ABSTRACT

Purpose: A national study found that infants born in low socioeconomic areas had the worst infant mortality rates (IMRs) and the highest racial disparity. Racial disparities in birth outcomes are also evident in the city of Milwaukee, with African American infants at 3 times greater the risk than white infants. This study was conducted to examine the influence of socioeconomic status (SES) and race on birth outcomes in the city of Milwaukee.

Methods: Milwaukee ZIP codes were stratified into lower, middle, and upper SES groups. IMR, low birth weight, and preterm birth rates by race were analyzed by SES group for the years 2003 to 2007.

Results: The overall IMR for the lower, middle, and upper SES groups were 12.4, 10.7, and 7.7, respectively. The largest racial disparity in IMR (3.1) was in the middle SES group, versus lower (1.6) and upper (1.8) SES groups. The overall percent of low birth weight infants for the lower, middle, and upper SES groups was 10.9%, 9.5%, and 7.5%, respectively. Racial disparity ratios in low birth weight were 2.0, 1.9, and 1.9 for lower, middle and upper SES groups. The overall percent of preterm birth was 15.4%, 13.2%, and 10.6% of births within the lower, middle, and upper SES groups, respectively, with a disparity ratio of 1.6 across all SES groups.

Conclusions: For all outcomes, African American infants born in the upper SES group fared the same or worse than white infants born in the lower SES group.

Although higher SES appeared to have a protective effect for whites in Milwaukee, it did not have the same protective effect for African Americans.

INTRODUCTION

Infant mortality and poor birth outcomes are major public health issues in the United States that disproportionately affect African American families. In 2006, African American infants were 2.4 times more likely to die within their first year than white infants. The leading cause of death for African American infants was low birth weight and preterm birth-related disorders, whereas the leading cause of death for white infants was congenital malformations, deformations, and chromosomal abnormalities. African American infants were 1.6 times more likely to be born preterm and 1.9 times more likely to be low birth weight.

Among 42 reporting states for the years 2003 to 2005, Wisconsin had the second highest African American infant mortality rate (IMR) at 16.4 deaths per 1000 live births—approximately 3 times the rate for Wisconsin whites. The city of Milwaukee, home to over half (63%) of the African American population in Wisconsin, experiences similar racial disparities. Between 2003 and 2007, Milwaukee’s African American infants were 3 times more likely to die within their first year of life than white infants, with IMRs of 16.2 and 5.1, respectively. These racial disparities have remained consistent over the past 15 years. In 2007, the leading cause of African American infant deaths in the city of Milwaukee was disorders related to low birth weight and preterm birth. Ngui and colleagues reported that from 1993 to 2006, African American women were 3 times more likely to have low birth weight and preterm infants than white women.

In an effort to further understand the factors contributing to these longstanding racial disparities in birth outcomes, Johnson and Katcher investigated the connection between racial disparities in infant mortality and education (1 indicator of socioeconomic status [SES]) in Wisconsin. They found that between 2002...
and 2004, African American women with education beyond high school were still 3.9 times more likely than their white counterparts to experience an infant death (with IMRs of 15.7 compared to 4.0, respectively). In addition, African Americans with education beyond high school were still twice as likely to experience an infant death than white women who did not graduate from high school (with IMRs of 15.7 and 8.3, respectively). Vila et al examined health outcomes in the city of Milwaukee by SES and found that health disparities existed among all SES groups; in particular, the lower SES group was 1.9 times more at risk than the upper SES group of experiencing an infant death, with IMRs of 14.5 and 7.7, respectively.

The objective of this study was to further investigate the influence of SES and race on birth outcomes (mortality, low birth weight, and preterm birth) in the city of Milwaukee.

METHODS

Data Sources and Sample

SES Groups—Vila and colleagues’ methodology was used to categorize city of Milwaukee ZIP codes into lower, middle, and upper SES groups. Vila and colleagues obtained income and education data from the 2000 Census at the ZIP code tabulation area (ZCTA) level. They then calculated an SES index for each ZIP code composed of 2 equally weighted components: the median reported income and the percentage of people with a bachelor’s degree. Next, the average and standard deviation of educational level and income across all the ZIP codes were calculated, and a z-score was assigned to each ZIP code by taking the value for the ZIP code minus the average across all ZIP codes, divided by the standard deviation across all ZIP codes. Each z-score (for education and for income) was then averaged into 1 score, and ZIP codes were ranked and grouped based on this summary index to obtain the lower, middle, and upper SES groupings.

Birth Outcome Data—Birth outcome data were obtained from the Wisconsin Department of Health Services’ Wisconsin Interactive Statistics on Health (WISH) data query system, a publicly available data set that provides city of Milwaukee birth data at the ZIP code level. IMR, low birth weight, and preterm birth data were queried by race and ZIP code for the years 2003 to 2007. WISH defines IMR as the number of infant (less than 1 year old) deaths per 1000 live births, low birth weight as less than 2500 grams at birth, and preterm birth as birth following less than 37 weeks gestation.

ZIP Codes—A city of Milwaukee ZIP code boundary map was obtained from Dynamap. Data included 56,373 total births from 2003 to 2007, including 24 births that were missing Mother’s Race/Ethnicity data. This analysis focused specifically on the disparities between whites and African Americans in the city of Milwaukee. From 2003 to 2007, the Hispanic IMR was similar to the white IMR (6.5 and 6.6 per 1000, respectively) compared to an African American IMR of 16.4.

Procedure
Because the SES grouping was based on both income and education using Vila and colleagues’ z-scores, overlapping incomes were not felt to wash out any real differences between groups. The WISH data set was queried by birth outcome, race, and ZIP code. A disparity ratio was calculated for each SES group by dividing the white outcome into the African American outcome. To determine the extent that the racial groups and the SES groups were different from each other, Pearson chi-square tests were conducted for each birth outcome by race and by SES group with significance set at P < 0.05.

ArcGIS 9.2 was used to illustrate the extent of racial disparities across SES groups by setting the white rate as the norm for that SES group. Each ZIP code experiencing a racial disparity contains a circle that increases in size proportionally with the size of the disparity. No circle is shown within ZIP codes that either do not have a racial disparity, or where the disparity is in the opposite direction (ie, a higher rate for whites versus African Americans). The University of Wisconsin-Milwaukee Institutional Review Board reviewed this project (IRB number 09.196).

RESULTS

Birth data were not available via WISH for city of Milwaukee ZIP codes that reported fewer than 1000 births since 1989, and therefore those ZIP codes were excluded from this analysis. The SES level and racial makeup of these 5 excluded ZIP codes with fewer than 1000 births are described in Table 1.

SES Group
Our analysis included a total of 55,349 live births (33,559 in the lower, 15,739 in the middle, and 5061 in the upper SES group). Table 2 provides overall birth data for the city of Milwaukee from 2003 to 2007 by SES group. During this time, 625 infant deaths occurred (417 in the lower, 169 in the middle, and 39 in the upper SES group).
The percent of white low birth weight infants in the lower (7.2%) and middle (7.2%) SES groups was greater than the upper (5.7%) SES group. The percent of low birth weight African American infants in the lower SES group (14.2%) was greater than the middle (13.4%) and upper (11.0%) SES groups. Compared to whites, a consistently higher percentage of African American infants were born with low birth weight across all groups. Further, the percent of low birth weight African American infants in the uppermost SES group (11%) was still worse than the lowest white SES group (7.2%). The racial disparity ratios were similar across all SES groups at 2.0, 1.9, and 1.9 for the lower, middle, and upper SES groups, respectively. The racial disparity for all of Milwaukee combined was 2.2. Pearson chi-square tests revealed significant differences among SES groups by race and among racial groups by SES groups. These results are summarized in Table 4 and illustrated in Figure 2.

Preterm Birth
The overall percent of preterm birth was 15.4%, 13.2%, and 10.6% of births within the lower, middle, and upper SES groups, respectively. The percent of white preterm infants in the lower SES group (11.7%) was greater than the middle (10.6%) and upper (8.8%) SES groups. The racial disparity ratios were similar across all SES groups at 2.0, 1.9, and 1.9 for the lower, middle, and upper SES groups, respectively. The racial disparity for all of Milwaukee combined was 2.2. Pearson chi-square tests revealed significant differences among SES groups by race and among racial groups by SES groups. These results are summarized in Table 4 and illustrated in Figure 2.

Table 2. Births in the City of Milwaukee by Socioeconomic Status (SES) Group, 2003-2007

<table>
<thead>
<tr>
<th>SES Group</th>
<th>Lower</th>
<th>Middle</th>
<th>Upper</th>
<th>All Milwaukee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>53204, 53205, 53206, 53208, 53210, 53212, 53215, 53216, 53218, 53226, 53228</td>
<td>53207, 53209, 53214, 53219, 53220, 53221, 53224, 53225, 53227, 53233</td>
<td>53202, 53203, 53211, 53213, 53217, 53222, 53223, 53226, 53228</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>4760</td>
<td>6970</td>
<td>2866</td>
<td>15,967</td>
</tr>
<tr>
<td>African American</td>
<td>17,829</td>
<td>6059</td>
<td>1514</td>
<td>25,690</td>
</tr>
<tr>
<td>Hispanic</td>
<td>9221</td>
<td>1965</td>
<td>240</td>
<td>11,644</td>
</tr>
<tr>
<td>Other Race/Ethnicity</td>
<td>1743</td>
<td>738</td>
<td>441</td>
<td>3048</td>
</tr>
<tr>
<td>Missing</td>
<td>6</td>
<td>7</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>33,559</td>
<td>15,739</td>
<td>5061</td>
<td>56,373</td>
</tr>
</tbody>
</table>

a ZIP codes that have reported less than 1000 births are not reported in WISH and thus were not included in the current analysis.
percent of African American preterm infants in the lower SES group (18.4%) was greater than the middle (16.8%) and upper (14.3%) SES groups. A consistently higher percentage of African American infants were born preterm than whites across all SES groups. The uppermost African American SES group experienced a larger percentage of preterm births (14.3%) than the lowest white SES group (11.7%). The racial disparity ratios among all SES groups was 1.6. The racial disparity for all of Milwaukee was 1.7. Pearson chi-square tests revealed significant differences among SES groups by race: all races, $\chi^2 (2, 54359) = 66.43, P<.0001$; whites, $\chi^2 (2, 14596) = 7.94, P<.05$; and African Americans, $\chi^2 (2, 25402) = 13.38, P=.001$; and significant differences among racial groups by SES groups: lower, $\chi^2 (1, 22589) = 166.18, P<.0001$; middle, $\chi^2 (1, 13029) = 134.74, P<.0001$; and upper, $\chi^2 (1, 4380) = 39.96, P<.0001$.

Table 4. Number and Percent of Low Birth Weighta Births by Socioeconomic Status (SES) Group in the City of Milwaukee, 2003-20073

<table>
<thead>
<tr>
<th>SES Group</th>
<th>Lower (%)</th>
<th>Middle (%)</th>
<th>Upper (%)</th>
<th>All Milwaukee</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>343 (7.2)</td>
<td>503 (7.2)</td>
<td>164 (5.7)</td>
<td>16,835 (6.2)</td>
</tr>
<tr>
<td>African American</td>
<td>2535 (14.2)</td>
<td>809 (13.4)</td>
<td>167 (11)</td>
<td>4607 (13.6)</td>
</tr>
<tr>
<td>All Races</td>
<td>3654 (10.9)</td>
<td>1492 (9.5)</td>
<td>380 (7.5)</td>
<td>24,754 (7)</td>
</tr>
<tr>
<td>Disparity Ratio</td>
<td>2.0</td>
<td>1.9</td>
<td>1.9</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Note: Pearson chi-square tests revealed significant differences among SES groups by race: all races, $\chi^2 (2, 54359) = 66.43, P<.0001$; whites, $\chi^2 (2, 14596) = 7.94, P<.05$; and African Americans, $\chi^2 (2, 25402) = 13.38, P=.001$; and significant differences among racial groups by SES groups: lower, $\chi^2 (1, 22589) = 166.18, P<.0001$; middle, $\chi^2 (1, 13029) = 134.74, P<.0001$; and upper, $\chi^2 (1, 4380) = 39.96, P<.0001$.

a Low Birth Weight (LBW) is defined as an infant weighing <2500 grams at birth and is calculated as a percentage of each group.

DISCUSSION

For city of Milwaukee African Americans, the percent of low birth weight and preterm infants in the lower SES groups was greater than in the upper SES groups; for whites, the same or higher rates of poor birth outcomes were observed in the lower SES groups than the upper SES groups. Sims and colleagues12 found that across large US cities, larger disparities existed between African American and white IMRs in higher poverty areas than areas with low poverty. Our findings seem inconsistent with these results for both low birth weight and preterm birth outcomes. Although we found expected SES disparities in birth outcomes, we found that racial disparities were similar across all SES groups for low birth weight and preterm birth. We
may have better access to care and support during pregnancy, as well as better access to services for infants who were born low birth weight or preterm (and thus are at higher risk of infant death) than middle SES groups. For example, families in the upper SES group might have the income to be able to access higher-quality insurance programs and health care. African Americans in the lower SES group might be more likely to be eligible for insurance and health care that is available to low-income individuals. The middle SES group may have just enough resources to not qualify for low-income services, but still lack the resources to access higher-quality care. We plan to conduct this same analysis over a longer time period to determine the consistency of these findings.

Our study has several limitations. Vila et al noted a limitation in their method of dividing SES groups because they had to arbitrarily categorize ZIP codes with similar demographics to create the SES groups. For example, although median incomes for each group were different ($27,331, $38,897, and $49,089, for the lower, middle, and upper SES groups, respectively), the income ranges for the middle and upper SES groups were not mutually exclusive (middle SES incomes ranged from $32,980 to $42,586 while upper SES incomes ranged from $38,897 to $49,089). We are uncertain as to the reasons for this finding and plan to investigate it further. In looking at the number of infant deaths and births within each African American SES group, it appears that we have large enough numbers to detect a difference if one was present. One potential hypothesis is that the lower and upper SES groups further found that the largest racial disparity in IMRs existed between African Americans and whites in the middle SES group. In addition, the racial disparity in IMR in the lower and upper SES groups was similar (1.6 and 1.8, respectively). Based on our findings, it appears that poverty (high versus low) does not have an effect on IMR in the city of Milwaukee. Although the racial disparity did not seem to vary across SES groups in our analysis, nonetheless, the racial disparities were wide, so much so that for all 3 outcomes, even the uppermost African American SES group fared worse than the lowest white SES group. These findings are consistent with others’ findings that income and education are not necessarily protective factors against poor birth outcomes in the African American population.8,13

One surprising finding was that the African American middle SES group suffered the highest IMR compared to African Americans in the lower and upper SES groups. We are uncertain as to the reasons for this finding and plan to investigate it further. In looking at the number of infant deaths and births within each African American SES group, it appears that we have large enough numbers to detect a difference if one was present. One potential hypothesis is that the lower and upper SES groups

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**Figure 1.** Extent of racial disparity by socioeconomic status (SES) group in IMRs in the city of Milwaukee, 2003-2007.

**Figure 2.** Extent of racial disparity by socioeconomic status (SES) group in percent low birth weight in the city of Milwaukee, 2003-2007.
these infants was preterm- and low birth weight-related disorders, both of which are experienced at a much higher rate for African Americans than whites across all SES groups. In our study, although higher SES appeared to have a protective effect for whites, it did not have the same protective effect for African Americans. These findings may support an approach that targets African Americans across all SES groups for interventions to improve birth outcomes within the city of Milwaukee. In this way, we can most effectively address the consistent racial disparities across all SES groups.

Table 5. Percent of Preterm Births\(^a\) (PTB) by Socioeconomic Status (SES) Group in the City of Milwaukee, 2003-2007\(^3\)

<table>
<thead>
<tr>
<th>SES Group</th>
<th>Lower</th>
<th>Middle</th>
<th>Upper</th>
<th>All Milwaukee</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>559 (11.7%)</td>
<td>741 (10.6%)</td>
<td>253 (8.8%)</td>
<td>28,185 (10.4%)</td>
</tr>
<tr>
<td>African American</td>
<td>3278 (18.4%)</td>
<td>1019 (16.8%)</td>
<td>216 (14.3%)</td>
<td>5896 (17.4%)</td>
</tr>
<tr>
<td>All Races</td>
<td>5168 (15.4%)</td>
<td>2069 (13.2%)</td>
<td>537 (10.6%)</td>
<td>39,644 (11.1%)</td>
</tr>
<tr>
<td>Disparity Ratio</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Note: Pearson chi-square tests revealed significant differences among SES groups by race: all races, \(\chi^2 (2, 54359) = 66.43, P < .0001\); whites, \(\chi^2 (2, 14596) = 16.00, P < .0001\); and African Americans, \(\chi^2 (2, 25402) = 16.14, P < .0001\); and significant differences among racial groups by SES group: lower, \(\chi^2 (1, 22589) = 117.5, P < .0001\); middle, \(\chi^2 (1, 13029) = 156.60, P < .0001\); and upper, \(\chi^2 (1, 4380) = 30.65, P < .0001\).

\(^a\) Preterm Birth (PTB) is defined as a birth at <37 weeks of gestation and is calculated as a percentage of each group.

Figure 3. Extent of racial disparity by socioeconomic status (SES) group in percent preterm births in the city of Milwaukee, 2003-2007.

from $30,659 to $74,572). However, the percent of people with a college degree was very different between the middle (17.9%) and upper (40.1%) SES groups. Further, Pearson chi-square tests revealed significant differences across all groups, which may indicate that the groups were different enough for the purposes of our analysis. An additional potential limitation in our analysis is that 5 ZIP codes (1 in the middle and 4 in the upper SES group) used in the Vila paper to calculate SES were not included in this analysis due to the low number of births occurring in those ZIP codes. An alternative for future study would be to redistribute ZIP codes by SES group without including those ZIP codes. Further, our analysis did not address other important maternal factors affecting birth outcomes, such as cigarette smoking, birth weight, age, marital status, and use of prenatal care.

Opportunities for future research include exploring how SES and race interact with other factors that affect birth outcomes, including those noted above. In addition, it may be informative to explore further how factors such as low birth weight and preterm birth affect infant mortality in each SES group. For example, David and Collins identified disorders related to preterm birth as the leading cause of death for African American infants in the United States, but as the second leading cause of death (behind congenital malformations) for white infants. In addition, they suggest using a life-course approach to understanding racial disparities in birth outcomes. Such an approach considers early life disadvantages (such as the mother being born low birth weight) as well as exposure to lifelong stressors that include not only poverty or low SES, but also interpersonal racial discrimination and job strain.

CONCLUSIONS

African Americans of all SES groups experienced a higher rate of infant mortality than whites in the city of Milwaukee. Furthermore, the leading cause of death for these infants was preterm- and low birth weight-related disorders, both of which are experienced at a much higher rate for African Americans than whites across all SES groups. In our study, although higher SES appeared to have a protective effect for whites, it did not have the same protective effect for African Americans. These findings may support an approach that targets African Americans across all SES groups for interventions to improve birth outcomes within the city of Milwaukee. In this way, we can most effectively address the consistent racial disparities across all SES groups.
Table 6. Percent of Infant Deaths by Leading Causes of Death and Socioeconomic Status (SES) Group, 2003-2007

<table>
<thead>
<tr>
<th>SES Group</th>
<th>Lower (N=417)</th>
<th>Middle (N=169)</th>
<th>Upper (N=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>African White</td>
<td>African White</td>
<td>African White</td>
</tr>
<tr>
<td></td>
<td>American</td>
<td>American</td>
<td>American</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>Disorders relating to PTB &amp; LBW</td>
<td>1.3</td>
<td>14.6</td>
<td>X</td>
</tr>
<tr>
<td>Congenital malformations, deformations and chromosomal abnormalities</td>
<td>1.7</td>
<td>26.8</td>
<td>X</td>
</tr>
<tr>
<td>Sudden Infant Death syndrome (SIDS)</td>
<td>27.1</td>
<td>1.7</td>
<td>X</td>
</tr>
<tr>
<td>Other</td>
<td>27.1</td>
<td>14.6</td>
<td>X</td>
</tr>
</tbody>
</table>

PTB = Preterm birth; LBW = low birth weight; X = number is <5, which is not reported by WISH.

The leading cause of death for the white upper SES group was “newborn affected by maternal complications of pregnancy” at 29%.

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Financial Disclosures: None declared.

REFERENCES
Self- and Registry-Reported Cancer in a Population-Based Longitudinal Study

Barbara E. K. Klein, MD, MPH; Kristine E. Lee, MS; Scot E. Moss, MA; Amy Trentham-Dietz, PhD; Ronald Klein, MD, MPH

ABSTRACT

Purpose: To evaluate the concordance of cancer diagnosis from self- and registry reports.

Methods: Self-reported diagnosis information from participants in a cohort study was compared with linkage data from the Wisconsin Cancer Reporting System.

Results: Overall, there was good agreement between self- and registry-reported cancers, with 90% of all matches being considered an exact match. Concordance varied by cancer site; agreement was excellent for breast (85.4%) and prostate (78.9%) cancers.

Conclusions: While self-reported cancer diagnoses for some cancers such as breast and prostate cancer are important sources of information and may be reliable substitutes when registry data are incomplete or not available, a combination of self and registry reports with mortality information may yield the most accurate information about cancer for purposes of health care planning and conducting epidemiologic studies.

INTRODUCTION

Population-based data for cancers are needed to estimate prevalence and to project incidence of cancers for estimating health care burden, to plan for care, to investigate possible causal associations, and to examine whether cancer may be a risk factor or indicator of other conditions. Self-reported information on cancer may be the only source of data in circumstances when cancer registry data are not available. In addition, self-reports may supplement deficits in registry data even when such data exist.

Other investigators have evaluated the concordance of self-reported cancer and cancer registry data. Parikh-Patel and colleagues used information from a mail survey\(^1\) and both Desai and colleagues\(^2\) and Simpson and colleagues\(^3\) used data from in-person interviews to compare to registry information. In the study by Desai et al, the odds ratio (OR) for false negative reporting of cancer history was 10.00 (95% CI 1.65, 60.45) for non-whites compared to whites. In addition, the odds ratios for false-negative reporting went up with increasing age category; the ORs were 3.04 (0.76, 12.16), 2.29 (0.82, 6.42), 4.18 (1.46, 11.97), and 10.06 (2.55, 39.73) for age groups 18-44, 65-74, 75-84, and \(\geq 85\) respectively, compared to those 45-64 years of age. In the study by Simpson et al, specifics of false negative rates of reporting by ethnicity and age were not given. However, the authors write that kappa scores used to compare self-reported condition with physician record of the medical conditions did decrease with age, but for diseases with excellent agreement (of which cancer was an example) age did not affect agreement. Specific effects of race/ethnicity on agreement were not given.

Incidence of cancers by self-report was obtained from volunteers in the American Cancer Society’s Cancer Prevention Study II and was compared against incidence obtained from cancer registries.\(^4\) The investigators found that some registries under-ascertained cancer cases. Longitudinal data from population-based cohorts may be especially useful in evaluating the consistency of self-reports over time. Also, the number of cancer cases is likely to go up with the increasing age of the population under study, and this is likely to improve estimates of the relationship of age to specific cancer sites from both sources of data. We examined self-reported data across four 5-year intervals from the Beaver Dam Eye Study population and compared the concordance between self- versus registry-reported diagnoses as well as the effects of demographic characteristics on the method of reporting.
The mission of the Wisconsin Medical Journal is to provide a vehicle for professional communication and continuing education of Wisconsin physicians.

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