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Abstract

Purpose: To measure Mortality-to-Incidence Ratios (MIRs) on Senatorial Districts Grouped to County Boundaries (SDGCs) to explore the female breast cancer (FBC) racial and age disparities in Missouri.

Methods: The MIRs and their 95% CI by age and race were calculated for the 20 SDGCs for the period from 2008-2012.

Results: For the 65+ years old FBC cases, the MIRs for whole Missouri and the 20 SDGCs were typically twice the MIR for thewhites.

Conclusions: FBC MIRs can be used as a measure of cancer inequalities in Missouri. These measures might be informative for policy makers to assess the existing policies and enforce effective interventions to tackle FBC disparities.

Key Words: Disparities, female breast cancer, Mortality-to-Incidence Ratio, MIR, Race.

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Cover Page Footnote

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ABSTRACT

Purpose: To measure Mortality-to-Incidence Ratios (MIRs) on Senatorial Districts Grouped to County Boundaries (SDGCs) to explore the female breast cancer (FBC) racial and age disparities in Missouri.

Methods: The MIRs and their 95% CI by age and race were calculated for the 20 SDGCs for the period from 2008-2012.

Results: For the 65+ years old FBC cases, the MIRs for whole Missouri and the 20 SDGCs were twice the MIR for the <50 and 50-64 years old categories. The MIRs for all of Missouri and the compared SDGCs were higher for the African-Americans than whites.

Conclusions: FBC MIRs can be used as a measure of cancer disparities in Missouri. These measures might be informative for policy makers to assess the existing policies and enforce effective interventions to tackle FBC disparities.

Key Words: Disparities, female breast cancer, Mortality-to-Incidence Ratio, MIR, Race.

INTRODUCTION

As a statistic, incidence rates estimate the actual underlying incidence of some conditions, but they are influenced by a number of factors. For example, incidence rates will be increased by

increasing the intensity of breast cancer screening measures and interventions and these rates might be decreased by increasing prevention measures for cancer risk factors (Ellis et al., 2014). The incidence rates will be affected by any changing in the coding and classification of any cancer. The central cancer registry database is considered to be a high quality source to estimate epidemiological rates because it follows regularly updated measures and standards (Berrino et al., 2007; Curado et al., 2007). Many studies have concluded the importance of estimation of multiple epidemiological indicators of cancers together, because presenting these epidemiological measures individually will mislead readers and therefore we will conduct this project to include all the measurements of the same period of time (Berrino et al., 2007; Ellis et al., 2014). Many studies revealed that there are disparities between cancer cases according to age, race, and stage and grade at diagnosis variables (Clegg et al., 2009; Harper et al., 2009; Howe et al., 2006; Merkin, Stevenson, & Powe., 2002; Newman & Martin, 2007; Schootman, Jeffe, Reschke, & Aft, 2003).
Cancer mortality rates could inform public health leaders if the cancer is a public health priority on the level of the senate districts in Missouri using the National Vital Statistics System (NVSS) database of the National Center of Health Statistics (NCHS) to determine cancer mortality is an excellent source of demographic, geographic and cause of death data (Centers for Disease Control and Prevention [CDC], 2015). Mortality rates could measure possible over-diagnosis bias in the breast cancer incidence and survival rates (Ellis et al., 2014).

Cancer mortality is considered as a disparity indicator, but without measuring the corresponding incidence it could be misleading (Ellis et al., 2014). Elevated mortality could result from rare lethal cancer survival with very low incidence, or could result from a modest survival cancer with high incidence rates of the same cancer (Herbert, Elder, & Ureda., 2006; Ward et al., 2004).

The Mortality-to-Incidence Ratio (MIR) is a measurement that could expand our interpretation and understanding of the relationship between the two epidemiological measures. This measurement could expand the understanding of the demographic, environmental, and social factors which might lead to unexpected changes of mortality rates based on the estimated incidence data (Woo, Thach, Choy, McGhee, & Leung, 2005). Matching MIR for any cancer by race and age offers an influential method to explore the cancer magnitude and prognosis. The MIR will help in exploring and addressing the hidden differences in cancer incidence and consequences by area, age, and race (Hebert et al., 2009). MIR affords a population-based meter of cancer prognosis (CDC, 2016).

Numerous evidence-based studies have concluded that the use of interactive geographic mapping software allows users to interact in a timely way with the data sets and publish high quality interactive reports (Chacalova, Dimitrova, Gavrilov, & Valernova, 2013; Driedger et al., 2007; Gao, Mioc, Anton, Yi, & Coleman, 2007; Van der wilk & Verschuuren, 2010). The web-based mapping systems’ contribution might be significant because these systems could enable users to visualize the interactive mapping breast cancer reports easily and in a timely way and the users can share this data with contributors in fields related to breast cancer. Distribution of geospatial health data will help public health leaders and decision makers in designing, developing and adopting effective and efficient strategies and programs to improve public health outcomes targeting specific geographical areas (Chacalova et al., 2013; Driedger et al., 2007; Gao et al., 2007; Van der wilk & Verschuuren, 2010)).

For instance, there are racial/ethnic disparities in cancer incidence and mortality, these variances are usually consequence of complicated sources. In the US, mortality rates of most cancers are higher amid African-Americans than other racial/ethnic categories (Kohler, 2015; Ward et al., 2004). For all cancers, African-Americans' mortality rates are 25% higher the whites' mortality rates (National Cancer Institute [NCI], 2011). For most cancer types, the incidence rates are higher among African-Americans than white, and African-Americans got diagnosed with aggressive cancers at younger ages than the whites (Hebert et al., 2009).

Our study proposes to estimate the female breast cancer (FBC) incidence using Missouri Cancer Registry (MCR) database, and assess the FBC mortality of the same period using the NCHS mortality data. The specific study objectives are: 1) To measure and spatially visualize the incidence rates in Missouri from 2008 to 2012 according to the female breast cancer cases' age at diagnosis, race, and the Senate District Grouped to County Boundaries (SDGCs) of diagnosis. 2) To measure and spatially visualize the female breast cancer mortality rates in Missouri from 2008 to 2012 according to age, race, and the SDGCs. 3) To measure and spatially visualize the Mortality-to-Incidence Ratio (MIR) of the SDGCs to explore the FBC racial and age disparities in Missouri.

METHODS

Female Breast Cancer Incidence

The study design is an observational epidemiological study. We did secondary analysis to all the female breast cancer cases in the MCR-ARC from 2008 to 2012. 2012 was the most recent year of diagnosis with complete data (>95% cases reported) at the time the project started. The starting point of 2008 was chosen arbitrarily, but using a 5 year period is somewhat common in research. Population data came from the mid-year estimates from the Census Bureau's Population Estimates Program, which is single-race bridged by National Center of Health Statistics (NCHS) and then released by the National Cancer Institute (NCI)'s Surveillance Epidemiology and End Results (SEER) program. NCI makes some modifications to the NCHS files, but they do not impact Missouri. The calculated incidence rates for every single Missouri county was age standardized using US 2000 Standard Population for comparability across regions with differing age structures. We calculated the 95% confidence interval for these rates using SEER*Stat statistical package (NCI, 2016). The Census Bureau's Cartographic Boundary Files (CBFs) were used to create maps showing SDGCs with a shapefile produced with ArcMap from the county-level CBF. A set of twenty (20) regions we termed "Senate District Grouped to County Boundaries" (SDGCs) were created that minimally aggregated the districts to follow county boundaries. The 20 SDGCs are each of the 14 districts that originally followed county boundaries (Senate districts # 6, 10, 16, 18, 19, 21, 25, 27, 28, 29, 31, 32, 33 & 34), along with the following six aggregated regions: eight senate districts of Franklin County, St. Louis City, and St. Louis County; two senate districts of St. Charles County; two senate districts covering six counties south of St. Louis; four senate districts of Jackson County; two senate districts covering 15 counties in northwest Missouri; and two senate districts covering Christian and Greene counties. Table 1 shows the SDGCs and their included counties.

Incidence rates were loaded along with the Cartographic Boundary Files into the InstantAtlas software to produce interactive mapping reports that display our study's results. The maps were published on the Internet, and we are going to attach them to the MCR-ARC website.

The interactive reports included maps, graphs, and tables for the 20 SDGCs (Schmaltz & Ben Ramadan, 2016a; Schmaltz & Ben Ramadan, 2016b).

Table 1. Senate Districts Grouped to County Borders (SDGCs) and their involved counties.

SDGCs #	***The senate district (SD) or counties (Cs) involved per SDGC***
SDGC #1	SD #6
SDGC #2	SD #10
SDGC #3	SD #16
SDGC #4	SD #18
SDGC #5	SD #19
SDGC #6	SD #21
SDGC #7	SD #25
SDGC #8	SD #27
SDGC #9	SD #28
SDGC #10	SD #29
SDGC #11	SD #31
SDGC #12	SD #32
SDGC #13	SD #33
SDGC #14	SD #34
SDGC #15	SD #s 01, 04, 05, 13, 14, 15, 24, 26
SDGC #16	SD #s 02, 23
SDGC #17	SD #s 03, 22
SDGC #18	SD #s 07, 08, 09, 11
SDGC #19	SD #s 12, 17
SDGC #20	SD #s 20, 30

Female Breast Cancer Mortality

The study design is an observational epidemiological study. We used the NCHS death file to catch all the female breast cancer deaths in Missouri for the period from 2008 to 2012 (NCI, 2016). The female breast cancer death data was on the county and SDGC level only since we could not further geocoded this data. We calculated the 95% confidence interval for these age-adjusted rates as well as testing for differences from the remainder of the state, which are shown in the area health profile report.

The Census Bureau's Cartographic Boundary Files, as we did in for incidence rates, were used to create maps showing state SDGCs with a shapefile produced with ArcMap from the county-level Cartographic Boundary File. The mortality results loaded along with the Cartographic Boundary Files into the InstantAtlas software to produce interactive mapping reports that display our study's results (ESRI. ArcMap, 2016). We will attach our interactive mapping reports to the MCR-ARC website. The interactive reports included maps, graphs, and tables for the 20 SDGCs and 115 counties (Schmaltz & Ben Ramadan, 2016a; Schmaltz & Ben Ramadan, 2016b).

Mortality-to-Incidence Ratio (MIR)

The MIRs by age and race for the FBC cases were calculated by dividing the FBC mortality rates by the FBC incidence rates for the 20 SDGCs for the period from 2008-2012. We also calculated the 95% Confidence Intervals (95% CI) of the MIRs based on a normal approximation to the log-scale using the delta method and then transformed the results back to the original scale (Wikipedia, 2017).

RESULTS

Our map designer at the MCR-ARC built SDGCs maps using InstantAtlas. The Cartographic Boundary Files were loaded along with the incidence and mortality rates to the InstantAtlas software to create the final interactive mapping reports (Schmaltz & Ben Ramadan, 2016a; Schmaltz & Ben Ramadan, 2016b). These reports visualize incidence and mortality data results. The results were displayed in two formats: area profile and double map formats. These reports include combined maps and statistical data. The following screen shots are showing the final formats of the InstantAtlas mapping reports we built at the MCR-ARC to display our results.

Figure 1. Area profile mapping report of 65+ years old female breast cancer (FBC) incidence rates by Senate Districts Grouped to County Boundaries (SDGCs) in Missouri 2008-2012 (Schmaltz & Ben Ramadan, 2016a)

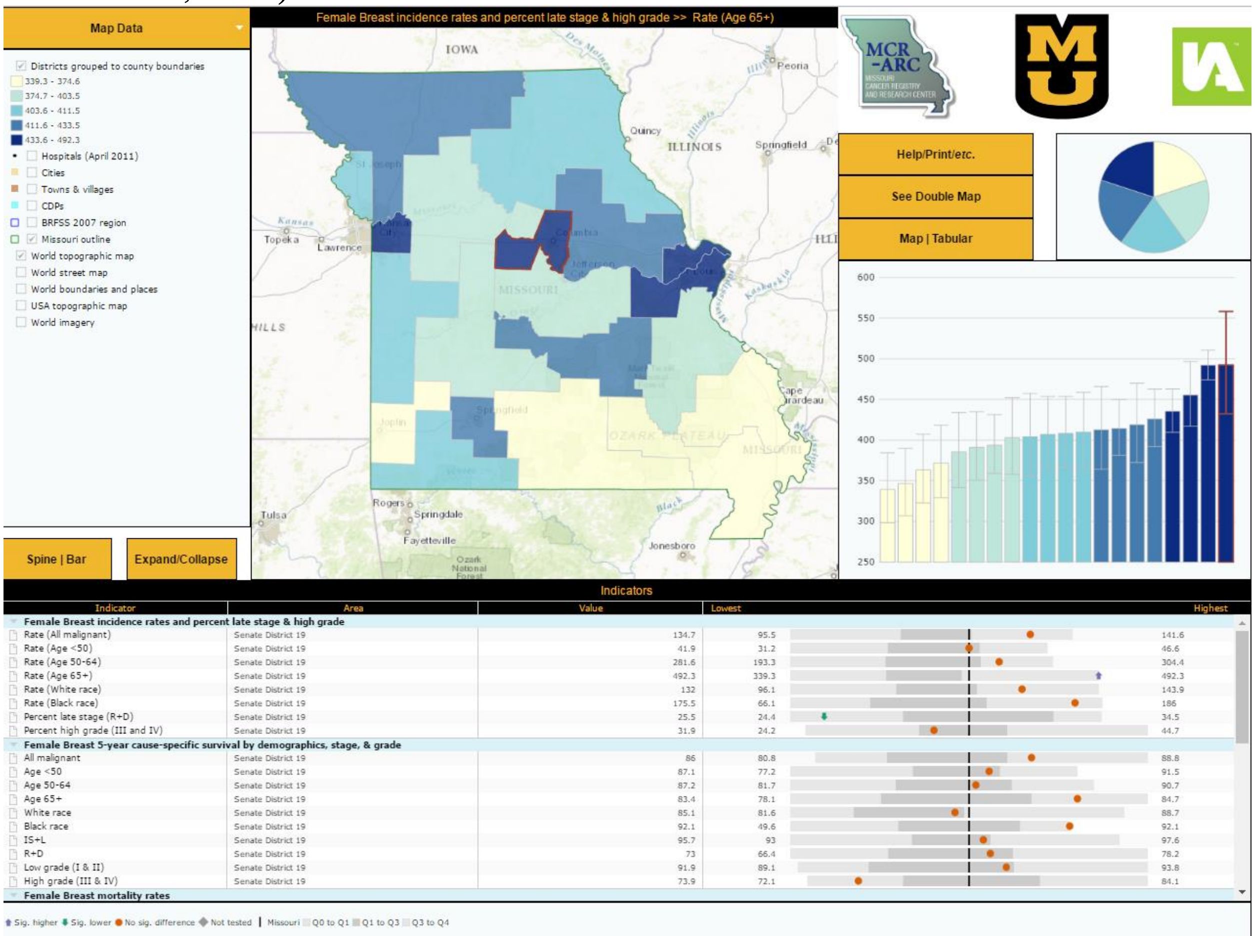


Figure 2. Area profile mapping report of female breast cancer (FBC) mortality rates of whites by Senate Districts Grouped to County Boundaries (SDGCs) in Missouri 2008-2012 (Schmaltz & Ben Ramadan, 2016a)

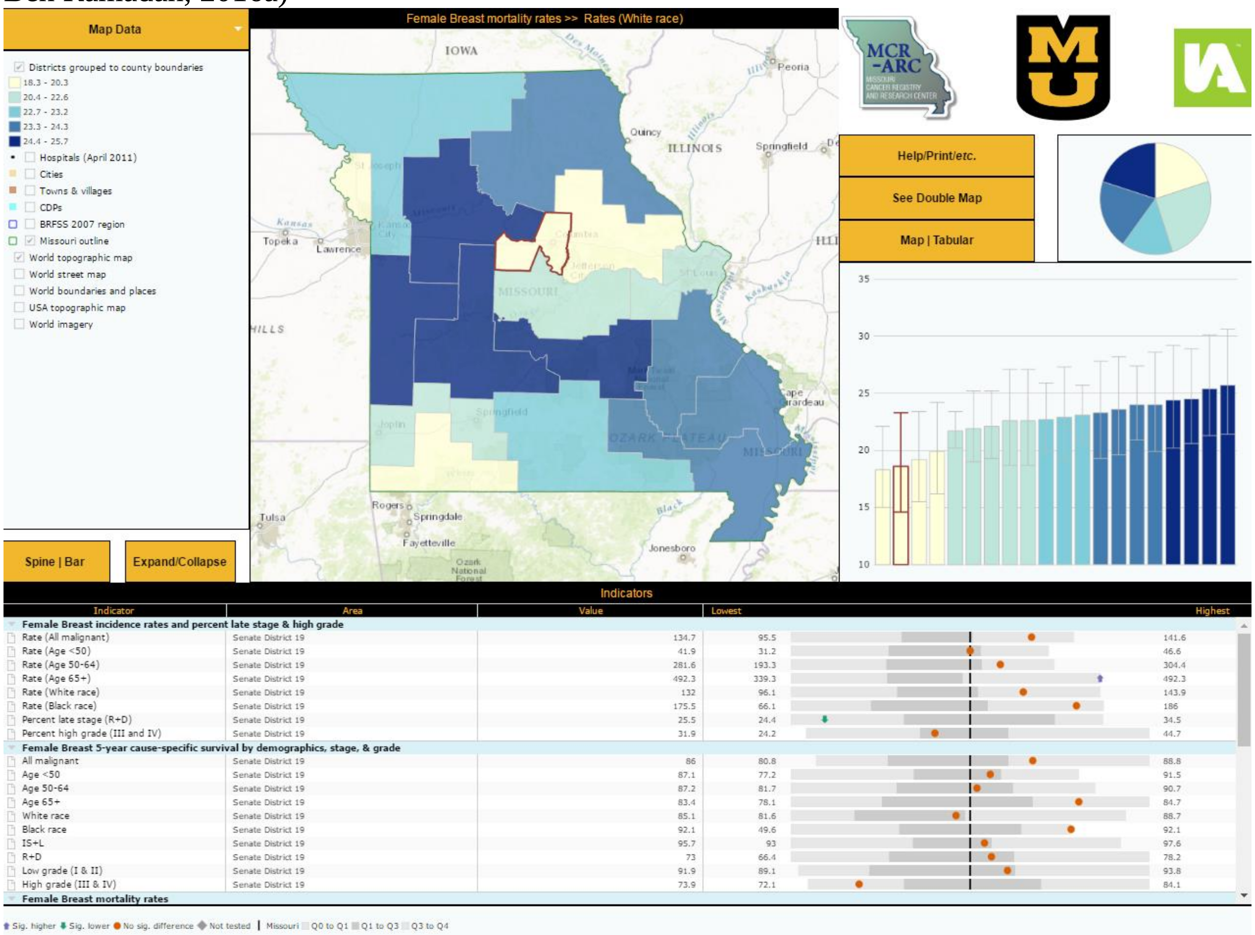
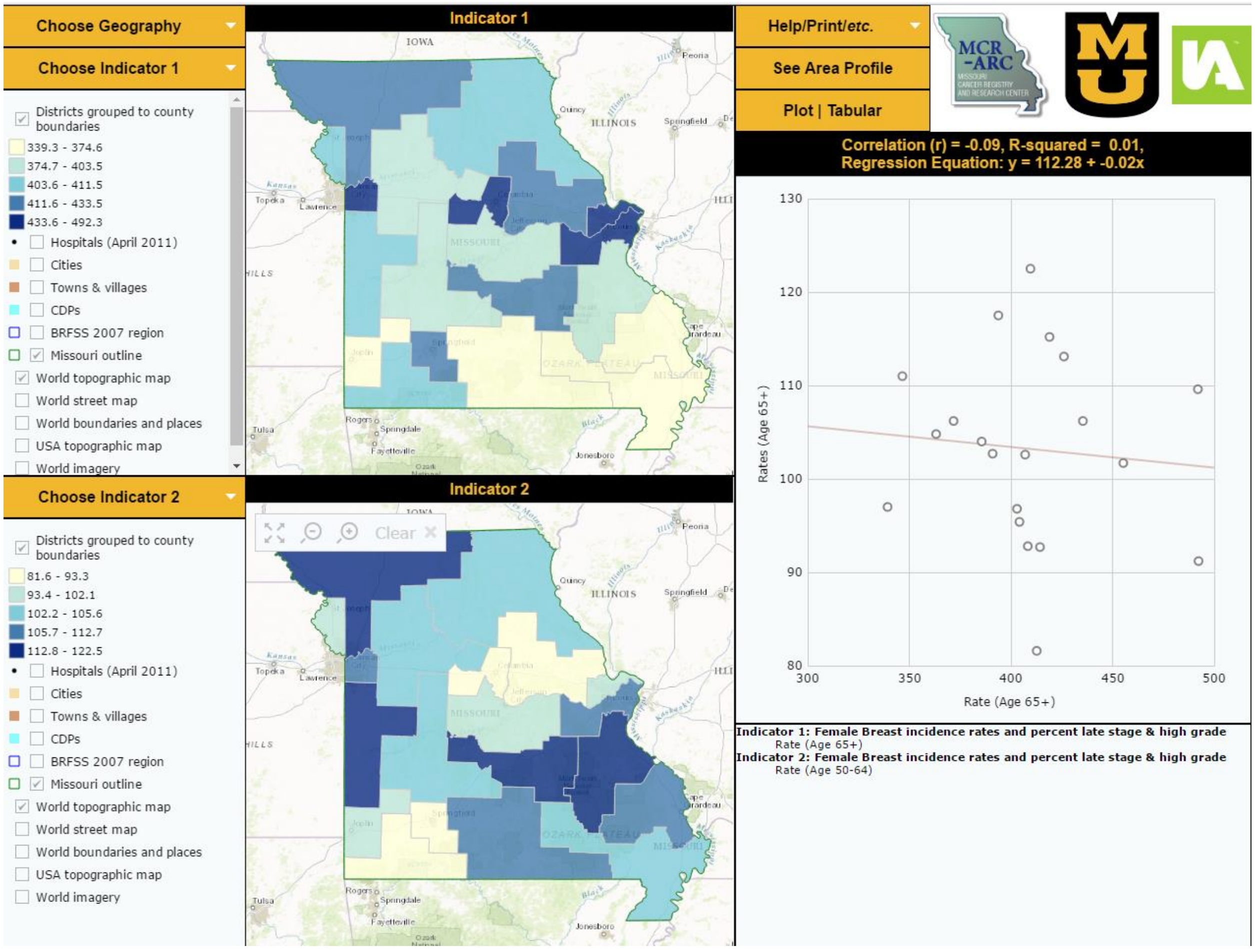


Figure 3. Double map InstantAtlas report of 65+ years old female breast cancer (FBC) incidence and mortality rates by Senate Districts Grouped to County Boundaries (SDGCs) in Missouri 2008-2012 (Schmaltz & Ben Ramadan, 2016b)



From all the above maps, we could create individual FBC mortality and incidence profiles for the constructed 20 SDGCs. By creating these profiles, we could compare the SDGCs' results to the state and compare the SDGCs to each other. This might give evidence to the public health professionals and cancer policy makers about the FBC per area, how to evaluate cancer laws and policies per area, and how to consider all the possible risk factors per area to positively impact cancer research and policy.

Table 2. Female breast cancer (FBC) Mortality-to-Incidence rate Ratios (MIRs) and the MIR 95% Confidence Intervals (95% CI) by Senate Districts Grouped to County Boundaries (SDGCs) and by age in Missouri 2008-2012

	Age Group								
	<50			**50-64**			**65+**		
SDGC	***MIR***	***95% CI LL***	***95% CI UL***	***MIR***	***95% CI LL***	***95% CI UL***	***MIR***	***95% CI LL***	***95% CI UL***
Missouri	0.12	0.11	0.13	0.16	0.15	0.17	0.25	0.24	0.26
SDGC #1	0.17	0.10	0.27	0.17	0.12	0.24	0.24	0.19	0.31
SDGC #2	0.10	0.05	0.18	0.14	0.10	0.21	0.20	0.15	0.26
SDGC #3	0.14	0.08	0.25	0.18	0.12	0.25	0.28	0.21	0.35
SDGC #4	0.17	0.10	0.28	0.15	0.11	0.22	0.25	0.20	0.32
SDGC #5	^	^	^	0.13	0.09	0.19	0.19	0.14	0.25
SDGC #6	0.22	0.14	0.35	0.18	0.22	0.13	0.27	0.21	0.35
SDGC #7	0.12	0.07	0.22	0.24	0.18	0.33	0.29	0.23	0.37
SDGC #8	0.11	0.06	0.20	0.20	0.14	0.28	0.29	0.22	0.37
SDGC #9	0.16	0.09	0.28	0.20	0.15	0.27	0.26	0.21	0.33
SDGC #10	^	^	^	0.14	0.09	0.21	0.23	0.18	0.29
SDGC #11	0.14	0.08	0.23	0.14	0.09	0.20	0.30	0.24	0.38
SDGC #12	0.16	0.09	0.27	0.19	0.13	0.27	0.29	0.22	0.37
SDGC #13	^	^	^	0.21	0.15	0.30	0.32	0.25	0.41
SDGC #14	0.09	0.05	0.16	0.14	0.10	0.20	0.24	0.18	0.31
SDGC #15	0.10	0.08	0.12	0.15	0.14	0.17	0.22	0.20	0.24
SDGC #16	0.10	0.07	0.15	0.13	0.10	0.16	0.22	0.18	0.27
SDGC #17	0.12	0.08	0.18	0.14	0.11	0.19	0.30	0.25	0.36
SDGC #18	0.16	0.13	0.21	0.19	0.16	0.23	0.24	0.21	0.28
SDGC #19	0.08	0.05	0.12	0.15	0.11	0.19	0.27	0.22	0.32
SDGC #20	0.12	0.08	0.18	0.15	0.11	0.19	0.22	0.19	0.27

LL: lower limit of the confidence interval.
UL: upper limit of the confidence interval.

^: Mortality and incidence statistics were based on small number of deaths and new cases are suppressed to help protect confidentiality. In accordance with NCHS's policies, the threshold of ten (10) deceased was utilized, and as commonly used by MCR-ARC and other central cancer registries, the threshold of five (5) was utilized.

Table 3. Female breast cancer (FBC) Mortality-to-Incidence rate Ratios (MIRs) by Senate Districts Grouped to County Boundaries (SDGCs) and by race in Missouri 2008-2012

	Race					
	White			**African-American**		
SDGC	***MIR***	***95% CI LL***	***95% CI UL***	***MIR***	***95% CI LL***	***95% CI UL***
Missouri	0.18	0.17	0.19	0.25	0.23	0.27
SDGC #1	0.19	0.16	0.24	^	^	^
SDGC #2	0.16	0.13	0.20	^	^	^
SDGC #3	0.21	0.17	0.25	^	^	^
SDGC #4	0.19	0.16	0.23	^	^	^
SDGC #5	0.14	0.11	0.18	^	^	^
SDGC #6	0.22	0.18	0.27	^	^	^
SDGC #7	0.22	0.18	0.27	0.35	0.19	0.65
SDGC #8	0.20	0.17	0.25	^	^	^
SDGC #9	0.22	0.18	0.26	^	^	^
SDGC #10	0.17	0.14	0.21	^	^	^
SDGC #11	0.21	0.17	0.25	^	^	^
SDGC #12	0.23	0.19	0.28	^	^	^
SDGC #13	0.24	0.20	0.29	^	^	^
SDGC #14	0.17	0.13	0.20	^	^	^
SDGC #15	0.15	0.14	0.16	0.24	0.21	0.27
SDGC #16	0.16	0.14	0.19	^	^	^
SDGC #17	0.20	0.18	0.24	^	^	^
SDGC #18	0.19	0.17	0.21	0.26	0.21	0.31
SDGC #19	0.18	0.16	0.21	^	^	^

SDGC #20	0.17	0.15	0.20	^	^	^

LL: lower limit of the confidence interval.
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^: Mortality and incidence statistics were based on small number of deaths and new cases are suppressed to help protect confidentiality. In accordance with NCHS's policies, the threshold of ten (10) deceased was utilized, and as commonly used by MCR-ARC and other central cancer registries, the threshold of five (5) was utilized.

We detected large differences in MIR by age and race for FBC in Missouri and across the SDGCs. These MIR differences are significant. For the 65+ FBC cases, the MIRs for Missouri statewide and the 20 SDGCs were mostly twice the MIR for the <50 and 50-64 years old categories.

From the interactive map and the tables 2 and 3, the current study revealed that there are huge spatial disparities by age and race based on rural and urban geographical distribution. For the <50 years FBC cases, the purely rural SDGCs #6 got the highest MIRs, followed by other three rural SDGCs #4, 9, & 12. But the urban SDGCs #18, which is a metropolitan area including Kansas City, also had high MIR. The same MIRs findings we got from the <50 years old FBC cases were applicable on the 50-64 years old FBC cases. For the 65+ years old population, the highest MIRs were distributed all over most of the rural SDGCs without any inclusion to SDGCs which included metropolitan areas.

DISCUSSSION

There is no previous efforts at MCR-ARC to assess MIR ratios variances among FBC cases by age and race in Missouri. By measuring these ratios, we could extend our understanding of the destiny of the diagnosed cancer cases.

In Missouri, the 65+ years old population has increased more than other age categories. It represents 13% of the total population and it is expected that by 2030 will be more than 21% because of the baby boomers (Missouri Department of Higher Education, 2017). Females 65+ years old represented 50.9% of total population in 2015 (United States Census Bureau, 2016). This group is mostly eligible to Medicare services.

The significantly high MIRs among the 65+ years old FBC cases, in comparison to other two age categories, might be interpreted as the comorbidity in 65+ years old cases restricting the capability to get good prognostic choices, for example, axillary lymph node dissection. The comorbidity might limit management decisions like exposure to strong chemotherapy courses with or without radiotherapy. Additionally, the death from causes other than breast cancer of the FBC cases might be missed by the death certificate writers to be attributed to the breast cancer (Yancik, 2001). As a retrospective cohort study was conducted on FBC of different age categories, > 70 years old FBC cases were significantly less likely to get management plans consistent with their breast cancer at diagnosis stages and grades (Yancik, 2001). The same study revealed that diabetes, renal failure, stroke, liver disease, a previous malignant tumor, and smoking were significant in expecting premature death for this FBC category (Yancik, 2001). Despite Medicare coverage of the 65+ years old females across Missouri, the highest MIRs for the 65+ years old FBC cases were for the rural Missouri. This could be attributed to the lack of accessibility of the rural FBC cases to the right oncology services, lack of treatment follow-up and compliance, poverty, and due to Medicare copayment (Card, Dobkin, & Maestas, 2007; Choi, 2015).

The current evidence-based literature concluded that insurance status and coverage has an important impact on treatment options and health consequences (Card et al., 2007). Uninsured patients have less intensive management and they are tend to discharged rather than referred for continuous care. The study revealed that those uninsured or with a limited coverage insurance patients are more likely to be discharged from the hospital in an unhealthy condition (Card et al., 2007). The researchers explained these findings with a shortage in the federal law in requiring the providers of making sure that their patients receive all necessary care or that they be transferred to the most appropriate treatment setting (Card et al., 2007).

There are huge spatial rural-urban disparities for the <65 years old FBC cases discovered by the current study: higher MIRs were found for rural SDGCs than the urban and metropolitan SDGCs. These findings could be attributed to poverty, lack of coverage, and inaccessibility to the available diagnostic and treatment due to limited eligibility to Medicaid services for the poor and rural at-risk population. Despite Medicare coverage of the 65+ years old females across Missouri, the highest MIRs for the 65+ years old FBC cases were for the rural Missouri. This could be attributed to the lack of accessibility of the rural FBC cases to the right oncology services, lack of treatment follow-up and compliance, poverty, and due to Medicare copayment (Card, Dobkin, & Maestas, 2007; Choi, 2015). The current study also revealed that the SDGCs which have better healthcare services, high education, and a good socio-economic situation had lower MIRs especially among whites (Card, Dobkin, & Maestas, 2007; Choi, 2015). Another study published in 2015 concluded that high cancer MIRs could be decreased by increasing the accessibility of the disadvantaged minorities and rural inhabitants to the federally supported community centers (Adams, 2015). Also, a study was published in 2006 concluded that cancer patients navigation by the providers could reduce the MIRs and cancer disparities (Battaglia, Roloff, Posner, Freund, 2007).

According to the 2010 census, the total African-American population count were 693,391 and they represented about 11.58% of the entire Missouri population (CensusViewer, 2012). African-American population percentages are higher in the major metropolitan areas than the rural areas of the state (CensusViewer, 2012). In 2015, according to the United States Census Bureau, the white population represented 83.3% and the African-American population represented 11.8% of the total population (United States Census Bureau, 2016). These study results supported the findings of a huge study done in Georgia and published in 2012 where African-Americans reported higher MIRs than whites for each cancer type (Wagner et al., 2012).

CONCLUSION

MIRs afford a distinctive measure of cancer disparities which consider to very important measures mortality and incidence rates. MIR could be used to estimate the fatality of FBC and to explore FBC age and racial disparities by area. This might help policy makers and intervention designers of tackling FBC effectively and efficiently in Missouri. From all of this, MIR ratios could construct a significant opportunity in outlining and resolving the cancer disparities in Missouri.

There is a plan to Map the MIRs per SDGCs in the near future. The mapped MIR ratios could be used to locate areas in need of suitable, intensive, extra consideration.

According to the current study and previous studies' results, there is an extreme need to conduct further evidence-based research exploring cancer comorbid diseases, social, behavioral, and environmental risk factors which might lead to the health disparities among diagnosed cancer cases.

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