Demographic differences and annual trends in childhood and adolescent cancer incidence and mortality in Michigan during the period 1999-2012

Gergana Damianova Kodjebacheva, Ph.D., University of Michigan-Flint
Jeremy Blankenship, MPA, University of Michigan-Flint
Lenwood W. Hayman, Jr., Ph.D., University of Michigan-Flint
Shan Parker, Ph.D., MPH, University of Michigan-Flint

ABSTRACT

Background. Michigan has declining economic conditions and factories that release pollutants. During the period 1999-2012, only 10 out of 50 states had an overall cancer incidence rate that was higher than that in Michigan. It is not known how children’s cancer rates in Michigan vary by age, gender, race/ethnicity, and year as well as how these rates compare to those in the U.S.

Method: The Center for Disease Control and Prevention WONDER database obtained cancer incidence and mortality data from cancer registries and death certificates. We compared age-adjusted incidence and mortality cancer rates by gender, race/ethnicity, and year for children and adolescents aged 0 to 19 years in Michigan and the U.S. for the period 1999-2012.

Results. Males in Michigan had higher incidence rates of cancer than females in both Michigan and the U.S. Non-Hispanic Whites had higher cancer incidence rates than people of all other races/ethnicities in Michigan. The childhood cancer incidence rates increased for all racial/ethnic groups except for Hispanic Whites in Michigan during the period 1999-2012. Incidence rates increased more so in Michigan compared to the U.S. for some racial/ethnic groups such as non-Hispanic Whites during the period 1999-2012. Hispanic Whites in all age categories had higher cancer mortality rates than people of all other races/ethnicities in Michigan. Mortality rates for both males and females exhibited a downward trend from 1999 to 2002 in both Michigan and the U.S.

Conclusions. Males, non-Hispanic Whites, and Hispanic Whites tended to be disproportionately affected by cancer in Michigan. Future research should investigate the relationship of genetic determinants, socio-economic factors, prenatal behaviors, and air pollution with cancer rates among racial/ethnic groups in Michigan.

Keywords: childhood cancer, race/ethnicity, age, gender, health disparities, geography
INTRODUCTION

According to the American Cancer Society, cancer is the spread of abnormal cells, which, if not controlled, may lead to death (2014a). Cancer is the leading cause of disease-related death in children and adolescents (American Cancer Society, 2014b). In 2013, there were approximately 11,600 new cases of pediatric cancer in the U.S. (National Cancer Institute, 2015). According to estimates, 1 in 285 children in the U.S. will be diagnosed with cancer before turning 20 (American Cancer Society, 2014a).

Most available epidemiological data on cancer incidence and mortality referenced adults rather than pediatric populations. The majority of cancer pediatric studies focused on the U.S. as a whole. Prior research found that cancer incidence and mortality rates among children and adolescents varied over time, by demographic factors and by region. For example, using the Surveillance, Epidemiology, and End Results (SEER) Program registries, Smith et al. (2010) reported that childhood cancer incidence rates increased from 1975 to 2006, while childhood cancer mortality rates decreased during the same period.

Other research focused on racial/ethnic differences in childhood cancer (American Cancer Society, 2014c). While African American children/adolescents had a lower incidence of cancer, they tended to have a similar mortality rate compared to other racial/ethnic groups. The highest incidence rates of childhood and adolescent cancer were among Non-Hispanic Whites and Hispanics (American Cancer Society, 2014a; American Cancer Society, 2014c). Incidence and mortality rates for childhood cancer are lower in females than males in the U.S. (American Cancer Society, 2014c).

In addition to racial/ethnic and gender differences in the rates of cancer, prior research found that childhood cancer incidence rates varied significantly according to geography (Li, Thompson, Miller, Pollack, & Stewart, 2008). Based on data from 39 National Program of Cancer Registries and 5 SEER statewide registries, children residing in the Northeast had the highest incidence rate of all geographic regions in 2001-2003 (Li, Thompson, Miller, Pollack, & Stewart, 2008). Pollack, Stewart and Thompson (2008) reported that in the U.S., even though there were overall reductions in childhood cancer mortality, declines were unequal across regions. Decreases in regional mortality rates from 1990 to 2004 were 2.1% per year in the Midwest, 1.8% per year in the South and Northeast, and 1.4% per year in the West (Pollack, Stewart, & Thompson, 2008). These prior studies on regional disparities provide a rationale for studying geographic disparities in cancer.

Limited research on childhood cancer disparities in Michigan has been conducted. Michigan is known as the center of the U.S. automotive industry since it is the home to the country's three major automobile companies. Michigan has experienced a significant economic decline in part due to the closure of many automobile manufacturing plants over the past 20 years. In 2009, 44% of children lived in low-income families (below 200% of the federal poverty level) in Michigan, compared 42% in the U.S. (Michigan 2011 Critical Health Indicators, 2011). Poverty rates increased in children of all racial/ethnic groups in Michigan. For example, the poverty rates (percentages of people living below the poverty level) among non-Hispanic White children aged under the age of 18 increased from 12% in 2005 to 17% in 2012. Those among Hispanic or Latino children increased from 27% in 2005 to 35% in 2012. The poverty rates among Black or African American children aged under the age of 18 increased from 43% in 2005 to 51% in 2012 (Kids Count Data Center, 2015). In addition, parts of Michigan experience increased air pollution. The Detroit-Warren-Flint, MI area was ranked one of the 25 most...
polluted U.S. cities by year-round particle pollution in 2011 (Centers for Disease Control and Prevention, 2016). Economic and environmental conditions in Michigan, which may be risk factors for poor health, provide the rationale for comprehensive cancer research in Michigan.

Over the period 1999 to 2012, for all cancers (adult and childhood), Michigan had an age-adjusted cancer rate of 500.8 per 100,000 compared to the U.S. rate of 474.5 per 100,000. Only 10 states had an overall cancer incidence rate that was higher than that in Michigan. It is not known how children’s cancer rates in Michigan vary by age, gender, race/ethnicity, and year as well as how these rates compare to those in the U.S.

Research related to cancer in Michigan is needed to generate hypotheses for future studies, understand what groups have greatest needs for interventions, develop interventions to prevent and treat childhood cancer, and increase awareness about childhood cancer. The objective of the current research, therefore, is to assess demographic and yearly differences in cancer incidence and mortality among children and adolescents aged 0 to 19 in Michigan. Another objective is to compare the cancer rates in Michigan to those in the U.S.

METHODS

The CDC Wonder Database

The study used the Center for Disease Control and Prevention (CDC) Wide-ranging ONline Data for Epidemiologic Research (Wonder) Database to compare cancer incidence and mortality rates among children and adolescents aged 0 to 19 from 1999 to 2012 in Michigan and the U.S. The year 2012 was the last year with available data at the time this study was published. The data in WONDER are provided by the CDC’s National Program of Cancer Registries (NPCR), the National Cancer Institute SEER program, and the CDC’s National Vital Statistics System (NVSS) (Centers for Disease Control and Prevention, 2016). In the database, the age-adjusted childhood cancer incidence and mortality rates are rates per 100,000 (Centers for Disease Control and Prevention, 2016).

The cancer incidence data used in WONDER are obtained from NPCR and SEER. Medical facilities such as hospitals, doctor’s offices, and pathology laboratories deposit the data in cancer registries. State cancer registries using Registry Plus™ software, send the demographic and incidence data to NPCR and SEER each year (Centers for Disease Control and Prevention, 2013). Mortality data are provided by the NVSS through the Mortality Medical Data System, which is used to enter and classify cause of death on death certificates (Centers for Disease Control and Prevention, 2010).

Demographic and year variables

Childhood cancer data in the WONDER dataset are available by the child’s age, gender, year, and race/ethnicity. Age groups include 0 to 19 years, 0 to 14 years, and 15 to 19 years. Race/ethnicities are classified as: White, Black, American/Indian or Alaskan Native, Asian, and Native Hawaiian or Pacific Islander. Ethnicities are classified as Hispanic and Not Hispanic (Centers for Disease Control and Prevention, 2016). Our study did not report on rates in Native Hawaiian and Pacific Islanders due to a low number of cases. The CDC protects the identities of individuals by suppressing data counts that are below a specified cut-off value (Table 1).

Analysis

The data were obtained by submitting queries in the CDC Wonder Cancer webpage. The results of the queries were exported in a .txt file, which was then imported into Microsoft Excel to generate tables, charts, and graphs. We first compared the incidence and mortality rates for
multiple variables (overall, gender, and race/ethnicity) and grouped them by age groups (0 to 19, 0 to 14, and 15 to 19) for the U.S. and Michigan. Most data on Hispanic and non-Hispanic Asian Pacific Islanders and American Indian/Alaska Natives were suppressed. We, therefore, compared the age-adjusted incidence rates for childhood cancer for each race excluding ethnicity for the U.S. and Michigan in order to provide more detail on Asian Pacific Islanders and American Indians/Alaska Natives.

We then investigated yearly changes in incidence and mortality from 1999 to 2012. First, a chart demonstrated trends in the yearly age-adjusted incidence rates of childhood cancer in the U.S. and Michigan. We presented yearly changes of childhood cancer incidence by race/ethnicity in Michigan and the U.S. A chart demonstrated yearly trends in incidence by gender in Michigan and the U.S. A chart compared the yearly changes of childhood cancer mortality in the U.S. and Michigan. Another chart showed the yearly changes in mortality rates by gender in the U.S. and Michigan. Sufficient data to present yearly changes in mortality rates by race/ethnicity were not available.

RESULTS
Gender differences in cancer incidence and mortality
Males in all age categories had higher cancer incidence and mortality rates than females in Michigan (Table 1). The childhood cancer incidence rate from 1999 to 2012 was higher in Michigan than the U.S. for both males (19.1 per 100,000 in Michigan versus 18.2 per 100,000 in the U.S.) and females (17.6 per 100,000 in Michigan versus 16.4 per 100,000 in the U.S.) (Table 1). Mortality rates for children and adolescents aged 0 to 19 were the same in the two genders in Michigan and the United States (Table 1). The highest mortality rate in Michigan was seen in males aged 15 to 19.

Racial/ethnic differences in cancer incidence and mortality
Non-Hispanic Whites in all age categories had higher cancer incidence rates than children and adolescents of all other races/ethnicities in MI (Table 1). Hispanic Whites in all age categories had higher cancer mortality rates than people of all other races/ethnicities in MI. The mortality rate for Asian and Pacific Islanders was higher in Michigan (2.9 per 100,000) than in the U.S. (2.3 per 100,000) (Table 1).

Overall yearly childhood cancer incidence and mortality
Childhood cancer incidence rates increased over the years in both Michigan and the U.S. (Figure 1). Between 1999 and 2012, the incidence rates for childhood cancer increased from 15.9 per 100,000 to 20.7 per 100,000 in Michigan and from 16.0 per 100,000 to 18.0 per 100,000 in the U.S. (Figure 1). Michigan had higher cancer incidence rates than the U.S. for most of the years (Figure 1).
Table 1: Childhood Cancer Incidence and Mortality Rates by Gender and Age Groups, U.S. and Michigan (MI), 1999 to 2012

<table>
<thead>
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<th>Ages Birth to 14</th>
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<th>Ages 15 to 19</th>
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S = Suppressed by CDC
Data were also suppressed for all groups of Hispanic Asian Pacific Islanders and Hispanic American Indian Alaskan Natives in MI
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Figure 1: Yearly Incidence Rates of Age-Adjusted Childhood and Adolescent Cancer for Children and Adolescents Aged 0 to 19 in Michigan and the U.S., 1999-2012

The cancer mortality rates for Michigan and the U.S. decreased between 1999 and 2011 (Figure 2). The U.S. demonstrated a consistent and steady decrease in mortality rates from 2.8 per 100,000 for the period 1999-2002 to 2.3 per 100,000 for 2009-2011. Michigan did not have a consistent decline; rates tended to fluctuate. There was an increase in mortality rates from 2.3 per 100,000 in 2011 to 2.4 per 100,000 in 2012 in the U.S. In Michigan, the mortality rates increased from 2.3 per 100,000 in 2011 to 2.6 per 100,000 in 2012.

Yearly changes in incidence by race/ethnicity

The childhood cancer incidence rates increased for all racial/ethnic groups except for Hispanic Whites from 1999 to 2012 in Michigan. Incidence rates increased more so in MI compared to the US for some racial/ethnic groups (Table 2). For example, the U.S. non-Hispanic White incidence rate increased from 16.9 per 100,000 in 1999 to 19.2 per 100,000 in 2012; the Michigan childhood cancer incidence rate for the same group increased from 16.7 per 100,000 to 21.5 per 100,000. The incidence rate for non-Hispanic Blacks across the U.S. increased from 12.2 per 100,000 in 1999 to 13.9 per 100,000 in 2012 while the Michigan rate for the same group increased from 11.9 per 100,000 to 17.2 per 100,000 (Table 2).
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Figure 2: Yearly Mortality Rates for Age-Adjusted Childhood and Adolescent Cancer for Children and Adolescents Aged 0 to 19, in Michigan and the U.S., 1999-2012

United States Cancer Statistics: 1999 - 2012 Mortality, WONDER Online Database. United States Department of Health and Human Services, Centers for Disease Control and Prevention
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Table 2: Yearly Changes of Childhood Cancer Incidence Rates by Race/Ethnicity in Michigan and the U.S., 1999 to 2012

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S = Data Suppressed by CDC

United States Cancer Statistics: 1999 - 2012 Incidence, WONDER Online Database. United States Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute

Yearly differences in cancer incidence and mortality by gender

Both males and females in Michigan and the U.S. experienced an upward trend in incidence rates from 1999 to 2002 (Figure 3). The male cancer incidence rate increased from 16.7 per 100,000 in 1999 to 21.7 per 100,000 in 2012 in Michigan (Figure 3). The female cancer incidence rate increased from 14.9 per 100,000 in 1999 to 19.6 per 100,000 in 2012 in Michigan (Figure 3). In 2012, Michigan males had a higher cancer incidence rate (21.7 per 100,000) compared to males in the U.S. (18.8 per 100,000) (Figure 3). In 2012, Michigan females also had a higher cancer incidence rate (19.6 per 100,000) than U.S. females (17.1 per 100,000) (Figure 3). Mortality rates for both males and females exhibited a downward trend from 1999 to 2002 in both Michigan and the U.S. (Figure 4).
Figure 3: Yearly Incidence Rates for Age-Adjusted Childhood and Adolescent Cancer for Children and Adolescents Aged 0 to 19, by Gender, in Michigan and the U.S., 1999-2012

United States Cancer Statistics: 1999 - 2012 Incidence, WONDER Online Database. United States Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute
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Figure 4: Yearly Mortality Rates for Age-Adjusted Childhood and Adolescent Cancer for Children and Adolescents aged 0 to 19, by Gender, in Michigan and the U.S., 1999-2012

United States Cancer Statistics: 1999 - 2012 Mortality, WONDER Online Database. United States Department of Health and Human Services, Centers for Disease Control and Prevention

DISCUSSION

Over the period 1999 to 2012, Michigan had an age-adjusted childhood cancer rate of 18.3 per 100,000, which was higher than the United States rate of 17.3 per 100,000. Only eight states had a higher incident rate of childhood cancer. Males, non-Hispanic Whites, and Hispanic Whites tended to be disproportionately affected by cancer in Michigan. In addition, several rates and trends related to childhood cancer were worse in Michigan than the U.S. Higher cancer incidence rates in Michigan compared to the U.S. existed for childhood cancer incidence overall and among males, females, and non-Hispanic Whites. Hispanic Whites in Michigan had higher cancer mortality rates than those in the U.S.

Overall, our results confirm the conclusions of other studies that there has been a steady increase in childhood cancer incidence rates while simultaneously there has been a decline in mortality rates. Declines in mortality may be explained by progress in and wide dissemination of treatments for pediatric cancers (Smith, Altekruse, Adamson, Reaman, & Seibel, 2014). Some Michigan children, however, did not benefit as much from treatment advancements and diffusion during some of the study years since the decline in mortality over the years was not as consistent in the state as it was across the U.S.

Most children and adolescents in Michigan are non-Hispanic White, non-Hispanic
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African American, and Hispanic. For example, in 2010, the racial/ethnic distribution of children and adolescents aged 0 to 19 in Michigan was as follows: 68.7% non-Hispanic White, 16.6% non-Hispanic Black, 7.2 Hispanic, 0.6% non-Hispanic Native American, 0.6% non-Hispanic Asian, 0.02% non-Hispanic Pacific Islander, 0.19% non-Hispanic other race, and 4% non-Hispanic multi-racial (Michigan Department of Technology, Management and Budget, 2010). The finding that non-Hispanic Whites tend to have high rates of childhood cancer compared to other racial/ethnic groups is consistent with prior research (Li, Thompson, Miller, Pollack, & Stewart, 2008; Ward, DeSantis, Robbins, Kohler, & Jemal, 2014). It is concerning that in Michigan childhood cancer incidence rates for non-Hispanic Whites increased from 16.7 per 100,000 in 1999 to 21.5 per 100,000 in 2012. In the U.S., the white non-Hispanic incidence rate increased from 16.9 per 100,000 in 1999 to 19.2 per 100,000 in 2012. Future research should investigate reasons for the elevated cancer incidence rates among non-Hispanic Whites in Michigan. One potential explanation is the greater predispositions to some types of cancer among non-Hispanic Whites than other groups. Future research should investigate the influence on cancer of other contributing factors such as residing in areas with poor air quality. While non-Hispanic Whites had among the highest incidence rates of cancer, they had among the lowest mortality rates in all age groups (ages 0 to 19, 0 to 14, and 15 to 19). These data support the conclusion that Non-Hispanic Whites benefited from available cancer treatments.

Hispanic Whites in all age categories had higher cancer mortality rates than people of all other races/ethnicities in Michigan. One explanation could be limited access to care among Hispanic Whites. Poverty rates among Hispanic or Latino children increased from 27% in 2005 to 35% in 2012 in Michigan (Kids Count Data Center, 2015). Despite significant increases in the rates of poverty, the overall mortality rate in non-Hispanic Blacks in the 0 to 19 age category was the same as that in Hispanic Whites in Michigan. The mortality rates for non-Hispanic Blacks, however, fluctuated more so than those for non-Hispanic Whites. The mortality rates for non-Hispanic Whites ranged from 11.8 per 100,000 to 14.2 per 100,000 between 1999 and 2012. Those for non-Hispanic Blacks ranged from 10.0 per 100,000 to 17.9 per 100,000. The mortality rates increased from 13.6 per 100,000 in 2011 to 17.2 per 100,000 in 2012 for non-Hispanic Blacks. Prior studies found that African Americans had higher cancer mortality than non-Hispanic Whites; they provided potential determinants that may explain the disparity such as differences in metabolism of drug therapies, tumor characteristics, late cancer detection, and socio-economic barriers to treatment (Siegel, Miller, & Jemal, 2015; Pui, Mullighant, Evans, & Reiling, 2012; Linabery & Ross, 2008). Future research should investigate the relationship of these determinants and other issues such as religiosity/spirituality and low health literacy with mortality among racial/ethnic groups in Michigan.

Gender disparities existed where males in Michigan had higher incidence rates of cancer than females in both Michigan and the United States. The finding on the higher incidence rates of cancer in males is consistent with prior research (Dorak & Karpuzoglu, 2012; Pearce & Parker, 2001; Linet & Devesa, 1991; Desandes et al., 2004; Ries, Smith, Gurney, Linet, & Young 1999). Differences in incidence by gender may be attributed to physiological differences, differences in the regulation of gene expression, and epigenetic mechanisms (Dorak & Karpuzoglu, 2012). Epigenetic mechanisms refer to non-genetic (i.e. external/environmental) influences on gene expression. Future research should investigate gender differences in any associations of economic, behavioral, and environmental factors with cancer.
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It is not known what the causes of cancer are in this study. According to the NCI, approximately 5 percent of childhood cancers are due to inherited mutations. Most cancers in children and adults start from a mutation in genes that leads to uncontrolled cell growth (National Cancer Institute, 2015). Environmental exposures such as cigarette smoke, asbestos, and ultraviolet radiation may cause mutations in adults. It is more difficult to point to environmental causes for childhood cancers because childhood cancer is rare. In addition, it is difficult to determine exposures that lead to cancer during early development. Investigations on the association of parental exposure to chemicals, child contact with infectious agents, and residence in proximity to nuclear power plants to cancer have shown inconsistent results (National Cancer Institute, 2014). Determinants that have a more definitive relation to pediatric cancer are maternal exposure to ionizing radiation and maternal use of diethylstilbestrol (nonsteroidal estrogen) during pregnancy (Anderson, Diwan, Fear, & Roman, 2000). Researchers should use birth certificates to investigate the link between reproductive health and cancer disparities in Michigan.

Possible factors that could help explain some of the higher rates in Michigan than the U.S. overall may be socioeconomic status (SES) and environmental pollution. The percentage of persons below the poverty level in Michigan is higher than that in the United States (United States Census, 2015). According to the Michigan Recession and Recovery Study, local residents have been subjected to layoffs, furloughs, and wage cuts (Gould-Werth and Burgard, 2012). Unemployment continues to be a major problem in Michigan (Gould-Werth and Burgard, 2012). According to the American Cancer Society, lower socioeconomic status is highly correlated with cancer presence and poor outcomes in adults; findings on financial distress and cancer in children, however, are conflicting and more research is needed (American Cancer Society 2014a).

A potential reason for some of the elevated cancer rates in Michigan may be air pollution. An example of an area with high pollution levels is the Detroit metropolitan area. The prevalence rates of cardiovascular diseases and asthma among children are higher in the city of Detroit than in the rest of the state (Assaf, 2014). These negative childhood health outcomes have been associated with poor air quality. The Detroit study focused on cardiovascular diseases and respiratory diseases but did not discuss cancer. In addition, Michigan has automobile factories, steel plants, and other factories that affect air quality. The Steel Plant in Dearborn, for example, releases many toxins into the atmospheres and is known as “one of metro Detroit’s biggest polluters” (Matheny, 2014). Poor air quality is associated with negative health outcomes such as cancer (Environmental Protection Agency, 2015).

Our study has several limitations. One limitation is that data were suppressed for several racial/ethnic groups. Another limitation is the lack of variables such as income, maternal health, birth weight, access to care, timeliness of diagnosis, child-parent-physician communication, toxic exposure, and parental awareness of cancer that may help understand the reasons for the elevated rates of cancer. Another disadvantage is that the study did not investigate differences in smaller geographic regions within Michigan. The study did not investigate proximity of geographic clusters in cancer incidence and mortality to sources of environmental pollution. The study did not investigate differences in incidence and mortality by cancer type. The latest available year for cancer data in WONDER was 2012.
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CONCLUSION
The current study helps increase awareness about regional cancer disparities in the US as well as childhood cancer in Michigan. There is limited funding for pediatric cancer research in the U.S. (Read, 2013). There is also a lack of public knowledge regarding childhood cancer. A poll found that many Americans did not realize that pediatric cancer was the leading cause of disease-related death in children (Alex’s Lemonade Stand Foundation, 2015). To promote children’s health and well-being, studies are needed to understand the reasons for disparities in cancer and develop interventions that decrease these disparities. Since childhood cancer is rare, large-scale studies that include multiple cancer centers in Michigan may be needed to understand disparities.

REFERENCES
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