Anxiety and depression among racial/ethnic minorities and impoverished women testing positive for BRCA1/2 mutations in the United States

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Abstract

Purpose

To outline the association between race/ethnicity and poverty status and perceived anxiety and depressive symptomologies among BRCA1/2-positive United States (US) women to identify high-risk groups of mutation carriers from medically underserved backgrounds.

Methods

211 BRCA1/2-positive women from medically underserved backgrounds were recruited through national Facebook support groups and completed an online survey. Adjusted odds ratios (aOR) and 95% confidence intervals (CIs) were estimated using multivariable logistic regression for associations between race/ethnicity, poverty status, and self-reported moderate-to-severe anxiety and depressive symptoms.

Results

Women ranged in age (18–75, M = 39.5, SD = 10.6). Most women were non-Hispanic white (NHW) (67.2%) and were not impoverished (76.7%). Hispanic women with BRCA1/2 mutations were 6.11 times more likely to report moderate-to-severe anxiety (95% CI, 2.16–17.2, p = 0.001) and 4.28 times more likely to report moderate-to-severe depressive symptoms (95% CI, 1.98–9.60, p < 0.001) than NHW women with BRCA1/2. Associations were not statistically significant among other minority women. Women living in poverty were significantly less likely to report moderate-to-severe depressive symptoms than women not in poverty (aOR, 0.42, 95% CI, 0.18–0.95, p = 0.04).

Conclusion

Hispanic women with BRCA1/2 mutations from medically underserved backgrounds are an important population at increased risk for worse anxiety and depressive symptomology. Our findings among Hispanic women with BRCA1/2 mutations add to the growing body of literature focused on ethnic disparities experienced across the cancer control continuum.

Introduction

In the United States (US), one in eight women will be diagnosed with breast cancer in their lifetime, but among these, 5–10% will test positive for BRCA1 and/or BRCA2 (BReast CAncer) genetic mutations [1]. These mutations are rare but reside on dominant genes, characteristic of a 50% inheritance rate, and thus, occur within biological family units. These mutations damage the genetic code, allowing breast, ovarian, and other cancers to grow uncontrollably [2, 3]. Unfortunately, these mutations result in a significant increase in breast cancer risk, up to 72% among BRCA1 carriers and 69% among BRCA2 carriers [4]. Similarly, when these diagnoses occur, they are more likely to be diagnosed as triple-negative breast cancer among BRCA1-positive women and hormone receptor-positive tumors among those who have BRCA2 mutations [5], both associated with higher risks of mortality [6]. Ovarian cancer incidence and recurrence are also elevated by the presence of these mutations, where BRCA1-affected women live with a 44% and BRCA2-positive women with a 17% increased risk of ovarian cancers before the age of 70 [4]. Rates of recurrence also follow an analogous path, experienced by approximately 25–30% of BRCA1/2-affected women, but remains highly contingent upon hormone receptor status, treatment(s), stage at
diagnosis [5], and associated lifestyle factors such as alcohol use, weight, and smoking, among others [7]. The gold standard of preventing breast and ovarian cancers among \textit{BRCA1/2}-positive women is through prophylactic surgeries, often conducted in combination, such as total hysterectomy, bilateral mastectomy, salpingectomy, and oophorectomy [8, 9]. Those who are planning to or currently having children opt for biannual surveillance (e.g., self-examination, magnetic resonance imaging [MRI], transvaginal ultrasound, mammogram, and bloodwork) or chemoprevention in lieu of surgery [10, 11].

Adverse mental health outcomes coexist with the impending risk of breast and ovarian cancers among \textit{BRCA1/2}-positive women in conjunction with associated prophylactic surgeries and ongoing surveillance that are necessary for health maintenance [12–14]. The constant worry about affected family members, risk of cancer, future childrearing, among others has a negative effect on mental health [14–16], health-related quality of life [17] (especially after prophylactic surgery [18, 19]), and perceived health [20, 21] among this population. Adverse mental health symptomologies have been found especially in relation to longitudinal health trajectories post-\textit{BRCA1/2} diagnosis [16, 22, 23], notably relevant if co-occurring with a cancer diagnosis [24], and among those who have or are planning to have children [20, 25]. Most commonly, anxiety and depressive symptoms occur when undergoing genetic testing [25], prophylactic surgeries [16, 20], and/or during biannual surveillance appointments [26]. While genetic testing, prophylactic surgery, and surveillance offer opportunities and knowledge to reduce breast and ovarian cancer risk among this population, it is also imperative to be aware of the pertinent negative psychosocial side effects of being diagnosed with \textit{BRCA1/2} mutations and what treatment may entail [14, 16, 20].

The impact of \textit{BRCA1/2} diagnoses and associated treatment/surveillance among medically underserved groups, such as racial/ethnic, sexual, and impoverished minorities, has outlined that breast and ovarian risk disparities exist [27]. Past literature has found that non-Hispanic white (NHW) women not living in poverty are more likely to undergo testing for \textit{BRCA1/2} mutations because these groups have access to quality healthcare and cost-related resources that other groups do not have [28]. While research on \textit{BRCA1/2} mutations and subsequent genetic testing continues to emerge, there remains unanswered questions regarding the severity of unintended consequences of these processes, such as anxiety and depression, especially among racial/ethnic and impoverished women. Furthermore, the impact on mental health among \textit{BRCA1/2}-positive women from racial/ethnic and impoverished groups remains relatively unknown, as past literature has targeted racial/ethnic minority women from one location due to difficulty in recruitment [29, 30].

\textit{Objectives}. The current study aims to outline the association between race/ethnicity and poverty status and perceived anxiety and depressive symptomologies among \textit{BRCA1/2}-positive US women to identify high-risk groups of mutation carriers from medically underserved backgrounds. Women with \textit{BRCA1/2} mutations may experience adverse mental health symptomologies related to their mutations and ongoing care, and we hypothesize that racial/ethnic minority and impoverished women may face an even more heightened threat.

\textbf{Methods}

\textbf{Study Design & Sample}

Women were recruited through national, online private support groups: \textit{BRCA1 BRCA2 Genetic Ovarian & Breast Cancer Gene} (~11,000 members), \textit{BRCA Genetic Sisters Support Group} (~6,000 members), \textit{BRCA1 & BRCA2 Support Group} (~3,300 members), \textit{BRCA Strong} (~2,500 members), \textit{BRCA Sisterhood of Hope} (~1,400 members), Understanding \textit{BRCA} (~1,500 members), \textit{BRCA Advanced & Other Hereditary Cancers Journal Club} (~3,200
members), BRCA Preventive Mastectomy & Hysterectomy Support Group (~ 900 members), and Facing Our Risk for Cancer Empowered (FORCE) [31] message boards. All support groups required prior approval to join. Recruitment began in December 2020 and ended when enrollment reached its ceiling at 225 participants in March 2021. One recruitment Facebook/message board post was posted per week within each group (BRCA Strong only allowed one post every other week), with written permission obtained from each groups’ moderators prior to posting. The recruitment post consisted of a brief announcement introducing the nature of the current study, eligibility criteria, link to the anonymous survey as well as the survey passcode. Eligibility was limited to women 18 years or older living in the US who could read and speak English. Additionally, eligible women had undergone and tested positive for either (or both) BRCA1 and/or BRCA2 genetic mutations within the past five years and identify with at least one medically underserved population (i.e., racial, ethnic, and/or sexual minority, person with a physical disability, those with low income, first-generation immigrant, and/or those who are chronically ill). When potential participants clicked the survey link from the recruitment post, they were rerouted to an anonymous screener survey to determine eligibility, and those that fit the above criteria were rerouted to the full online survey hosted by REDCap (Research Electronic Data Capture) [32, 33] managed by Johns Hopkins Bloomberg School of Public Health (JHSPH) information technology (IT) department. Participants consented by signing electronically prior to beginning the survey, which consisted of self-reported measures of anxiety, depression, demographic characteristics, clinical cancer and genetic testing information, prophylactic surgery and ongoing surveillance history, body satisfaction, perceived worry of cancer, cancer empowerment, health-related quality of life, healthcare discrimination, and healthcare access. Participants were compensated with a $20 Amazon e-gift card upon completion of the online survey. This study was approved and conducted according to the ethical standards of the JHSPH Institutional Review Board (IRB).

Model Variables

**Predictor variables.** Within the current analyses, two predictors (race/ethnicity, poverty status) were utilized. Race and ethnicity were two separate variables. The race variable was polynomial (American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, Black or African American, non-Hispanic white (NHW), biracial or multiracial) and ethnicity was dichotomous (Hispanic or Latino, not Hispanic or Latino). These two variables were then combined to create a racial/ethnic minority polynomial variable (NHW [referent], Hispanic, other racial/ethnic minority). The second predictor variable, poverty status, was originally polynomial, ranging from less than $20,000 to $200,000 or more per household per year. This was categorized by creating a cutoff in household family income pertaining to poverty status per household (less than $40,000 annually [referent], $40,000 annually or more) based upon the US Census Bureau [34]. One predictor was analyzed per outcome model.

**Outcome assessments.** Self-reported anxiety was measured using the Generalized Anxiety Disorder 7-item (GAD-7) scale [35]. Anxiety data is collected utilizing a 7-item, 4-point Likert scale asking the participant to rate how often they have been bothered by the following prompts over the past two weeks. Answers ranged from zero (not at all sure) to three (nearly every day) and were added to create a continuous total score that ranged from zero to 21. This score also could be analyzed using clinical cutoffs provided by past literature's validity and use in both the general population [35] and minority populations, such as sexual minorities [36]. Clinical cutoffs ranged from mild (zero to five), moderate (six to 10), and severe (11+) anxiety [37], with a sensitivity of 89% and specificity of 82% for generalized anxiety disorder [35]. Thus, the GAD-7 has been used in the general population as a screening tool for generalized anxiety disorder, especially among those scoring within the moderate to severe range [37], reflecting good reliability (α = 0.89) [35]. Within the current sample, reliability was excellent (α = 0.93). For the purposes of the
current study, clinical cutoffs were utilized by dichotomizing the polynomial outcomes (mild anxiety [referent], moderate/severe anxiety). Moderate/severe anxiety will be discussed as “moderate-to-severe anxiety”.

Self-reported symptoms of depression was outlined using the Patient Health Questionnaire (PHQ-9) Depression assessment, which is a 9-item, 4-point Likert scale [38]. Participants were asked to rate how often they have been bothered by the following prompts over the past two weeks, ranging from zero (not at all) to three (nearly every day). Scores were summed to create a continuous total score which ranged from zero to 27 with clinical cutoffs for minimal (zero to four), mild (five to nine), moderate (10–14) moderately severe (15–19), and severe depression (20–27) [38]. The PHQ-9 has been utilized in many diverse populations including the general US population, psychiatric populations, and obstetric-gynecologic populations, averaging 88% for sensitivity and 88% specificity for major depression. Within the current study, the PHQ-9 showed excellent reliability (α = 0.90), similar to that of past literature (α = 0.86–0.89) [38]. Clinical cutoffs were dichotomized for the purposes of this analysis and ease of interpretation for minimal/mild (referent) and moderate/moderately severe/severe depression symptoms. Moderate/moderately severe/severe depression will be discussed as “moderate-to-severe depressive symptoms”.

**Covariates.** Covariates were entered into all models considering past literature as well as having a significant relationship between covariate and the outcome or predictor. The following variables were entered as covariates across all models: age at survey completion, number of comorbid conditions, years since genetic testing, education, marital status, survivor/control status, and type of genetic mutation. Age at survey completion, number of comorbid conditions (including a past cancer diagnosis), and years since genetic testing were treated as continuous. Several categorical variables had original polynomial format such as education (less than high school, high school graduate or GED, some college or technical school, college graduate, some graduate school, Master’s degree, professional degree [JD, MD], doctoral degree) and marital status (married or living as married, divorced, separated, widowed, single). These variables were condensed into dichotomous variables for ease of interpretation: education (some college or less [referent], college graduate or above) and marital status (married/living as married [referent], other). Survivor/control status (no cancer history or control [referent], cancer history or survivor) and type of genetic mutation (BRCA1, BRCA2) were originally dichotomous.

**Statistical Methods**

Analyses were conducted utilizing Stata statistical software, version 16 [39]. Univariate chi-square tests for categorical variables and independent samples t-tests for continuous variables, combined with Pearson bivariate correlations, were conducted to determine potential covariates for demographic characteristics of interest. Crude (ORs) and adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were calculated using multivariable logistic regression models to determine an association between predictors (race/ethnicity, poverty status) and outcomes (anxiety, depression) while adjusting for potential confounders (age at survey completion, number of comorbid conditions, years since genetic testing, education, marital status, survivor/control status, and type of mutation). One model was conducted for each outcome with one corresponding predictor. All statistical tests were two-sided and statistical significance was indicated if p-values were below 0.05.

**Results**

**Characteristics of the Study Sample**

Table 1 presents the study population and characteristics overall and stratified by race/ethnicity and poverty status. A total of 211 BRCA1/2-positive women, both with and without a history of breast and/or ovarian cancer
meeting eligibility criteria were included in analyses. Overall, women ranged in age from 18 to 75 years ($M = 39.5$, $SD = 10.6$) and most did not have a history of cancer ($n = 138, 65.4\%$). The majority were non-Hispanic white (NHW) (67.2\%), completed a college or graduate degree (64.5\%), did not live in poverty (76.7\%), and identified being married or living as married (62.6\%). While 41\% of women reported having a physical disability, few reported being a sexual minority (23.2\%) or a first-immigration immigrant (6.6\%). Type of genetic mutation was split, with 43.1\% diagnosed with $BRCA1$ and 56.9\% with $BRCA2$ mutations. Per outcome, most women reported moderate-to-severe anxiety (54.0\%), while depressive symptomology was even (minimal/mild 59.2\%, moderate-to-severe 40.8\%). Multimorbidity was common in the current sample, as 61.6\% of women reported having two or more chronic conditions, including cancer. Demographic and model characteristics differed significantly between racial/ethnicity and poverty status. Women that did not live in poverty more often earned a college degree ($p = 0.000$) and were married ($p = 0.000$) than women living in poverty. Ethnically, Hispanic women reported moderate-to-severe anxiety ($p = 0.001$) more often than NHW or other women from racial/ethnic minority groups. NHW women reported minimal-to-mild depressive symptoms compared to Hispanic women, who reported them more often ($p = 0.001$).
Table 1
Participant demographic characteristics and disadvantaged health population factors, overall and by income status and racial/ethnic minority status

| PREDICTORS                      | Race/Ethnicity                        | Poverty Status                       | Total female sample |
|----------------------------------|---------------------------------------|--------------------------------------|---------------------|
|                                  | NHW (N = 142)                         | Hispanic (N = 39)                    | Overall (N = 162)   |
|                                  | Racial/Ethnic Minority (N = 30)       |                                      |                     |
|                                  | No. (%)                               | No. (%)                              | p-value             |
|                                  | No. (%)                               | No. (%)                              |                     |
|                                  | No. (%)                               | No. (%)                              |                     |
| No. (%)                          | No. (%)                               | No. (%)                              |                     |
| DISADVANTAGED HEALTH CHARACTERISTICS |                                      |                                      |                     |
| Disability status                | No disability                        | Disability                            | Missing             |
|                                  | 96 (67.6)                             | 46 (32.4)                            | 0 (0.0)             |
|                                  | 29 (74.4)                             | 10 (25.6)                            | 0 (0.0)             |
|                                  | 22 (73.3)                             | 8 (26.7)                             | 0 (0.0)             |
|                                  | 0.643                                 | 0.058                                | 0.068               |
|                                  | 118 (72.8)                            | 44 (27.2)                            | 64 (30.3)           |
|                                  | 29 (59.2)                             | 20 (40.8)                            |                     |
|                                  | 0.068                                 | 0.140                                |                     |
|                                  | 147 (69.7)                            | 64 (30.3)                            |                     |
|                                  | 162 (76.8)                            | 49 (23.2)                            |                     |
|                                  |                                      | 0 (0.0)                              |                     |
| Sexual orientation               | Straight or not gay                  | LGBTQ+ or something else             | Missing             |
|                                  | 106 (74.7)                            | 36 (25.3)                            | 0 (0.0)             |
|                                  | 33 (84.6)                             | 6 (15.4)                             | 0 (0.0)             |
|                                  | 23 (76.7)                             | 7 (23.3)                             | 0 (0.0)             |
|                                  | 0.426                                 | 0.074                                | 0.074               |
|                                  | 129 (79.6)                            | 33 (20.4)                            | 49 (23.2)           |
|                                  | 33 (67.4)                             | 16 (32.6)                            |                     |
|                                  | 0.074                                 | 0.140                                |                     |
|                                  | 162 (76.8)                            | 49 (23.2)                            |                     |
|                                  | 0 (0.0)                               | 0 (0.0)                              |                     |
| Immigration status               | Not a first-generation immigrant     | First-generation immigrant           | Missing             |
|                                  | 135 (95.1)                            | 7 (4.9)                              | 0 (0.0)             |
|                                  | 37 (94.9)                             | 2 (5.1)                              | 0 (0.0)             |
|                                  | 25 (83.3)                             | 5 (16.7)                             | 0 (0.0)             |
|                                  | 0.058                                 | 0.140                                | 0.074               |
|                                  | 149 (92.0)                            | 13 (8.0)                             | 14 (6.6)            |
|                                  | 48 (98.0)                             | 1 (2.0)                              |                     |
|                                  | 0.140                                 | 0.074                                |                     |
|                                  | 197 (93.4)                            | 14 (6.6)                             |                     |
| Multimorbidity                   | No multimorbidity                     | Two or more comorbid conditions      | Missing             |
|                                  | 53 (37.3)                             | 89 (62.7)                            | 0 (0.0)             |
|                                  | 15 (38.5)                             | 24 (61.5)                            | 0 (0.0)             |
|                                  | 13 (43.3)                             | 17 (56.7)                            | 0 (0.0)             |
|                                  | 0.828                                 | 0.463                                | 0.463               |
|                                  | 60 (37.0)                             | 102 (63.0)                           | 81 (38.4)           |
|                                  | 21 (42.9)                             | 28 (57.1)                            |                     |
|                                  | 0.463                                 | 0.463                                |                     |
|                                  | 81 (38.4)                             | 130 (61.6)                           |                     |
|                                  | 0 (0.0)                               | 0 (0.0)                              |                     |
|                                  | 0 (0.0)                               | 0 (0.0)                              |                     |
|                                  | 0 (0.0)                               | 0 (0.0)                              |                     |
## PREDICTORS

### COVARIATES

#### Education

|                          | Mild | Moderate/severe | Missing |
|--------------------------|------|-----------------|---------|
| College graduate or above| 86 (60.6) | 27 (69.2) | 23 (76.7) | 0.194 | 116 (71.6) | 20 (40.8) | **0.000** | 136 (64.5) |
| Some college or less     | 56 (39.4) | 12 (30.8) | 7 (23.3) | 0.000 | 46 (28.4) | 29 (59.2) | **0.000** | 75 (35.5) |
| Missing                  | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0.194 | 0 (0.0) | 0 (0.0) | **0.000** | 0 (0.0) |

#### Marital status

|                          | Mild | Moderate/severe | Missing |
|--------------------------|------|-----------------|---------|
| Married or living as married | 87 (61.3) | 27 (69.2) | 18 (60.0) | 0.629 | 118 (72.8) | 14 (28.6) | **0.000** | 132 (62.6) |
| Other                    | 55 (38.7) | 12 (30.8) | 12 (40.0) | 0.000 | 44 (27.2) | 35 (71.4) | 79 (37.4) |
| Missing                  | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0.000 | 0 (0.0) | 0 (0.0) | **0.000** | 0 (0.0) |

#### Cancer status

|                          | Mild | Moderate/severe | Missing |
|--------------------------|------|-----------------|---------|
| No cancer history        | 92 (64.8) | 26 (66.7) | 20 (66.7) | 0.998 | 102 (63.0) | 36 (73.5) | 0.148 | 138 (65.4) |
| Cancer survivor          | 47 (29.6) | 13 (33.3) | 10 (33.3) | 0.000 | 58 (35.8) | 12 (24.4) | 70 (33.2) |
| Missing                  | 3 (5.6) | 0 (0.0) | 0 (0.0) | 0.000 | 2 (1.2) | 1 (2.1) | 3 (1.4) |

#### Type of genetic mutation

|                          | Mild | Moderate/severe | Missing |
|--------------------------|------|-----------------|---------|
| BRCA1                    | 57 (40.1) | 17 (43.6) | 17 (56.7) | 0.251 | 72 (44.4) | 19 (38.8) | 0.483 | 91 (43.1) |
| BRCA2                    | 85 (59.9) | 22 (56.4) | 13 (43.3) | 0.000 | 90 (55.6) | 30 (61.2) | 120 (56.9) |
| Missing                  | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0.000 | 0 (0.0) | 0 (0.0) | 0 (0.0) |

### OUTCOMES

#### Anxiety

|                          | Mild | Moderate/severe | Missing |
|--------------------------|------|-----------------|---------|
| Mild                     | 63 (44.3) | 6 (15.3) | 13 (43.3) | **0.001** | 58 (35.8) | 24 (49.0) | 0.056 | 82 (38.9) |
| Moderate/severe          | 67 (47.1) | 32 (82.1) | 15 (50.0) | **0.001** | 94 (58.0) | 20 (40.8) | 114 (54.0) |
| Missing                  | 12 (8.6) | 1 (2.6) | 2 (6.7) | 0.000 | 10 (6.2) | 5 (10.2) | 15 (7.1) |
### PREDICTORS

**Depressive symptomology**

|                      | Minimal/mild | Moderate/moderately severe/severe | Missing |
|----------------------|--------------|-----------------------------------|---------|
| Age at survey completion | 40.5 (11.5) | 37.5 (8.24) | 37.5 (7.60) |
| p-value               | .151         | .069                              | .772    |
| Number of comorbid conditions | 2.13 (1.37) | 1.61 (.846) | 1.83 (1.41) |
| p-value               | .098         | .335                              | .05     |
| Years since genetic testing | 1.96 (1.49) | 1.97 (1.69) | 1.74 (1.61) |
| p-value               | .001         | .001                              | .001    |

|                      | Mean (SD) | Mean (SD) | Mean (SD) | p-value | Mean (SD) | Mean (SD) | p-value | Mean (SD) |
|----------------------|-----------|-----------|-----------|---------|-----------|-----------|---------|-----------|
| Age at survey completion | 40.5 (11.5) | 37.5 (8.24) | 37.5 (7.60) | .151 | 39.9 (9.69) | 38.2 (13.2) | .302 | 39.5 (10.6) |
| Number of comorbid conditions | 2.13 (1.37) | 1.61 (.846) | 1.83 (1.41) | .069 | 1.95 (1.29) | 2.12 (1.36) | .439 | 1.99 (1.31) |
| Years since genetic testing | 1.96 (1.49) | 1.97 (1.69) | 1.74 (1.61) | .772 | 1.99 (1.58) | 1.74 (1.37) | .335 | 1.93 (1.60) |

NHW = non-Hispanic white

LGBTQ+ = lesbian, gay, bisexual, transgender, queer, questioning, or other.

Poverty = when annual household income was less than $40,000 USD.

Disadvantaged health characteristics also include poverty status and racial/ethnic minority status.

Bolded font indicates statistically significant with corresponding p < 0.05.

### Perceived Anxiety by Race/Ethnicity and Poverty Status

Table 2 presents the associations between race/ethnicity, poverty status, and the odds of perceiving moderate-to-severe anxiety. Hispanic women with BRCA1/2 mutations were approximately six times more likely to report moderate-to-severe perceived anxiety than NHW women with BRCA1/2 mutations (OR, 6.10, 95% CI, 2.23–16.6, p = 0.001). After adjusting for covariates, this relationship remained (aOR, 6.11, 95% CI, 2.16–17.2, p = 0.001). Poverty status was not a significant predictor for odds of moderate-to-severe anxiety in crude or adjusted models. Within the crude model, poverty status was trending to predict the odds of moderate-to-severe anxiety (p = 0.05) however, this gap widened after adding covariates (p = 0.09).
**Table 2**
Crude and adjusted model odds ratios and 95% confidence intervals for odds of high anxiety associated with race/ethnicity and poverty status among BRCA1/2-positive women from disadvantaged health populations (N = 211).

| Predictors | Crude model | Adjusted model |
|------------|-------------|----------------|
|            | N | ORs  | 95% CI | p-value | N | aORs | 95% CI | p-value |
| **Race/Ethnicity** |   |       |        |         |   |       |        |         |
| NHW        | 130| 1.00  | reference |        | 129| 1.00  | reference |         |
| Hispanic   | 38 | 6.10  | 2.23–16.6 | <⑹001 | 37 | 6.11  | 2.16–17.2 | ⑹001 |
| Other racial/ethnic minority | 28 | 1.10  | .485–2.49 | .817 | 28 | 1.00  | .427–2.34 | .999 |
| **Poverty status** |   |       |        |         |   |       |        |         |
| No poverty | 152| 1.00  | reference | .052 | 150| 1.00  | reference | .088 |
| Poverty    | 44 | .510  | .259–1.00 |        | 44 | .497  | .229–1.10 |        |

NHW = non-Hispanic white

Missing values: anxiety (15), age (3), and survivor/control status (3).

Bold font indicates statistically significant with corresponding \(p<.05\).

In adjusted models, race/ethnicity and poverty status are included in subsequent models as covariates.

Covariates: age at questionnaire (continuous), number of comorbid conditions (continuous), years since genetic testing (continuous), education (some college or less, college graduate or above), marital status (married or living as married, other), survivor/control status (no cancer history, cancer history), and type of mutation (BRCA1, BRCA2).

Predictors: race/ethnicity (NHW [referent], Hispanic, other racial/ethnic minority [including Black women]) and poverty status (no poverty, poverty).

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**Perceived Depressive Symptoms by Race/Ethnicity and Poverty Status**

Table 3 depicts the relationship between race/ethnicity and poverty status and the odds of reporting perceived moderate-to-severe depressive symptomology. Race/ethnicity was the only significant predictor of moderate-to-severe depressive symptoms within crude models, where Hispanic women with BRCA1/2 mutations were significantly more likely to report moderate-to-severe depressive symptoms than NHW women with BRCA1/2 mutations (OR, 4.28, 95% CI, 1.98–9.6, \(p=0.001\)). In adjusted models, Hispanic women were almost five times more likely to report moderate-to-severe depressive symptoms than NHW women (aOR, 4.88, 95% CI, 2.12–11.2, \(p=0.001\)). Interestingly, when adjusting for covariates, women living in poverty were significantly less likely to report moderate-to-severe depressive symptoms than women living outside of poverty (aOR, 0.42, 95% CI, 0.18–0.95, \(p=0.04\)).
Table 3
Crude and adjusted model odds ratios and 95% confidence intervals for odds of more depression symptoms associated with race/ethnicity and poverty status among BRCA1/2-positive women from disadvantaged health populations (N = 211).

| Predictors                          | Crude model | Adjusted model |
|-------------------------------------|-------------|----------------|
|                                     | N  | ORs | 95% CI | p-value | N  | aORs | 95% CI | p-value |
| Race/Ethnicity                      |    |     |        |         |    |      |        |         |
| NHW                                 | 142 | 1.00 | reference |         | 137 | 1.00 | reference |         |
| Hispanic                            | 39  | 4.28 | 1.98–9.26 | <.001   | 38  | 4.88 | 2.12–11.2 | <.001   |
| Other racial/ethnic minority        | 30  | 1.51 | .676–3.38 | .313    | 30  | 1.38 | .585–3.26 | .461    |
| Poverty status                      |    |     |        |         |    |      |        |         |
| No poverty                          | 162 | 1.00 | reference | .067    | 158 | 1.00 | reference | .036    |
| Poverty                             | 49  | .519 | .258–1.04 |         | 47  | .416 | .183–.946 |         |

NHW = non-Hispanic white

Missing values: age (3) and survivor/control status (3).

Bold font indicates statistically significant with corresponding p < .05.

In adjusted models, race/ethnicity and poverty status are included in subsequent models as covariates.

Covariates: age at questionnaire (continuous), number of comorbid conditions (continuous), years since genetic testing (continuous), education (some college or less, college graduate or above), marital status (married or living as married, other), survivor/control status (no cancer history, cancer history), and type of mutation (BRCA1, BRCA2).

Predictors: race/ethnicity (NHW, Hispanic, other racial/ethnic minority [including Black women]) and poverty status (no poverty, poverty).

Discussion

Our study examined the associations between race/ethnicity and poverty status and perceived anxiety and depressive symptomologies among BRCA1/2-positive women from medically underserved backgrounds to identify high-risk groups of mutation carriers. Hispanic women with BRCA1/2 mutations were six times more likely to report moderate-to-severe perceived anxiety and more than four times more likely to report moderate-to-severe depressive symptoms than their NHW counterparts. Associations were not statistically significant among other minority women. Interestingly, women living in poverty were significantly less likely to report moderate-to-severe depressive symptoms than women not in poverty. Our findings among Hispanic women with BRCA1/2 mutations add to the growing body of literature focused on ethnic disparities experienced across the cancer control continuum from etiology through survivorship.

Over the past decade and due to the increasing availability of genetic testing, recent literature has begun to focus on BRCA1/2 genetic testing and incidence of associated cancers among specific populations [40]. In the US, access to quality healthcare, and subsequently genetic testing and associated care, are also limited among
disparate groups like Hispanic and Black/African American women with BRCA1/2 mutations [41, 42]. In a multiethnic sample of 97 Black/African American women from an urban clinic met referral criteria for BRCA1/2-associated genetic testing, but only 17 (17.5%) had received referrals from physicians [43]. Similarly, among Black/African American women at high risk for BRCA1/2 mutations, older age and not having a regular primary care physician were significantly associated with lower likelihood of genetic testing referral [44]. Black/African American and Hispanic women were also significantly less likely to be genetically tested, despite having family histories of BRCA1/2-associated cancers, than NHW women [45], with as many as 56.9% of Hispanic women in one study not knowing that this option was available. While we did not find racial differences among Black/African American women in the current study, it may be due to the underrepresentation of this population in the analyses.

A conducive study of 369 Hispanic women eligible for testing due to family history of breast/ovarian cancers, only 4.6% had reported being referred to prior BRCA1/2 testing [46]. Past literature has highlighted ethnic differences regarding the pathological characteristics of BRCA1/2-associated breast cancers [47], physician-patient communication during and after genetic testing [48], and epidemiological trends among Hispanic women in BRCA1/2 testing [49], showing that this group has a more difficult time finding and communicating care [41]. Related research has found that although interest for genetic testing was similar among racial/ethnic groups, it was more common among women who had family histories of breast or ovarian cancer regardless of race, while NHW women were more likely to pay more out-of-pocket for testing [50]. We know that Hispanic women are more likely to experience lack of access culturally-appropriate healthcare, health insurance, lower socioeconomic status, and the underutilization of preventive services such as mammograms and Pap testing [41]. Within the realm of genetic testing for BRCA1/2 mutations, cultural appropriation is pivotal for many groups, including those in the current study, to reduce language barriers to obtain accurate family histories [51]. While this appears as a small step, communicative barriers that exist today could contribute to anxiety and stress among Hispanic women being tested for BRCA1/2 mutations.

Anxiety and depression have been known to increase both during and after genetic testing for BRCA1/2 mutations [12–14]. For some populations such as Hispanic women, testing positive for BRCA1/2 mutations may feel like a death sentence, because breast cancer is the leading cause of death among this group and increase feelings of hopelessness, stress, and anxiety [52]. Unfortunately, Hispanic women and other minority women are faced with financial, communicative, and access-related barriers with receiving high-quality genetic testing and associated ongoing surveillance, prophylactic surgeries, and chemoprevention if positive [53, 54]. It appears as though Hispanic women from medically underserved backgrounds, as shown in the current study, may have an increased risk of anxiety and depression when facing a positive test versus NHW women with BRCA1/2 mutations. More recent literature has focused on general improvements for genetic testing and associated care to reduce the burden of anxiety and stress and to increase uptake from specific groups such as Hispanic and Black/African American women at risk for BRCA1/2 mutations. Specifically, current recommendations infer that culturally appropriate language and increasing the number of physicians who speak Spanish is imperative, as a larger proportion of Hispanic women have been tested when reporting to counselors or physicians in Spanish [55]. Increasing the knowledge of the benefits of genetic testing via primary care physicians [56] and bilingual media may be helpful to increase awareness of hereditary cancer risk and genetic testing availability [42].

**Study strengths.** The current study has several strengths. Our study recruited succinctly from a combination of hard-to-reach populations and those with rare hereditary cancer mutations, which are not easily recruited in-person or through hospital systems. The current study, therefore, acted as a pilot study, testing recruitment success among BRCA1/2-positive women from medically underserved backgrounds across the US. Most of the recent research on
BRCA1/2-positive women utilize small sample sizes or are qualitative in nature, however, we were successful in recruiting a moderately large sample of these at-risk women. This study was one of the first, to our knowledge, that recruited BRCA1/2-positive women from several medically underserved backgrounds, allowing limited generalizability to subgroups such as racial/ethnic minorities, those with low income, and those with cancer. Future research can utilize similar approaches to recruit BRCA1/2-positive women or other hard-to-reach groups for rare or stigmatized health conditions.

Limitations. The current study’s results should be interpreted in light of its limitations. While the current sample represented a moderately large sample, especially for a group that has been historically known as hard-to-reach [57], the data remains cross-sectional and based on self-report, possibly involving misclassification and/or recall bias. Results presented should be replicated with larger sample sizes to confirm similarities explained in this manuscript. It remains possible that by dichotomizing or condensing originally polynomial variables, we have limited the depth of detailed findings, as future research may inquire about specific racial/ethnic minority groups or levels of poverty that were not analyzed in the current study. Participants were also recruited directly from online support groups, which have been known to introduce bias by enrolling participants shown to be more open and willing to share private experiences than participants not in support groups [58]. Thus, the generalization of these results and their implications should be limited to BRCA1/2-positive women within various medically underserved populations in the US.

Abbreviations

aOR Adjusted odds ratio
BRCA BReast CAncer gene mutation
CI Confidence interval
NHW Non-Hispanic white
US United States

Conclusion

Hispanic women with BRCA1/2 mutations from medically underserved backgrounds are an important population at increased risk for anxiety and depressive symptomology. There is less incidence of cancer among Hispanic populations, but cancer remains the leading cause of death. Lack of access and insurance, coupled with underutilization of health services, such as screening, genetic testing, and prophylactic and chemoprevention treatments, may negatively impact anxiety and depression among this population. Future clinical care should focus on integrating culturally appropriate and bilingual care into genetic testing and referral medical offices, especially those offering preventive screening for breast and ovarian cancers. While anxiety and depression may be inescapable considering what BRCA1/2 mutations mean for impending cancer risk, implementing recommendations and supports for women from medically underserved backgrounds in particularly Hispanic women, may act to mitigate these adverse outcomes.

Declarations
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Availability of data and material: The datasets generated during and/or analyzed the current study are available at the Principal Investigator's (PI) discretion upon reasonable request.

Code availability: Syntax coding is available upon reasonable request from the corresponding author.

Author contributions: Kate E Dibble conceptualized and designed the study, was in charge of data acquisition, data analysis, and interpretation. Kate E Dibble also wrote the main manuscript text and revised the article, as well as approving the final version. Avonne E Connor assisted with study conceptualization and design, data interpretation, as well as drafting and finalizing the manuscript.

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Consent to participate: Informed consent was obtained from all individual participants included in the study.

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ADDITIONAL INFORMATION

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