, Antigua, Barbados, Saint Kitts and Nevis, Montserrat, and Guyana) (Nations Online, n.d.). Relationship status was recoded to four categories including Single, Married, In a Relationship, and Divorced. Living situation was also recoded to four categories including Own, Rent, Living with Family, and Other, where living with family was defined as not contributing financially to a household in which you do not own nor rent. Finally, health insurance was grouped into three categories which include Private, Employer-Provided, and Government (i.e. Medicaid, Medicare, Obamacare, VA).

2.2. Participants

The study consisted of 124 Black Caribbean women who resided in Broward County, Florida. IRB approval was obtained, and participants were provided consent forms. The participants were informed that their participation was voluntary, and any questions that they may find uncomfortable were at their discretion to answer. Participants were compensated for their time and those who declined to participate were provided an educational handout on cervical cancer prevention from the Centers for Disease Control and Prevention (CDC). The questionnaires were completed anonymously with no personally identifiable information collected.

Broward County is the second largest county and is an urban and industrialized county in Southeastern Florida. According to the US Census, Broward's population is estimated to be 1,930,983, with 62.5% identifying as White, 32% identifying as Black or African American, and 31.1% identifying as Hispanic or Latino in 2021 (U.S. Census Bureau QuickFacts: Broward County, Florida, n.d.). West Indians (Black Caribbean) make up approximately 18% of the population, with Haitians and Jamaicans making up approximately 6% each, respectively; approximately 34% of the residents of Broward County are foreign-born (U.S. Census Bureau QuickFacts: Broward County, Florida, n.d.).

Participants were recruited from community centers, such as religious centers, medical centers, medical offices, recreational centers, and other community-centered locations such as city hall in from January 2019 until April 2019.

2.3. Statistical Methods

All statistical analyses were conducted using IBM SPSS Statistics for Mac, version 27. The alpha level for statistical significance was set at 0.05. Frequencies and percentages were calculated for categorical variables, and means, medians, and standard deviations were calculated for continuous variables. Cross-tabulations were conducted using sociodemographic variables, cervical cancer knowledge variables, and perceived barriers for cervical cancer screening variables.

A **dendrogram** was created based on cluster analysis method to display the relationships between different groups of individuals based on their characteris-

tics or attributes, to help visualize and understand any patterns that may be present among the study participants and their screenings behaviors using Ward minimum variance methods to cluster the data. **Classification and Regression Trees** (CART) were also constructed in this study. The CART is a machine learning algorithm used for prediction by recursively partitioning the data based on the values of the predictor variables. This creates a tree-like structure where each node represents a decision based on the Gini Impurity Index, a specifically identified predictor variable, and continued for each branch tracing a possible outcome decision process (Lemon et al., 2003). The CART method is an appropriate method for this analysis not only because it is most likely to select independent variables that are different from the dependent variable, but it is best used to describe any associations within the data. It is a nonparametric technique that can be used without constraints on the distribution of the variables being assessed (Lemon et al., 2003). This method may be innovative in epidemiologic studies, as it has been previously used to assess predictors for healthcare utilization, the development of screening and diagnostic tools, and for identifying and reducing health disparities (Lemon et al., 2003).

In this study, we constructed CART for the comparative outcome variable Current with Pap test vs. Not current with Pap test, where current with Pap test was defined as having a Pap test within the last two years. The CART was created to help visualize the decision-making process for individuals and their cervical cancer screening decisions based on each of the comparative outcome variables.

3. Results

3.1. Demographics

The study was comprised of 124 female participants with an average age of 49 (SD = 14.2). Participants reported having between no children and 8 children, with an average of 2. Approximately 45% were Christians and 55% were Muslims. Self-identified African American/Black represented approximately 45% of the sample, followed by Other 34%. Of those who selected Other for race/ethnicity, 15% identified as Guyanese and 11% identified as West Indian. The sample consisted of 24% participants born in the United States, 22% born in Trinidad & Tobago, 21% born in Guyana, and 33% born in other Caribbean islands. When asked about having family close by, 87% of participants said yes, and 86% of could count on their family members for support. Similarly, 85% of participants reported having friends close by, and 82% could count on their friends for support (Table 1).

3.2. Healthcare-Seeking Practices

Most participants (71%) had their last physical exam with their primary care physician within the past year. The majority (72%) mentioned that they first heard about Pap tests from their healthcare providers. Approximately 57% re-

ported that their physician first initiated the Pap test conversation, while 33% said that they were the ones who initiated the conversation. When asked if they have ever undergone a Pap test, 65.3% of participants have had a Pap test at least once in their lifetime while 33.1% have never had a Pap test. When asked about the date of their last Pap test, approximately 73% of participants had a Pap test within the past two years, while 17% had the test more than two years ago and 10% have never had a Pap test.

Table 1. Sociodemographic characteristics of sample of Black Caribbean women in Broward county FL.

Number of Participants	124
Age (mean, SD)	49 (14.2)
20 - 29	10%
30 - 39	17%
40 - 49	27%
50 - 59	23%
60 and older	23%
Religion	
Christian	45%
Muslim	55%
Race/Ethnicity	
Black/African American	45%
Hispanic/Latino	8%
Asian/Pacific Islander	11%
Other	36%
Race/Ethnicity—Other	
Guyanese	15%
West Indian	11%
Place of Birth	
USA	24%
Trinidad & Tobago	22%
Guyana	21%
Other Caribbean Island	33%
Relationship Status	
Single	25%
Married	52%
Divorced	14%

Continued

Social Support	
Family Close By	87%
Count on Family	86%
Friends Close By	85%
Count on Friends	82%
Employment Status	
Unemployed	27%
Part-Time	13%
Full-Time	60%
Monthly Income	
Below \$1000	25%
\$1001 - \$3000	36%
\$3001 - \$5000	19%
Above \$5001	11%
Highest Education	
Did not finish high school	6%
High school graduate/GED	13%
Some college/2-year degree	35%
College (4-year degree)	15%
Master's degree	28%
PhD/ED/JD/MD	4%
Living Condition	
Own	61%
Rent	26%
Staying with family	13%
Health Insurance	
No	10%
Yes	90%
Type of Health Insurance	
Private	17%
Employer	44%
Government	31%
Other	8%
Last Physical Exam	
Within past year	71%

3.3. Cervical Cancer Beliefs and Knowledge

Around 32% participants believed that cervical cancer was a death sentence. However, most participants (83.9%) believed that early detection increases the chances of being completely cured, and 93.5% believed that early detection meant a longer life expectancy. In fact, 83.9% believed that there are effective treatments available for cervical cancer. Most participants (82.3%) have heard about the HPV vaccine, but 81.5% have not taken the vaccine. However, 63.7% said that they would encourage those who were eligible to take the vaccine.

We found that 58.9% of participants were not able to identify any risk factors for cervical cancer. When asked to identify cervical cancer symptoms, 20.2% were unsure, 20.2% identified bleeding from the vagina, 16.1% identified discharge from the vagina, with 43.5% selecting both bleeding from the vagina and discharge from the vagina as symptoms.

Participants who were US-born were able to correctly identify more cervical cancer risk factors and symptoms when compared to the other groups. Over 67% participants, and 67.4% Muslim, believed Pap tests were against their religious beliefs. Of those who believed Pap tests were against religious beliefs, 50.6% identified as Black/African American, and 30.1% identified as other, of which most identified as Guyanese (52%). In fact, when considering the place of birth and whether they believed Pap tests were against religious beliefs, 34.9% were from other Caribbean countries, of which 72.4% were from Guyana. Accounting for education and those who believed Pap tests were against religious beliefs, 34.9% had some college and/or a two-year degree, and 30.1% had a master's degree. When looking at the length of time in the US, individuals who immigrated to the US were more likely to believe that Pap tests were against religious beliefs compared to those who were born in the US (74.6% vs. 25.3%, respectively).

3.4. Dendrogram Results

All predictor variables were included in the construction of the dendrogram (**Figure 1**). There are four clusters in the dendrogram, with most variables located within the first cluster. Variables are listed in **Table 2**. The first cluster, *Awareness*, contains four variables: knowing the risk factors of cervical cancer, knowing the cause of cervical cancer, knowing the symptoms of cervical cancer, and not believing that a diagnosis of cervical cancer is a death sentence. The second cluster, *Cultural Beliefs and Trust*, contains three variables: place of birth (US vs Grenada vs Other Caribbean Islands), believing that Pap tests are against religious beliefs, and believing that early detection means living longer. The third cluster, *Knowledge*, contains three variables: the ability to correctly identify risk factors, number of correctly identified risk factors, and the ability to correctly identify symptoms. The fourth and final cluster, *Age*, contains the variable age which divides the ages based on ranges (see **Table 1** for breakdown).

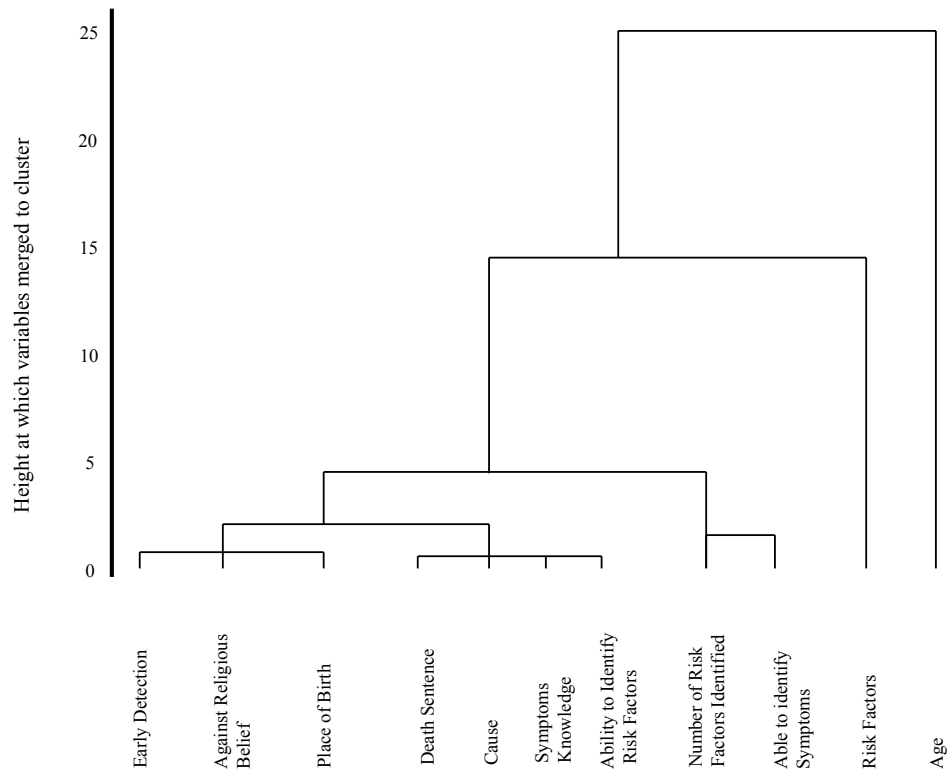


Figure 1. Dendrogram (clustering tree) of Predictor Variables, Ward Method. Variables defined in **Table 2**.

Table 2. Clusters of cervical cancer screening barriers.

Cluster/Variable Name	Description (True and false statements are marked with an asterisk*)
Cluster 1	Awareness
Risk Factors*	I know the risk factors of cervical cancer.
Cause*	I know the cause of cervical cancer.
Symptoms Knowledge*	I know the symptoms of cervical cancer.
Death Sentence*	I do not believe a diagnosis of a cervical cancer is a death sentence.
Cluster 2	Cultural Beliefs and Trust
Place of Birth	Place of birth.
Against Religious Belief*	I believe Pap tests are against my religious beliefs.
Early Detection*	I believe that early detection means I would live longer.
Cluster 3	Knowledge
Ability to Identify Risk Factors	Ability to correctly identify risk factors.
Number of Risk Factors Identified	Number of correctly identified risk factors.
Able to Identify Symptoms	Ability to correctly identify symptoms.
Cluster 4	Age
Age	Age Range

3.5. CART

The root node in the CART was the dependent variable Current vs. Not Current with Pap test (Figure 2). The primary node most associated with the variable was the time of their last annual check-up. This variable created two branches: those who had an annual check-up within the past two years and those who had an annual check-up at least within the past three years or more. Those who had an annual check-up at least within the past three years or more were influenced by whether they planned to receive an HPV vaccine or not. The dominant branch was those who had an annual check-up within the past two years, who were influenced by their length of time living in the United States. Those who were either born in the US or have lived there the longest have fewer variability in influencing variables which include not having heard of the HPV vaccine and how many risk factor they can identify. With individuals who have lived in the US for less than 20 years, being born in Guyana or another Caribbean Island provides more variability in whether they are current with Pap test with their relationship status and whether to their knowledge they have identified as ever having a Pap test.

4. Discussion

The goal of this study was to contribute to the prevention strategies for cervical cancer among Black Caribbean women in the US. We examined demographic and socio-economic factors, social support system, overall cervical cancer knowledge, barriers to cervical cancer screening, and overall cervical cancer screening

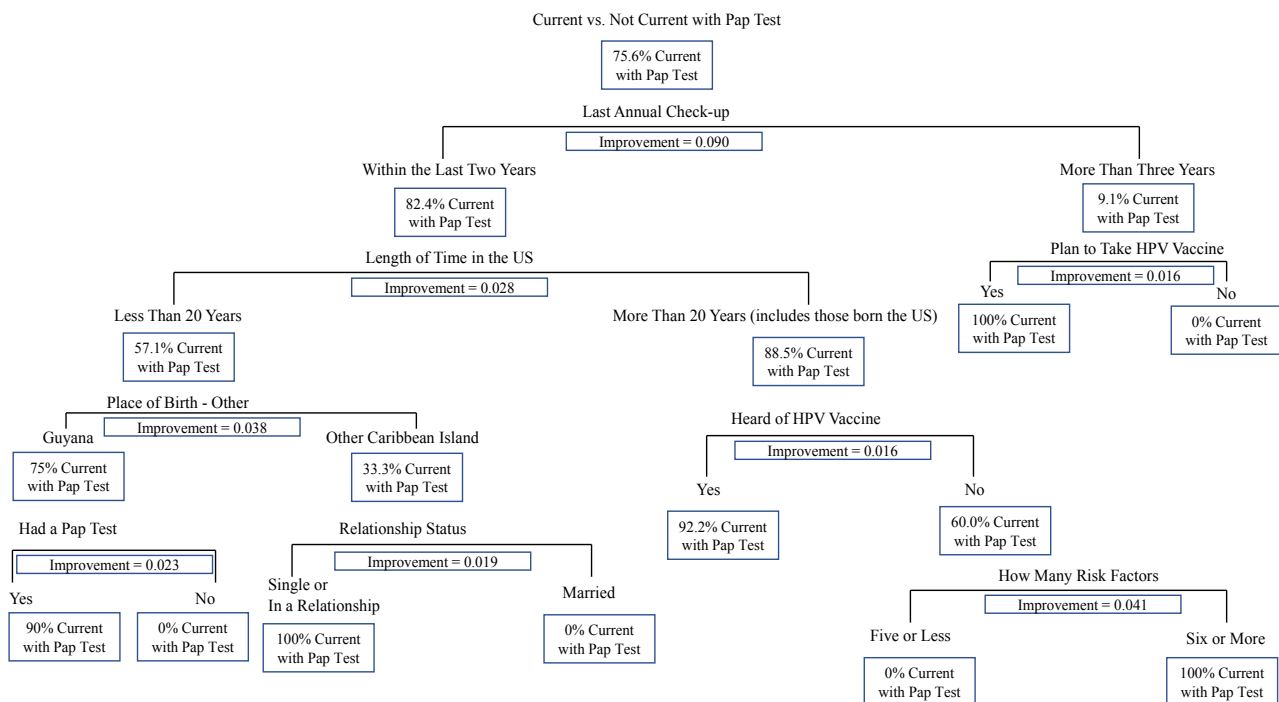


Figure 2. Classification and regression tree using Current vs. Not Current with Pap test as the predictor variable.

practices. Our study identified three areas of concern for cervical cancer screening behaviors amongst Black Caribbean women: awareness, knowledge, and beliefs. Historically, Black women have been grouped together based on their race without ever considering the implications of their varying cultural backgrounds. Our results indicated the need for identifying new approaches to reduce the current disparity.

4.1. Awareness and Knowledge

Awareness and knowledge have each identified as a barrier to cervical cancer screening by previous studies (Brown et al., 2011). This was also true for our study regarding cervical cancer knowledge, primarily its risk factors. Risk factors for cervical cancer include risky sexual behavior (such as infrequent condom use, multiple partners, early age at first intercourse), age, history of abnormal Pap tests, herpes simplex virus 2 (HSV 2) infection, and reoccurring HPV infections (American Cancer Society, 2021; Tsikouras et al., 2016; Burd, 2003).

Some studies have identified smoking as an independent risk factor that may or may not be associated with the development of cervical cancer (Su et al., 2018; Yuan et al., 2022; Fonseca-Moutinho, 2011). When asked to identify symptoms, most women could identify both vaginal bleeding and discharge from the vagina as symptoms. It is important to note that the bleeding from the vagina refers to post-intercourse bleeding, bleeding in-between menstrual cycles, and post-menopausal bleeding, and discharge from the vagina refers to foul vaginal discharge (Mwaka et al., 2016).

Regarding HPV vaccines, there are currently 3 HPV vaccines all of which can prevent infection from several strands of HPV that are known to cause cervical cancer: Gardasil, Gardasil 9, and Cervarix, each with varying dosages and age range for administration (Tsikouras et al., 2016; Petrosky et al., 2015). The first vaccine was introduced in 2007, with a max age of 26 for the first vaccination (Mwaka et al., 2016). This is important as the age range of the women who participated in this survey were between 21 - 90, with over 73% over the age of 40 at the time of the survey, thus implicating whether they were eligible to receive the vaccine at any given point. This was seen in the high percentage of participants who had not received their HPV vaccines.

Healthcare utilization was also a major factor in determining screening patterns. Time of last annual check-up was the prominent factor in the decision-making process for the participants. Participants who had attended their annual check-up within the last two years were more likely to be current with their Pap tests when compared to those who had attended their annual check-up longer than three years. Most of the participants discussed Pap tests with their healthcare provider, which has shown to be similar with other studies when compared to African American women (Amuta-Jimenez et al., 2022; Sharma et al., 2022). It is essential to explore possible interventions to bring women to healthcare, especially for their reproductive health and cancer screenings.

The CDC considers women to be of reproductive age from 18 to 44. This is

important to note as 58% of the participants were older than 44 years old. Pap tests correlate with reproductive age, as some studies have found that older women are less likely to undergo cervical cancer screening (MacLaughlin et al., 2019; Ahmed et al., 2020). One study found that women who have already undergone menopause are less likely to both seek and receive Pap tests as they believe they are no longer needed (Ahmed et al., 2022).

4.2. Beliefs

Beliefs presented as an area of concern. One of the biggest indicators of the complexity of the issue at hand is race/ethnicity. Race refers to creating groups of people based on physical characteristics and attributing those characteristics to social meaning, while ethnicity refers to the culture and geographic region in which individuals share characteristics such as language, customs, heritage, etc. Race is a social construct and thus interpretation varies. As previously mentioned in this paper, we cannot simply treat Black individuals as homogenous. Our study is based on Black Caribbean women, and yet, most of the participants did not select Black/African American as their race/ethnicity. Racial and ethnic complexities are only expected to rise as immigration increases, and individuals start to differentiate their racial identities and ethnic heritage (Mays et al., 2003). This may implicate the current screening approach as most campaigns may not be sensitive to the varying cultural, societal, and religious differences associated with race and ethnicity. Furthermore, systemic racism may affect the multi-level approach to healthcare, as Black women have been shown to identify trust in their healthcare provider and the healthcare system as catalysts for screening behaviors (Fuzzell et al., 2021). In addition to racial and ethnic groupings, place of birth appeared to be of interest. Literature has shown that culture and belief systems are heavily influenced by country of birth. Understanding that individuals who share geographical similarities can prove to be imperative when disseminating and promoting health information (Shaw et al., 2009).

4.3. Limitations

There are a few limitations associated with this study. Given the cross-sectional design of the study, follow-up with the participants to measure if the questionnaire prompted any new behaviors, such as more consistent screening practices or even improved communications with their healthcare providers was not feasible. The questionnaires were self-complete, which can lead to non-response bias as some questions may be uncomfortable for some participants to respond to, however, the anonymity and privacy provided to participants makes this unlikely. Furthermore, this is a convenient, snowball sample. The participants were recruited at local community centers where selection bias may have impacted recruitment and may not adequately represent the desired population. However, efforts had been made to recruit sample from ethnic grocery stores and low-income clinics to lower the bias. Despite possible limitations, these findings may stand as a useful contribution to addressing the gap in literature.

4.4. Summary

Using our methods, we were able to identify areas for intervention: increasing awareness, improving knowledge, and understanding beliefs. The need to increase awareness and improve knowledge about cervical cancer, as found in previous studies, is one of the most accessible areas for intervention (Taneja et al., 2021). Understanding both cultural and religious beliefs will prove necessary when promoting screenings (Padela et al., 2014). The findings suggest a complex approach to the issue at hand by indicating three levels of intervention points: women, clinicians, and screening programs. Women need to have access to information that is easy to digest and is sensitive to their varying cultures and backgrounds. Clinicians need to be trained on different methods in discussing the importance of Pap tests with their patients and how to tailor their approach to meet the needs of each individual patient. There is also a strong need to improve patient-provider relationships as this may aid in reducing the disparity (Fuzzell et al., 2021). Additionally, screening programs should be tailored to the community, not the overall population.

5. Conclusion

Our results have identified the points of interventions when determining screening behaviors amongst Black Caribbean women. Increasing awareness and knowledge as well as understanding cultural beliefs and trusts were observed as areas for improvement. Understanding healthcare-seeking patterns and promoting annual visits with primary care physicians also revealed to be imperative in promoting and increasing cervical cancer screenings.

There is a need to create and implement appropriate, culturally sensitive screening programs and campaigns to increase awareness and knowledge about cervical cancer screenings and overall female reproductive health. A user-friendly, multi-level approach is necessary to reach underserved women, with focusing on at-risk women, the clinicians that attend to them, and local public health officials. With the immigrant population expected to continue to rise exponentially, it is imperative that we create the tools and the proper environment for women of all cultural and social backgrounds to become informed about cervical cancer and perhaps start to bridge the gap.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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