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A Preliminary Evaluation of Cigarette Smoking and its Correlates Among Cancer Survivors in Puerto Rico

Ruthmarie Hernández-Torres[1], Eida M. Castro-Figueroa[2,3,4], Guillermo N. Armaiz-Pena[3,4,5], Zindie Rodriguez-Castro[3], Cristina Peña-Vargas[2,3], Lianel P. Rosario[2,3], Ana Cecilia Sala[6], Virmarie Correa-Fernández[7], Francisco Cartujano-Barrera[8], Rosario Costas-Muñiz[1,9] and Jamie S. Ostroff[1]

Abstract

Objective: This preliminary study aimed to examine the smoking rate among Puerto Rican cancer survivors and identify correlations with demographic, clinical, and psychological factors.

Methods: We conducted a secondary analysis using baseline data from 384 cancer survivors in Puerto Rico, collected between January 2018 and March 2023. Participants were recruited through community support groups and hospital settings. Data on sociodemographic characteristics, cancer type, treatments, psychological distress (assessed using the Patient Health Questionnaire-8 for depression and Generalized Anxiety Disorder-7 for anxiety), and smoking behaviors were analyzed. Significant associations with smoking were then tested in a logistic regression model, adjusted for all significant correlations.

Results: 7.5% of the sample reported smoking in the past 6 months, with a median consumption of six cigarettes per day. Depression was the only significant factor correlated with smoking, with participants who smoked reporting higher levels of depression. Other variables, such as age, gender, cancer type, and treatments, showed no significant correlation with smoking behavior. In the logistic regression model, elevated depressive symptoms were significantly associated with an increased likelihood of smoking, with individuals reporting such symptoms being 3.03 times more likely to smoke (95% CI [1.39, 6.63], $P = .005$). Other variables, such as age, gender, cancer type, and treatments, showed no significant correlation with smoking behavior.

Conclusion: Depressive symptoms are associated with smoking among Puerto Rican cancer survivors. This finding highlights the critical need for integrated mental health screening and support within smoking cessation programs tailored for this population.

Keywords

Puerto Rico, smoking, depression, cancer survivors

[1]Department of Psychiatry & Behavioral Sciences, Memorial Sloan Kettering Cancer Center, New York, NY, USA
[2]School of Behavioral Sciences, Ponce Health Sciences University, Ponce, PR, USA
[3]Ponce Research Institute, Ponce Health Sciences University, Ponce, PR, USA
[4]School of Medicine, Ponce Health Sciences University, Ponce, PR, USA
[5]School of Dental Medicine, Ponce Health Sciences University, Ponce, PR, USA
[6]Division of Cancer Medicine, University of Puerto Rico Comprehensive Cancer Center, San Juan, PR, USA
[7]Department of Psychological, Health, and Learning Sciences, University of Houston, Houston, TX, USA
[8]Department of Public Health Sciences, University of Rochester Medical Center, Rochester, NY, USA
[9]Department of Psychiatry, Weill Cornell Medical College, New York, NY, USA

Corresponding Author:
Ruthmarie Hernández-Torres, Department of Psychiatry and Behavioral Sciences, Memorial Sloan Kettering Cancer Center, 633 Third Avenue, 4 (th) Floor, New York, NY 10017, USA.
Email: hernr10@mskcc.org

Introduction

Cigarette smoking remains the leading preventable cause of cancer in the United States (U.S.)[1] and approximately 10% of the general Hispanic population in the U.S. report current smoking.[2,3] Smoking after a cancer diagnosis is associated with reduced health-related quality of life[4] and length of survival, exacerbates treatment toxicity, and increases the risk of cancer recurrence, second primary cancer, and other chronic conditions.[5-7] In the Hispanic population, significant differences in smoking prevalence have been observed by country of origin, with Puerto Ricans exhibiting the highest smoking rates in the U.S. at 29%.[8,9] However, data on smoking prevalence among Hispanic cancer survivors by country of origin is limited, especially for Puerto Ricans, given the rates observed in the general population.

Approximately 3.4 million Puerto Ricans reside on the archipelago, while 5.8 million live on the U.S. mainland, bringing the total Puerto Rican population in the U.S. to about 9 million, or roughly 1.8% of the total population.[10] Over the past decade, Puerto Rico, an unincorporated U.S. territory in the Caribbean, has faced significant healthcare challenges driven by factors such as economic decline and natural disasters like Hurricane Maria, earthquakes, and the COVID-19 pandemic. These events severely disrupted access to healthcare services, including cancer care, and had a detrimental impact on the mental health of cancer survivors.[11,12] Understanding the unique smoking patterns among cancer survivors in Puerto Rico's cultural, socioeconomic, and healthcare context is crucial for developing effective, comprehensive interventions to improve treatment outcomes and survival rates among cancer patients in the archipelago. These secondary analyses aimed to examine the prevalence of smoking among Puerto Rican cancer survivors and explore correlations with demographic, clinical, and psychological characteristics. This study represents an initial step toward understanding smoking behaviors among Puerto Rican cancer survivors and is intended to inform the design of more representative future studies.

Methods

Data Source

This secondary analysis utilized baseline data from a convenience sample of 384 cancer survivors in Puerto Rico collected to examine biopsychosocial factors influencing disease progression.[11-13] Participants were recruited through community support group meetings and hospital settings. Data were collected between January 2018 and March 2023, a period overlapping with Hurricane María's aftermath and the COVID-19 pandemic. While these events could have influenced smoking behavior and mental health, post hoc analyses showed no significant differences in smoking rates between pre-pandemic and pandemic periods.[11] Written informed consent was obtained from all participants prior to their inclusion in the study. Participants were provided with detailed information regarding the study's purpose, procedures, potential risks, and benefits, in accordance with the ethical principles.

Ethical Statement

All data included in the current study were collected in accordance with ethical principles and institutional guidelines. The studies adhered to all applicable ethical standards, ensuring the confidentiality of participant data and considering potential psychosocial impacts associated with research participation. All protocols received approval from the Institutional Review Board (IRB) at the Ponce Research Institute and Ponce Health Sciences University, Ponce, Puerto Rico. The approved projects and their corresponding protocol numbers are as follows: Protocol No. 180611-EC for the project post-hurricane cancer care: Patients' needs after Hurricane María, funded by the National Institute of Minority Health and Health Disparities (2018-2022); Protocol No. 16800 for the project Biopsychosocial predictors of tumor-associated inflammation and progression (2018-2023); and Protocol No. 2U54CA163071-06 for the project The Impact of Hurricane María on Biopsychosocial Outcomes and Health Care Services in Cancer Patients (2017-2019).

Measures

The measures included the following categories of variables: (1) sociodemographic (including age, gender, relationship status, and academic attainment); (2) clinical characteristics including type of cancer, cancer treatments received, and psychological distress, assessed using the Patient Health Questionnaire-8 (PHQ-8) for depressive symptoms[14,15] and the Generalized Anxiety Disorder-7 (GAD-7) for anxiety symptoms[15,16] and (3) smoking behaviors. Smoking behaviors were analyzed using two questions: (1) "Have you smoked cigarettes or tobacco in the last 6 months?" and, for those who answered "yes," (2) "If you checked YES, how many cigarettes do you smoke or smoked a day?". These questions, along with other study-developed items (eg, sociodemographic variables), were not formally validated but were reviewed by research staff for clarity and content relevance. Cancer types were categorized based on the Surgeon General's Report as either smoking-related cancers (SRCs) or non-smoking-related cancers (NSRC).[1,17] SRCs included cancers of the bladder, blood, cervix, colon, esophagus, kidney, larynx, leukemia, lung, liver, mouth, pancreas, rectum, stomach, throat, and uterus. NSRCs included cancers of the bone, brain, breast, gallbladder, lymphoma, melanoma, ovary, prostate, skin, soft tissue, testis, and thyroid. Respondents who reported a cancer diagnosis at any other site were categorized as survivors of other NSRCs.

Data Analysis

Descriptive statistics, including median (Mdn) and interquartile range (IQR), were used for continuous

variables. Chi-square (n > 10) and Fisher's exact (n < 10) were employed to evaluate correlations with smoking reported withing the last 6 months. A logistic regression analysis was conducted to examine associations between demographic and psychological factors and smoking among cancer survivors. Specifically, three theoretically justified covariates were included: depressive symptoms, relationship status and academic attainment.[18] The outcome variable was self-reported smoking in the past 6 months (yes/no). To assess model fit and explanatory power, the analysis included the Omnibus Test of Model Coefficients, Hosmer and Lemeshow goodness-of-fit test, and Nagelkerke R^2. To improve estimate stability given the small number of events, a bootstrap procedure with 1000 resamples and 95% percentile confidence intervals was employed. Statistical analyses were conducted using IBM Statistical Package for the Social Sciences for Windows, Version 29.0.1.0 (IBM SPSS v. 29.0.1.02023), including descriptive statistics and the logistic regression procedure.

Results

The analysis included 384 adult cancer survivors, of whom 29 individuals (7.5%) reported smoking within the last 6 months, with a median consumption of 6.0 cigarettes per day (IQR: 3.0-13.0). The study sample had a median age of 58 years (IQR: 50.0-66.8) and was predominantly female (94.0%). Half of the participants were either married or in a consensual union (50.8%), and nearly 40% had a high school or lower education level. Non-smoking-related cancers were the most frequent diagnosis (91.1%), with cancer treatments commonly including surgery (73.2%) and chemotherapy (60.9%). There were no significant correlations in terms of age, gender, relationship status, academic attainment, cancer type, cancer treatment, and anxiety between individuals who smoke and did not smoke ($P > .05$). The Chi-Square test indicates a statistically significant correlation between depression scores and smoking status, with a P-value of .004. This suggests that smoking status was associated with higher levels of depressive symptoms. Table 1 presents a summary of the results by group (smoking vs non-smoking).

The logistic regression model did not reach statistical significance, as indicated by the Omnibus Test of Model Coefficients ($\chi^2 = 9.682$, df = 5, $P = .085$). This suggests that the set of covariates, taken together, did not significantly associated with smoking behavior among cancer survivors. The model accounted for a modest proportion of variance in smoking status, with a Cox & Snell R^2 of 0.025 and a Nagelkerke R^2 of 0.060. Despite its limited explanatory power, the model demonstrated adequate goodness of fit according to the Hosmer and Lemeshow test ($\chi^2 = 5.062$, df = 8, $P = .751$), indicating no significant discrepancy between observed and predicted values. Participants who reported elevated depressive symptoms were significantly more likely to report smoking. Specifically, individuals categorized as having elevated depressive symptoms were 3.03 times more likely to report smoking within the past 6 months, 95% CI [1.39, 6.63], $P = .005$. This association remained statistically significant after bootstrapping (95% CI [0.18, 1.91], $P = .005$). No other significant correlations were found between smoking and relationship status or academic level (all $P > .05$). Although the model correctly classified 92.4% of participants overall, it failed to identify any of the individuals who reported smoking, reflecting a classification bias toward those who do not report smoking (specificity = 100%, sensitivity = 0%).

Discussion

The purpose of these secondary analyses was to examine the prevalence of cigarette smoking among Puerto Rican cancer survivors and to explore correlations with demographic, clinical, and psychological characteristics. The prevalence of cigarette smoking (7.5%) among this cancer survivor population is slightly lower than the 11.4% reported among cancer survivors in the U.S.[19] However, our findings reveal similarly that a notable proportion of adult cancer survivors in Puerto Rico smoke after cancer diagnosis and treatment. It is important to note the protective sociodemographic characteristics of the sample, considering that more than half of them had some technical to doctoral degree and were married or in consensual union. Additionally, the study sample had a mean age of 58 years, which is considering that smoking prevalence typically decreases with age among cancer survivors.[19] In the U.S. population, smoking rates are 15.7% for those aged 45 to 64 years (with a range of 12.7% to 19.3%), and 7.2% for individuals aged 65 and older (with a range of 6.0% to 8.7%).[20] In our sample, smoking in past 6 months rate was 7.5%, which is comparable to the national smoking rate of 7.2% for those aged 65 and older. This similarity suggests that our findings align with broader trends in decreased smoking among older cancer survivors in the U.S. These findings should be interpreted as hypothesis-generating, given the small sample of smokers and the non-representative nature of the dataset. For a more comprehensive understanding, future research should involve a larger sample of cancer survivors, incorporate age adjustments, and compare smoking behaviors between cancer survivors residing on the U.S. mainland and those in the archipelago. An age-adjusted analysis would likely highlight the challenge of persistent smoking among older cancer survivors, who are at an increased risk for poor treatment outcomes, reduced survival rates, and a greater likelihood of cancer recurrence.

Psychological distress commonly associated with a cancer diagnosis may significantly influence smoking behavior. The most notable finding from our analysis was the observed association between depressive symptoms and cigarette smoking. Individuals who reported smoking in the past 6 months also reported significantly higher levels of depressive symptoms. While our study design does not allow for testing directionality, prior literature suggests the relationship between depression and smoking may be bidirectional; individuals with depression may use

Table 1. Demographic and Clinical Characteristics of Smoking and Non-smoking Cancer Survivors in Puerto Rico (*N* = 384)

Characteristic	Total (*N* = 3 84)	Smoking (*N* = 29)	Non-smoking (*N* = 355)	*P*-value
Age median (IQR)	58.0 (50.0-66.8)	58.0 (51.0-68.5)	58.0 (49.0-66.0)	.624
Gender[a]	*n* (%)	*n* (%)	*n* (%)	
Female	361 (94.0)	27 (93.1)	334 (94.1)	.689
Male	23 (6.0)	2 (6.9)	21 (5.9)	
Relationship status[a]				
Single, never married	73 (19.0)	5 (17.2)	68 (19.2)	.388
Married/Consensual union	195 (50.8)	12 (41.4)	183 (51.5)	
Divorced/separated/widow	116 (30.2)	12 (41.4)	104 (29.3)	
Academic attainment (nominal)[a]				
high School or less	152 (39.6)	13 (44.8)	139 (39.2)	.377
technical course/associate degree	93 (24.2)	8 (27.6)	85 (23.9)	
Bachelor's degree/master's or doctorate	139 (36.2)	8 (27.6)	131 (36.9)	
Cancer type[a]				
Non-smoking related cancers	350 (91.1)	25 (86.2)	325 (91.5)	.309
Smoking related cancers	34 (8.9)	4 (13.8)	30 (8.5)	
Cancer treatment (yes vs no)				
Radiotherapy	182 (47.4)	14 (48.3)	168 (43.8)	.811
Chemotherapy	234 (60.9)	19 (65.5)	215 (56.0)	.525
Surgery	281 (73.2)	24 (82.8)	257 (66.9)	.129
Hormone Therapy	92 (24.0)	5 (17.2)	87 (22.7)	.491
Depression (PHQ-8)				
(0–9)	292(76.8)	16 (55.2)	276 (78.6)	**.004**
(10–24)	88 (23.2)	13 (44.8)	75 (21.4)	
Missing	4 (1.0)	0	4 (1.1)	
Anxiety (GAD-7)[a]				
(0–10)	317 (83.5)	24 (82.8)	293 (83.5)	.544
(11–21)	63 (16.6)	5 (17.2)	58 (16.5)	
Missing	4 (1.0)	0	4 (1.1)	

Note. Bold indicates statistical significance at $P < .05$.
[a]Indicates the use of Fisher's Exact Test.

smoking to self-regulate mood, while continued tobacco use may exacerbate or contribute to depressive symptoms. This dynamic is especially relevant in cancer populations, where both smoking and depression independently impact prognosis and quality of life.[21,22] Prior research has highlighted elevated depression rates among cancer patients who smoke, further supporting this interrelationship.[23] This finding is consistent with existing literature that identifies the significant association between depression and smoking, particularly among cancer survivors, individuals with chronic illnesses and the U.S. general adult population. The link observed between smoking and mental health emphasizes the necessity for further investigation into the interplay between these often-co-occurring conditions among Puerto Rican cancer survivors. Understanding how depression influences smoking behavior among Puerto Rican cancer survivors could inform the development of more effective smoking cessation interventions tailored to meet the psychosocial needs of this vulnerable population. For instance, integrating screening for psychological distress and mental health support into smoking cessation programs may help address the psychological barriers that individuals face when attempting to quit and maintaining smoking abstinence.

Continued smoking after a cancer diagnosis is associated with poorer treatment outcomes, increased toxicity, higher risk of recurrence, and reduced overall survival.[7] These risks are compounded when mental health conditions like depression are also present, as they can create additional barriers to cessation efforts. Integrated mental health and tobacco cessation interventions are therefore essential components of comprehensive oncology care. While the model showed high accuracy in classifying individuals who do not smoke, it failed to classify individuals who smoke. This indicates that the model may not adequately capture the factors influencing smoking behavior, particularly among those who smoke after a cancer diagnosis. It suggests that to enhance the model's accuracy for cancer survivors who smoke, additional or alternative factors, such as social drivers of health (eg, food insecurity, as identified in national U.S. samples), financial hardship, tobacco-related stigma and others should be considered.[24,25] These findings highlight the need to consider both mental health factors, such as depression, and tailored smoking cessation strategies for individuals with complex behavioral health profiles. Future research should explore the interplay between mental health conditions and smoking, especially in populations that are often overlooked in traditional smoking cessation efforts.

Additionally, further studies should seek to identify other potential factors that might better explain cigarette smoking among cancer patients, particularly those with treatment-related comorbidities.

This study has several limitations. First, the sample size was determined without a formal power analysis, which may affect the statistical power and generalizability of the findings. The use of a convenience sample primarily composed of individuals with a high school degree or higher and recruited from support groups with a predominance of women with breast cancer may limit the representativeness of the broader population of adult cancer survivors in Puerto Rico. This sample homogeneity restricted comparisons across cancer types, particularly non-smoking-related cancers, and may have introduced selection bias. Additionally, no significant demographic or clinical correlates of smoking were identified, underscoring the need for future studies to include factors such as nicotine dependence. In terms of measurement, the item assessing smoking ("Have you smoked in the past 6 months?") may not have been the most sensitive indicator of current smoking behavior. Standardized measures (eg, past 7 or 30 days) and a clearly defined timeframe for the "cigarettes per day" item could improve accuracy and interpretability. Moreover, the use of data collected over a 5-year period (2018-2023) may mask temporal trends in smoking behavior, especially in the context of events such as Hurricane María and the COVID-19 pandemic. Future studies should examine smoking rates over shorter timeframes to capture potential shifts in behavior. Importantly, the cross-sectional nature of the data precludes any causal inferences. Although a significant association was observed between depressive symptoms and smoking, the directionality of this relationship remains unclear. It is not possible to determine whether depressive symptoms lead to continued smoking, whether smoking exacerbates depressive symptoms, or whether both are influenced by unmeasured factors. Longitudinal studies incorporating repeated assessments of psychological distress (eg, PHQ-8, GAD-7) and smoking behavior are needed to test directional hypotheses and clarify the temporal dynamics of these relationships. Finally, the study did not assess several key clinical and contextual covariates that are known to influence smoking behavior in cancer populations. These could include cancer stage, time since diagnosis, active treatment status, nicotine dependence severity, and social drivers of health such as food insecurity and financial hardship. These omitted variables may act as confounders or effect modifiers in the relationship between psychological distress and smoking. Addressing these gaps is essential to develop targeted, equitable smoking cessation interventions tailored to the complex needs of Puerto Rican cancer survivors.

Conclusion

In conclusion, identifying the prevalence of smoking and its associations with mental health among cancer survivors in Puerto Rico is a critical step toward developing interventions that may improve treatment outcomes and enhancing overall health. By recognizing the multifaceted nature of smoking and its correlation to mood, oncology providers can better support their patients in reducing the risks of smoking post-cancer treatment. Targeted research and collaborative efforts are necessary to develop and implement effective smoking cessation interventions that resonate with the unique experiences of cancer survivors in Puerto Rico. Future research should focus on obtaining more comprehensive data on smoking behaviors among cancer survivors in Puerto Rico and developing culturally appropriate interventions that address the unique psychosocial needs of this population.

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ORCID iDs

Ruthmarie Hernández-Torres https://orcid.org/0000-0001-6270-0326
Guillermo N. Armaiz-Pena https://orcid.org/0000-0002-9081-5339
Cristina Peña-Vargas https://orcid.org/0000-0003-3495-5991
Lianel P. Rosario https://orcid.org/0000-0001-9446-3775
Ana Cecilia Sala https://orcid.org/0009-0002-9703-9691
Virmarie Correa-Fernández https://orcid.org/0000-0003-2548-1085
Francisco Cartujano-Barrera https://orcid.org/0000-0001-8069-1750
Jamie S. Ostroff https://orcid.org/0000-0003-2671-5680

Author Contributions

Conceptualization: Ruthmarie Hernández-Torres, Jamie S. Ostroff. Data collection: Ruthmarie Hernández-Torres, Zindie Rodríguez- Castro, Cristina Peña-Vargas, Material preparation: Ruthmarie Hernández-Torres, Zindie Rodríguez- Castro, Cristina Peña-Vargas, Lianel P. Rosario. Methodology: Ruthmarie Hernández-Torres, Jamie S. Ostroff. Formal analysis and investigation: Ruthmarie Hernández-Torres, Jamie S. Ostroff. Writing - original draft preparation: Ruthmarie Hernández-Torres, Jamie S. Ostroff. Writing - review and editing: Ruthmarie Hernández-Torres, Cristina Peña-Vargas, Lianel P. Rosario, Zindie Rodríguez- Castro, Guillermo N. Armaiz-Pena, Ana Cecilia Sala, Virmarie Correa-Fernández, Francisco Cartujano-Barrera, Rosario Costas-Muñiz, Jamie S. Ostroff. Funding acquisition: Eida M. Castro-Figueroa, Guillermo N. Armaiz-Pena. Resources: Eida M. Castro-Figueroa, Jamie S. Ostroff. Supervision: Eida M. Castro-Figueroa, Jamie S. Ostroff.

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

The datasets generated and/or analyzed during this study are not publicly available due to confidentiality agreements and the protection of sensitive participant information. However, they may be available from the corresponding author upon reasonable request, subject to institutional review and approval processes to ensure compliance with ethical guidelines.

Supplemental Material

Supplemental material for this article is available online.

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