Diagnostic Resolution after Abnormal Mammograms:

The Role of Contextual and Individual Factors

BY

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THESIS

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This thesis is dedicated to my family. To my loving husband, William, your unwavering support was vital to my success. Thank you for encouraging me to follow my dreams, your time listening to me, and your assistance during my absence many long nights and weekends. To my children, Mark, Sophie, and Mia. You serve as an inspiration for my work. To my parents and parents-in-law, thank you for your reassurance and belief in my ability. To Abby, Rosie, and Merry, thank you for your love and support during my many hours of work.

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LIST OF ABBREVIATIONS

CI	95% Confidence Interval
ACS	American Community Survey
BI-RADS	Breast Imaging Reporting and Data System
CHNS	Community Health Needs Assessment
DHS	Disproportionate Share Hospitals
ER+/ER-	Estrogen Receptors
HER2+/HER2-	Human Epidermal Growth Factor Receptor 2
HR	Hazard Ratio
HRSA	Health Resources and Services Administration.
LQ	Location Quotient
MSA	Metropolitan Statistical Area
MRI	Magnetic Resonance Imaging
MUA	Medically Underserved Areas
NASW	National Association of Social Workers
NCI	National Cancer Institute
NIH	National Institutes of Health
OR	Odds Ratio
PNMUA	Patient Navigation in Medically Underserved Areas
PR+/PR-	Progesterone receptors
SE	Standard Error
SEER	Surveillance, Epidemiology, and End Results Program

LIST OF ABBREVIATIONS (continued)

SES   Socioeconomic Status

TNM   Tumor, Node, and Metastasis

TSA   Total Service Area

U.S.   United States

UIC   University of Illinois at Chicago

USPSTF   United States Preventive Services Task Force

SUMMARY

Advances in early detection and treatment have resulted in an overall decline in breast cancer mortality rates in the United States (U.S.) (Surveillance, Epidemiology, and End Results Program [SEER], 2015; Berry et al., 2005; American Cancer Society, 2013). Despite these advances, significant socioeconomic and racial breast cancer mortality disparities persist. Survival rates are the lowest for Black women among all racial or ethnic groups in the U.S. (SEER, 2015). Black women are more often diagnosed at a later stage of breast cancer, and as a result, face higher mortality rates relative to their white counterparts (DeSantis, Siegel, Bandi, & Jemal, 2011; DeSantis, Ma, Bryan, & Jemal, 2014). In part, late stage diagnosis in Black women has been attributed to delay in diagnostic follow-up after an abnormal mammogram result (Smith-Bindman et al., 2006; Wujcik & Fair, 2008). Despite the literature documenting diagnostic delay after abnormal mammography, very little is known and few studies have examined the relationship between contextual-level factors, individual-level factors, and timely diagnostic follow-up after abnormal mammograms (Schootman et al., 2007; Wujcik & Fair, 2008).

Social work has a long and rich history of valuing and attending to the health of vulnerable populations in order to seek social justice. However, despite the efforts that date back to the 1800s to remedy conditions that lead to poor health in vulnerable populations, social and economic injustices remain determinants of poor health and health disparities (Gehlert et al., 2008). Likewise, health disparities are the result of social, economic, and environmental forces that are fundamental causes of the disparity. Today, health remains vastly different for various segments of the population. Mortality, morbidity, and well-being are determined by far more than genetics or even personal health behavior, moreover social and economic power structures

of a population shape health (Marmot & Wilkinson, 2006). Conceptually, the social determinants of health expand the definition of individual health to the conditions that people are conceived and born, live, grow, develop, and age. In order for social work to adequately address health disparities the social determinants of health must be addressed. Given the holistic perspective of the profession, social workers have the expertise and training to provide leadership in addressing health disparities. In addition, social work has a unique and integral role in the U.S. health care system. Social workers contribute to scholarly research and provide services across the health care continuum (NASW, 2005). According to the National Association of Social Workers (2005), social work is committed and has a continuing focus on addressing health disparities. Addressing health disparities is a matter of social justice and social workers have an ethical obligation to contribute to the transdisciplinary efforts in finding solutions to address the ongoing health disparities in vulnerable populations.

Informed by two theoretical frameworks, the model for analysis of population health and health disparities (Warnecke et al., 2008) and the Andersen behavioral model of health services use (Andersen, 1995), this study examined the relationship between multiple levels of influence, both contextual and individual, and timely diagnostic follow-up of abnormal mammograms. The study tested two hypotheses: 1) neighborhood poverty, racial residential segregation, and/or distance to mammography clinic will have a significant direct effect on diagnostic resolution; and 2) insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and/or BI-RADS value (Breast Imaging Reporting and Data System value) will have a significant direct effect on diagnostic resolution.

A data analysis was conducted to test the study hypotheses and assess the relationship between contextual factors and individual factors and diagnostic resolution after an abnormal

mammogram. The analytic sample was a subset of women in the Patient Navigation in Medically Underserved Areas (PNMUA) a randomized, controlled trial conducted in three hospitals in Chicago, Illinois. The longitudinal data was collected from patient electronic medical records and questionnaires. Data from 690 women were used for the study analyses.

Diagnostic resolution after an abnormal mammogram was operationalized using two dependent variables, diagnostic resolution and time to diagnostic resolution. The first dependent variable, diagnostic resolution, was dichotomized as patient completed or did not complete follow-up within 60 days after an abnormal mammogram. The second dependent variable, time to diagnostic resolution, was operationalized as the number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record. The independent variables were contextual factors (neighborhood poverty, distance to mammography clinic, and racial residential segregation) and individual factors (insurance status, usual source of healthcare, age, race/ethnicity, level of education, BI-RADS value, and household income). The control variables were patient navigation intervention status and the hospital where women received breast care.

Two statistical regression methods, binary logistic regression and Cox proportional hazards regression analyses, were used to test the study hypotheses. Results from the multivariate analyses indicated that the hospital where women received breast care, patient navigation, distance to mammography clinic, and age were associated with diagnostic resolution. Women who accessed care at Holy Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at Trinity. Women in the patient navigation intervention group had shorter time to diagnostic resolution compared to women in the standard of care group. Older women also had shorter time to diagnostic resolution. In addition, living farther

from the hospital mammography clinic was associated with shorter time to diagnostic resolution. Although there are limitations to the study that must be considered, findings of this study offer several important implications for research about contextual and individual factors related to timely diagnostic resolution after abnormal mammography and it builds on the seminal cancer disparities research that documents how health outcomes are related to social advantage and disadvantage. For social work practice, this study offers the opportunity to inform individual-level interventions that address the contextual environment in which women access early detection breast cancer services. This study contributes to understanding the complex interactions and multiple levels of influence impacting women accessing care in medically underserved areas that may inform policy efforts, future early detection interventions, and future directions for research.

A.   <u>Background and Rationale</u>

1.   <u>Social Work and Health Disparities</u>

Social work is a values based profession. Fundamentally, the foundation of social work is built on a mission that guides the profession based on a core set of values. These values include service, social justice, dignity and worth of the person, importance of human relationships, integrity, and competence (National Association of Social Workers [NASW], 2016). These values embody the primary social work concept of the importance of focusing on the environmental influences that contribute negatively to overall human well-being, particularly for people living in poverty, who are oppressed, marginalized, and vulnerable. Importantly, social work theoretical approaches to developing interventions and conceptual models that inform research rely on the ecological perspective of person-in-environment (Weiss-Gal, 2008). Social workers have a concomitant focus on social and economic justice and elimination of disparities between and among populations recognizing that social and financial status is intertwined with health status (Weiss-Gal, 2008; NASW, 2005).

This notion is not new to social work, and in fact, social work has a long and rich history of valuing and attending to the health of vulnerable populations in order to seek social justice. For example, in the 1890s, improving health was a fundamental task of residents in the settlement houses and a central focus of social reform movements (Schild & Sable, 2012). A cofounder of Hull House, Jane Addams, was elected public sanitarian in her Chicago ward. Jane Addams political activities and efforts, along with other women working for social reform, included teaching hygiene and other health-promoting behaviors. Despite the efforts that date back to the 1800s to remedy conditions that lead to poor health in vulnerable populations, social and economic injustices remain determinants of poor health and health disparities (Gehlert et al., 2008). Likewise, health disparities are the result of social, economic, and environmental forces that are fundamental

causes of the disparity. Today, health remains vastly different for various segments of the population (Surveillance, Epidemiology, and End Results Program [SEER], 2015). Mortality, morbidity, and well-being are determined by far more than genetics or even personal health behavior; moreover, social and economic power structures of a population shape health (Marmot & Wilkinson, 2006). Conceptually, the social determinants of health expand the definition of individual health to the conditions that people are conceived and born, live, grow, develop, and age. In order for social work to adequately address health disparities, the social determinants of health must be addressed (NASW, 2005). Given the holistic perspective of the profession, social workers have the expertise and training to provide leadership in addressing health disparities (NASW, 2005).

Importantly, social work has a unique and integral role in the U.S. health care system. Social workers contribute to scholarly research and provide services across the health care continuum (NASW, 2005). According to the National Association of Social Workers (2005), social work is committed and has a continuing focus on addressing health disparities. Addressing health disparities is a matter of social justice and social workers have an ethical obligation to contribute to transdisciplinary efforts in finding solutions to address the ongoing health disparities in vulnerable populations. The University of Illinois Hospital & Health Sciences System, a part of the University of Illinois at Chicago (UIC), consists of seven health science colleges, including the Jane Addams College of Social Work (University of Illinois Hospital and Health Sciences Systems, 2016). UI Health provides transdisciplinary comprehensive care, education, and research and is dedicated to the pursuit of health equity. This paper examines data collected from a randomized, controlled trial conducted at the University of Illinois at Chicago that tested the efficacy of an intervention to improve breast health outcomes for women living in medically underserved areas. Importantly, this transdisciplinary research includes key concepts from social work and other disciplines (i.e.,

biological, social, and behavioral sciences) to examine the broader view of health care access for women residing in geographical areas with known disparate health outcomes.

2. Breast Cancer in the United States

Worldwide, breast cancer is the most common cancer diagnosed among women. In the U.S., it is also the most prevalent type of cancer diagnosed among women with an estimated 231,840 new cases expected to have been diagnosed in 2015 (SEER, 2015). In the U.S., there are an estimated 2.9 million women living with breast cancer (SEER, 2015). Non-Hispanic White women, compared with all other racial and ethnic groups, consistently have the highest incidence rate of breast cancer. Between the years 2008-2012, the incidence rate was 128 per 100,000 for White women compared to 124 for Black, 96 for Asian Pacific Islander, 82 for American Indian/Alaska Native, and 92 for Hispanic women per 100,000 (SEER, 2015).

Breast cancer has the second highest mortality rate for women in the U.S. with an estimated 40,000 women dying from the disease in 2015 (SEER, 2015). However, from 1990 to 2010, breast cancer death rates decreased by 34% with the greatest decline in women younger than 50 (3.1% decrease per year) as compared to women 50 and older (1.9% decrease per year) (SEER, 2015). Correspondingly, over the past 40 years survival rates have increased. For example, the 5-year relative survival rate was 75.2% in 1975 and increased to 91.0% by 2007 (SEER, 2015). Between the years 2003-2009, the 5-year survival rate was 91.4% for Asians, 88.6% for non-Hispanic Whites, 87.0% for Hispanics, 86.8% for Asian Pacific Islanders, 85.4% for American Indian/Alaska Natives, and 78.9% for Blacks (SEER, 2015). Although Surveillance, Epidemiology, and End Results (SEER) data is used extensively, studies evaluating quality have found data inaccuracies regarding information concerning race, Hispanic ethnicity, and immigrant status (Clegg et al., 2007). The increase in survival rates and decrease in breast cancer mortality has been attributed to improvements in breast cancer treatment and early detection (Berry et al., 2005).

Despite the overall decrease in breast cancer mortality, all segments of the population have not benefited equally from the advances in early detection and treatment (SEER, 2015). Beginning in the early 1980s, mortality trends between Black and White women began a striking divergence (SEER, 2015). By 2010, the national breast cancer death rates for Black women were 41% higher than White women with breast cancer. Likewise, survival rates are the lowest for Blacks among all racial or ethnic groups in the U.S. Between the years 2007-2011, the national breast cancer mortality rate was 22 per 100,000 for White women and 31 per 100,000 for Black women (SEER, 2015). Consistent with the national trend, in Illinois a substantial survival disparity exists where the mortality rate was 23 per 100,000 for White women and 33 per 100,000 for Black women (SEER, 2015). Chicago has one of the highest racial disparities in breast cancer mortality in the U.S. with Black women dying at a 62% greater rate than White women (Metropolitan Chicago Breast Cancer Task Force, 2014). In addition, regardless of race, poverty has been associated with poorer breast cancer outcomes for all women (National Cancer Institute [NCI], 2008; Bigby & Holmes, 2005). A larger proportion of women compared with men as well as Blacks compared with Whites live in poverty (United States Census Bureau, 2013). Thus, Black women have a greater burden of poverty and are more likely to face barriers associated with being poor (Gerend & Pai, 2008).

According to the National Cancer Institute (2015a), a lack of medical coverage, barriers to early detection and screening, and unequal access to improvements in cancer treatment may be contributing factors to the survival differences between Black and White women. Similarly, poverty, less education, and a lack of health insurance have been associated with lower breast cancer survival (Sprague et al., 2011; Halpern, Ward, Schrag, & Chen, 2007). In addition to social and economic barriers, more recently, studies have found that aggressive breast tumors are

more common in Black and Hispanic women, and as a result, early detection of these tumors is vital for women's survival (NCI, 2015a; Carey et al., 2006). Black women have a higher breast cancer incidence rate before age 40 (American Cancer Society [ACS], 2013). Importantly, they also are more likely to die from breast cancer at every age compared to White women (ACS, 2013). Breast cancer tumors diagnosed at younger ages are often more aggressive and less responsive to treatment; additionally, these tumors are associated with poorer survival (Carey et al., 2006). Surviving breast cancer is strongly associated with the stage of the disease and tumor size when it is first diagnosed (SEER, 2015). Women who are diagnosed at later stages have markedly poorer prognosis for survival because treatment is far less successful for the advanced stage disease (ACS, 2013). For example, the five-year relative survival rate (the comparison of survival rates between women with breast cancer to women in the general population) is 99% for women with localized disease (the cancer is confined to the tissue where it began), 85% for regional disease (the cancer has spread into the adjacent tissues), and 26% for distant-stage metastasized disease (the cancer has spread from the primary tumor to distant organs or distant lymph nodes) (SEER, 2015).

Early detection of breast cancer reduces the risk of dying from the disease and may lead to a greater range of treatment options that are potentially less invasive and extensive (e.g., lumpectomy versus mastectomy) (ACS, 2013). Although the degree of the mortality benefit has been debated for younger women (Gotzsche & Olsen, 2000), most evidence-based guidelines such as the American Cancer Society (2013), continue to recommend regular screening for women beginning at age 40 (Humphrey, Helfand, Chang, & Woolf, 2002; Leitch et al., 1997). Results from randomized trials, collectively have found that use of mammography as a method of early detection may reduce the risk of dying from breast cancer by15% to 20% (Gotzsche &

Jorgensen, 2013; Nelson et al., 2009). A meta-analysis, conducted by Nelson et al. (2009) indicated mammography screening benefited breast cancer mortality for ages 39 to 69. Although mammography may be beneficial for women 70 and older, sufficient data and firm evidence are lacking (Nelson et al., 2009).

Since mammography can identify breast cancer several years before the physical symptoms develop, it is the single most effective method of early detection (ACS, 2013). When breast cancer tumors are small and most easily cured, typically women do not have any signs or symptoms of the disease. As a result, early detection screening mammography is vital. For many women age 40 and older in the U.S., screening mammography has become part of their routine healthcare. In 2013, the national estimate of women age 40 and older who received a mammogram in the past two years was 65.7% (Centers for Disease Control and Prevention [CDC], 2014). Of women receiving mammograms, on average 10% will have an abnormal or suboptimal/incomplete findings that will require diagnostic follow-up examinations (Yabroff et al., 2007; Rosenberg et al., 2006). Diagnostic follow-up examination refers to the tests conducted after abnormal mammogram findings to determine whether or not the abnormal or incomplete finding is breast cancer. These diagnostic tests can include a diagnostic mammogram, magnetic resonance imaging (MRI), ultrasound, and/or biopsy. While there is not a standard of consensus in the literature regarding timely diagnostic follow-up of abnormal or incomplete mammogram, delay or failure to return for an exam may impact treatability of the cancer (Brewer, Salz, & Lillie, 2007) and has been associated with higher breast cancer mortality (Richards, Smith, Ramirez, Fentiman, & Rubens, 1999). Delaying diagnosis and treatment as little as three months reduces survival rates (Elmore et al., 2005; Hershman et al., 2006), and as a result, improving early detection of breast cancer through timely diagnostic resolution after an abnormal

mammogram is important in reducing breast cancer related deaths in Black women. This dissertation study contributes to the scholarly knowledge about factors affecting the breast cancer survival disparity between Black and White women by examining the relationship between contextual and individual factors and diagnostic resolution after an abnormal mammogram.

3. <u>Cancer Health Disparities</u>

Cancer health disparities are differences in the incidence, prevalence, morbidity, mortality, cancer survivorship, and burden of cancer that exists among specific population groups (National Cancer Institute [NCI], 2015a). The population groups that experience the disparity may be characterized by gender, age, race, ethnicity, education, income, disability, or geographic location (NCI, 2015a). Breast cancer disparities are well-documented across the cancer continuum from incidence, prevalence, and mortality to survivorship (NCI, 2015a; Gerend & Pai, 2008). Health disparities are the result of a complex interplay of many contributing factors associated with the social determinants of health, which are the conditions in which people are conceived and born, live, grow, develop, and age (World Health Organization, 2015; Marmot & Wilkinson, 2006). The roots of health disparities are imbedded in poor and minority populations facing social factors that have a negative impact on health (Phelan, Link, & Tehranifar, 2010). The person-in-environment perspective, the hallmark of social work theory and practice, recognizes an individual is dynamically connected to multiple environmental systems that simultaneously affect one another (Hare, 2004). This concept reflects the dual aspirations of social work to provide care to individuals while simultaneously addressing social justice more broadly. Freeman and Chu (2004) expanded the person-in-environment perspective to reflect the importance of understanding cancer in the context of an individual's environment in the social determinants of health disparities in cancer model. The model incorporates three fundamental social determinants of cancer disparities including, social injustice, poverty, and

culture. These interconnected causal factors impact the entire cancer continuum, including cancer prevention, screening, early detection, diagnosis, treatment, and survivorship.

Cancer occurs within the context of human circumstances that include culture, poverty and low socioeconomic status, and social injustice (Freeman, 2004). The context of culture is vital in reflecting a set of beliefs and behaviors that are common to a particular social group (Freeman, 2004; Freeman & Chu, 2005). According to Freeman and Chu (2005), culture reflects an individual's or community's similarities in physical and social environment, communication system, and a set of learned and shared beliefs, values, and traditions. Multiple studies have highlighted the role of cultural factors in promoting racial breast cancer disparities. These factors have included spirituality, cultural beliefs and attitudes about breast cancer, perceived susceptibility to breast cancer, and general mistrust of the health care system (Gerend & Pai, 2008). Social injustice embodies structural factors that create and reinforce racial prejudice and discrimination and result in unequal distribution of resources (Freeman & Chu, 2005). Historical racism and discrimination against a particular racial group is a powerful determinant of socioeconomic status of that group, and as a result, low economic status contributes to disparities in disease and health. Low socioeconomic status is a primary factor associated with cancer disparity that is often related to a person's income, education level, and occupation (Freeman & Chu, 2005; NCI, 2015a). Socioeconomic status often predicts an individual's or group's access to health insurance, education, occupations, living conditions, and exposure to environmental conditions all of which are associated with developing and surviving cancer. Additionally, low socioeconomic status is linked to a variety of negative health behaviors such as tobacco smoking, physical activity, alcohol intake, and following cancer screening recommendations (NCI, 2015a; Chen & Miller, 2013).

At every stage of diagnosis, women living in resource-poor areas have lower five-year survival rates compared to women in higher-income areas (NCI, 2015a). Women from medically underserved areas and racial and ethnic minority populations experience an undue burden of cancer in the U.S. (NCI, 2015a). In the 1970s, medically underserved areas (MUAs) were designated at the federal policy level to address disparities and identify areas and populations that have limited access to health care services (Health Resources and Services Administration [HRSA], 2014). MUA designation allows for federal financial resources to establish healthcare delivery systems and has a direct effect on the allocation of health care provisions for the poor. Designation of an MUA is based on the ratio of primary medical care physicians, infant mortality rate, percentage of the population with incomes below the poverty level, and percentage of the population age 65 or over (HRSA, 2014). MUAs are communities characterized by multiple levels of disadvantage and often have high percentages of racial and ethnic minorities. Medically underserved women experience breast cancer disparities in prevention, detection, treatment, and survival of cancer that represent a complex interaction between social determinants of health, behavioral risk factors, and system access to timely and high quality care (NCI, 2015a).

In sum, the nature of cancer disparities is multifaceted and multi-causal. At the crux of social work is the professional ideology of the person-in-environment, and as a result social work plays an integral role in contributing to the scientific evidence by examining the multiple levels of influence that contribute to breast cancer disparities. Health disparities are fundamental issues faced by the social work profession that require further robust investigations that incorporate a multi-systemic perspective.

B. <u>**Factors Related to Timely Follow-Up of Abnormal Mammogram**</u>

A myriad of complex and interrelated individual factors (e.g. income, education, behavior) and structural factors (e.g. access to care, poverty) may affect timely follow-up in diagnostic testing (Yabroff et al., 2004; Adams et al., 2009; Goldman et al., 2013; Wujcik & Fair, 2008). Notably, most of the existing research has focused on individual level factors. For example, multiple studies have examined race and ethnicity and found that Black women are less likely to receive timely diagnostic resolution following an abnormal mammogram (Chang et al., 1996; Jones et al., 2005; Elmore et al., 2005). Also, women who are poor, under or uninsured, and/or have lower levels of education are less likely to complete timely follow-up of abnormal mammograms (Krok-Schoen et al., 2014; Battaglia et al., 2007; Strzelczyk & Dignan, 2002; Perez-Stable et al., 2013; Adams et al., 2009).

Reflecting the core social work concept of person-in-environment, in order to fully understand the social determinants of health, it is vital to examine the individual in her contextual social and physical environment (Hare, 2004). In their review of the theory, evidence, and policy implications of social conditions as fundamental causes of health inequities, Phelan, Link, and Tehranifar (2010), highlighted the importance of identifying and addressing contextual risk factors such as socioeconomic resources. Furthermore, potential interventions that address individual risk profiles must first identify factors that put individuals at risk. Otherwise, interventions aimed at changing individual-level behaviors, which are powerfully influenced by contextual factors, will not be affected by the intervention. Likewise, eliminating health disparities will require moving from the traditional individual approach to health that focuses on biology of disease to a multi-level approach that includes the social determinants of health (Koh et al., 2010).

Studies have documented that structural disadvantage including, neighborhood poverty, racial residential segregation, and access to healthcare have been associated with poor breast cancer screening rates and later stage breast cancer diagnosis (Fowler, 2014; Wujcik & Fair, 2008; Litaker & Tomolo, 2007; Coughlin, Leadbetter, Richards, & Sabatino, 2008; Kim, Chukwudozie, & Calhoun, 2013; Wang, McLafferty, Escamilla, & Luo, 2008). However, very little is known and few studies have examined the relationship between contextual factors and time to diagnostic resolution (Schootman et al., 2007; Wujcik & Fair, 2008). This study is an important contribution to the knowledge about the relationship between multiple levels of influence and diagnostic resolution after an abnormal mammogram. The purpose of this study was twofold. First, the relationship between diagnostic resolution after an abnormal mammogram and contextual factors including, neighborhood poverty, racial residential segregation, and distance to mammography clinic was examined. Second, the relationship between diagnostic resolution after an abnormal mammogram and individual factors (i.e., insurance status, usual source of healthcare, age, race, ethnicity, level of education, household income, BI-RADS standardized abnormal mammogram value) was examined.

The scientific evidence base to fully comprehend and eliminate cancer disparities is unclear (Gehlert et al., 2010). Most recent scholarly conceptualizations of health disparities recognize the multiple levels of causes from the molecular to the societal (LaVeist, 2005; Marmot & Wilkinson, 2006; Gehlert et al., 2010); however, researchers face a multitude of challenges when attempting to capture these complex conceptualizations and attempts to do so have been limited (Gehlert et al., 2010). Given the multifaceted and complex nature of cancer disparities, this study attempts to capture the complexity by incorporating individual level factors along with contextual level factors. Findings from this study offer several important implications.

It builds on the seminal cancer disparities research that documents how health outcomes are related to social advantage and disadvantage as well as informing social work practice and policy related to individual-level interventions that address the contextual environment in which women access early detection of breast cancer services.

II. THEORETICAL FRAMEWORK

At the core of social work is the professional ideology of person-in-environment, which embraces a holistic focus on the complex and dynamic interaction between people and their environments (NASW, 2005). As a profession, social work strives to provide individualized, strength-based care; yet, uniquely social work also recognizes the importance of the environmental conditions in which people live. For instance, scholars examining neighborhood and health recognize the theoretical importance of focusing on places rather than on people (Sampson, 2003). Similarly, early detection of breast cancer involves interaction between a woman and the larger environment in which she accesses services. In order to fully understand and create systems that positively influence access to early detection services, frameworks must expand from the individual perspective and intellectualize preventative health behaviors as a consequence of the multifaceted interrelationship of multiple individual, community, and structural influences (Pruitt et al., 2009).

Social workers must recognize and understand health is an issue of both economics and well-being (NASW, 2005). Breast cancer disparities are imbedded in factors related to social class, race, and geography (NCI, 2015a.). For instance, a woman with a car, health insurance, a primary care physician, and access to quality healthcare services, experientially, accessing diagnostic follow-up after an abnormal mammogram is very different compared with a woman without those enabling and supportive factors. Another example that highlights the potential barriers in seeking preventative or diagnostic services relates to the fact that some women do not have the ability to leave work during the hours in which health services are available. This example reflects social, economic, and institutional factors that operate as obstacles for women seeking necessary care.

Despite the multifarious causes of breast cancer disparities, a long history of social work theory and practice exists as a means of examining the potential mechanisms that have created these disparities. Certainly the root of breast cancer survival disparities between Black and White women will not point to one cause nor will it involve only individual level factors. Thus, theoretical assumptions that inform breast cancer disparities research must draw from comprehensive approaches that provide a framework that captures the complexity and interconnected transactions between a woman and her environment. Likewise, it is important to examine the pathways and mechanisms linking multilevel factors and timely diagnostic resolution after an abnormal mammogram.

A.   **Overview of Integrated Theoretical Model**

The fields of social work and public health offered a rich and well-established theoretical foundation and scholarship to guide this study. For this study, a conceptual model was developed by blending two theoretical frameworks: the model for analysis of population health and health disparities (Warnecke et al., 2008) and the Andersen behavioral model of health services use (Andersen, 1995). The model for analysis of population health and health disparities is a paradigm that expands the ecosystems framework specifically to health disparities (Warnecke et al., 2008). Breast cancer disparities are highly complex, multi-systemic, and involve a host of hereditary, individual behavioral factors, social circumstances, and environmental factors (Gehlert et al., 2008). Ecosystems theory is a widely accepted framework in social work practice, research, and policy that reflects the complexity of individual characteristics in the context of their environment (Mattaini & Huffman-Gottschling, 2012). The ecosystems perspective, developed in the 1970s, was designed to focus on the transactional complexity and delicate balance between individuals and the various interactions with in their environment

(Bronfenbrenner, 1979). The model for analysis of population health and health disparities is a population approach that incorporates individual level factors and recognizes the complexity and multilevel interactions between an individual and their environment (Warnecke et al., 2008). However, the model lacks a conceptualization regarding the factors that lead individuals to use healthcare services. When examining healthcare access behavior, it is necessary to incorporate theoretical assumptions about individual behavior. The Andersen behavioral model of health services use, a conceptual model that describes the factors that lead to individuals' decision making about accessing healthcare services, was also incorporated into the model for this study (Andersen, 1995). Several prior studies have used the Andersen theoretical framework as a model for examining individual factors related to accessing mammography (Champion, & Menon, 1997; Couture, Nguyen, Alvarado, Velasquez, & Zunzunegui, 2008; Harcourt et al., 2014). The Andersen model provides a framework for identifying important individual-level factors and characteristics that are related to utilization of healthcare services.

The scientific developments and theoretical conceptualizations within the aforementioned models have influenced the study design, selection of the variables, and hypothesized relationships between the independent and dependent variables. The two theoretical frameworks that were blended to develop a conceptual model for this study each have important and distinct components that capture the complexity of accessing healthcare services after abnormal mammography. The model for analysis of population health and health disparities (Warnecke et al., 2008) was selected as an ecosystems framework that embodies the person-in-environment approach that captures the complexity of an individual in the context of and interaction with multiple systems. Whereas, the Andersen behavioral model of health services use (Andersen, 1995) focuses on the individual and specific factors that contribute to decisions about access of

healthcare services. In order to address the limited knowledge about the relationship between contextual-level and individual-level factors and diagnostic resolution after an abnormal mammogram, two different models were merged to provide the necessary framework for examining the research aims in the study. Moreover, combining the models provides a stronger theoretical framework that accounts for the broader contextual social and physical environment along with specificity of individual factors and characteristics that predict access to healthcare services. The following section includes a review of the model for analysis of population health and health disparities (Warnecke et al., 2008), the Andersen behavioral model of health services use (Andersen, 1995), and the conceptual model developed for this study.

B.   <u>**Model for Analysis of Population Health and Health Disparities**</u>

Given the complexity of health disparities, research should concentrate on a population health approach that includes the determinants of disparate health outcomes across populations (Warnecke et al., 2008; Marmot & Wilkinson, 2006; Gehlert et al., 2008). A key conceptual and methodological issue in health disparities research is to differentiate between a difference and a disparity (Williams, Thomson, & Mitchell, 2006; Warnecke et al., 2008; Gehlert et al., 2008). Health disparities are inequities that are unjust or unacceptable, not just differences in health (Warnecke et al., 2008). Inequitable health outcomes stem from the inequities in access or the distribution of health resources that promote positive health outcomes (Warnecke et al., 2008; Gehlert et al., 2008). Differences in outcomes, in contrast, result from biological risk and additional individual factors unrelated to policy or discrimination in access (Warnecke et al., 2008). When certain subgroups in a population are not given access to resources to manage their differential risk, biologic or otherwise, a difference may become a disparity and result in poorer health outcomes. Population-level determinants are expressed as rates, averages, or distributions

of population characteristics such as patterns of segregation, aggregate poverty, or education

levels. Individuals have risk factors such as educational attainments, behavior, or genes.

Warnecke et al.'s (2008) model for analysis of population health and health disparities

provides a multilevel perspective with three primary determinants for understanding how

population risk relates to individual risk. First are the *distal* determinants, which are considered

fundamental causes of inequities, not differences in health outcomes. These determinants are

reflected at the population level (population social conditions, policies that affect social

conditions, policymaking bodies). Second are the *intermediate* determinants that are immediate

social contexts, physical contexts, and social relationships in which the distal effects are

experienced (community, neighborhood, social networks, pollution). The extent of residential

segregation, community poverty, and the availability and accessibility to local health care

healthcare resources are examples of potential intermediate determinants. Third are the *proximal*

determinants, which refer to individual characteristics (demographic factors, risk factors,

biological responses, biologic/genetic pathways) (Warnecke et al., 2008). Risk factors and

biological responses refer only to individuals, whereas demographic factors are both contextual

and individual and can have independent effects. For example, socioeconomic status is a

demographic factor that is both individual (having a low income) and contextual (living in a

resource poor neighborhood). Along with socioeconomic status, race/ethnicity, and gender are

examples of proximal determinants. These individual determinants can affect factors such as

individuals' ability to respond to their environment, the degree to which they have social support

networks, and the capacity to address their health needs. Individual determinants can also include

risk factors such as smoking and diet. The premise of the model is that intermediate determinants

are the links through which environmental factors affect the proximal factors that include

individual demographics and risks, biological responses, and biologic/genetic pathways. For example, a lack of transportation (intermediate factor) is the link between access to a healthcare clinic that offers mammography (distal factor) and a woman with low socioeconomic status (proximal factor). In sum, the model recognizes how environmental context affects individual health outcomes.

C.   **Behavioral Model of Health Related Patient Behavior**

The behavioral model developed by Aday and Andersen (1974) posits that health care utilization and access is a function of 1) *predisposing factors* (an individual's predisposition to use the services), 2) *enabling factors* (factors that enable or impede the use of services), and 3) *need characteristics* (a person's need for care). The *predisposing factors* include demographic characteristics such as age and gender; social structural characteristics such as race, ethnicity, education, and religion; and values about health and illness. The predisposing factors are present prior to access of the services and imply the propensity of individuals to use services. The *enabling factors* are factors that describe the circumstances of individuals that encourage or discourage the use of health services. The enabling factors can include individual, family, or community resources such as a having a primary care provider, income, and insurance coverage for medical care. The *need characteristics* refer to the perceptions related to health beliefs, attitudes, and knowledge about health services that might influence the perception of need for services or use of services. Examples of need characteristics are family history, perceived risk of having a disease, and health status.

D.   <u>**Study Conceptual Model**</u>

This study examined the relationship between contextual-level factors and individual-level factors and time to diagnostic resolution in women accessing care in hospitals located in South Chicago (Figure 1.).
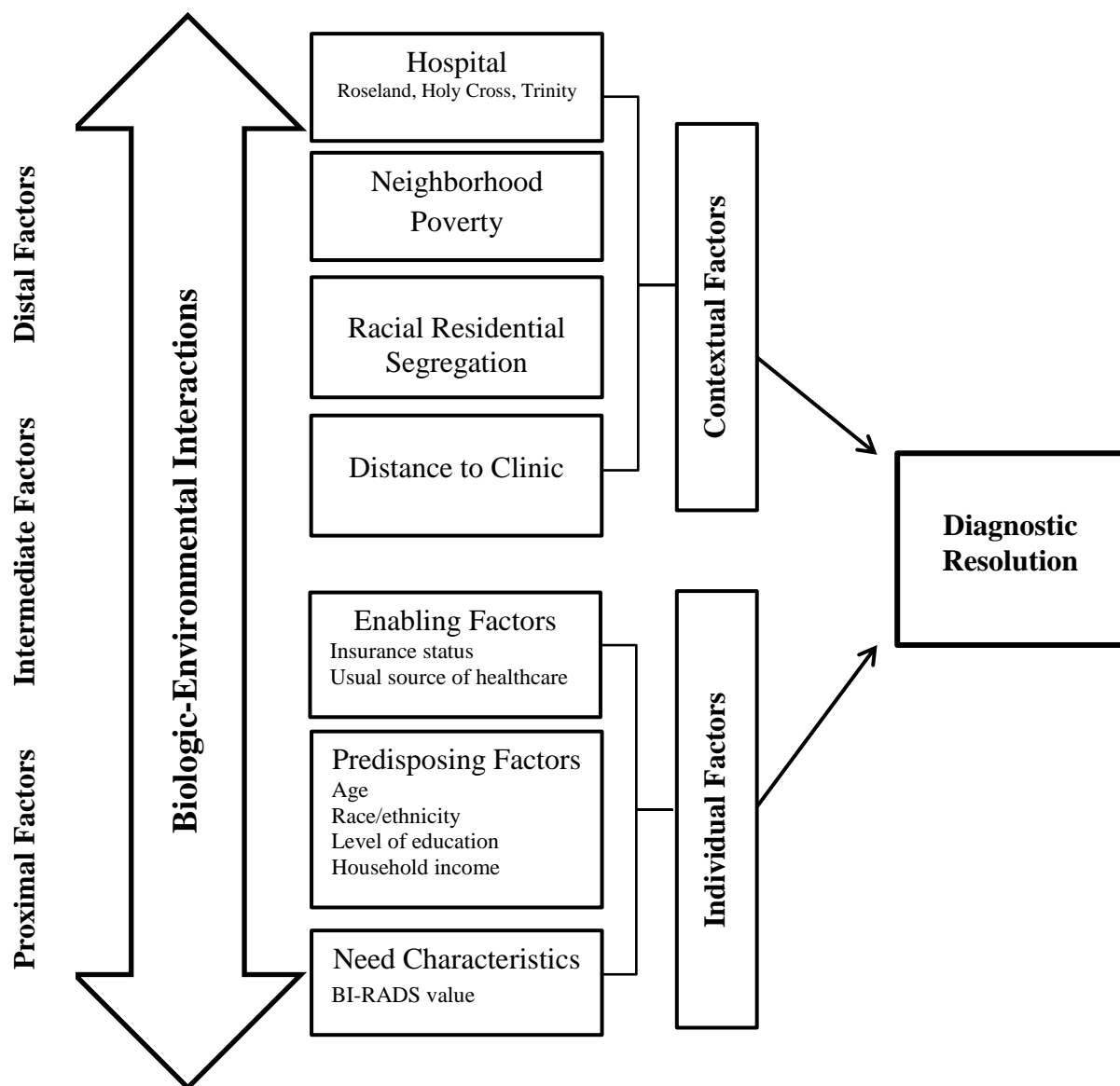
Figure 1. Conceptual model for diagnostic resolution.

1. <u>**Conceptual Definitions of Variables**</u>

Contextual factors included neighborhood poverty and racial residential segregation (that represents structural disadvantage) and distance to mammography clinic (that represents spatial access to health care).

Control variable included the hospital where women accessed diagnostic follow-up services. Recognizing women's experiences accessing diagnostic follow-up services varied based on the different location of the care, hospital was included in the statistical analysis. Women accessed diagnostic follow-up care at Roseland Hospital, Holy Cross Hospital, or Advocate Trinity Hospital. Roseland Community Hospital is a licensed, not-for-profit, 115-bed community hospital that is a full-service medical facility (Illinois Health Facilities and Services Review Board [IHFSR], 2015). The Hospital is owned by the Roseland Community Hospital Association. Established in March 1924, Roseland Community Hospital is located in the community of Roseland and received MUA designation in 1995. It is accredited by the Healthcare Facilities Accreditation Program. In 2012, 96.3% of patients were Black, 3.3% White, 1.5% Hispanic or Latino, and less than 1% all other races. The main payer sources for outpatient services were Medicaid (50%) and private insurance (31.6%). Holy Cross Hospital is a licensed, not-for-profit, 274-bed acute care hospital with a full range of medical services (IHFSR, 2015). Founded in 1927, the hospital is owned by the Sisters of St. Casimir. Holy Cross Hospital is located in the Chicago Lawn community (plus areas of West Lawn and Ashburn) and received MUA designation in 2008. It is accredited by the Healthcare Facilities Accreditation Program and the Commission on Accreditation of Rehabilitation Facilities. In 2012, 70.2% of patients were Black, 27.6% White, 12.4% Hispanic or Latino, and less than 2% all other races. The main payer sources for outpatient services were Medicaid (32.9%) and private insurance

(28.7%). Advocate Trinity Hospital is a licensed, not-for-profit, 250-bed community hospital that provides a full range of medical services (IHFSR, 2015). Established in 1895, the hospital is owned by Advocate Health and Hospital Corporation, one of the largest health care systems in metropolitan Chicago and the U.S. The hospital maintains a strong relationship with the Evangelical Lutheran Church and the United Church of Christ. Advocate Trinity Hospital is located in the Calumet Heights community and is MUA eligible but undesignated. It is accredited by the Joint Commission on Accreditation of Healthcare Organizations. In 2012, 84.3% of patients were Black, 7.4% White, 10.8% Hispanic or Latino, and less than 8% all other races. The main payer sources for outpatient services were private insurance (43.5%) and Medicaid (28.3%).

Individual factors represent enabling factors, predisposing factors, and need characteristics (Aday & Andersen, 1974). Enabling factors represent access to healthcare services that include insurance status and having a usual source of healthcare. Usual source of healthcare is a physician's office, clinic healthcare center, or other place that a woman accesses routine and preventative care. Predisposing factors include age, race/ethnicity, level of education, and household income. Need characteristics include the BI-RADS standardized abnormal mammogram value.

Diagnostic resolution represents the outcome variable. Conceptually, diagnostic resolution was a woman following-up with recommended exams after an abnormal mammogram to determine the presence or absence of breast cancer. Time to diagnostic was the number of days to complete diagnostic resolution.

2. <u>**Conceptual Relationship among the Variables**</u>

The association among the variables follows the assertion in the model for analysis of population health and health disparities (Warnecke et al., 2008). Proximal factors refer to individual demographics that can have independent effects as well as characterize the social and physical context (Warnecke et al., 2008). The proximal factors such as income or age can affect an individual's capacity to respond to the challenges in their environment and address their health care needs. It is hypothesized that the proximal factors (individual factors) have an effect on diagnostic resolution. Distal factors are population-level social conditions, policies, and the institutional context. The distal factors are contextual factors that represent the social condition of poverty, racial residential segregation, and distance to mammography clinic that were potential barriers to access to healthcare services. It is hypothesized that distal factors (environmental contextual factors) have an effect on diagnostic resolution.

Intermediate factors include social context, social relationships, and physical context through which the distal effects are experienced such as neighborhood poverty level or local healthcare resources (Warnecke et al., 2008). The arrow labeled biologic-environmental interactions on the side of Figure 1 represents the intermediate determinants that link the environmental-distal factors to proximal-individual factors. It is hypothesized that contextual factors and individual factors have a significant direct effect on diagnostic resolution.

E. <u>**Research Aims and Hypotheses**</u>

This study explored two main research aims and hypotheses:

1. **Aim 1:** To assess the relationship between neighborhood poverty, racial residential segregation, and/or distance to mammography clinic and diagnostic resolution after an abnormal mammogram among women accessing care in medically underserved areas.

   Hypothesis 1: Neighborhood poverty, racial residential segregation, and/or distance to mammography clinic will have a significant direct effect on diagnostic resolution.

2. **Aim 2:** To assess the relationship between individual factors including, insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and/or BI-RADS value and diagnostic resolution after an abnormal mammogram among women accessing care in medically underserved areas.

   Hypothesis 2: Insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and/or BI-RADS value will have a significant direct effect on diagnostic resolution.

III.   LITERATURE REVIEW

The literature was examined to inform the foundation of the study and explore the scholarly information about the relationship between contextual-level and individual-level factors and diagnostic resolution following an abnormal mammogram. Two bodies of literature provide the essential foundation for this study. The first body of literature is comprehensive breast cancer information about the disease, the methods for early detection, and the national standards for cancer disease staging. The second body of literature is diagnostic resolution following an abnormal mammogram. Studies were examined to determine the operationalized definitions for diagnostic resolution, the relationship between contextual factors and diagnostic resolution, and the relationship between individual factors and diagnostic resolution. The contextual factors included a review of studies examining neighborhood poverty, racial residential segregation, and distance between residence and mammography clinic. The individual factors included a review of studies examining enabling factors, predisposing factors, and need characteristics.

A.   <u>Breast Cancer Definition, Early Detection, and Staging</u>

Historically cancer has been perceived as one disease, however cancer is a term used to describe many diseases marked by abnormal cell division that can spread through the blood and lymph system to other parts of the body (ACS, 2013). There are more than 100 different types of cancer, many of which eventually form a lump or mass called a tumor (NCI, 2015b). Cancer is named for the part of the body in which it originates for instance, cancer that originates in the tissues of the breast is "breast cancer." Breast cancer can begin in the lobules that are the glands for milk production; the ducts connecting the lobules to the nipple; or the fatty, connective and lymphatic tissues (ACS, 2013).

1. **<u>Defining Breast Cancer</u>**

Noninvasive breast cancer (*in situ*) is a spectrum of abnormal breast changes in which the abnormal cells have not grown beyond the layer of cells where they originated (ACS, 2013; NCI, 2015b). Ductal carcinoma *in situ* (DCIS) and lobular carcinoma *in situ* (LCIS) are considered a noninvasive form of breast cancer. DCIS begins in the cells lining the breast ducts and is the most common type of *in situ* breast cancer (83% of women with *in situ* breast cancer). DCIS may or may not progress to invasive cancer, but if left untreated, at least one-third will progress to invasive cancer (Allred, 2010). LCIS is much less common than DCIS (12% of women with *in situ* breast cancer) and, despite the term "carcinoma," it is not a true pre-cancer or cancer. However, LCIS is an indicator of increased risk for developing invasive breast cancer.

Most breast cancers are invasive or infiltrating, meaning the cells have broken through the ductal or glandular walls where they originated and have grown into surrounding breast tissue (ACS, 2013; NCI, 2015b). Of the invasive types of breast cancer, the most prevalent type is ductal carcinoma that begins in the lining of the milk ducts. The milk ducts are thin tubes that carry milk from the lobules of the breast to the nipple. Of women with breast cancer, about 7 in 10 have ductal carcinoma. The second most common type is lobular carcinoma, which is cancer that begins in the lobular milk glands of the breast. About 1 in 10 women have this type of cancer. All other women with breast cancer have a combination of ductal and lobular type or less common types of breast cancer.

As research has progressed, breast cancer has been defined as a group of diseases distinguished by different molecular subtypes, risk factors, clinical behaviors, and responses to treatment (ACS, 2013; NCI, 2015b). Not only are tumor size and lymph node status examined, other clinical factors including estrogen-receptor and progesterone-receptor levels in the tumor

tissue, human epidermal growth factor receptor status, menopausal status, and general health of the patient are all considered in prognosis and treatment. Molecular subtypes including the presence or absence of estrogen receptors (ER+/ER-), progesterone receptors (PR+/PR-), and human epidermal growth factor receptor 2 (HER2+/HER2-) are identified to guide treatment (Reis-Filho & Pusztai, 2011).

At the molecular level, breast cancer is classified into the following subtypes: luminal A, luminal B, basil-like, and HER2 enriched. The most common subtype is luminal A (about 40% of cancers) (ACS, 2013). These tumors tend to be less aggressive than other subtypes, are slow-growing, and tend to be ER+ and/or PR+ and HER2-. The positive receptor status is associated with favorable response to hormone therapy (ACS, 2013). Although long-term survival is comparable to or even lower than the other subtypes, Luminal A is associated with the most favorable short-term prognosis. The Luminal B subtype is about 10% to 20% of cancers. Most luminal B tumors are also ER+ and/or PR+; however they are distinguished by either expression of HER2 or high numbers of cancer cells actively dividing. The basal-like subtype also occurs in about 10% to 20% of breast cancers. The majority of basal-like breast cancers are referred to as "triple negative" because they are ER-, PR-, and HER2- (Voduc et al., 2010). Due to the negative status of this subtype, the treatment cannot target the molecular subtype (Voduc et al., 2010). As a result, women have a poorer short-term prognosis compared to the other subtypes. The HER2 enriched is the least common subtype with about 10% of breast cancers producing excess HER2 (a growth-promoting protein). These tumors do not express hormone receptors (ER- and PR-) (Perou, Borresen, & Dale, 2001), tend to grow and spread more aggressively than other breast cancers, and are associated with poorer short-term prognosis compared to ER+ breast cancers (Blows et al., 2010).

2. **Breast Cancer Causes and Risk Factors**

Breast cancer is highly complex, may involve multiple risk factors, and the causes remain unknown. A risk factor is a factor associated with disease, but is not the cause (ACS, 2013). Whereas, a cause is a characteristic, event, or condition that must be present for the disease to occur. Most likely a combination of risk factors, some that are modifiable and some that are not, are involved in development of breast cancer (ACS, 2013; NCI, 2015b). The strongest risk factor for a woman developing breast cancer is age; as women age their risk for developing the disease increases. For example, based on the whole population, the probability of developing the disease is lower for a woman age 40 (1 in 68) than a woman age 60 (1 in 28) (NCI, 2012). A woman's individual risk of developing breast cancer is higher or lower based on several known risk factors such as genetic risk or lifestyle factors. Although not all the risk factors have been identified or fully understood, several factors are associated with increased relative risk including: biopsy-confirmed atypical hyperplasia, lobular carcinoma *in situ*, mammography dense breasts, and exposure to high-dose radiation to the chest (ACS, 2013). Women with a personal and family history of breast cancer have significantly higher relative risk compared to women without a personal and family history of breast cancer. Women with previous breast cancer are at higher risk of developing a second breast cancer, particularly if they were diagnosed at a younger age. In fact, women diagnosed before age 40 have an almost 4.5-fold increased risk of developing a subsequent breast cancer (ACS, 2009). Also, women with a history of other types of cancer, particularly ovarian, are at higher risk. Women with a family history, particularly in a first-degree relative (mother, sister, daughter, brother, or father), and if the diagnosis was before age 50, are at increased risk of developing breast cancer (Collaborative Group on Hormonal Factors in Breast Cancer, 2001). Compared to women with no affected relatives, the risk ratio becomes even higher for women with one or more first-degree relatives diagnosed with breast cancer. One

study combined data from 52 epidemiological studies and found the ratios for were 1.80 for one first-degree relative; 2.93 for two first-degree relatives; and 3.90 for three or more first-degree relatives (Lancet, 2001).

    3. <u>**Early Detection of Breast Cancer**</u>

        Mammography is the best screening tool used today because it can detect tumors at an early stage, when there are no signs or symptoms, and most easily treated and cured (ACS, 2013). Although mammography is an important tool in detecting breast cancer and reduces the chance that a woman will die from breast cancer, there are potential harms with mammography, including a "false-positive" result and over diagnosis (ACS, 2013; U.S. Preventive Services Task Force [USPSTF], 2015). False-positive results lead to additional follow-up examinations when cancer is not present, and as a result, the tests and procedures were unnecessary. In addition, false-positive results can provoke anxiety for women. Over diagnosis of breast cancer is the most serious harm related to mammography for women (USPSTF, 2015). Non-progressive cancer cannot be distinguished from a progressive cancer, and consequently, most all women diagnosed with breast cancer will be treated. In some women diagnosed with breast cancer, the cancer would not have progressed or otherwise been detected unless a woman underwent screening. The U.S. Preventive Services Task Force (USPSTF), an independent, volunteer panel of national experts in prevention and evidence-based medicine, recommends screening mammography based on women's ages (USPSTF, 2015). For women ages 50-74, the recommendation is biennial screening mammography. For women ages 40-49, the decision to screen before age 50 is an individual decision that should be made by a woman in partnership with her doctor. For women age 75 years and older, the USPSTF deems current evidence to be insufficient to assess the balance between benefits and harms of screening mammography. The American Cancer Society has different screening mammography guidelines. According to the American Cancer Society

(2013), women with average-risk for breast cancer should begin annual mammography at age 40 (Smith et al., 2013). In addition, there is not a specific upper age when a woman should discontinue mammography (Smith et al., 2013; ACS, 2013).

Screening tests can identify disease prior to the onset of symptoms, can detect cancer at earlier stages when it is easier to treat and cure, and therefore can decrease the chance of dying from the cancer (ACS, 2013; NCI, 2015b). Breast cancer screening involves two types of screenings: a clinical breast exam (CBE) and mammography (ACS, 2013). The first screening, a CBE, is a physical exam conducted by a trained health care provider in which the breasts and underarm areas are checked for lumps and changes (ACS, 2013). The American Cancer Society recommends that between the ages of 20 years and 39 years, average-risk women, should undergo CBE every 3 years and annually after age 40 years (Smith et al., 2013). The second screening, mammography, is low-dose x-ray procedure that provides visual images of the internal structure of the breast and can detect breast cancer before symptoms develop and before the cancer spreads (ACS, 2013).

Screening tests do not diagnose cancer; when a screening test is abnormal additional tests are performed to diagnose cancer (ACS, 2013). For example, a screening mammogram may detect a lump; however, the lump may be breast cancer or something else such as a cyst. As a result, additional diagnostic tests are necessary to determine a diagnosis of cancer. The additional diagnostic tests for breast cancer include a diagnostic mammogram, ultrasound, MRI, or biopsy (Susan G. Komen, 2015). A diagnostic mammogram involves additional images beyond a screening mammogram and is often used as follow-up procedure to an abnormal CBE or screening mammogram. An MRI uses magnetic fields to create images of the breast. MRI is used with mammography for high-risk women and women with extremely dense breasts in which

mammography images are not as clear. MRI is costly, more invasive than mammography, and is not recommended for women at average risk of breast cancer. Ultrasound uses sound waves to create images of the breast that can determine the difference between a liquid-filled cyst and a solid mass. This noninvasive procedure is often used as a follow-up test after an abnormal finding on a mammogram or clinical breast exam. When diagnostic mammography, ultrasound, or MRI cannot rule out breast cancer, a biopsy is performed. A biopsy is a procedure in which cells or tissues are removed and examined under a microscope by a pathologist.

There are two main types of biopsy, needle biopsy and surgical biopsy (ACS, 2013). A needle biopsy (either core needle biopsy or fine needle aspiration) uses a hollow needle to remove the cells or tissues from lumps or from a palpable mass that can be felt or a suspicious area that was seen on an imaging test, a non-palpable mass. A surgical biopsy (excisional biopsy or incisional biopsy) is more invasive than a needle biopsy; however, it is more accurate in diagnosing cancer and provides complete information about the tumor. An excisional biopsy removes the entire suspicious area along with some of the surrounding normal tissue from the breast. When the entire area is too large to remove, an incisional biopsy is performed in which only part of the area it is removed from the breast.

4. **Diagnostic Categories and Staging**

The American College of Radiology developed the BI-RADS) as a way to standardize reporting of mammogram findings and results (Sickles et al., 2013).

TABLE I

BI-RADS ASSESSMENT CATEGORIES AND MANAGEMENT RECOMMENDATIONS
ADAPTED FROM AMERICAN COLLEGE OF RADIOLOGY

Assessment	Management	Likelihood of Cancer
Category 0- Incomplete	Recall for additional images	Not applicable
Category 1- Negative	Routine mammography screening	0% likelihood of malignancy
Category 2- Benign	Routine mammography screening	0% likelihood of malignancy
Category 3- Probably benign	6 month follow-up	>0% but ≤2% likelihood of malignancy
Category 4- Suspicious	Tissue diagnosis	>2% but <95% likelihood of malignancy
Category 5- Highly suggestive of malignancy	Tissue diagnosis	≥95% likelihood of malignancy
Category 6- Proven malignancy	Treatment	Not applicable

The results are sorted into categories 0 through 6 (Table I). Category 0 indicates the result is

incomplete and additional imaging evaluation and/or comparison to prior mammograms is

needed prior to a final assessment (Sickles et al., 2013). Category 1 is negative and the

examination is normal. Category 2 is benign, a negative mammogram result, but other non-

cancerous findings such as benign calcifications were recorded in the report. Both Category 1

and 2 indicate there is no mammographic evidence of malignancy. Category 3 indicates that the

finding is probably benign with approximately greater than 98% likelihood of being a benign

result. Because the finding was not proven benign, generally the recommendation is follow-up

with repeat imaging in 6 months. Category 4 is suspicious abnormality with a wide range of

malignancy likelihood approximately between 2% and 95%. Often, a radiologist will recommend

a biopsy to determine if the abnormality is cancerous. Category 5 is highly suggestive of

malignancy with the probability of 95% or higher and a recommendation for tissue diagnosis.

Category 6 is known biopsy-proven malignancy with a recommendation of surgical excision when clinically appropriate.

Stage refers to the extent or spread of the cancer in the body when first diagnosed and is strongly associated with prognosis and treatment options (ACS, 2013; NCI, 2015b). The staging system is a standardized method to summarize the extent of the cancer, categorize patients with respect to prognosis, and formulate treatment decisions. The most common staging system used is the American Joint Committee on Cancer (AJCC) tumor, node, and metastasis (TNM) classification system (ACS, 2013; NCI, 2015b). In the TNM classification, "T" is the primary tumor size and how far it has spread within the breast, "N" is the extent of spread to regional lymph nodes, and "M" is the presence or absence of distant metastases or spread to other organs. Following the TNM determination, a stage of 0, I, II, III, or IV is assigned (stage 0 is *in situ*; stage I is early stage invasive cancer, and stage IV is the most advanced and disease has spread to other parts of the body). Although the AJCC staging system is widely used in clinical settings, a more simplified system is used for reporting cancer registry data. The SEER Summary Stage system has three categories: *local stage* to describe cancer confined to the breast; *regional stage* refers to tumors that have spread to nearby lymph nodes or tissue; and *distant stage* refers to cancers that have metastasized to distant organs (ACS, 2013; NCI, 2015b).

B.   **Diagnostic Resolution Following Abnormal Mammography**

Most of the studies examining the relationship between patient characteristics and diagnostic resolution are exploratory prospective and retrospective studies examining large data sets such as statewide data systems (Wujcik & Fair, 2008). Largely, studies have found that the majority of women with abnormal mammograms did achieve diagnostic resolution; and many of these women were timely in their follow-up. For example, Battaglia et al. (2010) identified

predictors of timely follow-up among racially/ethnically diverse inner city women with breast cancer screening abnormalities and found that of the 523 women in the study more than 90% achieved diagnostic resolution within 12 months. Wernli et al. (2011) also conducted a retrospective cohort study that included women aged 40-84 years who had an abnormal mammogram. Of women in the study, 20,060 had screening mammograms and 3,184 had diagnostic mammograms. The findings indicated that the proportion of women seeking care within 7 days was 23% for women who had received screening mammograms and 69% for women who had received diagnostic mammograms. Although overall it has been found that women follow-up after an abnormal mammogram, studies have found a significant difference in proportion of completion of diagnostic resolution and the timeliness for different groups. Most studies examining timely diagnostic resolution have focused on patient-level characteristics. It is well-documented in the literature that timeliness has been associated with several patient-level characteristics (Wujcik & Fair, 2008; Battaglia et al., 2010; Wernli et al., 2011).

1. **Defining Diagnostic Resolution and Timeliness**

According to the American College of Radiology, women with a BI-RADS value of 0, 3, 4, or 5 have an incomplete or abnormal mammogram result that requires additional medical examination to determine if breast cancer is present (Sickles et al., 2013). Diagnostic resolution is the determination of the presence or absence of breast cancer after incomplete or abnormal screening results using medical examinations that include diagnostic mammography, ultrasound, MRI, and/or biopsy (ACS, 2013). A critical component of reducing breast cancer morbidity and mortality is timely diagnostic resolution (Gotzsche & Jorgensen, 2013; Nelson et al., 2009). However, there are currently no standard practice benchmarks for the appropriate timing for follow-up evaluation after an abnormal mammogram result (Battaglia, Roloff, Posner, & Freund,

2007; Jones et al., 2005). In an effort to understand delayed or incomplete follow-up, numerous studies have examined timely diagnostic resolution. Nearly all of the studies have measured diagnostic resolution as an outcome variable reflecting the time period between abnormal screening and diagnostic resolution (Table II).

TABLE II

SUMMARY OF DIAGNOSTIC RESOLUTION MEASUREMENT

Author and Year	Dichotomous (yes/no)						Continuous
	At least some follow-up	60 Days	90 Days	120 Days	180 Days	270 Days	Number of Days
Battaglia, Roloff, Posner, & Freund 2007				X			
Jones et al. 2005						X	
Yarbroff et al. 2004	X						
Pérez-Stable et al. 2013		X					X
Markossian, Darnell, & Calhoun 2012		X					X
Bastani, Mojica, Berman, & Ganz 2010					X		
Battaglia, Mojica, Berman, & Ganz 2010					X		
Kerner et al., 2003			X				
Maly et al. 2011		X					X
Krok-Schoen et al. 2014							X
Adams et al. 2009		X					X
Press, Carrasquillo, Sciacca, & Giardina 2008							X

The operationalization of timeliness and diagnostic resolution differs across various studies and there is not a single definition of diagnostic resolution. Most studies have defined diagnostic resolution as the completion of all tests necessary to make a definitive diagnosis of

cancer or no cancer (Kerner et al., 2003; Battaglia et al., 2010; Markossian et al., 2012; Bastani et al., 2010; Perez-Stable et al., 2013; Krok-Schoen et al., 2014; and Adams et al., 2009). For example, Kerner et al. (2003) defined diagnostic resolution as completing all necessary follow-up that confirms either a cancer diagnosis or a noncancerous resolution of the abnormal finding review. Although less common, some studies have defined diagnostic resolution as any follow-up procedure after an abnormal mammogram regardless if additional tests are required for definitive diagnosis (Press, Carrasquillo, Sciacca, & Giardina, 2008; Yabroff et al., 2004).

Previous studies have used three different outcome measures for timeliness. First, timeliness has been categorized as a dichotomous variable of completing or not completing any diagnostic follow-up regardless of number of days. Yarbroff et al. (2004) conducted a study to identify factors related to diagnostic follow-up after an abnormal mammogram in a national sample of women in the U.S. The dichotomous outcome measure was defined as receipt of at least some diagnostic follow-up after an abnormal mammogram.

Second, several studies (Perez-Stable et al., 2013; Markossian, Darnell, & Calhoun, 2012; Bastani, Mojica, Berman, & Ganz, 2010; Battaglia et al., 2010; Kerner et al., 2003; Maly et al., 2011) have dichotomized diagnostic resolution as timely or not timely based on a cutoff number usually either 60 or 180 days. Some researchers have used 60 days as a measure of timeliness that corresponds to the National Breast and Cervical Cancer Early Detection Program guidelines for timely follow-up of abnormal mammography screening results. However, in another study of factors related to diagnostic resolution, Kerner et al. (2003) interviewed and examined the medical records of Black women with abnormal breast cancer screening results at three New York City clinics. Timeliness was dichotomized as successful or unsuccessful completion of diagnostic resolution in 180 days.

The third method of measuring diagnostic resolution uses a continuous variable of number of days from an abnormal mammogram result to diagnosis or additional imaging. For example, Krok-Schoen et al. (2014) examined how clinic and patient characteristics influence time to diagnostic resolution following an abnormal cancer screening test. Time to diagnostic resolution was measured by the number of days from the abnormal test to diagnostic resolution of the abnormality. Some studies have used both a dichotomous measurement and a continuous measurement of number of days. For example, Markossian et al. (2012) evaluated a patient navigation program established to encourage patients to achieve diagnostic resolution and reduce the amount of time from an abnormal screening test to diagnostic resolution. The main outcome variable of diagnostic resolution was dichotomized as achieved diagnostic resolution by 60 days (yes/no). The study also included a continuous outcome variable of time to diagnostic resolution, which was calculated as the number of days between the initial abnormal screening test and confirmation of a definitive malignant or benign diagnosis in the medical chart.

2. **Relationship between Contextual Factors and Diagnostic Resolution**

Because diagnostic resolution requires interaction between an individual and their larger contextual environment in which the services exist, it is necessary to conceptualize health and health behaviors as a product of the dynamic interrelationship of multiple levels of influence, including the individual, community, and structural (Pruitt, Shim, Mullen, Vernon, & Amick, 2009). Social and economic structures are powerful determinants that shape the health of populations (Marmot & Wilkinson, 2006). Furthermore, a substantial body of literature supports the critical impact of the social environment, including racial residential segregation, neighborhood poverty rates, and access to services on health outcomes (Do et al., 2008; LaVeist, 2005; Williams, 2006; Marmot & Wilkinson, 2006).

Neighborhood Poverty. Neighborhood characteristics affect a multitude of health outcomes, including breast health (Campbell et al., 2009; Diez Roux, 2001; Kawachi & Berkman, 2003). In an analysis of neighborhood-effects on health-related outcomes, Sampson, Morenoff, and Gannon-Rowley (2002), define neighborhoods "as ecological units nested within successively larger communities" (p. 445). The social and physical environmental contexts of neighborhoods often determine one's exposure to health risks and health outcomes; likewise systematic and structural disadvantage within communities exacerbates disparities in health (Diez Roux, 2001; LaVeist, 2005).

Despite the increased recognition of the impact of neighborhood context on health outcomes, only a limited number of studies have examined neighborhood context and diagnostic resolution after an abnormal mammogram. The majority of the breast cancer studies that have examined neighborhood context have focused on adherence to screening outcomes (Daily et al., 2007; Rosenburg et al., 2005; Jones et al., 2005) and stage at diagnosis (Flores et al., 2013; Gumpertz, Pickle, Miller, & Bell, 2006). For example, Dailey, Kasl, Holford, Calvocoressi, and Jones (2007) examined the relationship between neighborhood-level socioeconomic status (SES) and regular mammography screening in a prospective study of 1,229 women. Linking census-level information to the individual-level study data, the authors determined neighborhood-level SES using six conceptual domains (occupational class, median household income, percentage of persons with households below the U.S. poverty line, wealth, education, and crowding). Comparing women living in the most disadvantaged neighborhoods with the least disadvantaged neighborhoods, all neighborhood-level SES variables were significantly associated with screening non-adherence. All three individual-level SES measures (income, education, and occupation) also were significantly associated with screening non-adherence. Similarly,

Campbell et al. (2009) examined cancer registry data and found that women in high-poverty areas were at substantially greater risk for late-stage breast cancer diagnosis. Overall, studies have indicated that neighborhood level poverty and structural disadvantage were associated with poor breast cancer screening rates and later stage at diagnosis (Fowler, 2014; Wujcik & Fair, 2008).

Similar to the screening and stage at diagnosis studies, in a systematic literature review of neighborhood-level influences on delayed diagnostic follow-up after an abnormal mammogram among Black women, Fowler (2014) concluded that disadvantaged socioeconomic status in poor neighborhoods explained delays in diagnostic follow-up. Across racial/ethnic groups, residing in a low-income neighborhood, neighborhood deterioration, living in close proximity in urban metropolitan neighborhoods, geographic distribution of racial/ethnic groups, and increased residential segregation were all associated with late-diagnosis of breast cancer. For example, Plascak, Llanos, Pennell, Weier, and Paskett (2014), examined data from a randomized patient navigation trial to assess associations between time to resolution following abnormal breast or cervical cancer screening exam and patient characteristics and neighborhood-level characteristics (deprivation, racial segregation) of 801 women. Results indicated all estimated categorical measures of neighborhood deprivation were significantly associated with time to resolution. Likewise, higher neighborhood deprivation was associated with longer time to resolution. However, a statistically significant relationship was not found between time to resolution and home-to-clinic distance or Black segregation. Although studies have increased in recent years, a substantial gap in knowledge persists that requires further examination about the relationship between neighborhood poverty and time to diagnostic resolution after an abnormal mammogram.

Racial Residential Segregation. Residential segregation is an institutional mechanism of racism that has pervasive and adverse effects on the health of Blacks in the U.S (Williams, 2006). The physical isolation of one racial or ethnic group is a fundamental cause that reflect socioeconomic status disparities in health (Williams & Collins, 2001). The racial composition of neighborhoods and communities is not the determinant of the problem; rather it is the concentration of economic and social disadvantage and the absence of an infrastructure that promotes opportunity (Williams, Mohammed, Leavell, & Collins, 2010). Segregation affects health through multiple pathways. Segregation limits socioeconomic mobility by limiting access to quality education and employment opportunities, thereby creating an environment of concentrated poverty (Williams et al., 2010). In turn, concentrated poverty creates an environment of chronic and acute stressors at the individual, household, and neighborhood level. High poverty areas also are at risk for increased exposure to environmental toxins, poor quality housing, and lack of access to healthy food (Williams et al., 2010).

Conceptually, racial residential segregation refers to the physical separation of two racial populations in an area that could include neighborhood, census tract, or county (Dai, 2010). Segregation can be characterized by five distinct dimensions: unevenness, isolation, centralization, concentration, and clustering (Dai, 2010; Haas et al., 2008; Warner & Gomez, 2010). Measuring racial residential segregation varies by study; however, there were two main ways of measuring segregation across studies (White & Borrell, 2011). The first is measuring a large-area (e.g., county or metropolitan statistical area [MSA]) and formal segregation measures (e.g., MSA dissimilarity index). The second is using neighborhood composition measures (e.g., census tract percentages of race) used as proxy measures of segregation. Several studies have measured residential segregation using isolation indexes (Dai, 2010; Haas et al. 2008; Warner &

Gomez, 2010). This is a measure of the probability that a member of one racial/ethnic group is likely to be in contact with members of this same group. It compares residents in the same unit. The isolation index is different from using a percentage of a racial group in an area. The isolation index ranges from 0 (no segregation) to 1 (the greatest segregation) and evaluates whether one racial group concentrates in a subunit of an area and how the races mix within the subunit (Dai, 2010). It is interpreted as the chance of having the similar race as neighbors. For example, a county with a Black insolation index of 0.5 suggests that a Black individual in that county would be isolated and have a 50% chance of having only other Blacks as neighbors (Haas et al., 2008).

Schootman et al. (2009), Russell et al. (2012), and Pruitt et al. (2015) measured racial residential segregation using the percentage of racial/ethnic group in census tracts. Schootman et al. (2009) calculated residential segregation as the percentage Blacks compared to all residents in each census tract. A high percentage of Blacks per tract population was considered to be greater Black segregation. Russell et al. (2012) also measured neighborhood racial composition as the percent of Black residents in the census tract. In this study, authors additionally measured metropolitan area racial residential segregation using the Information Theory Index. This is a measure of local and regional diversity that assesses the evenness of racial distribution across neighborhoods. Similar to the isolation index, it ranges from 0 (completely even or integrated distribution) to 1 (completely segregated). Also, it approximates the proportion of the minority group who would need to move to a different neighborhood (or census tract) in order to achieve an even distribution within the region. Pruitt et al. (2015) measured Black segregation and Hispanic segregation in neighborhoods and compared it with the larger metropolitan statistical areas using the location quotient (LQ) measure. The LQ is a small-area measure of relative

segregation calculated at the residential census tract level, moreover it represents how much more segregated a neighborhood is relative to the larger overall metropolitan area.

Despite the increasing body of literature related to the impact of racial segregation on health, several challenges persist regarding conceptual, methodological, and analytical issues (Dai, 2010). Large-area measures do not reflect the daily experience of residents in an area. Similarly, neighborhood composition measures assume that the composition of one neighborhood is independent of the surrounding neighborhoods and across the greater MSA. This is problematic because conceptually segregation is spatial and regarded as dispersion.

According to the literature, racial residential segregation has important, but contradictory, implications for breast cancer detection and care. Many studies have documented the negative effects of racial residential segregation on breast cancer screening adherence, quality of cancer care, and mortality (Haas et al., 2008; Dai, 2010; Harper, Lynch, Meersman, Breen, Davis, & Reichman, 2009). For instance, Haas et al. (2008) found both Black and White women were less likely to receive adequate breast cancer care if they were living in areas with greater Black segregation. Dai (2010) found that women living in areas with greater Black segregation and poorer access to mammography had significantly increased risk of late diagnosis of breast cancer. However, other studies have revealed that minorities living in areas with a higher proportion of their own racial/ethnic group have better breast health outcomes (Warner & Gomez, 2010; Russell, Kramer, Cooper, Thompson, & Arrio, 2011). With the conflicting study results, some authors have argued that segregation operates as a protective factor (Warner & Gomez, 2010), whereas others contend segregation operates as a barrier adversely affecting breast health (Russell, Kramer, Cooper, Thompson, & Arrio, 2011). In addition, previous studies

have not untangled the effects of racial segregation from economic disadvantage (Dai, 2010; Campbell et al., 2008).

Most studies examining segregation and breast health have focused primarily on adherence to screening, stage at diagnosis, treatment, and mortality. One study evaluating the role of Black residential segregation and spatial access to healthcare in Detroit, results indicated that living in areas with greater Black segregation and poorer access to mammography significantly increased the risk for late stage diagnosis of breast cancer. Warner and Gomez (2010) examined the impact of racial residential segregation on stage at diagnosis and all-cause and breast cancer-specific survival between and within Black and White women diagnosed with breast cancer in California. The study results indicated that greater than or equal to 20% Black residents in a neighborhood was associated with lower mortality from breast cancer and all-cause mortality among Black women diagnosed with breast cancer. Across nearly all levels and most dimensions of segregation, there was a protective neighborhood effect that seemed to be more pronounced in more segregated regions. How segregation was operating as a protective factor was not examined in this study. On the other hand, for White women living in neighborhoods with more Blacks, there was an association with higher all-cause and breast-cancer specific mortality. In a similar study, Russell et al. (2012) explored the contribution of metropolitan area racial residential segregation, census tract racial composition, and breast cancer and all-cause mortality among Black and White breast cancer patients. The results indicated that breast cancer mortality disparities were largest in racially mixed tracts located in high metropolitan/micropolitan statistical segregation areas. Although not significant for White women, for Black women as the metropolitan /micropolitan statistical residential segregation increased, there was an increased risk for breast cancer. In addition, results indicated that for

Black women living in census tracts with higher proportions of other Black residents experienced a modest, but non-significant, increase in survival probabilities. The authors posited that Black women living in a neighborhood with more people of the same race potentially offered increased social support and social capital that collectively promoted health.

It is evident from the studies reviewed that living in areas with higher racial residential segregation is associated with breast cancer outcomes, however, there is a high degree of heterogeneity in the findings. The variability of the findings may be a reflection of the variation in methodological designs of the studies along with the challenges of racial residential segregation research and that different mechanisms affect different outcomes (e.g., early detection, survival). First, the studies all used administrative data that included large data sets such as the SEER, Medicare database, or state cancer surveillance programs (Haas et al., 2008; Warner & Gomez, 2010). Using administrative data sets limits study variables to those included in that particular data set as well as limits the research to the availability of the data. Second, racial residential segregation presents several measurement challenges (Russell et al., 2012). The geographic units measured (e.g., ZIP codes, census tracts) are too large to reveal individual-level variables and variation residential mobility (Dai, 2010). The finer scales of geographic units and other relevant individual-level data often are unavailable due to privacy protections or are not available in the data sets. Third, studies documenting racial residential segregation and breast cancer outcomes have all been ecological designs that are observational and not causal. Fourth, none of the studies used a life-course design. Using the life-course perspective may capture cumulative exposures and susceptibilities across a patients' life that add cumulative effects of segregation (Pruitt et al., 2015). Lastly, the relationship between residential segregation and poverty is well-documented; however, teasing out the effects of low socioeconomic status and

poverty is vital (Dai, 2010; Campbell et al., 2008). Segregation and concentrated poverty may affect health through multiple pathways (Russell et al., 2012). For instance, segregation and breast cancer outcomes may be medicated by poverty.

Despite the aforementioned limitations in research design and measurement, the studies revealed several important findings that add to the emerging literature suggesting differential effects of segregation. Overall, women living in areas with high racial residential segregation seem to have worse breast cancer outcomes. However, residential segregation alone does not fully explain the strong and persistent disadvantage experienced by Black women (Pruitt et al., 2015) and segregation may influence health differently for Black, White, and Hispanic women (Russell et al., 012). With the conflicting study results, some authors have argued that segregation operates as a protective factor, whereas others contend segregation operates as a barrier adversely affecting breast health (Haas et al., 2008; Warner and Gomez, 2010). Although racial segregation has been examined, its impact on time to diagnostic resolution after an abnormal mammogram is unclear and has not been adequately studied. It is pertinent to understand the underlying mechanisms that are deterrents to and supports of access to timely diagnostic follow-up care. This information has important implications for health care spending and policies. For example, health care resources and funding can be targeted to specific residential areas.

Distance to Mammography Clinic. Health care access to mammography screening and diagnostic services is critically important for early detection of breast cancer. Access is strongly influenced by financial, sociocultural, and geographic barriers (Kim, Chukwudozie, & Calhoun, 2013; Wang, McLafferty, Escamilla, & Luo, 2008). The effect of spatial access of travel distance to a clinic on women's follow-up after an abnormal mammogram has not been thoroughly

examined, and those studies that have examined travel distance have produced inconsistent results (Kim, Chukwudozie, & Calhoun, 2013; Onitilo et al., 2013; Celaya et al., 2010). The majority of studies have examined the relationship between travel distance and stage of breast cancer at diagnosis.

Most studies suggest that there is a significant relationship between spatial access to mammography and breast health outcomes. For example, Onitilo et al. (2013) examined patient characteristics associated with missed mammograms and the association between missed mammograms and stage of breast cancer at diagnosis. Findings indicted that the travel time to mammography was predictive of missing mammograms and each minute of travel time decreased the odds of attaining a mammogram in the 5 years before women were cancer diagnosed with cancer. Likewise, Elting et al. (2009) examined the association between a mammography facility in the county of residence among Texas women and the odds of screening and the odds of breast cancer stage of diagnosis. After controlling for confounding factors, having a facility in county was associated with significantly higher odds of screening and lower odds of late-stage breast cancer at diagnosis. Similarly, Huang, Dignan, Han, and Johnson (2009) examined the distance between residences of women living in Kentucky diagnosed with breast cancer and the nearest mammography facility. The findings indicated that women with longer travel distances compared to women with shorter travel distances had later stage diagnoses. When adjusting for individual factors at the census tract level, the odds increased for diagnosis of advanced stage breast cancer for women residing over 15 miles away from a facility than women within 5 miles living distance. On the other hand, Wang et al. (2008) examined the role of access to health care in explaining the variation of late-stage diagnosis of breast cancer in Illinois. The results suggest that poor geographical access to primary health care significantly increases the

risk of late diagnosis of breast cancer for women living outside the city of Chicago. Although

poor spatial access to primary health care was strongly associated with late diagnosis, after

spatial access to primary care and zip code socioeconomic characteristics were controlled for, no

statistically significant association was found between travel time to mammography services and

the stage of diagnosis. Similarly, Celaya et al. (2010) found no significant association between

later stage of breast cancer and travel time to the nearest mammography facility in New

Hampshire.

Zenk, Tarlov, and Sun (2006) examined the spatial distribution low- or no-fee screening

mammography facilities in Chicago and found that distance and travel times via automobile and

public transportation to facilities generally decreased as neighborhood poverty increased.

However, low-income Black neighborhoods had longer travel distances than low-income

neighborhoods with fewer Black residents. Relatedly, Kim, Chukwudozie, and Calhoun (2013)

examined racial/ethnic differences in the distance to the mammography clinic on stage of breast

cancer diagnosis. The results indicated that the average distance traveled to a clinic was farthest

among White women (6.7 mi) than for Hispanic (5.3 mi) or Black women (4.4 mi). Distance to a

clinic was found to be significantly associated with increased odds of having abnormal results.

However, after controlling for distance to clinic, the disparity in odds of having an abnormal

mammogram between White and Black women was no longer statistically significant. Also,

individual and neighborhood sociodemographic characteristics were significantly associated with

distance to clinic, however, were not associated with increased odds of having an abnormal

mammogram when controlling for distance to the clinic. In sum, there is a significant gap in the

literature and studies are limited that examine the spatial relationship between breast cancer

outcomes and distance to mammography clinic. Also, studies have not examined the relationship between distance to mammography clinic and follow-up after an abnormal mammogram.

3. **Relationship between Individual Factors and Diagnostic Resolution**

Enabling Factors. Previous studies have found a significant relationship between the enabling factors of insurance status (Krok-Schoen et al., 2014; Battaglia et al., 2007; Strzelczyk & Dignan, 2002) and having a regular care provider (Jones et al., 2005) and diagnostic resolution. Having private health insurance has been associated with less time to diagnostic resolution. Krok-Schoen et al. (2014) found that privately insured patients had a 79% higher rate of resolution following an abnormal breast, cervical, or colorectal screening test than uninsured patients. Battaglia et al. (2007) also found that women with private health insurance were more likely to have timely follow-up compared to those without health insurance. Underinsured women, compared to insured women, also were less likely to adhere to diagnostic follow-up in the Strzelczyk and Dignan (2002) study. Lack of a regular healthcare provider was predictive of inadequate follow-up in a study conducted by Jones et al. (2005); however, Maly et al. (2011) found no association between having a regular source of healthcare and timely diagnostic resolution.

Predisposing factors. Predisposing factors including age, race, ethnicity, level of education, and income consistently have been found to have statistically significant relationship with time to diagnostic resolution. One of the most widely examined individual characteristics is race/ethnicity (Perez-Stable et al., 2013; Battaglia et al., 2010; Adams et al., 2009; Press et al., 2008; Goldman, Walker, Hubbard, & Kerlikowske, 2013; Elmore et al., 2005; Jones et al., 2005; Warner et al., 2012; Maly et al., 2011). Most studies have found a significant relationship between race and timely diagnostic resolution with racial and ethnic minorities having more

delay in time to diagnostic resolution. However, studies did not specifically examine how race/ethnicity is a pathway to delayed diagnostic resolution. Thus, it is unclear if race/ethnicity is a proxy for access to healthcare, poverty, class or is an actual race/ethnicity effect. Press et al. (2008) conducted a retrospective cohort study of 6,722 women with an abnormal mammogram and found that the average days to resolution for Black women was 20, Hispanic women 21, and non-Hispanic White women 14 days. Similarly, Adams et al. (2009) conducted an examination of racial differences in time to follow-up after an abnormal mammogram using a state-wide service program that provides free mammography screenings to economically disadvantaged and medically underserved women. The median time to diagnostic resolution was 34 days for Black women and 28 days for White women. In a retrospective cohort study conducted by Elmore et al. (2005), following an abnormal mammogram Black women were less likely than White women to have completed a diagnostic evaluation within 30 days. In a prospective cohort study, with 635 Black women and 816 White women, being Black was associated with inadequate follow-up (Jones et al., 2005). Maly et al. (2011) examined data obtained from a cross-sectional study with a sample of 921 low-income women newly diagnosed with breast cancer. Blacks, compared to Whites, had the longest interval between detection and diagnostic resolution, 64 and 22 days respectively. Using a sample of 21,427 women diagnosed with breast cancer at one of eight National Comprehensive Cancer Network centers, Warner et al. (2012) found that the median time to diagnosis following abnormal mammogram was 29 days for Blacks and 21 days for Whites. A few studies have found that race/ethnicity does not predictive timeliness. For example, Battaglia et al. (2010) found that site of care was a predictor of timely follow-up rather than any demographic characteristics of individuals, including race/ethnicity.

The relationship between age and time to diagnostic resolution is unclear. Studies have found a significant relationship (Battaglia et al., 2007; Markossian et al., 2012; Krok-Schoen et al., 2014; Yabroff et al., 2004); however, other studies have failed to find a significant relationship (Kerner et al., 2003). For example, Kerner et al. (2003) interviewed and reviewed the medical records of 184 Black women and found there was not a significant relationship between age and time to diagnostic resolution. Among the studies that have found a significant relationship between age and time to diagnostic resolution, the results are inconsistent with timeliness being associated with being younger or older. Battaglia et al. (2007) evaluated a patient navigator intervention among inner city women and found that women over 65 years of age were more likely to have timely follow-up compared to women aged 40–64; likewise, women aged 18–39 were less likely to have timely follow-up. Yabroff et al. (2004) also found younger women (less than age 50) were less likely to report abnormal mammogram follow-up. Similarly, Krok-Schoen et al. (2014) also found a significant association between being older and less time to diagnostic resolution. Results indicated that there was a 4% increase in the rate of resolution for each five-year increase in patient age. Conversely, in a study evaluating the efficacy of patient navigation, results indicated that being older was significantly associated with longer time to diagnostic resolution (Markossian et al., 2012). In sum, the relationship between age and time to diagnostic resolution is inconsistent and differs among various studies.

Several studies found a significant relationship between education and time to diagnostic resolution. For example, Yabroff et al. (2004) found that women with less than a high school education were less likely to report diagnostic follow-up compared to women who had at least completed college. Krok-Schoen et al. (2014) also found that educated patients had an 87% higher rate of resolution than patients with less than a high school education. In a secondary data

analysis, Strzelczyk and Dignan (2002) found women with less education were less likely to adhere to diagnostic follow-up.

Studies have consistently found a significant relationship between income and time to diagnostic resolution. Higher income has been associated with less time to diagnostic resolution; similarly, women with lower income have longer time to resolution (Perez-Stable et al., 2013; Krok-Schoen et al., 2014; Adams et al., 2009). Perez-Stable et al. (2013) found that significant delays in diagnosis were associated with having an income of less than $10,000. Similarly, in the Krok-Schoen et al. (2014) study, patients with annual incomes of greater than $50,000 had a 51% higher rate of diagnostic resolution than patients with annual incomes less than $10,000. Adams et al. (2009) also found an association between income and completion of the diagnostic follow-up.

Need characteristics. A number of studies have examined individual characteristics related to perceptions of need for health services. Time to diagnostic resolution has been associated with BI-RADS value (Perez-Stable et al., 2013; Markossian et al., 2012; Kerner et al., 2003). Women with more serious initial mammogram findings have less delay in diagnostic resolution (Perez-Stable et al., 2013; Markossian et al., 2012; Kerner et al., 2003). For example, in the Kerner et al. (2003) study, women with more serious mammography abnormality results were more likely to have diagnostic resolution within 90 days than women with less serious mammography results. In another study, Perez-Stable and colleagues (2013) conducted telephone surveys and reviewed medical records of women with abnormal mammograms in order to understand the efficiency of the evaluation of abnormal findings. Of the 938 women with abnormal mammograms, the median time to diagnosis was 183 days for BI-RADS 3, 29 days for BI-RADS 4/5, and 27 days for BI-RADS 0. Over 80% of women with BI-RADS 0, 4, or

5 completed their diagnostic evaluation within 60 days. However, of women with BI-RADS 3, only 29% completed their diagnostic evaluation within 60 days and only 50% of women had completed their diagnostic evaluation at 6 months. Similarly, in the Markossian et al. (2012) study, a BI-RADS 3 finding for initial abnormal mammogram/ultrasound was associated with longer time to diagnostic resolution compared to all other women.

In sum, studies consistently have found that women without health insurance, without a regular care provider, less education, lower income, and higher BI-RADS value have more delay in diagnostic follow-up after abnormal mammograms. Most studies examining the relationship between race and ethnicity and diagnostic resolution have found that women from minority racial and ethnic populations have more delay in diagnostic resolution compared to women from non-minority racial and ethnic populations (Adams et al., 2009; Press et al., 2008). However, a limited number of studies have not found a relationship between race and ethnicity and diagnostic resolution after an abnormal mammogram (Battaglia et al., 2010). The relationship between age and diagnostic resolution is ambiguous with some studies finding no relationship, others younger age was associated with more delay, and others finding older age was associated with greater delay in diagnostic follow-up after an abnormal mammogram.

C. **Conclusions**

Consistent with the core of the social work professional ideology, the person-in-environment, that embraces a holistic focus of the complex and dynamic interaction between people and their environments (NASW, 2005), associations between contextual-level factors and individual-level factors and breast cancer outcomes were well-documented across a number of studies. It is important to recognize the experiences and conditions that are potential influences for women as they make decisions about follow-up breast care. Early detection of breast cancer

can be lifesaving; yet, research has demonstrated often women delay important follow-up services (Perez-Stable et al., 2013). In order to reduce the breast cancer mortality rates for Black women, early detection of breast cancer is necessary. Moreover, it is vital to examine the multitude of potential factors that influence women, particularly women living in medically underserved areas, accessing care.

Although associations have been found between contextual-level factors and individual-level factors and breast cancer outcomes, many of the studies have findings that are heterogeneous, especially in the studies examining individual-level outcomes. The conflicting findings may reflect the limitations and variation in methodological designs of the studies, inconsistency in the definition of the variables, and the substantial variation in the measurement of variables. In addition, many of the studies have ecological designs that are observational and not causal. Most of the studies also used large, retrospective databases that limit study variables to those included in the data set as well as limits the research to the availability of the data. Most studies examining diagnostic resolution have focused on patient-level characteristics, and have documented several patient-level factors such as level of education, age, and insurance status that are significantly related to time to diagnostic resolution. Yet as previously noted, many of these studies have conflicting findings, and as a result, the relationship between patient-level factors and timeliness is poorly understood. Likewise, despite the increased recognition of the impact of contextual-level factors on breast health outcomes, few studies have examined broader contextual factors. Of the limited contextual studies, neighborhood level poverty, racial residential segregation, and structural disadvantage have been found to be associated with poor breast cancer screening rates and later stage breast cancer diagnosis. These studies have examined the relationship between neighborhood context and adherence to screening and/or

stage of diagnosis, but have neglected to examine time to diagnostic resolution. Distance from women's residence to mammography clinic is another contextual factor that has been examined, and similar to neighborhood poverty, screening adherence and/or stage of diagnosis has been the focus of the studies, not diagnostic resolution. In conclusion, timely diagnostic resolution after abnormal mammography is a critical component of reducing breast cancer morbidity and mortality. Moreover, there is a dearth of studies examining diagnostic resolution, the limited studies present conflictual findings, and have failed to examine both the contextual and individual factors. This study is an important contribution to the literature because it aims to address this gap by examining both contextual-level factors and individual-level factors associated with diagnostic resolution after an abnormal mammogram. Furthermore, this study supports the hallmark of social work, the person-in-environment perspective, which recognizes a woman is dynamically connected to multiple environmental systems that simultaneously affect one another (Hare, 2004). To fully understand the dynamics of a woman accessing diagnostic follow-up care after an abnormal mammogram in medically underserved areas, the environmental conditions in which she resides must be taken into account.

IV.   RESEARCH METHODS

A.   <u>Research Design and Method</u>

A data analysis was conducted to test the study hypotheses and assess the relationship between contextual factors and individual factors and diagnostic resolution after an abnormal mammogram. The analytic sample was a subset of women in the PNMUA randomized, controlled trial conducted in three hospitals in Chicago. The analytic sample included women with an abnormal mammogram result that required diagnostic follow-up care. The longitudinal data was collected from patient electronic medical records and questionnaires.

B.   <u>Data</u>

1. <u>Study Population</u>

The original study collected data from June 2011 through June 2014 as part of the PNMUA trial. This randomized, controlled trial was conducted to evaluate the efficacy of a patient navigation intervention among low-income women in Chicago, Illinois, in improving screening, treatment adequacy, and adherence to treatment recommendations along the breast cancer care continuum. The trial was conducted at three hospitals located in medically underserved areas. The study had three overlapping phases. Phase I was a retrospective analysis of two years of mammography patient data (approximately October 2008-October 2010) to establish baseline measures for comparison (Table III). A waiver of HIPAA authorization was requested to access a limited data set from three participating hospitals.

TABLE III

SOURCES OF DATA FOR PATIENT NAVIGATION IN MEDICALLY UNDERSERVED
AREAS STUDY

SUMMARY OF STUDY DATA SOURCES

<u>Phase I: Retrospective data analysis</u>

Electronic medical records data

<u>Phase II: Randomized trial of patient navigation for mammography screening patients</u>

Electronic medical records data (all participants)

Baseline patient questionnaires (participants in navigation group; 575 in control group)

Barrier tracking log (participants in navigation group only)

Measurement of patient satisfaction/exit interview (participants in navigation group only)

<u>Phase III: Women in navigation group and 575 women in control group with abnormal</u>

<u>mammography findings and/or diagnosed with breast cancer</u>

<u>Abnormal mammography findings</u>: Follow-up patient questionnaires (participants in

navigation group and 575 in control group with abnormal mammography findings)

<u>Breast cancer diagnosis</u>: Follow-up patient questionnaires (participants in navigation group

and 575 in control group who receive a breast cancer diagnosis)

Phase II was an intervention program designed to measure the relative effect of
navigation on breast cancer outcomes alone and in combination with MUA designation in an
established MUA area (Roseland Hospital), a newly designated MUA area (Holy Cross
Hospital), and an area eligible for designation but not designated as an MUA (Advocate Trinity
Hospital). Phase III evaluated the effects of navigation on diagnosis and treatment for women in
the navigation group and those from the sample of women in the control group.

The study inclusion criteria included female patients, age 18 or older, who were not pregnant with an initial mammogram referral from a primary care provider for a screening mammography or for a diagnostic mammography based on an abnormal clinical breast exam. Participants were excluded if they had not been referred for screening or diagnostic mammography from primary care. Women who were already in process of diagnostic services following an abnormal screening mammogram when the study began were also excluded from participation.

Navigators, stationed at each mammography site (community hospital), identified eligible patients scheduled for screening or diagnostic mammography appointments and assigned them to the navigation arm (intervention) or standard of care arm (control) based on a randomization software program (1:1). Navigators recruited eligible patients by phone or in-person from the hospital scheduled mammogram appointment list. Prior to the appointment, a navigator called to remind patients about their upcoming mammogram, the study was explained, and patients were asked if they were interested in participating in the study. For interested patients, the navigator met the patient at her scheduled mammography appointment and obtained written informed consent. For patients unavailable by phone, the navigator met the patient at her appointment, the study was explained, and oral informed consent was obtained for interested patients. Women randomized into the control arm received standard of care. Women in the control arm ("passive controls") did not interact with study staff and their data were drawn from electronic medical records. A subset of women randomized into the control arm (n = 575) were selected to interact with study staff based on appointment date ("active controls"). This subset interacted with study staff by phone to provide consent and complete survey questionnaires. Data also was abstracted

from electronic medical records for women in the active control group. The study was approved

by the University of Illinois at Chicago Institutional Review Board (UIC Protocol #: 2010-0997).

The patient navigation intervention was developed following the lay patient navigator

model (Wells et al., 2008). This model relies on individuals with relatively low salaries, whose

training and experience is more limited than a healthcare worker, but whose presence within the

system could prove effective and affordable. Patients randomized to the navigation group were

assigned a trained female navigator. The navigators were paid hospital employees. Two days

before patient's imaging appointment, the navigator called the patient and used a "teach back"

method to ensure the patient understood the instructions for the mammography preparation,

answered any questions, assessed any potential barriers to attending the appointment, and

problem solved to eliminate these potential barriers. On the day preceding the appointment, the

navigator called again to remind the patient about the appointment and re-assessed any potential

barriers to compliance. The navigator then met the patient at the appointment to assess if the

patient had any questions, provided education and information, and discussed how the results of

the exam would be communicated to the patient. The navigator worked with the hospital clinical

staff to ensure results were delivered to the patient and that the patient understood the results and

the recommended follow-up (annual rescreening, additional diagnostic testing, or treatment

initiation). Patients who continued with diagnostic testing or treatment initiation completed an

additional questionnaire designed to explore what clinical services were offered, what the patient

understood about these services, what services were accepted by the patients and reasons for

their decision. Patients randomized to the control group received care as usual at each hospital.

Phase III evaluated the effects of navigation on diagnosis and treatment for women in the

navigation group and those from the sample of women in the control group. Women with

abnormal mammography findings were invited to complete an additional set of questionnaires that examined specific barriers, beliefs, and cultural issues in order to understand whether non-adherence to diagnostic recommendations resulted from healthcare not being offered, patients refusing services, or a combination of these two. Women who were diagnosed with breast cancer were invited to complete a third set of questionnaires that examined whether occurrences of inadequate treatment resulted from healthcare not being offered, patients refusing treatment, or a combination of these two.

2. **Study Sample**

The study sample included all women consented and randomized to either the navigation arm (intervention) or the standard of care arm (control), with electronic medical records during the study, completed baseline patient questionnaires, and an abnormal mammogram finding. A Cox regression power analysis was conducted using PASS 14 Version 14.0.5 (2016) to determine the ideal sample size necessary for the study (Wilson VanVoorhis & Morgan, 2007). The analysis indicated a total of 623 women would be needed to adequately power the study. A Cox regression of the log hazard ratio on a covariate with a standard deviation of 1.5000 based on a sample of 623 observations achieves 80% power at a 0.05000 significance level to detect a regression coefficient equal to 0.2000. The sample size was adjusted because a multiple regression of the variable of interest on the other covariates in the Cox regression is expected to have an R-Squared of 0.8000.

The analytic sample is summarized in Figure 2. Of the women 9,506 recruited into the PNMUA study, 11% refused or later withdrew from the study. A total of 8,452 women were enrolled in the PNMUA study. A total of 3,123 (72%) women completed the baseline survey. Of women with completed survey data, 690 (16%) had an abnormal mammogram with a BI-RADS value of 0, 4, or 5. Data from the 690 women were used for the study analyses.

C.   **Measurement and Definitions**

1. **Dependent Variables**

Conceptually, diagnostic resolution was a woman following-up with recommended exams after an abnormal mammogram to determine the presence or absence of breast cancer. For the study, diagnostic resolution was operationalized using two dependent variables, *diagnostic resolution* and *time to diagnostic resolution* (Table IV.). The first dependent variable, *diagnostic resolution*, was dichotomized as patient completed or did not complete follow-up within 60 days after an abnormal mammogram. The second dependent variable, *time to diagnostic resolution*, was operationalized as the number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record. Time to diagnostic resolution was not limited to 60 days.

2. **Independent Variables**

The independent variables included variables representing contextual factors and individual factors of women in the sample.

Contextual factors. The contextual factors examined were neighborhood poverty, racial residential segregation, and distance to clinic. Neighborhood poverty was measured as a continuous variable using the 2011 American Community Survey (ACS) census-tract level data to determine the percentage of residents living below the federal poverty line. Racial residential segregation distribution also was measured as a continuous variable using the 2011 ACS census-tract level data to determine the percentage of Black, White, and Hispanic residents. Distance to clinic was a continuous variable measured by the driving distance in miles from the patient's address to hospital where the patient received breast care. This measurement does not take into account women may take public transportation that requires walking and various indirect routes to the hospitals.

Enabling factors. The individual factors that represented enabling resources were insurance status and having a usual source of healthcare. Insurance status was categorized as private, Medicare, or Medicaid/uninsured. Usual source of healthcare was measured from a questionnaire item: "Is there a particular doctor's office or other place that you usually go when you need routine or preventative care, such as a physical examination or check up?" Usual source of healthcare was then dichotomized as yes or no.

Predisposing factors. The predisposing factors included age, race/ethnicity, level of education, and household income. Age was measured as a continuous variable. Race/ethnicity was dichotomized White (including Hispanic)/other or Black. Level of education was categorized as 8th grade or less/some high school, high school diploma (or equivalent), some college/vocational training, associate's degree/college degree, or graduate/professional degree. Income was categorized as less than $10,000, $10,000-19,999, $20,000-29,999, $30,000-39,999, $40,000-49,999, $50,000 or more, or don't know/refused to answer.

Need characteristics. The variable related to need characteristic was abnormal mammography BI-RADS value. Abnormal BI-RADS values were categorized as 0 or 4/5.

3. **Control Variables**

Participation in the patient navigation intervention was dichotomized yes or no. Hospital included the location of the mammogram either Roseland Community Hospital, Holy Cross Hospital, or Advocate Trinity Hospital.

TABLE IV

DEPENDENT, INDEPENDENT, AND CONTROL VARIABLES

Variable	Operationalization	Level of Measurement
Dependent Variables		
diagnostic resolution	patient completed or did not complete follow-up within 60 days after an abnormal mammogram	dichotomized
time to diagnostic resolution	number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis	continuous
Independent Variables		
neighborhood poverty	percentage of residents in census track living below federal 100% poverty line	continuous
racial residential segregation	percentage of Black, White, Hispanic residents in census track	continuous
distance to mammography clinic	driving distance in miles from patient address to mammography facility	continuous
insurance status	private, Medicare, Medicaid/uninsured	categorical
usual source of healthcare	yes or no	categorical
age	number of years old	continuous
race/ethnicity	White (including Hispanic)/other or Black	categorical
level of education	8th grade or less/some high school, high school diploma (or equivalent), some college/vocational training, associate's degree/college degree, or graduate/ professional degree	categorical
household income	less than $10,000, $10,000-19,999, $20,000-29,999, $30,000-39,999, $40,000-49,999, $50,000 or more, or don't know/refused	categorical
BI-RADS value	0 or 4/5	categorical
Control Variables		
patient navigation intervention	yes or no	dichotomized
hospital	Roseland Community Hospital, Holy Cross Hospital, Advocate Trinity Hospital	categorical

D.   Data Analysis

Univariate, bivariate, and multivariate data analyses were conducted according to the

following analysis plan. The data were analyzed using IBM SPSS 23 analytical software (IBM

Corp, 2014).

1. **<u>Univariate Analyses</u>**

A univariate exploratory data analysis including measures of central tendency (means and medians) and measures of variability (range and standard deviations) was calculated for the continuous variables, including age, neighborhood poverty, racial residential segregation, distance to clinic, and time to diagnostic resolution to check the normality assumptions and visualize patterns. For the categorical variables—diagnostic resolution, patient navigation intervention, hospital, usual source of healthcare, insurance status, race/ethnicity, level of education, household income, and BI-RADS value—frequencies and/or modes were calculated.

2. **<u>Bivariate Analyses</u>**

Multiple types of bivariate relationships were analyzed to determine the relationships between the categorical and continuous indicators of contextual factors and the dependent variables; individual factors and the dependent variables; and relationships between the control variables and the dependent variables. Methods of bivariate analysis included chi-square tests (for pairs of categorical variables) and t-tests or one-way analysis of variance (for pairs with one dichotomous/categorical and one continuous variable).

3. **<u>Multivariate Analyses</u>**

Two statistical regression methods, binary logistic regression and Cox proportional hazards regression analyses, were used to test the study hypotheses. Binary logistic regression, a standard probabilistic statistical classification model, was used to evaluate the dichotomous dependent variable, diagnostic resolution, and the categorical and continuous independent variables. The Cox proportional hazards regression statistical technique was selected to explore the relationship between the continuous dependent variable, time to diagnostic resolution, and the categorical and continuous independent variables. The Cox proportional hazard model is considered robust for many different survival analysis situations (Kleinbaum & Klein, 2012).

The purpose of the Cox model is to simultaneously explore the effects of several variables. The

Cox proportional hazard model involves regressing the survival times (hazard function) on the

independent variables. The survival analysis involves the time between entry into a study and an

event, in this study the event was diagnostic resolution. After adjusting for the independent

variables, a Cox model provides an estimate of the treatment effect on survival and on the

estimated hazard (or risk) ratio for each variable. The hazard function is the probability that a

woman will experience the event (i.e., diagnostic resolution) within the time interval; therefore,

it is interpreted as the risk of the event within a specified time. For this study a positive

regression coefficient for an independent variable indicates that the hazard ratio is higher, and

thus longer time to diagnostic resolution. Conversely, a negative regression coefficient means

less time to diagnostic resolution with higher values of that independent variable. For this study,

the event was considered diagnostic resolution (i.e., the event did occur or the event did not

occur). Survival time, time to diagnostic resolution, was coded as the number of days between an

abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive

diagnosis, either benign or malignant, in the electronic medical record. A key analytic problem in

survival analysis is censoring, whereby some information is unknown about an individual's

survival time. For women who failed to return for abnormal mammogram follow-up during the

course of the study, the survival time (i.e., follow-up) was unknown. As a result, these women

were censored, which means that the period of observation was terminated before diagnostic

resolution occurred. Importantly, despite censoring, the Cox regression analysis provides an

unbiased result.

     The assumption in survival analysis is that censoring is independent, which means

women who are censored at a particular time should be representative of the women who

remained in the study with respect to their survival experience (i.e., time to diagnostic resolution) (Kleinbaum & Klein, 2012). Sensitivity analyses also were conducted to determine the extreme parameters of the Cox proportional hazard models in order to estimate violations of the independence assumptions. If the results of the sensitivity analyses were not meaningfully different from the results of the Cox proportional hazards regression analyses, then it is presumed that at most a small bias can result from the analyses that assumed independence. After each Cox proportional hazards regression analysis was conducted, two sensitivity analyses were conducted that set parameters of censoring women at 60 days and 365 days. As such, for the first sensitivity analysis women who did not complete diagnostic resolution within 60 days were censored (i.e., the period of observation was terminated). Then, for the second sensitivity analysis, women who did not complete diagnostic resolution within 365 days were censored.

Hypothesis 1. Factors related to neighborhood poverty, racial residential segregation, and/or distance to mammography clinic will have a significant direct effect on diagnostic resolution. To test this hypothesis a set of models were built regressing each dependent variable (diagnostic resolution and time to diagnostic resolution) on the independent variables and the control variables.

A sequence of binary logistic regression models along with collinearly diagnostics were obtained to assess the relationship between independent variables (neighborhood poverty, racial residential segregation, distance to mammography clinic) and the dichotomous outcome variable diagnostic resolution (patient completed or did not complete follow-up within 60 days after an abnormal mammogram).The binary logistic regression modeled effect of the independent variables and the probability of 60 day completion of diagnostic resolution.

Cox proportional hazards regression analyses were conducted to assess the relationship between the independent variables (neighborhood poverty, racial residential segregation, distance to mammography clinic) and dependent variable time to diagnostic resolution (number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record).

Model 1 included the control variables (patient navigation intervention, hospital) and neighborhood poverty; Model 2 included the control variables (patient navigation intervention, hospital) and racial residential segregation; Model 3 included the control variables (patient navigation intervention, hospital) and distance to mammography clinic; Model 4 included the control variables (patient navigation intervention, hospital) and neighborhood poverty, racial residential segregation, and distance to mammography clinic. Model 5 included the control variables (patient navigation intervention, hospital), individual factors (insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and BI-RADS value), and contextual factors (neighborhood poverty, racial residential segregation, and distance to mammography clinic).

Hypothesis 2. Factors related to insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and/or BI-RADS value have a significant direct effect on diagnostic resolution. To test this hypothesis a set of models was built regressing each dependent variable (diagnostic resolution and time to diagnostic resolution) on the independent variables and the control variables.

A sequence of binary logistic regression models along with collinearly diagnostics were conducted to assess the relationship between independent variables (insurance status, usual

source of healthcare, age, race/ethnicity, level of education, household income, BI-RADS value) and the dichotomous outcome variable diagnostic resolution (patient completed or did not complete follow-up within 60 days after an abnormal mammogram). The binary logistic regression modeled effect of the independent variables and the probability of 60 day completion of diagnostic resolution.

Cox proportional hazards regression analyses were conducted to assess the relationship between the independent variables (insurance status, usual source of healthcare, age, race/ethnicity, level of education, household income, BI-RADS value) and dependent variable time to diagnostic resolution (number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record).

Model 1 included control variables (patient navigation intervention, hospital) and enabling factors (insurance status, usual source of healthcare); Model 2 included control variables (patient navigation intervention, hospital), enabling factors (insurance status, usual source of healthcare), and predisposing factors (age, race/ethnicity, level of education, household income); Model 3 included control variables (patient navigation intervention, hospital), enabling factors (insurance status, usual source of healthcare), predisposing factors (age, race/ethnicity, level of education, household income), and need characteristics (BI-RADS value).

The purpose of using this modeling approach was to allow for comparison of predisposing, enabling, and need variables in order to distinguish which set of variables have a direct effect on diagnostic resolution (Varga & Surratt, 2014). Previous studies examining factors associated with healthcare services have built a sequence of models using the Andersen (1995) behavioral model of health services domains (i.e., predisposing, enabling, and need variables).

For example, Varga and Surratt (2014) evaluated the impact of each domain of the model on predicting healthcare utilization among a sample of Black, street-based female sex workers in Miami, Florida. The model that included only enabling variables was the most efficient model in predicting health care utilization.

E. <u>Human Subjects Protections</u>

The initial study protocol "Patient Navigation in Medically Underserved Areas" (Protocol # 2010-0997) was determined to be minimal risk, reviewed under expedited procedures, and approved by the UIC Institutional Review Board on February 10, 2011. The study protocol remains open and a continuing review of research application is submitted annually. Data collection is complete and the only research activity is data analysis. Breach of patient confidentiality is the greatest risk in the study. To address the potential risk, data collected from medical records has been managed via a written protocol. Study data were never linked directly with participant names. Each database application functions as a discrete, stand-alone system. Each application is password protected; additionally, each computer on which the application is deployed is only accessible through a protected user ID and password system. The main study database is maintained at the Institute for Health Research and Policy (IHRP) at UIC on a secure server dedicated to this research program. Only IRB and HIPAA-certified study personnel have access to the main database. Access to the server is restricted to study personnel and access to the database requires a unique user ID and password. In addition, firewall protection, antivirus software, and spyware tracking software has been loaded onto each computer for additional safety. All servers at UIC are Windows 2000-based systems that are firewall-protected and monitored by IHRP's IT department. Data on the server is backed up each night; backup discs are stored nightly in water and fireproof cabinets. Each application is

automatically backed up every two minutes on the computer on which it is being run in order to account for computer glitches or unexpected computer shutdowns.

The "Patient Navigation in Medically Underserved Areas" is a research project funded by two center grants, the Center for Population Health and Health Disparities (National Cancer Institute P50CA106743) and the Center of Excellence in Eliminating Disparities (National Institute on Minority Health and Health Disparities P60MD003424). The Principal Investigator (PI) of the current study is the Project Director of the Center of Excellence in Eliminating Disparities. In addition, the PI is key research personnel and the study is within the primary research aims of the "Patient Navigation in Medically Underserved Areas" study (Protocol # 2010-0997).

V.   RESULTS

A.   <u>Study Sample</u>

The analytic sample is summarized in Figure 2. Of the women 9,506 recruited into the

PNMUA study, 11% refused or later withdrew from the study. A total of 8,452 women were

enrolled in the PNMUA study. Of these women, a total of 3,123 (72%) women completed the

baseline survey. Of women with completed survey data, 690 (16%) had an abnormal

mammogram with a BI-RADS value of 0, 4, or 5. Women with a BI-RADS value of 3 were not

included because the recommended diagnostic follow-up is six months and immediate diagnostic

follow-up is not recommended (Sickles et al., 2013). Data from the 690 women were used for the
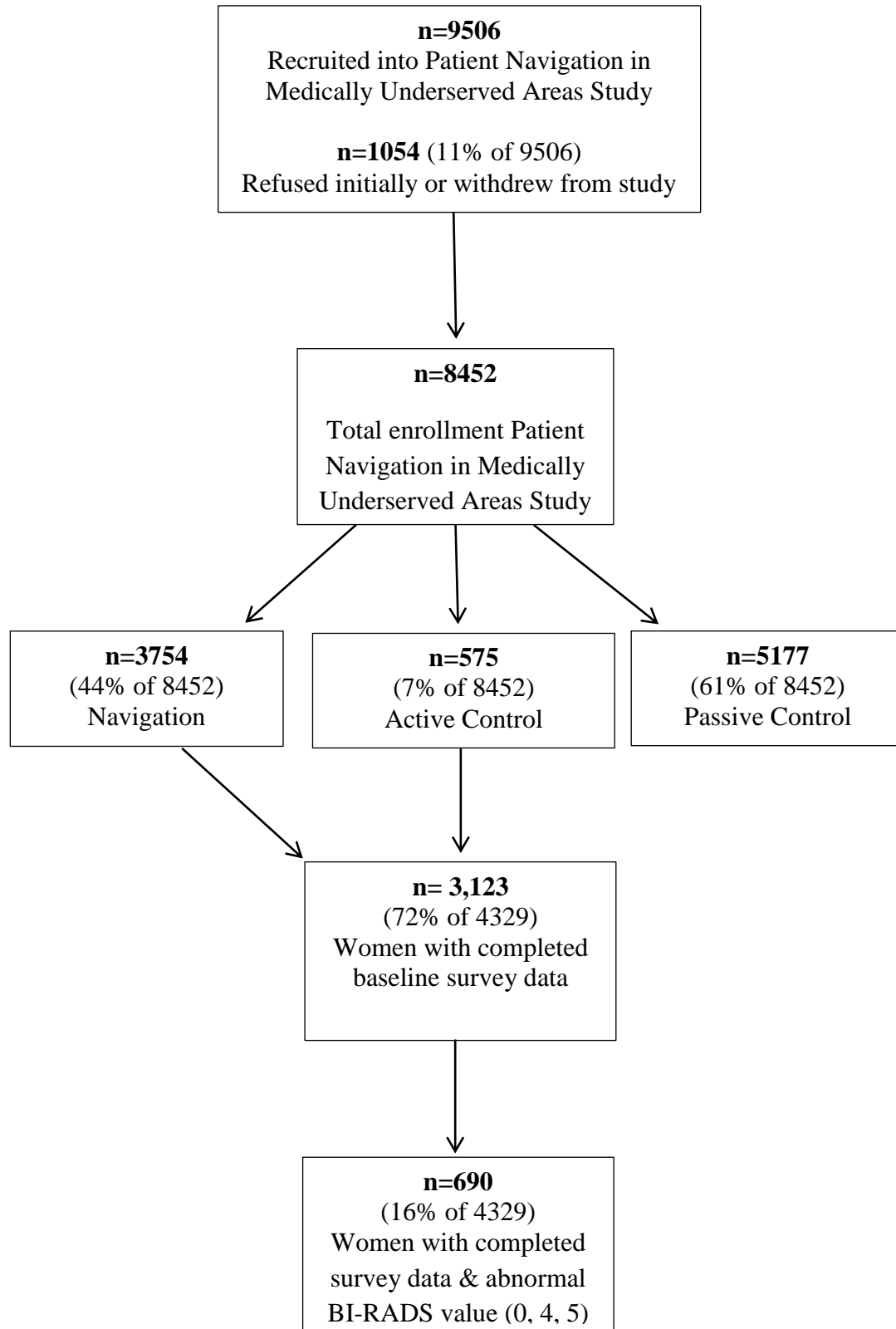
study analyses.

Figure 2. Diagram for study analytic sample.

B. **Univariate Analyses**

The univariate variables for the overall PNMUA study group (navigation group, active control group, and passive control group), women with completed survey data group (women in the navigation group and active control group), and women with completed survey data and an abnormal mammogram value of 0, 4, or 5 are provided in Table V. The characteristics of the study analytic sample demographics and health information are summarized in Table VI, the contextual level variables are summarized in Table VII, and the control and outcome variables are summarized in Table VIII.

1. **Characteristics of the Study Groups**

Table V provides a summary of the univariate variables for the overall PNMUA study group, women with completed survey data group, and the analytic sample (women with completed survey data and an abnormal mammogram value of 0, 4, or 5). Importantly, these groups are not mutually exclusive and exhaustive. The women in the completed survey data group are included in the overall PNMUA study group; likewise, women in the analytic sample were in the completed survey data group. Among the three groups, there were minimal differences in the average percentages of the demographic variables. The average age of women in the overall PNMUA study was 59. All three groups were predominantly Black (the PNMUA group was 80%, the completed survey data group was 79%, and the analytic sample was 86%). Private insurance was the most common type of insurance with each group having an average of more than 50%. Medicare was the second most common type of health insurance with a range of between 31% and 33%. The least common type of insurance was Medicaid/uninsured with an average of 16% for the overall PNMUA study group, 18% for the completed survey data group, and 14% for the analytic sample.

As expected, the analytic sample had a significantly higher percentage of BI-RADS values of 0, 4, and 5 compared to the other two groups. As a result of the study design, the completed survey data group and analytic sample had a significantly higher percentage of women in the navigation intervention, 81% and 87% respectively. More than half of women in all groups received mammography at Trinity with the highest percentage in analytic sample group (85%).

There were some differences in the contextual variables between the three groups. The overall PNMUA study group had a higher percentage of neighborhood poverty and Black and White racial residential segregation. Neighborhood poverty was 23% compared to 21% in the other two groups. Black racial residential segregation was significantly higher in the overall PNMUA study group (73%) compared to women with completed survey data (56%) and the analytic sample (54%). The same pattern existed for White racial residential segregation; the overall PNMUA study was 17% compared to the completed survey data group (15%) and the analytic sample (14%). However, Hispanic racial residential segregation was considerably lower in the PNMUA study group (16%) compared to the completed survey data group (28%) and the analytic sample (29%). Among the three groups, the average distance to mammography clinic was similar between 5.1 and 5.9 miles.

In terms of the outcome variables, the overall PNMUA study group had the most delay in diagnostic follow-up. The average for the analytic sample was the timeliest. For diagnostic resolution, the completion follow-up within 60 days, the PNMUA study group had an average of 80%, whereas the completed survey data group had an average of 98% and the analytic sample average was 96%. Time to diagnostic resolution, the number of days between an abnormal mammogram and confirmation of a definitive diagnosis, was similar in the PNMUA study group

(52 days) and the completed survey data group (51 days). The analytic sample was notably

timelier at an average of 12 days to confirmation of a definitive diagnosis.

TABLE V

CHARACTERISTICS OF THE PNMUA STUDY, WOMEN WITH COMPLETED SURVEY
DATA, AND WOMEN WITH COMPLETED SURVEY DATA AND AN ABNORMAL
BI-RADS VALUE

Variable	PNMUA Study	Completed Survey	Completed Survey & Abnormal BI-RADS
	n=8,452	n= 3,123	n=690
		Percentage	
BI-RADS value			
0	20	23	93
1	32	28	
2	40	39	
3	7	8	
4	1	2	7
5	0	0.1	0.3
Insurance status			
private	51	50	56
Medicare	33	32	31
Medicaid/uninsured	16	18	14
Race/ethnicity			
White (including Hispanic)/other	20	21	14
Black	80	79	86
Patient navigation intervention			
Navigated	29	81	87
Active control	6	19	13
Passive control	54		
Hospital			
Holy Cross	29	40	15
Roseland	7	8	0.9
Trinity	64	53	85
Diagnostic resolution (60 days)	80	98	96
		Mean (SD)	
Time to diagnostic resolution	n=1902	n=778	n=618
	52.02 (97.67)	50.66 (95.39)	12.04 (34.48)
Age	59.39 (12.49)	58.47 (12.39)	57.65 (12.95)
Neighborhood poverty	23.34 (12.52)	21.40 (12.22)	20.51 (11.36)
Distance to mammography clinic	5.57 (27.51)	5.142 (5.15)	5.91 (5.53)
Racial residential segregation-Black	72.67 (35.20)	55.77 (40.95)	54.42 (40.80)
Racial residential segregation-White	17.30 (2.77)	14.50 (23.26)	14.42 (23.55)
Racial residential segregation-Hispanic	16.25 (26.96)	27.74 (32.10)	29.12 (33.18)

2. **<u>Characteristics of the Analytic Sample</u>**

Sample demographics and health information are summarized in Table VI. The sample was primarily Black (81%) with the remaining women identifying as White including Hispanic or other. The women's ages ranged from 25 to 93, with a mean of 58 and a median of 56. Women's education level varied with about 10% having less than 8th grade education or some high school, 23% had a high school diploma or GED, and the remaining 67% having at least some college or higher. Sixteen percent of the women in the sample did not know or refused to report their household income. Of those who did, one-third reported a household income of less than $19,999, one-third reported between $20,000 and $49,999, and one-third reported $50,000 or more.

The majority of women (87%) had either private insurance or Medicare and the remaining 13% had Medicaid or were uninsured. A very high percentage of women (97%) reported having a usual source of healthcare. Almost 93% of women in the sample had a BI-RADS value of 0, which indicates the mammogram result is incomplete and additional imaging evaluation is needed prior to a final diagnostic determination (Sickles et al., 2013). The remaining 7% of women had a BI-RADS value of 4 or 5, which indicates a suspicious abnormality that also requires additional imaging or biopsy.

TABLE VI

ANALYTIC SAMPLE DEMOGRAPHIC CHARACTERISTICS

	n (%)	Missing n (%)
Race/ethnicity		13 (1.9)
Black	580 (81.4)	
White (including Hispanic)/other	97 (14.1)	
Insurance status		11 (1.6)
Private	382 (56.3)	
Medicare	207 (30.5)	
Medicaid/uninsured	90 (13.3)	
Education		0
8th grade or less/some high school	65 (9.40)	
High school diploma/GED	159 (23.0)	
Some college/vocational training	229 (33.2)	
Associates degree/college degree	146 (21.2)	
Graduate or professional degree	91 (13.2)	
Household income		4 (0.01)
less than $10,000	85 (12.3)	
$10,000-19,999	98 (14.2)	
$20,000-29,999	65 (9.4)	
$30,000-39,999	65 (9.4)	
$40,000-49,999	48 (7.0)	
$50,000 or more	214 (31.0)	
don't know/refused	111 (16.1)	
BI-RADS value		8 (1.2)
0	641 (92.9)	
4/5	49 (7.1)	
Usual source of healthcare		1 (0.001)
Yes	670 (97.1)	
No	19 (2.8)	
	M (SD)	
Age	57.7 (13.0)	12 (1.7)

The analytic sample contextual level variables including neighborhood poverty, distance to mammography clinic, and racial residential segregation are summarized in Table VII. There were few missing data for the individual level sample characteristics; however, a significant amount of contextual characteristics data were missing. Thirty-seven percent of the neighborhood poverty and racial residential segregation data were missing. The reason for the missing data is unknown, but most likely women's addresses were missing from the EMR data and could not be geocoded. Women in the sample lived in neighborhoods with an average of 21% of residents in census track living below federal 100% poverty line. The average percentage of racial residential segregation was dissimilar between Black, White, and Hispanic. Women resided in neighborhoods that had an average of 54% Black, 14% White, and 29% Hispanic residents in the census track. The range of driving distance from residential address to the hospital mammography clinic was less than 1mile to 51 miles. The average distance was 5.9 miles and the median was 4.6 miles.

TABLE VII

SAMPLE CONTEXTUAL VARIABLES AND NEIGHBORHOOD CHARACTERISTICS

	M (SD)	Missing n (%)
Neighborhood poverty	20.5 (11.4)	256 (37.1)
Distance to mammography clinic	5.9 (5.5)	16 (2.3)
Racial residential segregation-Black	54.4 (40.8)	256 (37.1)
Racial residential segregation-White	14.4 (23.5)	256 (37.1)
Racial residential segregation-Hispanic	29.1 (33.2)	256 (37.1)

The control and outcome variables are summarized in Table VIII. The majority of the sample (87%) was in the intervention group and received patient navigation. Also, about 85% of the women accessed mammography at Trinity Hospital. For the outcome variables, overall most women in the sample received timely follow-up care. Most of the women (96%) completed diagnostic resolution within 60 days. Among the women, there was a wide range of time to diagnostic resolution, the number of days between an abnormal mammogram and confirmation of a definitive diagnosis. This continuous indicator of time to diagnostic resolution displayed extreme skew (8.88) and kurtosis (104.10). Nineteen of the women (3%) followed-up on the same day, whereas one woman did not follow-up for 515 days. The average the number of days to a definitive diagnosis was 12 with a median of 1 day.

TABLE VIII

CONTROL AND OUTCOME VARIABLES

	n (%)	Missing n (%)
Patient navigation intervention		0.0
Navigated	600 (87.0)	
Active Control	90 (13.0)	
Hospital		0.0
Holy Cross/Roseland	107 (15.5)	
Trinity	583 (84.5)	
Diagnostic resolution (60 days)	665 (96.4)	1 (0.10)
	M (SD)	
Time to diagnostic resolution	12.04 (34.5)	72 (0.10)

C.   **Bivariate Analyses**

Bivariate analyses were conducted using chi-square tests, t-tests, one-way analysis of variance, and correlations to examine relationships between: (1) control variables and the dichotomous dependent variable, (2) categorical independent variables and the dichotomous dependent variable, (3) continuous independent variables and the dichotomous dependent variable, (4) control variables and the continuous dependent variable, (5) categorical independent variables and the continuous dependent variable, and (6) continuous independent variables and the continuous dependent variable.

In the bivariate analyses using chi-square tests, several of the cells had less than the expected frequencies, and consequently the relationships could not be assessed between the control variables and the dichotomous dependent variable and the categorical independent variables and the dichotomous dependent variable. According to Cochran (1954), the chi-square approximation may not be reliable when tables have expected cell frequencies of less than 5. Furthermore, the chi-square test for tables with expected cell frequencies less than 0 should be avoided.

1. <u>**Control Variables and the Dichotomous Dependent Variable**</u>

Table IX shows the results of chi-square tests used to assess the relationship between the

two dichotomous variables, hospital where women accessed follow-up care and patient

navigation intervention, and the dependent variable diagnostic resolution. Hospital and

diagnostic resolution were significantly associated, X^2 (1, N = 689) = 6.01, p = .002. Of the

women completing diagnostic resolution within 60 days, 82% accessed care at Trinity. There

was not a significant relationship between patient navigation intervention and diagnostic

resolution.

Table IX

BIVARIATE ANALYSES (CHI-SQUARE): CONTROL VARIABLES AND DICHOTOMOUS
DEPENDENT VARIABLE DIAGNOSTIC RESOLUTION IN 60 DAYS

	Diagnostic Resolution within 60 days		
	Yes	No	p
Hospital	n (%)	n (%)	.002
Holy Cross/Roseland	99 (14.4)	8 (1.2)	
Trinity	566 (82.1)	16 (2.3)	
Patient Navigation Intervention	n (%)	n (%)	.226
Navigated	580 (84.2)	19 (2.8)	
Active control	85 (12.3)	5 (0.7)	

The relationships also were examined between the two control variables, hospital and patient navigation intervention. Table X shows the results of chi-square tests used to assess the relationship. Hospital was significantly associated with patient navigation intervention at $p=.000$. Seventy-seven percent of the women in the navigation group accessed mammography at Trinity.

TABLE X

BIVARIATE ANALYSES (CHI-SQUARE): CONTROL VARIABLES

	Hospital		
	Holy Cross /Roseland	Trinity	p
Patient Navigation Intervention	n (%)	n (%)	.000
Navigated	71 (10.3)	529 (76.7)	
Active control	36 (5.2)	54 (7.8)	

2. **Categorical Independent Variables and the Dichotomous Dependent Variable**

Table XI shows the results of chi-square tests used to assess the relationship between these variables. There was not a significant relationship between the categorical independent variables—insurance, race/ethnicity, education level, household income, usual source of healthcare, BI-RADS value—and diagnostic resolution. However, many of the cells with failure to complete diagnostic resolution in 60 days had less than the minimum expected count, and as a result, the relationships cannot be assessed between the independent variables and diagnostic resolution.

TABLE XI

BIVARIATE ANALYSES (CHI-SQUARE): CATEGORICAL INDEPENDENT VARIABLES AND DICHOTOMOUS DEPENDENT VARIABLE DIAGNOSTIC RESOLUTION IN 60 DAYS

	Diagnostic Resolution within 60 days	
		No
	n (%)	n (%)
Insurance		
Private	367 (54.1)	14 (2.1)
Medicare	199 (29.4)	8 (1.2)
Medicaid/uninsured	88 (13.0)	2* (0.3)
	n (%)	n (%)
Race/ethnicity		
White (including Hispanic)/other	93 (13.8)	4* (0.6)
Black	559 (82.7)	20 (3.0)
	n (%)	n (%)
Education Level		
8th grade of less/some high school	63 (9.1)	2* (0.3)
High school diploma/GED	154 (22.4)	5 (0.7)
Some college/vocational training	220 (31.9)	8 (1.2)
Associate's degree/college degree	138 (20.0)	8 (1.2)
Graduate or professional degree	90 (13.1)	1* (0.1)
	n (%)	n (%)
Household income		
less than $10,000	81 (11.8)	4* (0.6)
$10,000-19,999	92 (13.4)	6 (0.9)
$20,000-29,999	63 (9.2)	2* (0.3)
$30,000-39,999	61 (8.9)	4* (0.6)
$40,000-49,999	46 (6.7)	2* (0.3)
$50,000 or more	208 (30.4)	6 (0.9)
don't know/refused	110 (16.1)	0* (0.0)
	n (%)	n (%)
Usual source of healthcare		
No	1* (0.1)	18 (2.6)
Yes	23 (3.3)	646 (93.9)
	n (%)	n (%)
BI-RADS value		
0	617 (89.6)	23 (1.3)
4 or 5	46 (6.7)	1* (0.1)

* Cells have less than the minimum expected count.

3. <u>Continuous Independent Variables and the Dichotomous Dependent Variable</u>

Table XII shows the results of analysis of variance tests used to assess the relationship between these variables. There was not a significant relationship between the continuous independent variables— age, neighborhood poverty, distance to mammography clinic, White racial residential segregation—and diagnostic resolution. Diagnostic resolution was associated at $p<.05$ with Black and Hispanic racial residential segregation. Women that completed diagnostic resolution within 60 days had significantly higher average of Black residential segregation in the census track where they lived. Conversely, women that did not complete diagnostic resolution had significantly higher average of Hispanic residential segregation in the census track where they lived.

TABLE XII

BIVARIATE ANALYSES (UNIVARIATE ANALYSIS OF VARIANCE): CONTINUOUS
INDEPENDENT VARIABLES AND DICHOTOMOUS DEPENDENT VARIABLE
DIAGNOSTIC RESOLUTION IN 60 DAYS

		Mean	P-Value
Age	yes	57.7	0.594
	no	55.5	
Neighborhood poverty	yes	20.6	0.669
	no	18.6	
Distance to mammography clinic	yes	6.0	0.143
	no	3.4	
Racial residential segregation			
White	yes	14.5	0.744
	no	17.7	
Black	yes	54.8	0.035
	no	19.5	
Hispanic	yes	28.7	0.020
	no	60.4	

4. **Control Variables and the Continuous Dependent Variable**

Table XIII shows the results of analysis of variance tests used to assess the relationship between these variables. Time to diagnostic resolution was associated at $p<.05$ with the hospital where women received care and the patient navigation intervention. Women who accessed mammography care at Trinity had a significantly lower time to diagnostic resolution compared to women who accessed care at Holy Cross/Roseland. Women in the patient navigation intervention also had a significantly lower time to diagnostic resolution compared to women in the control group who received the standard of care.

TABLE XIII

BIVARIATE ANALYSES (UNIVARIATE ANALYSIS OF VARIANCE): CONTROL VARIABLES AND CONTINUOUS DEPENDENT VARIABLE TIME TO DIAGNOSTIC RESOLUTION

	Mean	P-Value
Hospital		0.000
Holy Cross/Roseland	29.8	
Trinity	9.4	
Patient Navigation Intervention		0.014
Navigated	10.8	
Active control	21.1	

5. **Categorical Independent Variables and the Continuous Dependent Variable**

Table XIV shows the results of analysis of variance tests used to assess the relationship between these variables. There was not a significant relationship between any of the categorical independent variables— insurance, race/ethnicity, education level, household income, usual source of healthcare, BI-RADS value—and time to diagnostic resolution.

TABLE XIV

BIVARIATE ANALYSES (UNIVARIATE ANALYSIS OF VARIANCE): CATEGORICAL
INDEPENDENT VARIABLES AND CONTINUOUS DEPENDENT VARIABLE TIME TO
DIAGNOSTIC RESOLUTION

	Mean	P-Value
Insurance		0.923
Private	12.7	
Medicare	11.4	
Medicaid/uninsured	12.0	
Race/ethnicity		0.112
White (including Hispanic)/other	18.0	
Black	11.3	
Education level		0.410
8th grade or less/some high school	14.5	
High school diploma/GED	13.2	
Some college/vocational training	12.5	
Associate's degree/college degree	13.2	
Graduate or professional degree	5.1	
Household income		0.118
less than $10,000	13.1	
$10,000-19,999	18.7	
$20,000-29,999	10.3	
$30,000-39,999	20.7	
$40,000-49,999	8.0	
$50,000 or more	10.2	
don't know/refused	7.04	
Usual source of healthcare		0.636
No	16.1	
Yes	11.9	
BI-RADS value		0.907
0	12.0	
4 or 5	12.6	

6. **Continuous Independent Variables and the Continuous Dependent Variable**

Table XV shows the results of Pearson correlation tests used to assess the relationship

between these variables. There was not a significant relationship between any of the continuous

independent variables— age, neighborhood poverty, distance to mammography clinic, racial

residential segregation—and time to diagnostic resolution.

TABLE XV

BIVARIATE ANALYSES (PEARSON PRODUCT-MOMENT CORRELATION
COEFFICIENT): CONTINUOUS INDEPENDENT VARIABLES AND CONTINUOUS
DEPENDENT VARIABLE TIME TO DIAGNOSTIC RESOLUTION

	r	P-Value
Age	0.033	0.418
Neighborhood poverty	0.015	0.769
Distance to mammography clinic	0.063	0.123
Racial residential segregation		
White	0.026	0.604
Black	0.010	0.840
Hispanic	-0.030	0.551

D. **Multivariate Analyses**

Multivariate regression analyses were performed to test the two study hypotheses. The first hypothesis was that factors related to neighborhood poverty, racial residential segregation, and/or distance to mammography clinic will have has a significant direct effect on diagnostic resolution. A sequence of multivariate binary logistic regression models were conducted to assess the relationship between the dichotomous dependent variable diagnostic resolution (patient completed or did not complete follow-up within 60 days after an abnormal mammogram) and the independent variables (neighborhood poverty, racial residential segregation, distance to mammography clinic). Hosmer-Lemeshow goodness-of-fit tests were conducted to identify potential problems adequate fit of the model. A sequence of standard Cox survival models were conducted to assess the relationship between the continuous dependent variable time to diagnostic resolution (number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record) and the independent variables (neighborhood poverty, racial residential segregation, distance to mammography clinic).

The second hypothesis was factors related to insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and/or BI-RADS value will have a significant direct effect on diagnostic resolution. A sequence of multivariate binary logistic regression models were conducted to assess the relationship between the dichotomous dependent variable diagnostic resolution (patient completed or did not complete follow-up within 60 days after an abnormal mammogram) and the independent variables (insurance status, usual source of healthcare, age, race/ethnicity, level of education, household income, BI-RADS value). Hosmer-Lemeshow goodness-of-fit tests were conducted in order to identify potential problems

with model fit and adjust the models accordingly. A sequence of standard Cox survival models also were conducted to assess the relationship between the continuous dependent variable time to diagnostic resolution (number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record) and the independent variables (insurance status, usual source of healthcare, age, race/ethnicity, level of education, household income, BI-RADS value).

1. **Binary Logistic Regression Analyses for Hypothesis 1**

Table XVI shows the results of the multivariate binary logistic regression conducted for the dichotomous dependent variable diagnostic resolution, patient completed or did not complete follow-up within 60 days after an abnormal mammogram, control variables, and neighborhood poverty. There was not a significant association between the control variables, neighborhood poverty, and diagnostic resolution. The Hosmer-Lemeshow goodness-of-test was not significant, indicating that the model did not appear to be mis-specified.

TABLE XVI

MULTIVARIATE LOGISTIC REGRESSION: MODEL 1 CONTROL VARIABLES AND NEIGHBORHOOD POVERTY

	β (SE)	OR	95% CI	P-Value
Patient navigation intervention	-0.97 (0.706)	0.38	(0.10, 1.52)	0.171
Hospital	0.06 (0.547)	1.06	(0.36, 3.10)	0.914
Neighborhood poverty	0.01 (0.027)	1.01	(0.96, 1.06)	0.757
Hosmer and Lemeshow Test $\chi^2(8) = 10.09, p = .259$				

Note. n=433

Table XVII shows the results of the multivariate binary logistic regression conducted for the dichotomous dependent variable diagnostic resolution, patient completed or did not complete follow-up within 60 days after an abnormal mammogram, control variables, and distance to mammography clinic. Hospital where women received follow-up care was significant. Women accessing care at Trinity were significantly more likely to complete diagnostic resolution within 60 days compared to women accessing care at Holy Cross or Roseland. Patient navigation intervention and distance to mammography clinic were not significant in this model. The Hosmer-Lemeshow goodness-of-test was not significant, indicating that the model did not appear to be mis-specified.

TABLE XVII

MULTIVARIATE LOGISTIC REGRESSION: MODEL 2 CONTROL VARIABLES AND DISTANCE TO MAMMOGRAPHY CLINIC

	β (SE)	OR	95% CI	P-Value
Patient navigation intervention	-0.33 (0.543)	0.72	(0.25, 2.08)	0.538
Hospital	0.53 (0.235)	1.70	(1.07, 2.69)	0.024
Distance to mammography clinic	-0.03 (0.130)	0.97	(0.92, 1.03)	0.387
Hosmer and Lemeshow Test $\chi^2(8)$ = 6.44, p = .598				

Note. n=673

Table XVIII shows the results of the multivariate binary logistic regression conducted for the dichotomous dependent variable diagnostic resolution, patient completed or did not complete follow-up within 60 days after an abnormal mammogram, control variables, and racial residential segregation. None of the variables in this model were significant. The Hosmer-Lemeshow goodness-of-test was not significant, indicating that the model did not appear to be mis-specified.

TABLE XXVIII

MULTIVARIATE LOGISTIC REGRESSION: MODEL 3 CONTROL VARIABLES AND RACIAL RESIDENTIAL SEGREGATION

	β (SE)	OR	95% CI	P-Value
Patient navigation intervention	-1.02 (0.717)	0.36	(0.09, 1.47)	0.155
Hospital	0.02 (0.551)	1.02	(0.35, 3.01)	0.968
Racial residential segregation				
White	0.05 (0.075)	1.05	(0.91, 1.22)	0.520
Black	0.06 (0.071)	1.06	(0.92, 1.21)	0.437
Hispanic	0.08 (0.072)	1.08	(0.94, 1.25)	0.275

Hosmer and Lemeshow Test $\chi^2(8) = 5.10$, $p = .747$

Note. $n=433$

Table XIX shows the results of the multivariate binary logistic regression conducted for the dichotomous dependent variable diagnostic resolution, patient completed or did not complete follow-up within 60 days after an abnormal mammogram, control variables, neighborhood poverty, distance to mammography clinic, and racial residential segregation. None of the variables in this model were significant. The Hosmer-Lemeshow goodness-of-test was not significant, indicating that the model did not appear to be mis-specified.

TABLE XIX

MULTIVARIATE LOGISTIC REGRESSION: MODEL 4 CONTROL VARIABLES, NEIGHBORHOOD POVERTY, DISTANCE TO MAMMOGRAPHY CLINIC, AND RACIAL RESIDENTIAL SEGREGATION

	β (SE)	OR	95% CI	P-Value
Patient Navigation	-1.07 (0.716)	0.34	(0.09, 1.40)	0.136
Hospital	0.07 (0.552)	1.07	(0.36, 3.16)	0.900
Neighborhood poverty	0.01 (0.032)	1.01	(0.95, 1.08)	0.753
Distance to mammography clinic	0.10 (0.100)	1.10	(0.90, 1.34)	0.342
Racial residential segregation				
White	0.05 (0.076)	1.05	(0.91, 1.22)	0.486
Black	0.06 (0.071)	1.06	(0.92, 1.22)	0.436
Hispanic	0.08 (0.073)	1.08	(0.94, 1.25)	0.276

Hosmer and Lemeshow Test $\chi^2(8) = 5.07, p = .750$

Note. $n=421$

Table XX shows the results of the multivariate binary logistic regression conducted for the dichotomous dependent variable diagnostic resolution, patient completed or did not complete follow-up within 60 days after an abnormal mammogram, control variables (patient navigation intervention, hospital), individual factors (enabling factors, predisposing factors, and need characteristics) and contextual factors (neighborhood poverty, distance to mammography clinic, and racial residential segregation). In the bivariate analysis of BI-RAD value and the dichotomous dependent variable diagnostic resolution within 60 days, the cell with BI-RAD value 4 or 5 and failure to complete diagnostic resolution had less than the minimum expected count. Also, in the bivariate analysis of usual source of healthcare and diagnostic resolution, the cell with no usual source of healthcare and completion of diagnostic resolution within 60 days had less than the minimum expected count. As a result, an extremely high stand error occurred in the binary logistic regression analysis. Therefore, BI-RAD value and usual source of healthcare were removed from model. None of the variables in this model were significant. The Hosmer-Lemeshow goodness-of-test was not significant, indicating that the model did not appear to be mis-specified.

TABLE XX

MULTIVARIATE LOGISTIC REGRESSION: MODEL 5 CONTROL VARIABLES, INDIVIDUAL FACTORS, AND CONTEXTUAL FACTORS

	β (SE)	OR	95% CI	P-Value
Patient Navigation Intervention	-1.51 (0.801)	0.22	(0.05, 1.07)	0.060
Hospital	0.18 (0.638)	1.20	(0.34, 4.17)	0.780
Insurance status	0.76 (0.658)	2.13	(0.59, 7.75)	0.250
Age	-0.05 (0.026)	0.96	(0.91, 1.01)	0.085
Race	-0.08 (1.120)	0.92	0.10, 8.26	0.940
Level of education	-0.03 (0.246)	0.73	(0.60, 1.58)	0.912
Household income	0.20 (0.233)	1.22	(0.77, 1.93)	0.394
Neighborhood poverty	0.01 (0.034)	1.01	(0.95, 1.08)	0.726
Distance to mammography clinic	0.09 (0.101)	1.10	(0.90, 1.34)	0.361
Racial residential segregation				
White	0.06 (0.075)	1.06	(0.91, 1.22)	0.468
Black	0.06 (0.071)	1.06	(0.92, 1.22)	0.410
Hispanic	0.08 (0.072)	1.08	(0.94, 1.25)	0.265

Hosmer and Lemeshow Test $\chi^2(8)$ = 5.46, p =.708

Note. n=419

2. __Binary Logistic Regression Analyses for Hypothesis 2__

Table XXI shows the results of the multivariate binary logistic regression conducted for the dichotomous dependent variable diagnostic resolution, patient completed or did not complete follow-up within 60 days after an abnormal mammogram, the control variables (patient navigation, hospital), and enabling factors (insurance status and usual source of healthcare). The Andersen behavioral model of health services (1995) domains (i.e., predisposing, enabling, and need variables) was used as a modeling approach to test the second hypothesis. The purpose of using this approach was to allow for comparison of predisposing, enabling, and need variables in order to distinguish which set of variables have a direct effect on diagnostic resolution (Varga & Surratt, 2014). Hospital where women received follow-up care was significant. Women accessing care at Trinity were significantly more likely to complete diagnostic resolution within 60 days compared to women accessing care at Holy Cross or Roseland. None of the other variables were significant in this model. The Hosmer-Lemeshow goodness-of-test was not significant, indicating that the model did not appear to be mis-specified.

TABLE XXI

MULTIVARIATE LOGISTIC REGRESSION: MODEL 1 CONTROL VARIABLES AND ENABLING FACTORS

	β (SE)	*OR*	95% CI	P-Value
Patient navigation intervention	-0.37 (0.551)	0.69	(0.23, 2.03)	0.499
Hospital	0.64 (0.248)	1.90	(1.17, 3.08)	0.010
Insurance status	0.39 (0.306)	1.48	(0.81, 2.70)	0.200
Usual source of healthcare	0.08 (1.102)	1.08	(0.12, 9.36)	0.945

Hosmer and Lemeshow Test $\chi^2(4)$ = 3.17, *p* = .530

Note. *n*=677

Table XXII shows the results of the multivariate binary logistic regression conducted for the dichotomous dependent variable diagnostic resolution, patient completed or did not complete follow-up within 60 days after an abnormal mammogram, the control variables (patient navigation intervention, hospital), enabling factors (insurance status and usual source of healthcare), and predisposing factors (age, race/ethnicity, level of education, and household income). Hospital where women received follow-up care was significant. Women accessing care at Trinity were significantly more likely to complete diagnostic resolution within 60 days compared to women accessing care at Holy Cross or Roseland. Age was marginally significant at p= .054. None of the other variables were significant in this model. The Hosmer-Lemeshow goodness-of-test was not significant, indicating that the model did not appear to be mis-specified.

TABLE XXII

MULTIVARIATE LOGISTIC REGRESSION: MODEL 2 CONTROL VARIABLES, ENABLING FACTORS, AND PREDISPOSING FACTORS

	β (SE)	OR	95% CI	P-Value
Patient navigation intervention	-0.52 (0.575)	0.60	(0.19, 1.84)	0.369
Hospital	0.71 (0.280)	2.04	(1.18, 3.52)	0.011
Insurance status	0.65 (0.369)	1.92	(0.93, 3.95)	0.078
Usual source of healthcare	0.06 (1.116)	1.06	(0.12, 9.46)	0.957
Age	-0.03 (0.018)	0.97	(0.93, 1.00)	0.054
Race/ethnicity	-0.20 (0.635)	0.82	(0.24, 2.84)	0.753
Level of education	-0.05 (0.185)	0.96	(0.70, 1.30)	0.771
Household income	0.16 (0.144)	1.17	(0.88, 1.55)	0.281

Hosmer and Lemeshow Test $\chi^2(8) = 5.46$, $p = .707$

Note. $n=671$

Table XXIII shows the results of the multivariate binary logistic regression conducted for the dichotomous dependent variable diagnostic resolution, patient completed or did not complete follow-up within 60 days after an abnormal mammogram, the control variables (patient navigation intervention, hospital), enabling factors (insurance status and usual source of healthcare) predisposing factors (age, race/ethnicity, level of education, and household income), and need characteristics (BI-RADS value). Consistent with previous models, hospital where women received follow-up care was significant. Women accessing care at Trinity were more than two times as likely to complete diagnostic resolution within 60 days compared to women accessing care at Holy Cross or Roseland. Age also was significantly associated with diagnostic resolution. Older women were more likely to complete diagnostic resolution within 60 days compared to younger women. None of the other variables were significant in this model. The Hosmer-Lemeshow goodness-of-test was not significant, indicating that the model did not appear to be mis-specified.

TABLE XXIII

MULTIVARIATE LOGISTIC REGRESSION: MODEL 3 CONTROL VARIABLES, ENABLING FACTORS, PREDISPOSING FACTORS, AND NEED CHARACTERISTICS

	β (SE)	*OR*	95% CI	P-Value
Patient navigation intervention	-0.46 (0.580)	0.63	(0.20, 1.97)	0.427
Hospital	0.74 (0.283)	2.09	(1.20, 3.64)	0.009
Insurance	0.64 (0.368)	1.90	(0.92, 3.90)	0.082
Usual source of healthcare	0.10 (1.120)	1.10	(0.12, 9.94)	0.930
Age	-0.04 (0.018)	0.97	(0.93, 1.00)	0.047
Race/ethnicity	-0.24 (0.637)	0.79	(0.23, 2.76)	0.712
Level of education	-0.04 (0.158)	0.96	(0.71, 1.31)	0.804
Household income	0.15 (0.143)	1.16	(0.88, 1.54)	0.293
BI-RADS value	0.18 (0.264)	1.19	(0.71, 1.20)	0.507

Hosmer and Lemeshow Test $\chi^2(8) = 8.96$, *p* =.346

Note. *n*=671

3. Cox Survival Analyses for Hypothesis 1

Table XXIV shows the results of the Cox survival analysis conducted to assess the

relationship between the continuous dependent variable time to diagnostic resolution, number of

days between an abnormal screening mammogram or diagnostic mammogram and confirmation

of a definitive diagnosis, either benign or malignant, in the electronic medical record, the control

variables (patient navigation intervention and hospital), and neighborhood poverty. Patient

navigation intervention and hospital were significantly associated with days to diagnostic

resolution. Women in the patient navigation intervention group had shorter time to diagnostic

resolution compared to women in the standard care group. Women who accessed care at Holy

Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at

Trinity. Neighborhood poverty was not significant. Sensitivity analyses also were conducted to

determine the extreme parameters of the Cox proportional hazard models in order to estimate

violations of the independence assumptions (Kleinbaum & Klein, 2012). Women were censored

at 60 days and 365 days. Results from the two analyses indicated no difference when restricting

the analysis to 60 and 365 days.

TABLE XXIV

COX SURVIVAL ANALYSIS: MODEL 1 CONTROL VARIABLES AND NEIGHBORHOOD
POVERTY

	β (SE)	HR	95% CI	P-Value
Patient Navigation Intervention	-0.25 (0.136)	0.78	(0.61, 1.00)	0.049
Hospital	0.29 (0.064)	1.34	(1.18, 1.52)	0.000
Neighborhood poverty	0.002 (0.003)	1.00	(1.00,.1.00)	0.594

Table XXV shows the results of the Cox survival analysis conducted to assess the relationship between the continuous dependent variable time to diagnostic resolution, number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record, the control variables (patient navigation intervention and hospital), and distance to clinic. Patient navigation intervention and hospital were significantly associated with days to diagnostic resolution. Women in the patient navigation intervention group had shorter time to diagnostic resolution compared to women in standard care group. Women who accessed care at Holy Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at Trinity. Distance to mammography clinic was not significant. Sensitivity analyses were conducted censoring women at 60 days and 365 days. Results from the analyses indicated no difference when restricting the analysis to 60 and 365 days.

TABLE XXV

COX SURVIVAL ANALYSIS: MODEL 2 CONTROL VARIABLES AND DISTANCE TO MAMMOGRAPHY CLINIC

	β (SE)	*HR*	95% CI	P-Value
Patient Navigation Intervention	-0.26 (0.125)	0.76	(0.61, 0.99)	0.042
Hospital	0.31 (0.062)	1.36	(1.20, 1.53)	0.000
Distance to mammography clinic	-0.01 (0.007)	0.99	(0.98, 1.00)	0.123

Table XXVI shows the results of the Cox survival analysis conducted to assess the relationship between the continuous dependent variable time to diagnostic resolution, number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record, the control variables (patient navigation intervention and hospital), and racial residential segregation (White, Black, and Hispanic). Patient navigation intervention was marginally significant in the analysis of White and Hispanic racial residential segregation at $p < .06$, whereas patient navigation was significant in the analysis of Black racial residential segregation at $p < .05$. This indicates that women in the patient navigation intervention group had shorter time to diagnostic resolution compared to women in the standard care group. Also, women who accessed care at Holy Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at Trinity. Racial residential segregation was not significant. Sensitivity analyses were conducted censoring women at 60 days and 365 days. Results from the analyses indicated no difference when restricting the analysis to 60 and 365 days.

TABLE XXVI

COX SURVIVAL ANALYSIS: MODEL 3 CONTROL VARIABLES AND RACIAL RESIDENTIAL SEGREGATION

	β (SE)	HR	95% CI	P-Value
Patient Navigation Intervention	-0.24 (0.125)	0.79	(0.61, 1.00)	0.052
Hospital	0.31 (0.062)	1.36	(1.20, 1.54)	0.000
Racial residential segregation White	-0.001 (0.002)	1.00	(1.00, 1.00)	0.588
Patient Navigation Intervention	-0.26 (0.126)	0.77	(0.60, 0.99)	0.038
Hospital	0.29 (0.063)	1.33	(1.18, 1.51)	0.000
Racial residential segregation Black	0.001 (0.001)	1.00	(1.00, 1.00)	0.223
Patient Navigation Intervention	-0.24 (0.125)	0.79	(0.62, 1.01)	0.055
Hospital	0.31 (0.063)	1.36	(1.20, 1.54)	0.000
Racial residential segregation Hispanic	-0.001 (0.001)	1.00	(0.92, 1.17)	0.656

Table XXVII shows the results of the Cox survival analysis conducted to assess the relationship between the continuous dependent variable time to diagnostic resolution, number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record, the control variables (patient navigation intervention and hospital), neighborhood poverty, distance to mammography clinic, and racial residential segregation. Consistent with the previous models, patient navigation intervention and hospital were significantly associated with days to diagnostic resolution. Women in the patient navigation intervention group had shorter time to diagnostic resolution compared to women in the standard care group. Women who accessed care at Holy Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at Trinity. Neighborhood poverty, distance to mammography clinic, and racial residential segregation were not significant in this model. Sensitivity analyses were conducted censoring women at 60 days and 365 days. Results from the analyses indicated no difference when restricting the analysis to 60 and 365 days.

TABLE XXVII

COX SURVIVAL ANALYSIS: MODEL 4 CONTROL VARIABLES, NEIGHBORHOOD POVERTY, DISTANCE TO MAMMOGRAPHY CLINIC, AND RACIAL RESIDENTIAL SEGREGATION

	β (SE)	*HR*	95% CI	P-Value
Patient Navigation Intervention	-0.29 (0.130)	0.76	(0.59, 0.97)	0.027
Hospital	0.30 (0.068)	1.34	(1.18, 1.53)	0.000
Neighborhood poverty	-0.002 (0.006)	1.00	(0.99, 1.01)	0.688
Distance to mammography clinic	-0.01 (0.007)	0.99	(0.98, 1.00)	0.234
Racial residential segregation				
White	-0.001 (0.002)	1.00	(1.00, 1.00)	0.808
Black	0.002 (0.002)	1.00	(1.00, 1.01)	0.634
Hispanic	0.001 (0.002)	1.00	(1.00, 1.00)	0.721

Table XXVIII shows the results of the Cox survival analysis conducted to assess the relationship between the continuous dependent variable time to diagnostic resolution, number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record, the control variables (patient navigation intervention and hospital), individual factors (enabling factors, predisposing factors, and need characteristics), and contextual factors (neighborhood poverty, distance to mammography clinic, and racial residential segregation). Patient navigation intervention, hospital, age, and distance to mammography clinic were significantly associated with days to diagnostic resolution. Women in the patient navigation intervention group had shorter time to diagnostic resolution compared to women in the standard care group. Women who accessed care at Holy Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at Trinity. Older women had shorter time to diagnostic resolution. Although not significant in the previous models, in Model 5 distance to mammography clinic was significant. Women living farther from the hospital mammography clinic had shorter time to diagnostic resolution. Insurance status, usual source of healthcare, race/ethnicity, level of education, household income, BI-RADS value, neighborhood poverty, and racial residential segregation were not significant in this model. Sensitivity analyses were conducted censoring women at 60 days and 365 days. Results from the analyses indicated no difference when restricting the analysis to 60 and 365 days.

TABLE XXVIII

COX SURVIVAL ANALYSIS: MODEL 5 CONTROL VARIABLES, INDIVIDUAL
FACTORS, AND CONTEXTUAL FACTORS

	β (SE)	HR	95% CI	P-Value
Patient Navigation Intervention	-0.40 (0.131)	0.67	(0.52, 0.87)	0.002
Hospital	0.34 (0.074)	1.42	(1.22, 1.64)	0.000
Insurance status	0.001 (0.061)	1.02	(0.89, 1.16)	0.992
Usual source of healthcare	-0.09 (0.267)	0.91	(0.54, 1.54)	0.744
Age	-0.01 (0.003)	0.99	(0.98, 1.00)	0.000
Race/ethnicity	-0.04 (0.128)	0.96	(0.74, 1.23)	0.776
Level of education	0.05 (0.030)	1.04	(0.98, 1.10)	0.134
Household income	0.002 (0.001)	1.02	(0.97, 1.07)	0.208
BI-RADS value	-0.06 (0.039)	0.94	(0.87, 1.02)	0.152
Neighborhood poverty	-0.003 (0.006)	1.00	(0.99, 1.01)	0.666
Distance to mammography clinic	-0.02 (0.008)	0.98	(0.97, 1.00)	0.039
Racial residential segregation				
White	-0.001 (0.002)	1.00	(1.00, 1.00)	0.605
Black	0.002 (0.002)	1.00	(1.00, 1.01)	0.344
Hispanic	0.001 (0.002)	1.00	(1.00, 1.01)	0.741

4. **Cox Survival Analyses for Hypothesis 2**

Table XXIX shows the results of the Cox survival analysis conducted to assess the

relationship between the continuous dependent variable time to diagnostic resolution, number of

days between an abnormal screening mammogram or diagnostic mammogram and confirmation

of a definitive diagnosis, either benign or malignant, in the electronic medical record, the control

variables (patient navigation intervention and hospital), and enabling factors (insurance status

and usual source of healthcare). Hospital was significantly associated with days to diagnostic

resolution. Women who accessed care at Holy Cross or Roseland had longer time to diagnostic

resolution compared to women accessing care at Trinity. Patient navigation, insurance status, and

usual source of healthcare were not significant in this model. Sensitivity analyses were

conducted censoring women at 60 days and 365 days. Results from the analyses indicated no

difference when restricting the analysis to 60 and 365 days.

TABLE XXIX

COX SURVIVAL ANALYSIS: MODEL 1 CONTROL VARIABLES AND ENABLING
FACTORS

	β (SE)	*HR*	95% CI	P-Value
Patient Navigation Intervention	-0.23 (0.125)	0.79	(0.62, 1.01)	0.063
Hospital	0.30 (0.064)	1.35	(1.19, 1.53)	0.000
Insurance status	-0.06 (0.061)	0.94	(0.84, 1.06)	0.348
Usual source of healthcare	-0.12 (0.261)	0.89	(0.53, 1.49)	0.659

Table XXX shows the results of the Cox survival analysis conducted to assess the relationship between the continuous dependent variable time to diagnostic resolution, number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record, the control variables (patient navigation intervention and hospital), enabling factors (insurance status and usual source of healthcare), and predisposing factors (age, race/ethnicity, level of education, and household income). Patient navigation, hospital, and age were significantly associated with days to diagnostic resolution. Women in the patient navigation intervention group had shorter time to diagnostic resolution compared to women in standard care group. Similarly, older women had shorter time to diagnostic resolution. Women who accessed care at Holy Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at Trinity. Usual source of healthcare, race/ethnicity, level of education, and household income were not significant in this model. Sensitivity analyses were conducted censoring women at 60 days and 365 days. Results from the analyses indicated no difference when restricting the analysis to 60 and 365 days.

TABLE XXX

COX SURVIVAL ANALYSIS: MODEL 2 CONTROL VARIABLES, ENABLING FACTORS, AND PREDISPOSING FACTORS

	β (SE)	*HR*	95% CI	P-Value
Patient Navigation Intervention	-0.34 (0.128)	0.72	(0.56, 0.93)	0.008
Hospital	0.37 (0.070)	1.45	(1.26, 1.66)	0.000
Insurance status	0.01 (0.061)	1.02	(0.90, 1.17)	0.841
Usual source of healthcare	-0.10 (0.265)	0.91	(0.54, 1.53)	0.702
Age	-0.02 (0.003)	0.99	(0.98, 0.99)	0.000
Race/ethnicity	-0.04 (0.129)	0.95	(0.74, 1.22)	0.761
Level of education	0.03 (0.029)	1.03	(0.97, 1.09)	0.245
Household income	0.002 (0.001)	1.01	(0.97, 1.06)	0.172

Table XXXI shows the results of the Cox survival analysis conducted to assess the relationship between the continuous dependent variable time to diagnostic resolution, number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record, the control variables (patient navigation intervention and hospital), enabling factors (insurance status and usual source of healthcare), predisposing factors (age, race/ethnicity, level of education, and household income), and need characteristics (BI-RADS value). Patient navigation intervention, hospital, and age remained significantly statistically associated with days to diagnostic resolution in this model. Women in the patient navigation intervention group had shorter time to diagnostic resolution compared to women in the standard care group. Similarly, older women had shorter time to diagnostic resolution. Women who accessed care at Holy Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at Trinity. Usual source of healthcare, race/ethnicity, level of education, household income, and BI-RAD value were not significant in this model. Sensitivity analyses were conducted censoring women at 60 days and 365 days. Results from the analyses indicated no difference when restricting the analysis to 60 and 365 days.

TABLE XXXI

COX SURVIVAL ANALYSIS: MODEL 3 CONTROL VARIABLES, ENABLING FACTORS,
PREDISPOSING FACTORS, AND NEED CHARACTERISTICS

	β (SE)	*HR*	95% CI	P-Value
Patient Navigation Intervention	-0.36 (0.128)	0.71	(0.55, 0.91)	0.005
Hospital	0.36 (0.070)	1.44	(1.26, 1.66)	0.000
Insurance status	0.02 (0.061)	1.03	(0.90, 1.17)	0.790
Usual source of healthcare	-0.11 (0.265)	0.90	(0.54, 1.52)	0.689
Age	-0.01 (0.003)	0.99	(0.98, 1.00)	0.000
Race/ethnicity	-0.04 (0.128)	0.95	(0.74, 1.22)	0.771
Level of education	0.04 (0.029)	1.03	(0.97, 1.09)	0.226
Household income	0.002 (0.001)	1.02	(0.97, 1.06)	0.178
BI-RADS value	-0.06 (0.039)	0.95	(0.87, 1.02)	0.158

E.   **<u>Summary of Findings</u>**

The aim of this study was to explore the relationship between contextual factors, individual factors, and diagnostic resolution after an abnormal mammogram among women accessing care in medically underserved areas. The study tested two hypotheses:

1. Neighborhood poverty, racial residential segregation, and/or distance to mammography clinic will have a significant direct effect on diagnostic resolution.

2. Insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and/or BI-RADS value will have a significant direct effect on diagnostic resolution.

The findings indicate partial support for the hypotheses. In all of the Cox survival analyses, hospital and patient navigation were significantly associated with the continuous dependent variable time to diagnostic resolution. Women in the patient navigation intervention group had shorter time to diagnostic resolution compared to women in standard of care group. Women who accessed care at Holy Cross or Roseland had longer time to diagnostic resolution compared to women accessing care at Trinity. These findings suggest contextual factors including, where women receive healthcare and participation in healthcare access interventions increase the timeliness of diagnostic resolution. Age and distance to mammography clinic were also significant in the final Cox survival analysis model with all the independent variables. Older women had shorter time to diagnostic resolution. Living farther from the mammography clinic was associated with shorter time to diagnostic resolution.

Binary logistic regression analyses were conducted to assess the relationship between the dichotomous dependent variable diagnostic resolution and the contextual independent variables. However, there was minimal variability in dependent variable with about 96% of the women in

the sample completing diagnostic resolution within 60 days. Moreover, in the bivariate analyses

of diagnostic resolution and the control and independent variables, several of the cells had less

than the minimum expected count. This produced extremely high standard errors, and as a result

usual source of health care and BI-RAD value were removed from the binary logistic regression

models, thereby limiting variables in the analyses. Nonetheless, consistent with the findings in

the Cox analyses, hospital and age were significantly associated with diagnostic resolution.

VI.   DISCUSSION

This study examined the relationship between contextual and individual level factors with the timeliness of diagnostic resolution after abnormal mammograms. The data were collected as part of the PNMUA study, a randomized controlled trial, evaluating the efficacy of patient navigation intervention among women accessing breast care at three hospitals located in medically underserved areas of Southern Chicago, Illinois.

The discussion begins with the study purpose and hypotheses. Next, a discussion is presented of the main study findings. Third, limitations of the study are reviewed. Lastly, the implications are presented for theory, research, social work education, practice, and policy.

A.   <u>Study Purpose and Hypotheses</u>

The main purpose of this study was to examine the relationship between diagnostic resolution after an abnormal mammogram and contextual factors (neighborhood poverty, racial residential segregation, and distance to mammography clinic) and individual factors (insurance status, usual source of healthcare, age, race/ethnicity, level of education, household income, and BI-RADS value). The study was informed by a conceptual model that was developed by blending two theoretical frameworks: the model for analysis of population health and health disparities (Warnecke et al., 2008), a paradigm that expands the ecological framework specifically to health disparities, and the Andersen behavioral model of health services use (Andersen, 1995), a model that identifies important individual-level factors and characteristics that are related to utilization of healthcare services. Few studies have examined the relationship between contextual factors and time to diagnostic resolution; likewise, even fewer have examined both contextual and individual factors (Schootman et al., 2007; Wujcik & Fair, 2008). This study is unique in its exploration of the relationship between multiple levels of influence on

diagnostic resolution after an abnormal mammogram. Specifically, the study tested two hypotheses:

1. Neighborhood poverty, racial residential segregation, and/or distance to mammography clinic will have a significant direct effect on diagnostic resolution.

2. Insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and/or BI-RADS value will have a significant direct effect on diagnostic resolution.

B.   Discussion of Findings

1. Sample and Diagnostic Resolution

The final analytic sample included 690 women (16% of all women in the PNMUA study) who were consented and randomized to either into the navigation arm (intervention) or the standard of care arm (control), with electronic medical records during the study, completed baseline patient questionnaires, and with an abnormal mammogram finding (BI-RADS value of 0, 4, or 5). The majority of women (87%) in the sample received patient navigation, whereas the remaining 13% received standard of care. In addition, 85% of the women obtained diagnostic resolution and follow-up care at Trinity. Nearly all women (96%) completed diagnostic resolution within 60 days. Likewise, for women who completed and did not complete diagnostic resolution, the average number of days to a definitive diagnosis was 12 with a median of 1 day. Largely, studies have found that the majority of women with abnormal mammograms did achieve diagnostic resolution and were timely in their follow-up (Wujcik & Fair, 2008; Battaglia et al., 2010; Wernli et al., 2011). However, a considerably higher percentage of women in this study completed diagnostic resolution and the average number of days to diagnostic resolution was significantly fewer compared to women in previous studies. For example, one study found

that of the 523 women with abnormal mammograms, 90% achieved diagnostic resolution within 12 months (Battaglia et al., 2010). In another study that included women who were recommended for follow-up care after having an abnormal mammogram (20,060 screening and 3,184 diagnostic) found that 23% of women who had received screening mammograms and 69% of women who had received diagnostic mammograms accessed follow-up within 7 days (Wernli et al., 2011). This study calculated time to follow-up care as the date of the mammogram until the first date of follow-up care and not diagnostic resolution.

It is possible that the high percentage and timeliness of diagnostic resolution is the result of patient navigators interacting with the women. The analytic sample included women in the navigation intervention group and active control group. Women in the intervention group received patient navigation; however, women in the active control group also had interaction with the navigators. Women in the active control group received a phone call from navigators reminding them about their upcoming mammogram appointment and were invited to participate in the study. In addition, women in the active control group also completed surveys with the patient navigators. Those women were not contacted by phone, instead they were met by patient navigators at the appointment, invited to participate in the PNMUA study, and completed surveys.

In sum, all 690 women in the analytic sample, both the intervention group and active control group, interacted with patient navigators. Consequently, the interaction with patient navigators may have contributed to the high percentage of diagnostic resolution and timeliness. Women in the passive control group did not have interaction with patient navigators and had an average of 80% diagnostic resolution, whereas the average diagnostic resolution was 98% for the women who had contact with a patient navigator (intervention group and active control group).

Many of the women had limited interaction with a patient navigator and still attained diagnostic resolution. This has implications for patient navigation intervention strategies. It suggests the possibility that patient navigation interventions are dose responsive and limited interaction with patients potentially results in complete and timely diagnostic resolution.

In addition, it is possible that the hospital where women received care contributed to the high percentage and timeliness of diagnostic resolution. A chi-square test was used to assess the relationship between patient navigation intervention and hospital (Table X). Patient navigation and hospital were significantly associated, X^2 (1, N = 690) = 47.38, p = .000. Of the women, 583 accessed care at Trinity and only 107 women accessed care at Holy Cross/Roseland. In addition, 77% of the Trinity women were in the patient navigation intervention group compared to only 10% of the Holy Cross/Roseland women.

2. <u>Relationship between Contextual Factors and Diagnostic Resolution</u>

Studies have found an association between neighborhood poverty and poor breast cancer screening rates and later stage at diagnosis (Fowler, 2014; Wujcik & Fair, 2008), however the relationship is not well understood and timely follow-up of abnormal mammograms have not previously been studied. This study hypothesized that neighborhood poverty would be associated with diagnostic resolution and time to diagnostic resolution. Uniquely, this study incorporated individual characteristics and neighborhood poverty. Neighborhood poverty was measured as a continuous variable using the 2011 ACS census-tract level data to determine the percentage of residents living below federal 100% poverty line. Results indicated neighborhood poverty was not significantly associated with diagnostic resolution within 60 days or time to diagnostic resolution, the number of days to a definitive diagnosis. Despite the fact that neighborhood poverty measures were not significantly associated with diagnostic resolution and time to

diagnostic resolution in the analysis, neighborhood characteristics are an important contributing factor to health outcomes, including breast health (Campbell et al., 2009; Diez Roux, 2001; Kawachi & Berkman, 2003). Numerous studies have documented the negative association between health outcomes and residence in disadvantaged neighborhoods (Diez Roux, 2001; Ellen, Mijanovich, & Dillman, 2001; Dailey et al., 2007; Do et al., 2008). Yet, it is unclear whether the disparities are the result of different neighborhood conditions or the different characteristics of households living the different neighborhoods (Ellen et al., 2001).

Studies examining neighborhood effects have multiple methodological limitations that present challenges for neighborhood empirical research and interpretations of the findings problematic. Drawing a conclusive explanation requires a multilevel analysis that includes measures of the neighborhood environment and individual-level data. This study included both and, similar to previous studies, poverty rates were used to represent neighborhood conditions. However, these measures may not have accurately reflected the neighborhood conditions and may not have been the most relevant influence on follow-up diagnostic resolution. Greater sophistication and more comprehensive measurement of neighborhood residential environment that captures relevant contributing factors should be investigated with respect to timely diagnostic resolution after an abnormal mammogram.

Roseland, Holy Cross, and Trinity all serve predominantly minority populations. The Trinity total service area (TSA), the geographical area served by the hospital, is 81% African American; however, there is a fast growing Hispanic (10%) population concentrated within four communities on the Southeast side of the service area. Holy Cross serves a population of 49% Hispanic and 43% African American. The community of Roseland has a population of 97% African American and <1% Hispanic. This study hypothesized that racial residential segregation

would be associated with diagnostic resolution and time to diagnostic resolution. Racial residential segregation also was measured as a continuous variable using the 2011 ACS census-tract level data to determine the percentage of Black, White, and Hispanic residents. Results indicated racial residential segregation was not significantly associated with diagnostic resolution within 60 days or time to diagnostic resolution the number of days to a definitive diagnosis. Previous studies have found a relationship between racial residential segregation and adherence to screening, stage at diagnosis, treatment, and mortality. However, findings from these studies are contradictory. Some authors have argued that segregation operates as a protective factor (Warner & Gomez, 2010; Russell, Kramer, Cooper, Thompson, & Arrio, 2011), whereas others contend segregation operates as a barrier that adversely affects breast health (Haas et al., 2008; Dai, 2010; Harper, Lynch, Meersman, Breen, Davis, & Reichman, 2009). In addition, previous studies have not untangled the effects of racial segregation from economic disadvantage (Dai, 2010; Campbell et al., 2009). Despite the fact that racial residential segregation was not significantly associated with diagnostic resolution after an abnormal mammogram in the analysis, it is evident previous studies have documented that living in areas with higher racial residential segregation is associated with breast cancer outcomes. Similar to the limitations of neighborhood effects research, the heterogeneity in the findings may be a reflection of the variation in methodological designs of the studies along with the challenges of racial residential segregation research. The current study has several measurement limitations; however, it is also possible that in the analytic sample there is not a relationship between diagnostic resolution and racial residential segregation.

In the Cox survival analysis, distance to clinic (e.g., driving distance in miles from patient address to the hospital where the patient received breast care) was associated with time to

diagnostic resolution. Surprisingly, living farther from the mammography clinic was associated with shorter time to diagnostic resolution. One possible explanation was women with an abnormal mammogram may have requested same day diagnostic follow-up to avoid additional travel. On the other hand, perhaps women who live further from the hospital have fewer barriers and more supports to access health care. For instance, women coming from further away may live in more affluent neighborhoods that offer better transportation compared with women living close to the hospital. Other studies also have found a relationship between spatial access to mammography and breast health outcomes (Elting et al., 2009); however, other studies have found no significant relationship (Celaya et al., 2010). Further research is warranted to examine the spatial relationship distance to mammography clinic and time to follow-up after an abnormal mammogram.

The hospital where women received care emerged as a highly significant contextual factor in terms of timely follow-up of abnormal mammogram. In all Cox survival analyses, hospital was significant at $p = .000$ with women at Holy Cross and Roseland having an average time to diagnostic resolution of 30 days compared to 9 days for women accessing care at Trinity. Similarly, the results of the binary logistic regression analyses indicated a significant relationship between hospital and diagnostic resolution within 60 days. This contributes to the argument that the underlying disparity in diagnostic delay, which has been associated with late-stage breast cancer detection and poorer survival (Williams, Tortu, & Thompson, 2010; Richards et al., 1999), is a mechanism of the hospitals where women receive care and not individual characteristics of the women. Breast care facilities that serve more racial/ethnic minorities have greater delay in diagnostic resolution (Goldman et al., 2013). However, in the current study all three hospitals are registered as Disproportionate Share Hospitals (DHS), a status designation by

HRSA that the hospital serves a significantly disproportionate number of low-income patients (HRSA, 2016). Despite the common DSH designation, one potential explanation for the substantial difference in timeliness is that the hospitals are markedly different from one another. This notion is supported by a study that examined predictors of timely abnormal screening follow-up in racially/ethnically diverse urban women (Battaglia et al., 2010). Site of care was the significant predictor of timely follow-up care and not the population served, including the sociodemographic characteristics of the patients.

Molina, Silva, and Rauscher (2015) examined the between-facility effects using data collected for the Breast Cancer Care in Chicago Study and found that facility factors accounted for 43% of the disparity in diagnostic delay. The study findings indicated that an important mediating factor for timely diagnostic resolution was Breast Imaging Center of Excellence (BICOE) accreditation from the American College of Radiology. To receive BICOE accreditation status, facilities are assessed on quality control, assurance for staff, and breast cancer detection equipment (e.g., mammography, breast ultrasound, MRI, stereotactic biopsy) (American College of Radiology, 2016). Other studies have found that accredited hospitals are more likely than non-accredited hospitals to meet national benchmarks for Mammography Quality Standards Act guidelines (Rauscher et al., 2014). Accredited facilities often have the necessary resources for timely and high-quality care, and for that reason women receiving care from accredited facilities are more likely to obtain diagnostic resolution in less time (Molina et al., 2015; Rauscher et al., 2014). Importantly, Trinity has BICOE accreditation, whereas Holy Cross and Roseland are not accredited. Given the recent research on the impact of quality on timely diagnostic resolution coupled with the accreditation status of the each of the three

hospitals, it is possible that hospital quality and resources were contributing factors to differences in timeliness.

Additionally, despite that fact that all three hospitals have a DSH designation, organizational structure and financial capacities are strikingly different between the hospitals. Trinity is part of Advocate Health Care, which is the largest health system in Illinois and one of the largest healthcare providers in the Midwest (Advocate Health Care, 2016). Advocate offers more than 250 sites of care, 12 acute-care hospitals (3,300 beds), 6,300 physicians, 35,000 employees, and has 1,878,528 total outpatient visits per year (2014). In addition, Advocate diagnoses and treats more cancer patients than any other hospital or system in Illinois. Specifically, Trinity treats more than 90,000 patients each year and has 300 physicians with expertise in more than 50 specialties.

In 2012, to strengthen their capacity to serve the community Holy Cross merged with a larger healthcare provider, Sinai Health System, which includes: Mount Sinai Hospital, Sinai Children's Hospital, Schwab Rehabilitation Hospital, Sinai Medical Group, Sinai Community Institute and Sinai Urban Health Institute (Sinai Health System, 2016). Unlike Trinity and recently Holy Cross, Roseland is owned and operated as a single entity (Roseland Community Hospital, 2016). Moreover, Roseland has a long and tumultuous history of financial instability that has resulted in several threats of closure. In 2013, the financial situation became so dire that temporary emergency financial assistance was provided to Roseland from the State of Illinois to prevent its closure.

Financial stability and capacity are potential proxies for and indicators of resources to provide timely and high-quality care (Rauscher et al., 2014). The size, scope of services, and facility resources are reflected in their ownership, finances, and management of Holy Cross,

Roseland, and Trinity. For example, in 2012, Trinity had four mammography machines, whereas Holy Cross had two and Roseland only one. Thus, annual volume of mammograms greatly differs between Trinity (8,564), Holy Cross (1,869), and Roseland (585). The lower volume of mammograms at Holy Cross and Roseland also accounts for the fewer patients enrolled in the PNMUA study from those hospitals.

In addition to resources, patient satisfaction is another potential indicator of quality of care (Gupta, Rodeghier, & Lis, 2014). The Illinois Hospital Report Card outpatient satisfaction survey question, "patients would definitely recommend this hospital to friends and family," response mirrored the resources of the hospitals with Trinity having the highest rating at 57%, Holy Cross 50%, and Roseland 29% (Illinois Department of Public Health, 2016).

Along with facility level differences, the communities where the hospitals are located may contribute to the differences in timely follow-up care after an abnormal mammogram. The hospital's MUA status is an important potential component that relates to the community. Prior research suggests that MUAs with designation differ from undesignated MUAs in their level of social and political mobilization and available medical care, both of which may result in better medical care and stronger attachments to the health care system (Aday, Begley, Lairson, & Slater, 2004). Chicago can be divided into: 1) more affluent areas not eligible and never designated as MUAs, 2) areas eligible to become MUAs but never designated, and 3) areas eligible and designated as MUAs. One of the primary aims of the PNMUA study was to examine the impact of MUA designation on access to and use of breast cancer early detection services. Of particular interest was the contrast between the eligible MUA, but never established, and the eligible and designated MUAs. All three hospitals in the study are MUA eligible; Roseland was designated in 1995, Holy Cross in 2008, and Trinity was not designated. Findings from this study

do not support the original PNMUA hypothesis that the older designated MUA has greater resources and has better-established healthcare delivery systems that result in a stronger effect on health outcomes. Roseland the oldest-designated MUA and Holy Cross the newer-designated MUA had a significantly higher average number of days to diagnostic resolution compared to Trinity the eligible, but undesignated MUA.

The Patient Protection and Affordable Care Act (2010) mandates that each U.S. hospital must conduct a community health needs assessment (CHNA) that describes the needs of the community, not just the patients accessing care at the hospital. Trinity and Holy Cross have published CHNA reports. The community, TSA for Trinity, has a population of 586,271 residents, spans 12 zip codes, and includes 20 community areas as defined by the City of Chicago Department of Planning (Advocate Trinity Hospital, 2013). The community is defined as the hospital's primary and secondary service areas that include the following zip codes: 60617, 60619, 60620, 60628, 60643, and 60649 (primary), 60409, 60621, 60633, 60636, 60637, and 60827 (secondary). With the exception of Calumet City (zip code 60827), the TSA is in the Chicago city limits in Cook County. The community, TSA for Holy Cross, has a total population of 365,026 and is located in 10 community areas as defined by the City of Chicago Department of Planning (Holy Cross Hospital, 2013). Without a report Roseland's TSA is unknown; however, Roseland is located in the Roseland community and has a population of 51,744 (United States Census Bureau, 2010).

The three hospital service areas all have poverty rates that exceed the City of Chicago average (21.4%), but there does not appear to be a significant difference in the poverty rates between the communities served. The poverty rate within the Trinity primary service area is 20% and the secondary service area poverty rate is twice the state and national averages at 30%

(Advocate Trinity Hospital, 2013). The median income in the primary service area is $33,943. Although the majority of the 10 community areas served by Holy Cross are comprised of economically challenged families, there is variation in the economic profiles among the 10 communities. The poverty rate is 28%, which also is higher than the City of Chicago average (Holy Cross Hospital, 2013). In the 10 community areas served by Holy Cross, the range of median income is $20,813 to $50,140. According to the United States Census Bureau (2010), Roseland has a 27% poverty rate and a median income of $39,038.

3. <u>Relationship between Individual Factors and Diagnostic Resolution</u>

This study hypothesized that individual-level factors including, insurance status, having a usual source of healthcare, age, race/ethnicity, level of education, household income, and/or BI-RADS value will have a significant direct effect on diagnostic resolution. In the bivariate analyses, individual-level factors were not associated with either the dichotomous dependent variable diagnostic resolution within 60 days or the continuous dependent variable time to diagnostic resolution, number of days between an abnormal screening mammogram or diagnostic mammogram and confirmation of a definitive diagnosis, either benign or malignant, in the electronic medical record. This lack of significance is possibly a reflection of the fact that there was minimal variation in the two dependent variables. Nearly all women (96%) completed diagnostic resolution within 60 days and the average number of days to a definitive diagnosis was 12 with a median of 1 day.

In regards to enabling factors, previous studies have found a significant relationship between the enabling factors of insurance status (Krok-Schoen et al., 2014; Battaglia et al., 2007; Strzelczyk & Dignan, 2002) and having a regular care provider (Jones et al., 2005) and diagnostic resolution. For example, women with private health insurance compared to those

without health insurance were more likely to have timely follow-up (Battaglia et al., 2007). The findings in this study did not confirm the results of previous studies. However, this could be a reflection of the characteristics of the analytic sample. The majority of the sample (87%) had private or Medicare insurance and only 13% had Medicaid or were uninsured. It should be noted that Medicaid provides coverage for mammography and diagnostic resolution services. It was not possible to determine if any of the women were paying out of pocket for mammography and follow-up diagnostic testing, however it is possible that women in the analytic sample were not paying out-of-pocket for the services. Similarly, the majority of the women (97%) reported having a usual source of healthcare. The minimal variability resulted in cells having less than the minimum expected count in the bivariate analysis and high standard error in the multivariate analyses. As a result, the relationships could not be fully assessed between usual source of health care and diagnostic resolution.

Of the predisposing factors, age was associated with the continuous dependent variable time to diagnostic resolution and the dichotomous dependent variable diagnostic resolution within 60 days. In addition, when both individual and contextual factors were examined together, age remained the only significant individual-level factor. Age is a particularly important individual factor because it is the greatest risk factor for breast cancer. This study found older age was associated with greater odds of fewer days to diagnostic resolution. Although some studies have similar findings (Battaglia et al., 2007; Krok-Schoen et al., 2014), other studies have found older age was associated with longer time to diagnostic resolution (Markossian et al., 2012), and others have failed to find a relationship between age and diagnostic resolution (Kerner et al, 2003). In sum, this finding lends particular support to the notion that age is an important predictor of timely follow-up of abnormal mammograms.

The need characteristic of BI-RADS value examined for this study was not associated with either diagnostic resolution or time to diagnostic resolution. Of the sample, 93% of the women had a BI-RADS value 0, which indicates the result is incomplete or unknown. The remaining women (7%) had a BI-RADS value 4 (suspicious) or 5 (highly suggestive of malignancy) (Sickles et al., 2013). Previous studies have found that women with more serious initial mammogram findings had less delay in diagnostic resolution (Perez-Stable et al., 2013; Markossian et al., 2012; Kerner et al., 2003); however, these studies all included BI-RADS value 3. The recommendation for BI-RADS value 3 is monitoring and follow-up in six months not immediate diagnostic follow-up (Sickles et al., 2013; Raza, Chikarmane, Neilsen, Zorn, & Birdwell, 2008). In another study, Perez-Stable and colleagues (2013) conducted telephone surveys and reviewed medical records of women with abnormal mammograms in order to understand the efficiency of the evaluation of an abnormal findings. Of the 938 women with abnormal mammograms, the median time to diagnosis was 183 days for BI-RADS value 3 compared to 29 days for BI-RADS values 4/5 and 27 days for BI-RADS value 0. Over 80% of women with BI-RADS value 0, 4, or 5 completed their diagnostic evaluation within 60 days. However, of women with BI-RADS value 3, only 29% completed their diagnostic evaluation within 60 days and only 50% of women had completed their diagnostic evaluation at 6 months. Including BI-RAD value 3 is a potential limitation of previous studies. The current study only included BI-RADS values 0, 4, and 5 because each of these values requires an immediate diagnostic follow-up; whereas value 3 was not selected because of the recommended follow-up is six months.

C.   Limitations

The current study includes limitations related to the lack of generalizability beyond the women in the sample and measurement. The PNMUA study obtained a non-random sample from all women meeting the eligibility criteria with an upcoming mammography appointment at each of the three hospitals. For this study, a convenience sample was used, and as a result generalizability of the findings from the sample to the larger population is limited. In addition, the sample included only women who completed surveys and these women may be different from the women who did not complete surveys. One potential difference is that women who completed surveys are more activated and engaged in their health care.

There are several limitations to be considered related to measurement. Due to the minimal variability in the dependent variable diagnostic resolution (96% of women in the sample completed diagnostic resolution within 60 days), hospital, patient navigation, usual source of health care, and race/ethnicity were removed from several binary logistic regression models. Removing these variables limited full the exploration of relationships between the independent variables and the dependent variable.

In addition, attrition was a threat to the internal validity of the study. In the analytic sample, 72 women (10%) with abnormal mammograms never returned for follow-up to the hospital where they received the abnormal mammogram result during the observational interval (i.e., during the study). Women may have accessed follow-up care from another provider, completed diagnostic follow-up after the conclusion of the study, or decided not to access follow-up care. However, the reason for failure to return for follow-up is unknown. Missing data was another study limitation. Specifically, contextual-level variables were missing data including, neighborhood poverty (37%), distance to mammography clinic (16%), and racial

residential segregation (37%). The data were geocoded using the women's address. It is possible the address was missing in the EMR data; however, the reason for the missing data is unknown. The missing data may have reduced the representativeness of the sample, and as a result may distort any inferences made about the population.

In terms of construct validity, the measurement of the contextual-level variables may have some potential limitations. While census-tract measures are commonly used as proxies for neighborhood poverty and racial residential segregation (Schootman et al., 2009; Russell et al., 2012; Pruitt et al., 2015), there is a potential issue with validity of this measurement. Conceptual, methodological, and analytical issues exist with large-area measures. This type of measurement does not reflect the nuanced experience of residents in an area and the qualitatively different types of neighborhoods. The geographic units measured (i.e., census tracts) may be too large to reveal individual-level variables and variation in residential mobility (Dai, 2010). Having a finer scale of geographic units coupled with other relevant individual-level data would have strengthened the measurement in this study. The measurement of distance to clinic also is a potential limitation. Travel time is a typical measure of geographic access to healthcare; likewise it is calculated by geocoding residential address to site of care. However, differences may exist between potential and actual travel time (Alford-Teaster et al., 2016) that may have resulted in measurement error. Future research is necessary to adequately measure contextual-level constructs intended to represent structural disadvantage and spatial access to health care.

D. **Implications**

The findings of this study offer several important implications for social work theory, research, education, practice, and policy.

1. Implications for Social Work Theory

Social workers are charged with the mission of advancing scholarly knowledge through research along with developing and implementing policies and practices that address systemic issues facing populations who are poor, marginalized, oppressed, and racial and ethnic minorities (NASW, 2005). Health disparities abound in the U.S., and in order to eliminate these disparities the lens of health must be expanded from a traditional individual approach to an integrated, multi-level, social determinants approach focusing on social and economic factors that contribute to disparities (Hudson & Gehlert, 2015). Moreover, current definitions of health disparities are moving away from the notion of health differences and towards a definition that distinguishes disparities as a subset of health differences that are reflective of social injustices (Braveman et al., 2011). Defining health disparities in this manner reflects ethical principles and human rights.

By examining multiple levels of influence that go beyond individual characteristics of women, this study interpolates ethical principles of human rights and social justice in the theoretical underpinning that guided this study. Although human rights literature was previously dominated by attorneys, social work scholars are adopting human rights frameworks into their studies and calling for the integration into multiple areas of social work practice (Reisch, Ife, & Weil, 2012). Adopting a human rights framework and rhetoric into scholarship is a means of ultimately achieving more socially just outcomes. Although social work has been described as the profession of social justice (NASW, 2005), with the developments in the theoretical

understanding of health disparities social workers must return to the definition of health disparities that highlights the underlying causes that reflect social and economic disadvantage.

In terms of theory, an important gap was addressed in the timely diagnostic resolution after an abnormal mammogram literature. This study contributes to the gap by adding to the theoretical understanding about the multiple influences on diagnostic follow-up after an abnormal mammogram. The theoretical model developed for this study examined individual characteristics that can reflect disadvantage such as health insurance status and contextual factors such as neighborhood poverty. In addition, disadvantaged groups experience the systematic, plausibly avoidable disparities. Black women residing in medically underserved areas in Chicago experience disparate outcomes compared with their White counterparts (SEER, 2015). Recognizing the importance of examining systemic mechanisms that contribute to the disparities among these women, this study examined a group of predominantly Black women accessing care in medically underserved areas. Furthermore, diagnostic follow-up as a means of timely identification of breast cancer is an avoidable and modifiable risk, and as a result the focus of this study included women with an abnormal mammogram who required immediate diagnostic follow-up.

Additionally, the focus and findings of the current study builds on the seminal cancer disparities research conducted by the Centers for Population Health and Health Disparities investigators who developed a theoretical multilevel model of the determinants of cancer disparities that incorporated proximal, intermediate, and distal levels of influence (Warnecke et al. 2008; Hudson & Gehlert, 2015). The theoretical model developed for this study incorporated proximal, intermediate, and distal levels of influence in examining diagnostic resolution. Identifying women who are likely or unlikely to have timely follow-up is necessary prior to the

development of interventions or policies addressing the disparity. Despite the emerging evidence documenting the multiple levels of influence on health behavior and outcomes, few studies have examined the relationship between contextual-level factors, such as neighborhood poverty and racial residential segregation, and timely diagnostic resolution after an abnormal mammogram. Using a multilevel theoretical model, this study was unique in its examination both individual-level and contextual-level characteristics that impact timely resolution. A significant relationship was found between both individual-level and contextual-level factors and diagnostic resolution, which is consistent with the multilevel theoretical model and points to the importance of examining the multiple levels of influence on timely diagnostic resolution after an abnormal mammogram.

2. <u>Implications for Social Work Research</u>

Social work advances transdisciplinary research through distinctive expertise about critical environmental factors that serve as potential barriers or supports to health behavior and ultimately health outcomes. In 2003, the National Institutes of Health (NIH), the largest funder of research worldwide, developed a Roadmap for 21st Century Medical Research that essentially was a directive for the NIH institutes to collaboratively work together to address health problems (Gehlert, 2012). The NIH Roadmap encourages research to move from multidisciplinary and interdisciplinary to transdisciplinary. According to Gehlert (2012), the description of transdisciplinary is "team members from a variety of professional backgrounds develop a shared language, based on their separate disciplinary languages, pool bodies of knowledge and theories, and jointly develop new methods and analytical techniques" (p. 260). This study is an example of transdisciplinary research in that key concepts were drawn from separate disciplines (i.e., biological, social, and behavioral sciences) to pool the best disciplinary theories to allow

multilevel analysis. The NIH Roadmap addresses research specifically, however there are also implications for how social work views the broader health care system. Consistent with the person-in-environment perspective, it forces the inclusion of social and behavioral factors that contribute to health outcomes.

This study also addressed the gap in literature by advancing knowledge about individual and contextual factors related to timely diagnostic resolution after an abnormal mammogram. The study sample was comprised of women accessing care in medically underserved areas in Chicago. These women represent risk of poor cancer outcomes that include increased breast cancer morbidity and mortality. Despite significant efforts and investment to alleviate breast cancer disparities, research persistently documents disparities at each level of the breast cancer continuum (SEER, 2015). Timely identification of breast cancer is vital to reducing mortality disparities for women accessing care in medically underserved areas where cancer disparities are particularly stark (Smith-Bindman et al., 2006; Fair et al., 2010; DeSantis, Siegel, Bandi, & Jemal, 2011; DeSantis, Ma, Bryan, & Jemal, 2014). An especially important finding from this study was the significance of the hospital where women received follow-up care and timeliness of diagnostic resolution. Studies are emerging that examine quality of the location of care and diagnostic follow-up care after an abnormal mammogram (Molina, Silva, and Rauscher, 2015; Rauscher et al., 2014). Consistent with the results of these studies, findings from this study suggest the quality of the hospital is an important consideration and factor related to timely diagnostic resolution. In addition, this study contributes to the existing research examining the effectiveness of patient navigation as an intervention strategy to increase timely diagnostic resolution.

3. <u>**Implications for Social Work Education**</u>

Given the broad range of social and environmental factors that contribute to disparities, it is well-recognized that eliminating health and health care disparities will require sustained efforts from within the healthcare system and beyond. Health, public health, and health disparities are fundamental issues faced by the social work profession, and as a result, the findings from this study have relevant implications for social work education and practice. The biopsychosocial model is a holistic approach that simultaneously considers biological, psychological, and social dimensions and their complex interactions in understanding health, illness, and health care delivery (Engel, 1977). Social workers must possess sufficient knowledge to simultaneously address the complexity of biological, psychological, and social factors embedded in health (Gehlert, 2012). Moreover, social workers have an ethical obligation to address health care needs of vulnerable and disenfranchised populations (NASW, 2005). Many social work programs offer medical or health concentrations for students; moreover, dual-degree programs in social work and public health are proliferating across the county (Ruth, Marshall, Velásquez, Bachman, 2015). Transdisciplinary education, research, and approaches are particularly relevant health and social problems that are multifaceted and are embedded in complicated socioenvironmental systems (James, Gehlert, Bowen, & Colditz, 2015). This study explores the social determinants of health by examining individuals within their contextual environment and the influences on their health behavior, which may be of importance for students with a social work and public health dual focus along with students interested in the social determinants of health and health disparities. Also, this study may be of interest to MSW students in health-related field placements.

The person-in-environment perspective is a unifying principle of social work practice and a core component of social work education. This concept reflects the dual aspirations of social workers to provide individual care and to further social justice (Weiss-Gal, 2008). Yet, research, policy, and interventions are often individually focused; moreover, tension persists in regard to the micro–macro dualism of the social work profession (Kondrat, 2002). Consistent with this individual focus, the majority of breast cancer disparities studies, including timely diagnostic follow-up, have focused on individual-level factors related to accessing follow-up care. The individual-level focus potentially neglects important environmental influences. For example, it is more common for women residing in census tracts with higher percentages of residents below the federal poverty line to be diagnosed with later stage breast cancer (Campbell et al., 2009). Recognizing the importance of environmental influences on individual health behavior, the model for analysis of population health and health disparities was selected for this study as an ecological framework that embodies the person-in-environment approach that captures the complexity of an individual in the context of and interaction with multiple systems (Warnecke et al., 2008). This study incorporates individual-level and contextual-level factors, which provides a specific example of the person-in-environment template and integration of social work and public health theory. The study findings reveal the importance of examining the relationship between contextual factors, in addition to individual factors, and timely diagnostic follow-up of abnormal mammogram in order to detect breast cancer early.

4. **Implications for Social Work Practice**

For social work practice, this study offers the opportunity to inform individual-level interventions that address the contextual environment in which women access early detection breast cancer services. Health inequities are the result of a complex interplay between many

contributing factors associated with the social determinants of health that are the conditions in which people are conceived and born, live, grow, develop, and age (World Health Organization, 2015). Thus, social workers can contribute to the reduction of health inequities by incorporating a population health perspective into their practice. Population health is defined as the overall health of a population, the health outcomes of a group of individuals, and the distribution of these health outcomes (Kindig, & Stoddart, 2003). In a broad sense, this includes multiple determinants of health such as access to medical care, the social environment, and the physical environment. Taking a population health approach to assessment and intervention, accounts for the multifaceted transactional complexity between individual health behavior that is shaped by the social and environmental context. This multisystem perspective allows social workers to identify and conduct assessments of individual-level and contextual-level barriers to early detection of breast cancer, and as a result develop robust multilevel interventions.

Historically, patient navigation arose as an intervention to address racial, ethnic, and socioeconomic disparities in cancer mortality by eliminating barriers to timely diagnosis and treatment (Paskett et al., 2011). Patient navigation is aligned with social work's core value of social justice. For instance, change efforts concentrate on eliminating barriers associated with discrimination and other forms of social injustice (NASW, 2016). A core function of social work is to ensure people have access to needed information, services, and resources. Study findings suggest implications for the breast cancer early detection system of care, specifically the role of patient navigators. In the analyses, a significant relationship consistently immerged between timely diagnostic resolution and patient navigation. The fact that women who had interaction, even minimal interaction (i.e., reminder phone call), with a patient navigator were more likely to have diagnostic resolution in 60 days and to have fewer days to diagnostic resolution compared

to women without contact suggests even limited support from a patient navigator is effective in encouraging diagnostic follow-up after an abnormal mammogram. Patient navigation has emerged as an important strategy to increase timely identification of breast cancer (Battaglia et al., 2007). This study substantiates the importance of intervention efforts to increase early detection in women accessing care in medically underserved areas.

The Patient Protection and Affordable Care Act (2010) created sweeping changes that provide wide-ranging opportunities for social workers. For example, Andrews, Darnell, and Gehlert (2013) have identified three important opportunities for social workers including, patient navigation, behavioral health treatment, and care coordination. According to the Oncology Nursing Society, the Association of Oncology Social Work, and the National Association of Social Workers Joint Position on the Role of Oncology Nursing and Oncology Social Work in Patient Navigation, oncology nurses and social workers function in patient navigator roles based on the scope of practice for each discipline (Oncology Nursing Society, 2013). In addition, navigation services delegated to other trained nonprofessionals and/or volunteers should be supervised by nurses or social workers (Oncology Nursing Society, 2013). However, currently there are no standard personnel designated to perform navigation services, and a vast range of individuals perform navigation including professionals (e.g., social worker or clinical nurse) and laypeople (e.g., health educators, case managers, and volunteers) (Darnell, 2007). For example, the current study used trained nonprofessional staff supervised by research and hospital staff. Oncology social workers and other medical social workers in the role of patient navigators offer the unique education, values, and training to provide comprehensive services to women seeking early detection services and/or cancer treatment (Davis, Darby, Likes, & Bell, 2009). With the proliferation of patient navigation across the country, social workers are key stakeholders in the

development and implementation of navigation programs. As a model of intervention, patient

navigation, aims to assist women in overcoming barriers that serve as obstacles to breast care

(Freeman, 2004). Social workers have a lengthy and revered role in navigating clients through a

complex web of services, addressing barriers that prohibit accessing services, and advocating on

behalf of clients. Social workers are ideally positioned to provide and supervise navigation as

well as contribute as leaders to the policy reform around patient navigation services for women.

According to Davis et al. (2009), social workers must claim patient navigation as social work

domain in order to maintain their necessary positions as a member of oncology treatment teams.

In addition, given the prolific expansion of patient navigation and efforts to evaluate its efficacy

along the continuum of breast cancer care, future trials should evaluate the use of social workers

as navigators compared to other types of professionals such as nurses and nonprofessional staff

and volunteers.

5. <u>Implications for Social Work Policy</u>

Breast cancer disparities are embedded in broader social, political, and economic contexts

in which women reside, and as a result, findings from this study may also contribute to the

development of effective policies that address timely diagnostic resolution after an abnormal

mammogram. There have been several landmark reports, significant legislation, and initiatives at

the federal, state, local, community, and provider level addressing the reduction of health

disparities (U.S. Department of Health and Human Services [HHS], 2015). For example, the

Minority Health and Health Disparities Research and Education Act of 2000 created the National

Center for Minority Health and Health Disparities (HHS, 2015). In addition, the Institute of

Medicine produced two foundational reports that documented racial and ethnic disparities in

access to high-quality care. More recently, the Patient Protection and Affordable Care Act (2010)

included provisions that explicitly address the efforts to reduce health disparities and to improve health for vulnerable populations (HHS, 2015).

Social workers have the opportunity to contribute to policy through a valued-based lens that recognizes the importance of population-based health care. With persistent health disparities, clearly there are systemic problems in the manner in which health care is accessed and delivered. For example, in this study women accessing care at the hospital with the most resources and with accreditation were timelier in their diagnostic resolution. This suggests the hospital and system of care are the mechanism and pathway to timely identification of breast cancer. With the changes in health care legislation and policies regarding delivery models of care, this is the ideal political landscape for social workers to advocate for population-based and values-based health care.

Despite the increased awareness and legislative response to address health disparities, substantial disparities persist in the U.S. Thus, policy recommendations and initiatives remain vital to eliminating health and health care disparities (HHS, 2015). In addition, the Patient Protection and Affordable Care Act (2010) was enacted with an emphasis on disease prevention (Koh & Sebelius, 2010). The act provides access to clinical preventative services to individuals with private health plans, private insurance policies, and public insurance programs. For example, screening for breast cancer is a covered service with no cost sharing by the beneficiary. The act also authorizes funding to address awareness, knowledge, research, and support for women with breast cancer. With the current change in policies and recognition of the importance of preventative care, the climate is ripe for social workers to join the policy efforts to ensure future patient navigation involves social workers as the providers of care as well as supervisors of those individuals providing the navigation services.

This study has important policy implications related to patient navigation and timely diagnostic resolution of abnormal mammogram. The Patient Navigator Act of 2005 authorized $25 million dollars in grants to develop prevention, access to care, and screening programs in vulnerable communities. However, funding for navigation programs is in jeopardy because a single source of funding was not designated (Moy & Chabner, 2011). Similarly, the Patient Protection and Affordable Care Act authorizes continued funding for patient navigation programs, but the law does not guarantee funding. Every year, Congress determines annual spending and authorizes funding. Given the current U.S. fiscal climate, additional evidence about the factors that contribute to the early detection of breast cancer is critical to meaningfully change cancer outcomes for vulnerable women. This study contributes to growing evidence that patient navigation improves breast cancer outcomes. Women in the study who interacted with patient navigators had significantly higher diagnostic completion rates and were timelier in their diagnostic follow-up compared to women who did not interact with patient navigators. Additional research is necessary to determine the cost-effectiveness of patient navigation.

In addition, findings from this study also have important policy implications related to quality standards for hospitals with mammography clinics. Consistently, a significant relationship was found between timely diagnostic resolution and the hospital where women received diagnostic follow-up care. Previous studies have found an important mediating factor for timely diagnostic resolution was BICOE accreditation from the American College of Radiology (Molina, Silva, and Rauscher, 2015; Rauscher et al., 2014). In this study, the women accessing care at the hospital with BICOE accreditation had significantly less delay in diagnostic resolution compared to the two hospitals without BICOE accreditation. This suggests mandating

standards requiring breast-imaging accreditation for hospitals, particularly in medically underserved areas, would influence timely early detection of breast cancer.

6. <u>**Summary of Implications**</u>

Findings from this study contribute to the growing body of literature that documents how health outcomes are related to social advantage and disadvantage. The stark breast cancer survival disparity between Black and White women is an issue of social justice. Health disparities are systematic health differences that adversely affect economically and socially disadvantaged groups (Braveman et al., 2011). These groups experience discrimination and marginalization that reflect social advantage and disadvantage (Braveman et al., 2011; LaVeist, 2005; Williams, 2006; Marmot & Wilkinson, 2006). Moreover, health disparities are the result of oppressive societal structures that produce and reinforce oppression and marginalization of disadvantaged groups (Braveman et al., 2011). Social workers must recognize and understand health is an issue of both economics and well-being (NASW, 2005). Breast cancer disparities are imbedded in factors related to social class, race, and geography (NCI, 2015a.). In recognizing the importance of contextual level factors for women accessing breast care, this study incorporated hospital of care, neighborhood poverty, racial residential segregation, and access to healthcare. The findings highlight the pathways and mechanisms linking multilevel factors and timely diagnostic resolution after an abnormal mammogram. In conclusion, this study contributes to understanding the complex interactions and multiple levels of influence impacting women accessing care in medically underserved areas that may inform policy efforts, future early detection interventions, and future directions for research.

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