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Influences of race and breast density on related cognitive and emotion outcomes before mandated breast density notification

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Abstract

Rationale: Many states have adopted laws mandating breast density (BD) notification for applicable women; however, very little is known about what women knew or felt about BD and related breast cancer (BC) risk before implementation of BD notification laws.

Objective: We examined between-race differences in the extent to which having dense breasts was associated with women's related BD cognition and emotion, and with health care providers' communication about BD.

Methods: We received surveys between May and October of 2015 assessing health care provider (HCP) communication about BD, BD-related knowledge, BD-related anxiety and BC worry from 182 African American (AA) and 113 European American (EA) women in the state of Michigan for whom we had radiologists' assessments of BD.

Results: Whereas having dense breasts was not associated with any BD-related cognition or emotion, there were robust effects of race as follows: EA women were more likely to have been told about BD by a HCP, more likely to know their BD status, had greater knowledge of BD and of BC risk, and had greater perceptions of BC risk and worry; AA women had greater BD-related anxieties. EA women's greater knowledge of their own BD status was directly related to the increased likelihood of HCP communication about BD. However, HCP communication about BD attenuated anxiety for AA women only.

Conclusion: We present the only data of which we are aware that examines between-race differences in the associations between actual BD, HCP communication and BD related cognition and emotion before the implementation of BD notification laws. Our findings suggest that the BD notification laws could yield positive benefits for disparities in BD-related knowledge and anxiety when the notifications are followed by discussions with health care providers.

Keywords

Michigan, USA; Breast density; Racial difference; Cognition; Emotion; Anxiety

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.socscimed.2016.09.037>.

Increased breast density (BD: ratio of fibro-glandular to fatty breast tissue) is associated with greater breast cancer (BC) risk (Boyd et al., 2010, 2011; McCormack and dos Santos Silva, 2006). Although women are somewhat aware of this risk, few women actually know how dense their own breasts are (Manning et al., 2013; O'Neill et al., 2014). BD notification laws, adopted in 27 of the United States (Are You Dense Advocacy Inc, 2016), address this lack of awareness by mandating disclosure of dense breast status via mammogram reports. Despite arguments that BD notifications may unnecessarily make some women anxious (Grady, 2012; Hardy, 2012), no research has examined whether women's actual BD, and their awareness of their BD, predict related cognitions (e.g., BC and BD risk knowledge, BC risk perception) and emotions (e.g., BD anxiety, BC worry) *prior* to implementation of mandated BD notification in any state. Thus it is impossible to say whether BD notifications make women with dense breasts more anxious relative to their non-dense counterparts, or whether they were more anxious to begin with.

BD anxiety and related psychological responses are important because risk-related cognition and emotion predict relevant health behaviors (Conner and Sparks, 1996; Fishbein, 2008; Rosenstock, 1990). Epidemiological studies have shown that supplemental BC screening rates increased after BD notification laws were introduced (Destounis et al., 2015; Weigert and Steenbergen, 2012, 2015). However, lacking an existing frame of reference for how having dense breasts influence cognition and emotion, we may only speculate that women's psychological responses to BD notifications (in contrast to their physicians' propensities for referral) lead to increased supplemental screening rates. Therefore, we examined the associations between having dense breasts and related cognitions and emotions in a cohort of women before implementation of BD notification.

We also examined whether there were between-race differences in the effects of breast density on related cognition and emotion. African American (AA) women reported more anxiety compared to European American (EA) women after receiving BD notifications; however, anxiety strengthens EA women's, but weakens AA women's intentions to discuss notifications with their physicians (Manning et al., 2016a, 2016b). Those differences in emotional responses may be due to pre-existing cognitive differences, given studies showing that EA women have more knowledge of what BD is (Manning et al., 2013; O'Neill et al., 2014), and that AA women scrutinize information about BD more (Manning et al., 2016c). The differential effects of anxiety on behavioral intentions is noteworthy given the robust association between intentions and behavior (Ajzen, 1991). The findings portend between-race differences in important post-notification follow-up behaviors (e.g., requests and referrals for supplemental BC screening), which in turn suggests that BD notification laws may differentially impact AA and EA women. This could directly impact racial health disparities since differences in BC screening accounts for some of the racial disparity in BC mortality (Curtis et al., 2008). To definitively assert that AA and EA women respond differently to receiving BD notifications, we must first discern how and why AA and EA women's cognition and emotion differed before implementation of the law.

It is reasonable to expect that health care provider (HCP) communication about BD influences cognition and emotion - we use HCP to describe any clinician who may discuss health and health care with a patient (e.g., primary care physicians, radiologists, nurse

practitioners, etc.). Since BD evaluation is image-based, women must be informed about their BD by their HCP. Prior to mandated BD notification, HCPs' reporting of BD to their patients was, anecdotally, inconsistent at best. To date, no studies have described how being informed about having dense breasts influenced women's related cognitions and emotion, especially before reporting was mandated BD. A woman who is told that she has dense breasts should ostensibly have greater BD and BC risk knowledge and increased perception of BC risk. Some studies show that perceptions of greater risk lead to anxiety and worry (Dillard et al., 2012; Portnoy et al., 2014; Shaw et al., 1999); however, separate evidence showed that when women were informed of another BC risk (BRCA1/2 mutations) there were no increases in anxiety (Claes et al., 2005; Kinney et al., 2005) – though this may be due to the voluntary nature of genetic testing and findings that BRCA testing may relieve anxiety among individuals who are aware of a BC family history (Garg et al., 2016; Ormondroyd et al., 2007). In the current study, we examined how HCP communication about BD influenced women's BD and BC related cognitions and emotions.

We also examined whether HCP communication, and the effects of HCP communication, differed by race. Despite diminishing between-race differences in incidence and mortality for other cancers, comparatively poorer BC mortality persists for AA women (DeSantis et al., 2016b; O'Keefe et al., 2015). The differences in BC mortality has been directly related to differences in BC screening uptake (Curtis et al., 2008; Smith-Bindman et al., 2006), which is itself related to differences in HCP communication and recommendations for screening (Rauscher et al., 2005; Young et al., 2011). HCP communication may be poorer among AA women given the high likelihood that many AA women in and around Detroit have racially discordant medical interactions (i.e., an AA patient with a non-AA HCP). Prior research has documented the dearth of minority physicians at all levels of medical practice and training (Basco et al., 2010; Sullivan and Suez Mittman, 2010). A cursory examination of websites such as RateMD (RateMDs Inc, 2016) and healthgrades (Healthgrades Operating Company Inc., 2016) cross referenced with listings for AA physicians (Black Doctor Inc., 2016) indicates that only a small fraction of family medicine, internal medicine and obstetricians/gynecologists that practice in and around metro-Detroit are AA. Racially-discordant medical interactions feature lower quality communication and transfer of information (Eggly et al., 2011, 2013). Therefore, we expect that, compared to EA women, AA women with dense breasts are less likely to be informed about it by their HCPs. We further expect that between-race differences in HCP communication will partially explain between-race differences in the effects of having dense breasts on women's cognition and emotion.

In summary, we examined between-race differences in [1] the association between actual BD and women's relevant cognitions and emotions, [2] HCP communication about BD, and [3] the extent to which HCP communication mediated the association between actual BD and relevant cognitions and emotions before implementation of mandated BD reporting in the state of Michigan. To our knowledge, we are the first to examine the effects of women's *actual* BD on related cognitions and emotions.

1. Methods

1.1. Participants and procedure

We sent survey invitations to 2500 women who were previously screened at a cancer center in Detroit MI and for whom we had BD data. Women were eligible to participate if they had no prior diagnosed BC. The survey was administered online between May and October 2015 via Qualtrics (Qualtrics, 2015). Participants signed into survey with unique password, read an information sheet which served as informed consent, and completed items assessing demographics, cancer history, related cognitions and emotions, HCPs communication, and other constructs not reported here (e.g., communication with family members, BC and BD information seeking, etc.). Our study was approved by Wayne State University's institutional review board. We received responses from 345 women (14% response rate) of whom 311 were self-reported AA or EA – we excluded other races from analyses given their low frequencies. We excluded two individuals who identified as males and three who indicated no gender. We also excluded 10 women who self-reported prior BC diagnoses, and one who did not respond to the item.

1.2. Measures

Actual BD was assigned by a radiologist following each woman's screening mammogram. Women whose BD was classified as either Breast Imaging Reporting And Data System (BI-RADS) density categories *a* (entirely fatty) or *b* (scattered density) were designated as not having dense breasts, and women classified as *c* (heterogeneously dense) or *d* (extremely dense) were designated as having dense breasts. We used contrast codes (−0.5 for non-dense breasts; 0.5 for dense breasts) when actual BD was included as a predictor in path analysis.

BD Awareness was assessed with binary responses (“Yes”, “No”) to the item “Do you know how dense your own breasts are?” We used contrast codes (−0.5 for No, 0.5 for Yes) when entered as predictors in path analysis.

BD Knowledge was assessed with responses to the item “Do you know what breast density is?” Women responded on a scale from 1 (“I have never heard about it”) to 5 (“I know exactly what it is”).

BC Risk Knowledge was assessed with procedures suggested by prior research (McMenamin et al., 2005). Participants indicated whether each of 15 items (e.g., age, family history, eating fatty foods) decreased, had no effect on, or increased women's risk of breast cancer. The proportion of correct responses to total responses served as women's BC risk knowledge score.

BC Risk Perception was assessed with responses to the item “On a scale of 0%–100%, where 0 = certain not to happen and 100 = certain to happen, how likely are you to get breast cancer in your lifetime?” Women responded by indicating a likelihood between 0 and 100 with a digital “slider”. To facilitate path model convergence, we rescaled scores by dividing responses by 10 for path analysis.

BC Worry was assessed with responses to the item “How often do you worry about breast cancer?” Responses were on scale from 1 (“not at all”) to 5 (“most of the time”).

BD Anxiety was assessed with a 12-item measure adapted from the negative dimensions subscale of the Psychological Consequences of Mammogram scale (Cockburn et al., 1992), which assessed negative physical (e.g., “Had trouble sleeping”; 4 items, $\alpha = 0.87$), social (e.g., “Found yourself noticeably withdrawing from other people”; 3 items, $\alpha = 0.85$) and emotional (e.g., “Been unhappy or depressed”; 5 items, $\alpha = 0.92$) psychological consequences associated with “thoughts and feelings about breast density.”

HCP Communication was assessed with binary responses to the item “Have any of your previous health providers told you that you have dense breasts?”; thus, the construct was specifically operationalized as communication indicating that one’s breasts were dense. We used contrast codes (−0.5 for No, 0.5 for Yes) for path analysis when entered as a predictor.

Demographic covariates. Participants indicated their numerical *age* (divided by 10 for path analysis). Participants indicated *race* categorially from among 8 options, including “two or more race” and “Other”; participants were included for analyses if they indicated “Black or African American” or “White or Caucasian American.” Participants indicated *income* categorially in one of 11 \$10,000 income ranges (e.g., Less than \$9999; \$10,000 – \$19,999, etc.). We used dummy codes to identify whether income was at or above, or below the median income category (\$50,000 to \$59,999). Participants categorially indicated their highest *education* level, and responses were aggregated into three categories (high school; higher education; graduate or professional school) for analyses. Participants categorially indicated *marital status*, and responses were aggregated into three categories (married or partnered; separated, widowed or divorced; single or never married) for analyses. Women indicated *family history of BC* with binary responses to the item “Has anyone in your family ever been diagnosed with breast cancer?”

1.3. Planned analyses

Analyses were completed using SPSS v 23 (IBM Corp, 2014) and packages implemented with R (R Core Team, 2014). We adopted a 5% Type 1 error rate (i.e., $p < 0.05$) for statistical significance. For the continuous outcomes, we used 2 separate MANCOVAs to examine the unique and joint effects of race and actual BD on cognition and emotion. We controlled for the main effects of categorical predictors, including BD awareness and included age as a continuous covariate. We conducted ancillary non-parametric Mann-Whitney U Tests for the BD Anxiety subscales given that they were negatively skewed.

We examined effects of race and actual BD on self-reports of HCPs’ communication and on awareness of one’s own BD with separate stepwise logistic regressions. Indicators for race, density and their interaction were entered on the first step, and covariates were entered on the second step. Given potential intra-individual changes in BD over time (Busana et al., 2016; Maskarinec et al., 2006) and inter-rater differences in assessments of BD (Pérez-Gómez et al., 2012; Spayne et al., 2012), reports of HCP communication about BD among women who did *not* have dense breasts may represent discrepancies between our singular assessments of BD and prior assessments; therefore, we treated self-reports as veritable.

We used multi-group path analysis to examine questions related to between-race differences in the mediational role of HCP communication between actual BD and cognition and emotion outcomes. Fig. 1 presents a conceptual representation of the path model. To test the moderation by racial group, we first fit an invariant model in which all model parameters except for the exogenous covariances were constrained to be equivalent between racial groups, followed by a variant model in which all parameters were freely estimated. Significant improvement in model fit indicates that the parameter estimates vary between racial groups. We used the lavaan package (Rosseel, 2012) implemented with R (R Core Team, 2014) to fit the model, and employed full information maximum likelihood estimation in light of missing data – of variables included in analyses, 11 (65%) had missing values which comprised 2% of all observations. The cognition and emotion variables were specified as correlated endogenous outcomes. HCP communication and BD awareness were specified as uncorrelated endogenous variables with direct paths to cognition and emotion (*paths c and d*), and a direct path was specified from HCP communication to BD awareness (*path b*). Actual BD and control variables were specified as exogenous variables with direct paths to all endogenous variables (*paths a, e and f*); however, we excluded marital status as a predictor of HCP communication as preliminary evidence indicated no significant association, and doing so allowed us to preserve degrees of freedom for tests of model fit for the variant model. We estimated indirect effects as the product of relevant path coefficients, and examined whether there were between race differences in (1) the extent to which effects of actual BD on cognition and emotions were mediated by HCP communication (*products of paths a and c*); (2) the extent to which HCP communication mediated the effects of actual BD on BD awareness (*products of paths a and b*); (3) the extent to which the HCP communication mediated effect of actual BD on cognition and emotion was itself mediated by BD awareness (*products of paths a and b and d*). Standard errors for the indirect effects were estimated via the Delta method (Oehlert, 1992; Rosseel, 2015). We also examined between race differences in direct effects within the model.

2. Results

Our final sample consisted of 182 (62%) AA and 113 (38%) EA women (Table 1). Overall, EA women were significantly more likely to have dense breasts, be wealthy, highly educated, married, and to report a family history of BC. The distribution of physical, social and emotional BD anxiety were negatively skewed for both AA and EA women (Table 2); 63% of women reported no physical anxiety, 67% no social anxiety, and 47% no emotional anxiety related to thoughts about BD. (Bivariate associations between control and outcome variables are presented in Supplemental Table 1).

2.1. Effects of racial group and actual BD on BD-Related cognition and emotion

Before conducting our planned analyses, we examined bivariate associations of race and actual BD with BD awareness and the cognition and emotion outcomes. EA women were more likely to report knowing how dense their breasts were (42% vs 15%; $\chi^2(1) = 26.34, p < 0.001$). EA women had greater BC risk knowledge (0.68 vs. 0.54; $F_{1,289} = 56.93, p < 0.001$), BD knowledge (3.85 vs. 2.85; $F_{1,289} = 52.61, p < 0.001$) and BC risk perception (39.74 vs 32.26; $F_{1,232} = 5.53, p < 0.05$) compared to AA women. AA women indicated

greater physical (1.49 vs. 1.25; $F_{1,288} = 8.21$, $p < 0.01$) and social (1.47 vs. 1.28; $F_{1,288} = 4.96$, $p < 0.05$) dimensions of BD anxiety, and less BC Worry (2.34 vs. 2.72, $F_{1,291} = 10.09$, $p < 0.01$). Results for anxiety were corroborated by non-parametric Mann Whitney U tests which indicated marginally significant between race differences in physical and social dimensions of anxiety ($p = 0.05$). Women with dense breasts were more likely to report knowing how dense their breasts were (41% vs. 19%, $\chi^2 (1) = 13.72$, $p < 0.001$), and had greater BC risk knowledge (0.64 vs. 0.58, $F_{1,289} = 7.85$, $p < 0.01$) and BD knowledge (3.59 vs. 3.09; $F_{1,289} = 9.39$, $p < 0.01$) compared to women without dense breasts.

MANCOVA for the cognition outcomes indicated significant effects of race on BC Risk knowledge, BD Knowledge and BC Risk Perception — see Supplemental Table 2 for full model. For each outcome, mean values for EA women were higher than mean values for AA women (Table 3). There were no statistically significant effects of actual BD or of the race by BD interactions on any outcome. These results indicate that racial group membership, and not actual BD status, influences these relevant cognitions, even when we control for the demographic variables that co-vary with race.

MANCOVA for the emotion outcomes indicated no main effects of race, actual BD, or significant interactions on any of the emotion outcomes. The effects of income, education, marital status and family history of BC (Supplemental Table 1) may have accounted for the significant between-race differences in physical and social BD anxiety and BC worry noted in bivariate analyses.

2.2. Effects of racial group on HCP communication and awareness of one's BD

Seventy eight women (27.3% of 286 responders; 9 women skipped item) indicated that a previous health provider had told them that they had dense breasts. Before conducting our planned analyses we examined the bivariate associations between race and HCP communication separately for women with and without dense breasts. EA women were more likely to report being advised that they had dense breasts whether they had dense breasts (54.5% vs. 27.8%; $\chi^2 = [1] = 5.81$, $p < 0.05$) or not (30.3% vs. 17.1%; $\chi^2 = [1] = 4.63$, $p < 0.05$). Results of our stepwise regression (Table 4) indicated that the main effects of race and actual BD were both significant at the first step. Actual BD remained a significant predictor at the second step, whereas race was a marginally significant predictor. The final model correctly classified 75.8% of the respondents. The absence of a significant race by actual BD interaction indicates that AA women were less likely to report being advised about their breast density regardless of whether they had dense breasts. See Supplementary Appendix A for results of analyses restricted to women with dense breasts.

Seventy three women (25% of 291 responders; 4 respondents skipped item) indicated being aware of their BD. Bivariate analyses, conducted separately for women with and without dense breasts, indicated that EA women were more likely to indicate BD awareness whether they had dense breasts (55.8% vs. 22.2%; $\chi^2 [1] = 9.18$, $p < 0.01$) or not (32.8% vs. 13.1%; $\chi^2 [1] = 11.44$, $p < 0.01$). Results of our stepwise regression analyses indicated that race and actual BD were significant predictors at the first step (Table 5). Race remained a significant predictor at the second step; actual BD did not. The final model correctly classified 75.8% of respondents. The absence of main effect of actual BD, or an actual BD by race interaction,

indicated that AA women were less likely to know their own BD regardless of actual BD status. See Supplementary Appendix B for results of analyses restricted to women with dense breasts.

2.3. Race-moderated mediations

We used multi-group path models to examine between-race differences in the extent to which HCP communication mediated the effects of actual BD on relevant cognition and emotions. Model comparisons indicated that the data fit the variant model better compared to the invariant model ($\chi^2 [94] = 140.21, p < 0.01$). Fit statistics for the final model indicated good fit (Model $\chi^2 = 2.93, ns$; $RMSEA = 0.00$, 90% $CI = 0.00$ to 0.11 ; $CFI = 1.00$; $SRMSR = 0.01$). Standardized model parameters and indirect effects are presented in Fig. 2 — we have excluded control variables and endogenous residual covariances from the figure for clarity; however, full model parameters are presented in Supplemental Table 3. Despite HCP communication being significantly associated with BD awareness for both AA and EA women, HCP communication significantly mediated the effect of actual BD on BD awareness for EA women only (path $a * b$; indirect effect = $0.09, p < 0.05$, standardized estimate = 0.08). The mediation of the effects of actual BD on BD knowledge by HCP communication and BD awareness (path $a * b * d_2$) was significant for EA women only (indirect effect = $0.06, p 0.05$, standardized indirect effect = 0.03). These between race differences can be attributed to the finding that actual BD predicted HCP communication for EA women only. None of the other indirect effects were significant.

Additionally, there were distinct between-race differences in the associations between HCP communication and cognition and emotion (direct effects c in Fig. 2). HCP communication was associated with greater BC risk knowledge and BD knowledge for AA women whereas it was only marginally associated with BD knowledge for EA women. For AA women, HCP communication was generally associated with less anxiety across physical, social and emotional dimensions, whereas there were no similar associations for EA women. Recalling our evidence that AA women had more BD related anxiety, these results suggest that HCP communication is important when it comes to attenuating AA women's BD anxiety. See Supplementary Appendix C for ancillary analyses restricted to women with dense breast.

3. Discussion

We examined cognitions and emotions related to BD among women in Michigan before implementation of the state's BD notification law. Importantly, we were able to examine between-race differences in the extent to which self-reported HCP communication about dense breasts mediated the effects of actual BD on BD-related cognition and emotion *before* such communication was mandated by law. In doing so, we provide a snapshot of these associations that may serve as a baseline to compare between-race differences in women's psychological and behavioral responses to BD notifications *after* implementation of the law.

3.1. HCP communication

Our theoretical model explicitly proposed that a HCP informs a woman that she has dense breasts, thus leading to her being aware of her density status which in turn influences her

related cognitions and emotions. This positions HCP communication as an important conduit that translates a BC risk factor to psychological responses. Since there were significant indirect effects via HCP communication on BD awareness and BD knowledge for EA women only, our data supported this theory more for EA women than for AA women. This between-race difference can be directly attributed to AA women's lower likelihood of reporting being informed about BD by their HCPs regardless of their BD status. This finding may be due to one of two causes: either physicians are less likely to inform AA women about their density status, or AA women are less likely to recall being informed about their density status.

Given the high likelihood of racially discordant medical interactions for AA women (Rayburn et al., 2016), lower quality communication on the part of both the physicians and the patients (Peek et al., 2010) likely portend failure to discuss non-pressing medical matters. Extant research documents that AA patients participate less actively in racially discordant medical interactions, that communication in those interactions are less effective, and that AAs attribute ineffective communication to unfair treatment and disrespect (Eggly et al., 2011; Gordon et al., 2006; Johnson et al., 2004b). Additionally, physicians provide less health education, are more verbally dominant, and treat AA patients more contentiously in racially discordant interactions (Gordon et al., 2006; Johnson et al., 2004a; Oliver et al., 2001; Penner et al., 2012; Street et al., 2007). These challenges to information sharing make it more likely that non-emergent medical matters, such as BD, are not discussed in the absence of a prompt to do so (e.g., a patient's potential questions regarding her BD notification).

AA women may also have less veritable recall of being informed about density status compared to EA women. Prior research has indicated less accurate recall of prior cancer screenings by AA individuals. For example, a meta-analysis indicated that racial differences in cancer screening rates were actually larger than those suggested by national surveys due to racial and ethnic minorities' inaccurate self-reports (Rauscher et al., 2008), and population estimates of cancer screening rates may have to be adjusted downwards by as much as 30% for some ethnic minorities (McPhee et al., 2002). Similar patterns likely exist when it comes to between-race differences in accurate recall of HCP communication about BD. We did not identify any research that directly examined *why* recall of medical procedures or communications may be worse for AA women; however, we posit that this could also be related to poorer communication for AA patients in racially discordant medical interactions. Research in different health domains indicates that higher quality communication in medical interactions facilitate patient recall of information (Brandes et al., 2015; Harrington et al., 2004; Wagner et al., 2014). Poorer HCP communication about BD among AA women may be due to a significant proportion of AA women receiving care from non-AA physicians, which, as described in this and the previous paragraph, is associated with lower quality health communication and worse recall about relevant information following medical interactions. Because it may prompt a patient to speak to her physician, mandated BD reporting may strengthen the association between having dense breasts and self-reported HCP communication about density status among AA women.

3.2. Cognition and emotion

AA women fared worse on BD-related cognition and emotion regardless of actual BD status. AA women had worse BC risk knowledge, and worse BD knowledge. AA women also perceived that they were at less risk for BC compared to EA women, which is somewhat accurate given that the BC incidence had been comparatively lower for AA women until the rates converged in 2012 (DeSantis et al., 2016a). However, consistent with their having poorer BD knowledge, there was a moderately significant and troubling trend indicating that AA women with dense breasts perceived themselves to be at *lower* risk. HCP communication was directly associated with greater BC risk knowledge and BD knowledge for AA women, though not for EA women, further highlighting how important physicians' medical information sharing is for AA women's health knowledge. Future research may examine why HCP communication did not have similar effects on cognition for EA women.

Whereas results from bivariate analyses indicated that AA women reported more BD-related anxieties, multivariate results suggested that this effect was mediated by demographic covariates. Given that AA women had lower education levels and less income compared to EA women, and given that lower income and education were associated with more anxiety, the results suggest that these particular covariates may account for the between race differences in BD anxiety independent of actual BD. Women with less education and lower income also had less knowledge about BC risk and BD risk. In a separate study that is currently being prepared for publication, we show that greater BD knowledge attenuates BD-related anxiety. Altogether, these data implicate BD knowledge as a cognitive linchpin that relates sociodemographic variables to BD-related anxiety. No published research has examined the relation between BD knowledge and BD-related anxiety; however, research from separate domains indicated that knowledge about MRI attenuated anxiety among patients scheduled for MRI procedures (Munn and Jordan, 2013), and knowledge about colorectal cancer alleviated fears about colorectal cancer screening (Honda and Gorin, 2005). Additionally, research on interventions designed to improve patient decision-making by improving their knowledge showed that knowledge attenuates anxiety across a number of cancer screening outcomes (Green et al., 2004; O'Brien et al., 2009). Future studies should explore whether interventions to increase women's BD knowledge decrease anxiety related to learning how dense ones breasts are, and whether such interventions have downstream effects on subsequent decision-making. Importantly, given greater anxiety among AA women, such interventions may attenuate potential between-race differences in psychological responses to receiving BD notifications.

3.3. Limitations and future direction

All behavioral data were self-reported, and we were unable to adjudicate women's self-reported HCP communication for the current sample and we were unable to assess women's actual risk. Examination of a subset of the population from which this sample was recruited for whom we had repeat mammograms ($N = 1884$) indicated that 10% of women were assigned a BI-RADS density that would adjust their classifications from having dense to non-dense breasts (Purrington, 2015a,b). Thus, there may be a small proportion of women for whom our single assessment of actual BD may not be fully consistent with they were told about their BD. We lacked data on who women's referring HCPs were, and

consequently we are unable to examine whether there were any systematic between-race differences in HCPs for EA and AA women. Future studies may cluster patients within their respective HCPs so that we may include any significant effects not investigated here. Nonetheless, the current study is the first to examine between-race differences in the associations between actual BD and important psychological outcomes in the state of Michigan before implementation of the state's BD notification law. As such, we present the only data that allows comparisons of these associations before and after the law's implementation.

The distributions for the BD anxiety constructs were negatively skewed. Nonetheless, (a) there were some women who reported higher levels of anxiety related to thinking about BD even without an accompanying BD notification, and (b) our forthcoming study is consistent in showing that AA women who actually received BD notifications reported higher levels of anxiety (Manning et al., 2016a,b). These findings regarding anxiety must be replicated with different assessments of anxiety. It is also important to determine whether between-race differences in anxiety predicts subsequent between-race differences in supplemental breast cancer screening behaviors and downstream breast cancer detection.

3.4. Conclusions

We have presented the only data of which we are aware that examines between-race differences in the associations between actual BD, HCP communication and BD related cognition and emotion before the implementation of BD notification laws. Our study demonstrated that regardless of actual BD, AA women were less likely to know their own BD and less likely to report being informed that they had dense breasts. When AA women's physicians informed them about having dense breasts, they had better BD knowledge and reported less anxiety. These findings suggest that the BD notification laws could yield positive benefits for disparities in BD-related knowledge and anxiety *if* the notifications are followed by discussions with physicians. However, the potential for between-race differences in physicians' advice for follow-up and in their targeted referrals for supplemental breast cancer screening suggest that we must continue to closely monitor the behavioral and epidemiological outcomes related to BD notifications if we are to mitigate downstream racial disparities in breast cancer detection among women with dense breasts.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Fig. 1.

Conceptual representation of path model. = marital status is excluded as predictor of HCP communication. HCP = Health Care Provider, BC = Breast cancer.

Fig. 2. Standardized direct effects. Control variables and endogenous residual covariances have been excluded from figure to facilitate presentation. HCP=Health Care Provider, AA = African American, EA = European American. [†] $p < 0.10$. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Table 1

Sample demographic data

	EA		AA	
	M	SD	M	SD
Age	59.54	8.57	58.07	7.85
	<i>N</i>	%	<i>N</i>	%
Income ^{***}				
< Median (\$50K – \$59K)	26	24%	113	64%
Median (\$50K – \$59K)	83	76%	64%	36%
Highest Education [*]				
High School	12	11%	36	20%
Higher education	63	56%	104	57%
Graduate; Professional Degree	38	34%	42	23%
Marital Status ^{***}				
Married; Partnered	72	64%	50	28%
Separated; Widowed; Divorced	26	23%	75	42%
Single; Never Married	14	13%	54	30%
Family BC ^{**}				
No	47	42%	104	57%
Yes	66	58%	78	43%
Dense Breasts ^{***}				
No	69	61%	146	80%
Yes	44	39%	36	20%

Significant between-race differences:

^{***}
= $p < 0.001$ ^{**}
= $p < 0.01$ ^{*}
= $p < 0.05$

Table 2

Means, SD, and correlations for cognition and emotion outcomes.

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7
1 BD awareness	0.25	0.43							
2 BC risk knowledge	0.59	0.17	0.25 ^{***}						
3 BD knowledge	3.23	1.24	0.43 ^{***}	0.48 ^{***}					
4 BC risk perception	35.24	24.05	-0.03	0.07	0.03				
5 BD anxiety - physical	1.40	0.69	-0.07	-0.21 ^{***}	-0.16 ^{***}	0.20 ^{***}			
6 BD anxiety - social	1.39	0.72	-0.02	-0.22 ^{***}	-0.16 ^{***}	0.16 [*]	0.81 ^{***}		
7 BD anxiety - emotional	1.57	0.78	-0.07	-0.18 ^{***}	-0.16 ^{***}	0.30 ^{***}	0.84 ^{***}	0.80 ^{***}	
8 BC worry	2.49	1.01	0.02	0.13 [*]	0.02	0.39 ^{***}	0.31 ^{***}	0.23 ^{***}	0.44 ^{***}

Note:

*** = $p < 0.01$ * = $p < 0.05$. BC=Breast cancer. BD=Breast density.

MANCOVA implied means demonstrating effects of race and actual breast density on continuous cognitive and emotion outcomes.

Table 3

	BD	Mean (SE)		F values ($F_{1,210}$) ^a		
		AA	EA	Race	BD	Interaction
Cognitive outcomes						
BC risk knowledge	Non-dense	0.54 (0.02)	0.63 (0.02)	7.78**	0.75	0.26
	Dense	0.58 (0.03)	0.63 (0.03)			
BD knowledge	Non-dense	3.09 (0.12)	3.61 (0.15)	8.95**	0.08	0.01
	Dense	3.15 (0.19)	3.63 (0.18)			
BC risk perception	Non-dense	33.97 (2.95)	37.38 (3.64)	5.62*	1.27	3.07 [†]
	Dense	23.29 (4.76)	39.70 (4.45)			
Emotion outcomes						
BD anxiety - physical	Non-dense	1.52 (0.07)	1.35 (0.09)	3.22 [†]	0.10	0.03
	Dense	1.50 (0.12)	1.30 (0.11)			
BD anxiety - social	Non-dense	1.52 (0.08)	1.34 (0.10)	0.85	0.08	0.64
	Dense	1.47 (0.13)	1.45 (0.12)			
BD anxiety - emotional	Non-dense	1.65 (0.08)	1.53 (0.11)	0.01	0.02	0.97
	Dense	1.56 (0.14)	1.65 (0.13)			
BC worry	Non-dense	2.33 (0.10)	2.53 (0.13)	2.41	0.18	0.06
	Dense	2.36 (0.18)	2.63 (0.16)			

AA = African American. EA = European American. BC=Breast cancer. BD=Breast density.

[†] $p < 0.10$.

* $p < 0.05$.

** $p < 0.01$.

^aControlling for income, education, marital status and family history of BC and age.

Table 4

Logistics regression parameters for physician communication outcome.

	log <i>OR</i>	<i>SE</i>	<i>OR</i>	log <i>OR</i>	<i>SE</i>	<i>OR</i>
African-American	-0.73 [*]	0.36	0.48	-0.66 [†]	0.40	0.51
Dense breasts	0.96 [*]	0.41	2.61	1.00 [*]	0.45	2.72
African-American × dense breasts	-0.43	0.61	0.65	-0.28	0.65	0.76
Income	—	—	—	0.93 [*]	0.38	2.52
Age	—	—	—	0.05 ^{**}	0.02	1.05
Separated/Divorced ^a	—	—	—	-0.02	0.38	0.98
Single ^a	—	—	—	0.63	0.43	1.88
Higher education ^b	—	—	—	0.26	0.47	1.30
Graduate school ^b	—	—	—	-0.67	0.55	0.51
Family history BC	—	—	—	0.49	0.31	1.63
Constant	-0.86 ^{**}	0.27	0.42	-5.32 ^{**}	1.42	0.00
Cox & Snell <i>R</i> ²	0.07			0.13		

[†]*p* < 0.10.^{*}*p* < 0.05.^{**}*p* < 0.01.

BC=Breast cancer.

^aReference = Married.^bReference = high school education.

Table 5

Logistic regression parameters for breast density awareness outcome.

	log <i>OR</i>	<i>SE</i>	<i>OR</i>	log <i>OR</i>	<i>SE</i>	<i>OR</i>
African-American	-1.18**	0.36	0.31	-1.37**	0.43	0.25
Dense breasts	0.82*	0.41	2.26	0.41	0.44	1.51
African-American × dense breasts	-0.35	0.64	0.70	0.33	0.70	1.38
Income	—	—	—	1.26**	0.42	3.51
Age	—	—	—	0.01	0.02	1.01
Separated/Divorced ^a	—	—	—	0.03	0.42	0.97
Single ^a	—	—	—	1.70***	0.47	5.50
Higher education ^b	—	—	—	1.08 [†]	0.60	2.94
Graduate school ^b	—	—	—	0.91	0.65	2.50
Family history BC	—	—	—	-0.14	0.32	0.87
Constant	-0.67*	0.26	0.51	-3.09*	1.39	0.05
Cox & Snell <i>R</i> ²	0.10			0.19		

BC=Breast cancer.

[†]
 $p < 0.10$.*
 $p < 0.05$.**
 $p < 0.01$.***
 $p < 0.001$.^aReference = Married.^bReference = high school education.