




The Revised Champion's Health Belief Model Scale: Predictive Validity Among Brazilian Women

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Abstract

Introduction: Mammography screening is provided free of charge for the recommended target population in Brazil but participation rates have remained low, and breast cancer mortality has continued to increase. Thus, it is important to identify factors that are associated with poor participation in mammography screening so that service providers can target health promotion messages and screening programs more effectively. **Objective:** To evaluate the predictive validity of the Revised Champion's Health Belief Model scale (RCHBMS) for identifying women at high risk of not adhering to national guidelines for mammography screening in Brazil. **Methods:** We used a longitudinal survey design with a 1-year follow-up data from 194 women living in northeastern Brazil, in the city of Fortaleza, Ceará, participants completed the RCHBMS at baseline, and mammography uptake was measured 1 year later. Hierarchical logistic regression was used to determine the predictive validity of the RCHBMS for identifying women who had not adhered to recommendations for mammography screening, after accounting for the women's sociodemographic and clinical characteristics. The sensitivity and specificity of various cut-off points were calculated to determine the optimal cut-off point for identifying women at high risk of not adhering to mammography screening guidelines. **Results:** Two subscales of the RCHBMS uniquely predicted nonadherence: susceptibility and barriers, along with race and family history of cancer. The total scale score (with barriers reverse coded) was also highly predictive. For our sample, using only the RCHBMS with a cutoff of ≤ 3.67 (out of a total possible range of 1–5) yielded a high sensitivity and specificity for predicting nonadherence. **Conclusion:** Study findings support the validity and clinical utility of the RCHBM for identifying women at risk of not adhering to national guidelines for mammography screening in Brazil.

Keywords

mammography screening, instrument validation, health behavior, breast cancer, Brazil

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There is extensive research evidence showing the association between mammography screening, early detection, and higher rates of breast cancer survival (Blanks et al., 2019; Dave et al., 2018). National guidelines for mammography screening were introduced in Brazil in 2004 and were updated in 2015. Current guidelines recommend biennial screening for women between 50 and 69 years of age (National Cancer Institute, 2015). Mammography screening is provided free of charge for the recommended target population in Brazil but

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participation rates examinations have remained low. For example, a large national study by Theme Filha et al. (2016) found that adherence to national guidelines was 41.5%, much lower than the goal of 80% set by the National Cancer Institute (2015). Other population-based studies in Brazil have found similarly low rates of mammography uptake, particularly among women with lower levels of education and income (e.g., Viacava et al., 2019; Vieira et al., 2015). Low rates of mammogram screening have also been found in other low- and middle-income countries around the world, for example, in Tanzania (Ng'ida et al., 2019) and Turkey (Yilmazel, 2018) as well as in the rural Appalachian area of the United States (VanDyke & Shell, 2017). Breast cancer mortality has continued to increase in Brazil (Diniz et al., 2017), in contrast to North American and European countries where mortality has been decreasing (Siegel et al., 2017; Torre et al., 2017). Between 2008 and 2013, the total number of breast cancer deaths in Brazil increased by an average of 3.75% per year (Diniz et al., 2017). Thus, it is important to identify factors that are associated with poor participation in mammography screening so that service providers can target health promotion messages and screening programs more effectively.

Data from the 2013 National Health Survey in Brazil showed that participation in mammography screening was associated with sociodemographic factors (Silva et al., 2017). Women of low socioeconomic status, in particular, those with a lower level of education, were less likely to engage in mammography screening, as were women from ethnic minority groups and those with less healthy lifestyle behaviors. However, other researchers have highlighted women's beliefs as an important influence on mammography uptake (Marmarà et al., 2017), a factor that may be modifiable by health-care providers.

The Health Belief Model (Champion, 1999) offers a useful theoretical framework for studying breast cancer screening behavior such as breast self-examination and mammography screening. According to the Health Belief Model, preventive health behaviors and screening behaviors are influenced by perceived susceptibility to, and seriousness of the condition, perceived benefits from action, and perceived barriers to action (Skinner et al., 2015).

Review of Literature

Champion (1999) and colleagues (e.g., Champion et al., 2005) have used the Health Belief Model as a foundation for the development of several instruments related to breast cancer and mammography in the United States. Champion first developed a scale to measure perceived susceptibility to breast cancer in 1984, followed by scales to measure the perceived benefits and barriers related to

mammography, in 1995 (Champion, 1999). In 1999, these were combined and revised to become Champion's Health Belief Model Scale (CHBMS), a 19-item, 3-factor scale to measure beliefs about breast cancer and mammography screening (Champion, 1999). Although Champion's study provided evidence of internal consistency, test-retest stability, and confirmation of its factor structure, only the benefits and barriers subscales were associated with mammography screening within 6 weeks of completing the questionnaire. There was no significant difference in susceptibility scores between those who underwent mammography and those who did not.

Since its development, the CHBMS has been used extensively and translated for use in other cultures and countries including Spain (Esteva et al., 2007), Florida, United States (Medina-Shepherd & Kleier, 2010), and Peru (Huaman et al., 2011) with mixed evidence of validity. In each of these studies, all 19 items were retained as 3 factors after exploratory factor analysis (Huaman et al., 2011; Medina-Shepherd & Kleier, 2010) or confirmatory factor analysis (Esteva et al., 2007), although the latter study found that only 34% of the variance was accounted for. Yilmaz and Sayin (2014) translated the instrument into Turkish and found that the 19 items factored into 4 subscales: Items in the barriers domain split into two factors, one of which they labeled as *prejudices* against mammogram. Notably, after Champion's initial 1999 development work, none of the other psychometric studies using the 19-item, 3-factor CHBMS evaluated its predictive validity using longitudinal or prospective designs. Moreover, the two studies that did evaluate the validity of the CHBMS using concurrent validity or known groups analysis with cross-sectional data found little or no evidence of its association with mammography adherence. Huaman et al. (2011) found the barriers subscale alone to be associated with having had a mammography within the past 15 months, whereas Esteva et al. (2007) found no difference for any of the three subscales when comparing scores for 274 women who were and were not in a mammography screening program.

Mixed findings have also been obtained in psychometric studies that used variations of the CHBMS, although these, too, were limited by the use of cross-sectional data. Wu and Yu (2003) included a subscale to measure beliefs about the seriousness or severity of breast cancer and translated this four-factor instrument into Chinese for use with Chinese-American women. Beliefs about the seriousness of breast cancer had been included in Champion's 1984 study, but Champion later advised against its inclusion due to a lack of variability (Champion, 1999). Nonetheless, Wu and Yu found that barriers and seriousness were each correlated with having had a mammography within the past 2 years, in

both bivariate and multivariate analysis. More recently, Lee et al. (2016) included measures of seriousness and self-efficacy for obtaining a mammography and translated this five-factor instrument into Korean for use with Korean–American women. Consistent with Wu and Yu’s study, they found that barriers and seriousness were associated with ever having had a mammography as well as self-efficacy. A 10-item self-efficacy scale had been developed by Champion et al., (2005), and although it showed an association with having had a mammogram within the past 15 months, the authors did not specifically recommend the scale be incorporated into the CHBMS. Another study that included self-efficacy (but not seriousness or susceptibility) found that all three factors (benefits, barriers, and self-efficacy) were associated with having ever had a mammography (Anagnostopoulos et al., 2013).

More recently, researchers translated and adapted the CHBMS for use with women in Brazil (Moreira, 2016). Evaluation of content validity, reliability, and factor structure of the Revised Champion’s Health Belief Model scale (RCHBMS) yielded a seven-item, three-factor scale (Moreira, 2020). The evaluation procedure and items are described later in the Measures section.

Purpose

In follow-up to the initial psychometric study (Moreira, 2020), the purpose of this study was to test the predictive validity of the revised scale for identifying women at high risk of not adhering to Brazilian national guidelines for mammography screening. Three specific research objectives guided our analysis:

1. To evaluate the predictive validity of the RCHBMS subscales for identifying women at high risk of non-adherence after accounting for the effects of sociodemographic and clinical characteristics.
2. To evaluate the predictive validity of the RCHBMS total scale score for identifying women at high risk of nonadherence after accounting for sociodemographic and clinical characteristics.
3. To determine an optimal cut-off score for the total scale score for identifying women at high risk of nonadherence.

Methods

Design, Setting, and Sample

This study used a longitudinal survey design with a 1-year follow-up. The study was conducted in northeastern Brazil, in the city of Fortaleza, Ceará, with approval from the Federal University of Ceará ethics committee. Participants were recruited as a convenience sample

from one primary health-care center located in the outskirts of the city. The study targeted women between 50 and 69 years of age who attended the health center to access the gynecological prevention program, were referred for a mammogram according to the Brazilian guidelines (National Cancer Institute, 2015), and were due for a mammogram within 1 year or less. Sample size requirements for logistic regression analyses were based on Hosmer et al.’s (2013) recommendation to use a minimum of 20 cases per predictor variable. To test a model with 10 predictors would, therefore, require 200 participants. Recruitment and baseline data collection procedures took place over a 3-month period from October through December, 2016, yielding a sample of 194 women who met the inclusion criteria.

Measures

The RCHBMS. The original scale (Champion, 1999), consisting of 19 items that measure beliefs about susceptibility to breast cancer (3 items), the benefits of mammography (5 items), and perceived barriers to screening (11 items), was translated into Brazilian Portuguese in 2016 (Moreira, 2016). Initial testing with 40 members of the target population and 20 health-care professionals provided evidence of its face and content validity. Drawing on a sample of 206 women between 50 and 69 years of age, exploratory factor analysis with varimax rotation supported the 3-factor structure, but with the retention of only 7 items (Moreira, 2020; see Table 1). Cronbach’s alphas for the three factors in this revised scale were .81, .52, and .47 for susceptibility (three items), benefits (two items), and barriers (two items), respectively. Notably, the model explained 71% of the variance in the data.

Questions were answered on a 5-point Likert-type response scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), and mean scores were computed for each subscale. Thus, higher scores represent perceptions of greater susceptibility to breast cancer, greater benefits from screening, and higher barriers to screening. Higher susceptibility and benefit scores were expected to correlate positively with mammography uptake (and negatively with nonadherence to the Brazilian national guidelines). The opposite was expected for higher perceived barriers. A total scale score was also derived by computing the mean of the mean subscale scores, with barriers reverse coded. Thus, subscale scores and the total scale score each had a possible range of scores from 1 to 5.

Control Variables. Control variables consisted of sociodemographic and clinical characteristics that have been associated with mammography uptake in the 2013 national health survey and other Brazilian studies

Table 1. Items in the Revised Champion's Health Belief Model Scale.

	Items (in Brazilian Portuguese)	Items (in English)
Susceptibility		
S1	É provável que terei câncer de mama.	It is likely that I will get breast cancer.
S2	Minhas chances de ter câncer de mama nos próximos anos são grandes.	My chances of getting breast cancer in the next few years are great.
S3	Sinto que terei cancer de mama em algum momento da minha vida.	I feel I will get breast cancer sometime during my life.
Benefits		
B2	Realizar a mamografia me ajudará a encontrar mais cedo os tumores na mama.	Having a mammogram will help me find breast lumps early.
B4	Para mim, a realização de uma mamografia é a melhor forma de encontrar um tumor muito pequeno.	Having a mammogram is the best way for me to find a very small lump.
Barriers		
Ba1	Eu tenho medo de fazer uma mamografia porque pode ser que eu descubra que há algo de errado.	I am afraid to have a mammogram because I might find out something is wrong.
Ba2	Eu tenho medo de fazer uma mamografia porque não entendo o que vai ser feito.	I am afraid to have a mammogram because I do not understand what will be done.

Source: Moreira (2020).

(Silva et al., 2017; Souza et al., 2017). Sociodemographic variables included age, marital status, self-reported race (in terms of skin color; see Loveman et al., 2012), religion, education, employment, and income. Low income was calculated as less than R\$880, per the 2016 Brazilian Ministry of Labour guidelines. Clinical characteristics were measured as binary variables (*yes* = 0, *no* = 1) and included having a chronic disease, family history of cancer, personal history of cancer, benign breast alteration, premature menarche, late menopause, obesity, hormone replacement therapy, nulliparity, first gestation after age 30, and past history of having biennial mammograms.

Criterion Measure. The outcome variable of interest was whether or not the women had a mammogram as recommended, within 12 months of referral and baseline data collection (*yes* = 0, *no* = 1 for nonadherence). The women were all due for a mammogram within 1 year or less.

Data Collection Procedures

Baseline data collection took place from October to December, 2016. The women completed the RCHBMS, and the sociodemographic characteristics and clinical history questionnaire while they were in the primary health-care center waiting room. The questions were administered verbally to all the participants due to the prevalence of low literacy levels and for consistency. For most participants ($n = 166$), mammogram status was collected 12 months later through chart audits at the health-care center. The 28 women who had not

returned to the health center were phoned, and they self-reported their mammogram status.

Data Analysis

Bivariate statistics, using *t* tests and chi-square tests, were computed to examine the unadjusted associations between the RCHBM scores and women's sociodemographic and clinical characteristics, and mammography uptake within 12 months. A series of hierarchical logistic regression models were then tested to investigate the relationships between the three RCHBM subscale scores and mammography uptake, after controlling for demographic and clinical characteristics (Research Objective 1). To assess the minimum data requirements for identifying women at risk for nonadherence to mammography guidelines, we also conducted logistic regression analysis using the total RCHBM scale score and only those control variables that showed statistical significance in the hierarchical logistic regression analyses (Research Objective 2). Our final strategy for assessing the validity of the RCHBMS was to calculate an optimal cut-off point for the total scale score, based on sensitivity and specificity rates for various cut-off points, and use this score in a logistic regression model to determine how well it predicted nonadherence (Research Objective 3). All analyses were performed using SPSS for Windows, version 21, with an alpha of .05.

Results

Participant Characteristics

The 194 study participants ranged in age from 50 to 69 years ($M = 56.6$, $SD = 5.6$). Table 2 reports their

Table 2. Sociodemographic and Clinical Characteristics of Study Participants, and Association With Mammography Adherence.

Variables	Total <i>n</i> (%)	Mammography adherence		Chi-square <i>p</i>
		Yes (<i>n</i> = 100) <i>n</i> (%)	No (<i>n</i> = 94) <i>n</i> (%)	
Sociodemographic characteristics				
Marital status				
With partner	112 (57.7)	60 (60.0)	52 (55.3)	.607
Without partner	82 (42.3)	40 (40.0)	42 (44.7)	
Race				
White	34 (17.5)	21 (21.0)	13 (13.8)	.088
Black	70 (36.1)	30 (30.0)	40 (42.6)	
Brown	80 (41.2)	46 (46.0)	34 (36.2)	
Yellow	10 (5.2)	3 (3.0)	7 (7.4)	
Religion				
Catholic	126 (64.9)	70 (70.0)	56 (59.6)	.171
Noncatholic	68 (35.1)	30 (30.0)	38 (40.4)	
Education (<i>n</i> = 168)				
< 10 years	120 (71.4)	64 (71.1)	56 (71.8)	1.00
≥ 10 years	48 (28.6)	26 (28.9)	22 (28.2)	
Employment				
Employed	48 (24.7)	27 (27.0)	21 (22.3)	.558
Unemployed	146 (75.3)	73 (73.0)	73 (77.7)	
Income				
Low income	120 (61.9)	65 (65.0)	55 (58.5)	.434
Not low income	74 (38.1)	35 (35.0)	39 (41.5)	
Clinical characteristics				
Chronic diseases				
Yes	124 (63.9)	71 (71.0)	53 (56.4)	.049
No	70 (36.1)	29 (29.0)	41 (43.6)	
Family history of cancer				
Yes	78 (40.2)	48 (48.0)	30 (31.9)	.033
No	116 (59.8)	52 (52.0)	64 (68.1)	
Benign breast alteration				
Yes	34 (17.5)	26 (26.0)	8 (8.5)	.003
No	160 (82.5)	74 (74.0)	86 (91.5)	
Premature menarche				
Yes	12 (6.2)	7 (7.0)	5 (5.3)	.851
No	182 (93.8)	93 (93.0)	89 (94.7)	
Obesity				
Yes	18 (9.3)	9 (9.0)	9 (9.6)	1.00
No	176 (90.7)	91 (91.0)	85 (90.4)	
First gestation after 30 years				
Yes	12 (6.2)	7 (7.0)	5 (5.3)	.851
No	182 (93.8)	93 (93.0)	89 (94.7)	
History of biennial mammograms				
Yes	30 (15.5)	20 (20.0)	10 (10.6)	.109
No	164 (84.5)	80 (80.0)	84 (89.4)	

Note. *N* = 194. No participants reported being on hormone replacement therapy or being nulliparous, and only 1% reported late menopause and personal history of cancer. Therefore, these are not included in the bivariate analyses.

sociodemographic and clinical characteristics. Most notably, very few (17.5%), identified themselves as *white*, and the majority had less than 10 years of education (71.4%), were unemployed (75.3%), and were considered low income (61.9%). With regard to their clinical history, 40.2% had a family history of cancer but very

few (15.5%) of the women reported having received mammograms biennially in the past. None of the participants reported nulliparity or being on hormone replacement therapy, and only 1% reported late menopause or a personal history of cancer; therefore, these four characteristics are not included in Table 2.

Table 3. RCHBM Scores and Association With Mammography Adherence.

	Total Mean (SD)	Mammography adherence		t test p
		Yes (n = 100) n (%)	No (n = 94) n (%)	
RCHBM subscales				
Susceptibility	2.07 (1.34)	2.49 (1.37)	1.68 (1.18)	.000
Benefits	4.75 (0.72)	4.90 (0.40)	4.60 (0.93)	.004
Barriers	1.99 (1.34)	1.27 (0.65)	2.76 (1.45)	.000
RCHBM total scale score ^a	3.61 (0.72)	4.04 (0.52)	3.16 (0.62)	.000

Note. N = 194. RCHBM = Revised Champion's Health Belief Model scale.

^aBarriers subscale score was reversed for computation of RCHBM total scale score.

Approximately half of the participants ($n = 94$, 48.5%) failed to receive a mammogram within the 12 months following baseline data collection and referral for mammography screening. Table 3 reports the RCHBM subscale and total scale mean scores, out of a possible range of 1 to 5.

Bivariate Statistics

Tables 2 and 3 also report the associations between the sociodemographic and clinical characteristics of study participants, the RCHBM scores, and mammogram adherence. None of the seven sociodemographic variables showed a statistically significant relationship with mammogram adherence, although race yielded a p of .088. Three of the clinical characteristics were shown to be associated with mammogram adherence such as having a chronic disease, having a family history of cancer, and having had a benign breast alteration. The three RCHBM subscale scores and the total scale score were also associated with mammography adherence.

Logistic Regression Results

Research Objective 1. Table 4 shows results for the three hierarchical logistic regression models that were tested to investigate the relationships between the three RCHBM subscale scores and mammography uptake, after controlling for demographic and clinical characteristics. The control variables included in the models were those that showed statistical significance in the bivariate tests at $p < .10$.

Race was not found to be statistically significant in Models 1 or 2. However, after adding the RCHBM subscale scores in Model 3, self-identifying as black-skinned (odds ratio [OR] = 10.02, 95% confidence interval [CI] = [1.96, 51.13]) or yellow-skinned (OR = 13.62, 95% CI = [1.48, 125.24]) was associated with a far greater likelihood of nonadherence. Having a family history of cancer (OR = 0.31, 95% CI = [0.38, 0.82]) was the only clinical characteristic that showed statistical significance in the third model. Although all the three RCHBM

subscale scores had shown an association with mammography uptake in the bivariate analysis, only susceptibility (OR = 0.39, 95% CI = [0.26, 0.59]) and barriers (OR = 6.14, 95% CI = [3.32, 11.37]) were significant in the adjusted model, with susceptibility functioning as a unique protective factor and barriers functioning as a unique risk factor for nonadherence. The model correctly identified 71.3% of the women who did not receive a mammogram by year end.

Research Objective 2. Table 5 shows logistic regression results for a model that included the total RCHBM scale score, rather than subscale scores, and only those control variables that were significant in Model 3. Similar to Model 4, self-identifying as black- or yellow-skinned was statistically significant, but having family history of cancer was not. The total RCHBM scale score performed as a strong protective factor (OR = 0.03, 95% CI = [0.01, 0.09]) against nonadherence to mammography guidelines. The model correctly identified 75.5% of the women who did not receive a mammogram by year end.

Research Objective 3. Table 6 presents the sensitivity and specificity rates for various RCHBMS cut-off points with respect to identifying adherence and nonadherence to recommended mammography screening. For our data, we determined that the optimal cut-off point was to identify scores of 3.67 and lower as high risk. This yielded a high sensitivity rate of 90.4% and acceptable specificity rate of 65.0%. We then recoded total RCHBMS scores into a binary variable (above/below the cutoff of 3.67) and used this variable as the sole predictor in a final logistic regression. The resulting odds ratio of 17.54 (95% CI = [7.88, 39.06]) indicated that women in our sample who received scores of 3.67 or less were 17.5 times more likely to not have the recommended mammography screening within 12 months of referral.

Table 4. Hierarchical Logistic Regression Results for Mammography Nonadherence.

Variables	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Race (reference = white)			
Black	2.15 [0.93, 4.98]	1.71 [0.69, 4.24]	10.02 [1.96, 51.13]
Brown	1.19 [0.53, 2.71]	0.95 [0.39, 2.30]	3.37 [0.76, 14.78]
Yellow	3.77 [0.83, 17.2]	2.50 [0.49, 12.71]	13.62 [1.48, 125.24]
Clinical characteristics			
Have chronic disease		0.53 [0.28, 1.02]	1.02 [0.38, 2.70]
Have family history of cancer		0.49 [0.26, 0.92]	0.31 [0.12, 0.82]
Had benign breast alteration		0.30 [0.12, 0.75]	0.67 [0.16, 2.90]
History of biennial mammograms		0.52 [0.21, 1.28]	0.43 [0.14, 1.39]
RCHBM subscales			
Susceptibility			0.39 [0.26, 0.59]
Benefits			0.53 [0.25, 1.13]
Barriers			6.14 [3.32, 11.37]
Cox & Snell R^2	3.3%	12.7%	48.1%
Nagelkerke R^2	4.5%	16.9%	64.1%
Correct classification			
Nonadherence (sensitivity)	50.0%	69.1%	71.3%
Adherence (specificity)	67.0%	53.0%	87.0%
Overall correct classification	58.8%	60.8%	79.4%

Note. OR = odds ratio; CI = confidence interval; RCHBM = Revised Champion's Health Belief Model scale.

Table 5. Logistic Regression Results for Mammography Nonadherence Using RCHBM Total Scale Score.

Variables	OR (95% CI)
Race (reference = white)	
Black	6.64 [1.84, 23.93]
Brown	2.80 [0.87, 8.99]
Yellow	15.73 [2.06, 119.86]
Clinical characteristics	
Family history of cancer	0.46 [0.23, 1.06]
RCHBM total scale score	0.03 [0.01, 0.09]
Cox & Snell R^2	43.4%
Nagelkerke R^2	57.9%
Correct classification	
Nonadherence (sensitivity)	75.5%
Adherence (specificity)	83.0%
Overall correct classification	79.4%

Note. OR = odds ratio; CI = confidence interval; RCHBM = Revised Champion's Health Belief Model scale.

Discussion

The key findings of this study provide evidence of the predictive validity and utility of the seven-item three-factor RCHBMS for identifying women at high risk of not adhering to national guidelines for mammography screening in Brazil. Each of the subscales was shown to be associated with nonadherence in bivariate analysis, although only susceptibility and barriers were uniquely associated with nonadherence in the multivariate analysis, with barriers being the much stronger predictor. Using the total scale score with a high-risk cut-off score of < 3.67 yielded a sensitivity rate of 90% and

Table 6. Sensitivity and Specificity Rates for Various RCHBMS Cut-Off Scores, for Predicting Mammography Nonadherence.

Cut-off point (high risk)	Sensitivity (Nonadherence, %)	Specificity (Adherence, %)
≤3.00	51.1	96.0
≤3.50	62.8	89.0
≤3.65	63.8	86.0
≤3.67	90.4	65.0

Note. RCHBM = Revised Champion's Health Belief Model scale.

specificity of 65%. Women with high risk scores were 17.5 times more likely to have not obtained a screening mammography within 12 months of referral.

Although the CHBMS has been used in many instrument revision and/or psychometric evaluation studies since its development in 1995, most studies have focused on internal consistency, test-retest reliability, content validity, and factorial structure (e.g., Medina-Shepherd & Kleier, 2010; Yilmaz & Sayin, 2014), while very few have addressed criterion validity (concurrent or predictive validity). Other studies of the CHBMS have addressed breast self-examination as an outcome or criterion measure, but not mammography screening.

The few studies that have assessed the criterion-related validity of the CHBMS have yielded mixed findings that may be at least partially due to the differences in study setting, research design, the relative timing of data collection for predictor and outcome variables, and the particular scale used. V. L. Champion's (1999) evaluation of the original 3-factor, 19-item scale found that

the barriers and benefits subscales, but not susceptibility, were associated with mammography uptake within 6 weeks of completing the questionnaire. However, of the two other studies that used translated versions of the 19-item scale, Huaman et al. (2011) found that barriers was the only subscale associated with having had a mammography within the past 15 months, whereas Esteva et al. (2007) failed to find any association with mammography screening.

Other researchers have used a revised or expanded scale, for example, by excluding subscales from the original scale and/or adding in scales/constructs for seriousness and self-efficacy. Wu and Yu (2003) added a fourth subscale for seriousness and found that having had a mammography in the past 2 years was associated with barriers and seriousness, but not with susceptibility or benefits. Anagnostopoulos et al. (2013) replaced the susceptibility subscale with a measure of self-efficacy and found that all three factors (barriers, benefits, and self-efficacy) were associated with having ever/never having had a mammogram. In a more recent study, Lee et al. (2016) added measures of both seriousness and self-efficacy for a five-factor CHBM scale and found that barriers, seriousness, and self-efficacy (but not susceptibility or benefits) were associated with ever/never having been screened. Thus, the barriers subscale has shown the most consistent associations with mammography uptake irrespective of translation or the addition of other scales/constructs, whereas only two of the six studies found significant associations for the benefits subscale and, in contrast to our findings, none of the studies found significant associations for susceptibility.

We speculate that our findings have differed from that of other studies due to its longitudinal design with a 1-year follow-up, compared with V. L. Champion's (1999) 6-week follow-up period or the more usual cross-sectional data collection. For example, having had a mammography in the past 15 or 24 months could influence women's beliefs about mammography and thus, their responses on the CHBMS. In our study, only 15.5% of the women had a history of having biennial mammograms. Our study also differed in that, with only seven items, the RCHBMS is much shorter than the scales used in the other criterion-related validity studies and may, therefore, be more specific or relevant to Brazilian women. The barriers subscale, which showed the strongest association with mammography uptake, was also the most abbreviated subscale, having been reduced from 11 items in the original scale to 2 (Moreira, 2020), suggesting that there may be cultural or contextual differences in terms of barriers to mammography screening. For example, there may be differences in cultural norms of privacy and modesty that may have influenced women's responses to the CHBMS or their screening behaviors (Sarma, 2015).

In contrast to many other Brazilian studies (e.g., Borges et al., 2016; Vieira et al., 2015), our study failed to find associations between any socioeconomic factors and mammography uptake, other than race. Moreover, race became a significant predictor only after accounting for health beliefs related to mammography, indicating the importance of the women's beliefs. However, this is consistent with findings of a systematic review of research literature from the United States (Schueler et al., 2008) which found that many presumed socioeconomic barriers were less predictive of mammography uptake than other factors such as physician access and beliefs about mammography screening.

Study Limitations

The generalizability of our results is tempered by the moderate sample size and dependence on a sample drawn from only one health center. We also acknowledge that our sample does not fully represent the Brazilian population as a whole. Although our sample was representative in terms of women who identify as brown-skinned (36% vs. 37%, Foundation Brazilian Institute of Geography and Statistics, 2010), our sample included a lower proportion of women who identify as white and higher proportion of women who identify as black, compared with women 50 to 69 years of age within the total Brazilian population. However, our sample was fairly representative in terms of low education (71% vs. 66%) and low income (62% vs. 51%). For practical reasons of time and resources, the same participants were used for this validity study as for the exploratory factor analysis study that identified the seven items to be retained in the RCHBMS (Moreira, 2020). In an ideal world, the predictive validity study would have been conducted on a second group of participants (with new baseline data and follow-up data). Finally, the characteristics of the data may have influenced the statistical validity of the study. As is common in many cultural groups (Ares, 2018), Brazilian respondents tend to choose the extreme response options (completely agree and completely disagree) more so than more moderate responses. The limited variability of the responses may have influenced not only the exploratory factor analysis results (Moreira, 2020) but also the strength of association with the outcome measure. Therefore, although we recommend implementation of the seven-item scale for use in clinical practice in Brazil, it is important that follow-up studies examine the predictive validity of the scale in other cities and states of the country as there may be sociodemographic, cultural, or health system differences that influence the accuracy of prediction. Finally, we acknowledge that administering the RCHBMS verbally to participants, to do the low

literacy levels in the target sample, may have influenced their responses.

The results of this study reinforce the importance of doing more than merely translating an instrument. It is important to also assess the predictive validity of the translated and revised instrument, using longitudinal studies. Still, it is not clear from our study to what degree women's beliefs and personal characteristics may be causal or merely correlational. It is likely that increasing mammography uptake may require more than targeted cancer control messaging; it may also require adjustments to the health-care system to make mammography screening more accessible. For example, living in an urban rather than rural area and living in the richest and most developed southern regions of Brazil where there are greater health-care resources have been found to be associated with higher levels of mammography uptake (e.g., Rodrigues et al., 2015). Another study (Souza et al., 2017) found that women in Brazil who had a recent primary care appointment were more likely to subsequently have a mammogram, which suggests the importance of direct influence. To our knowledge, this is the first Brazilian study to offer a validated and easily used scale for investigating women's adherence to mammography screening, drawing on behavioral theory. This scale should be further evaluated, but future research should control for other factors that may influence adherence to the screening guidelines, and should include qualitative methods to better understand reasons for women's nonadherence to national screening guidelines.

Study Strengths and Implications for Practice

Despite limitations of the study, an important strength of our study is that we conducted three sets of analyses that were aimed at both theoretical and practical applications. The first regression analysis examined the predictive power of each subscale and provided a more granular understanding of the applicability of the Health Belief Model. These results also serve to identify priority or focal issues for cancer early detection messaging for this population. For example, in the RCHBMS, both of the items retained in the highly predictive barriers scale pertained to fear: "because I might find out something is wrong" and "because I don't understand what will be done." Findings from the second regression analysis, which used the total score for the seven-item scale, showed the utility of the overall scale for predicting mammography uptake and provide support for the Health Belief Model more generally. However, it is the third set of analyses, the empirical identification of a cut-off point that identifies women as high risk for nonadherence that makes a unique contribution to clinical practice.

The ultimate goal of this study was to identify an efficient, effective, and acceptable means of identifying women at high risk for not adhering to guidelines for mammography screening so as to facilitate additional targeted cancer control efforts. It seems likely that women would be willing to complete a short seven-item scale while waiting for a clinic appointment—and the identification of a cut-off point might facilitate health-care provider interpretation of scores. Knowing that the total score is highly predictive of nonadherence makes it possible for other Brazilian clinical sites to use the scale but set their cut-off score at a point where they can prioritize women to be targeted with additional health messaging.

Conclusion

The results of our study indicate that it is possible to identify women who are at high risk for not adhering to mammography screening guidelines with a short screening tool that carries little burden for the women or health-care providers. Awareness of women's beliefs and other factors that are associated with nonadherence may contribute to the development of health messaging, strategies, and services targeted to the needs and characteristics of women most vulnerable to not accessing mammography screening. In turn, increased screening is expected to reduce the incidence of late-stage breast cancer identification. Finally, more timely and efficient identification of women who are at high risk for nonadherence may yield benefits in terms of human resource and other health-care costs.

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