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Community-level characteristics of high infant mortality: A tool to identify at-risk communities

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ABSTRACT

Infant mortality (IM) rate is a key indicator of population health and has been gradually improving in the United States. However, it is still a public health problem among minority and low-income communities. Maternal factors explain some of the variation, but community-level factors may also be a contributor. This study examines measures to identify a set of indicators that explain variations in IM at the community-level. Data for 77 communities in a city were obtained from local health databases. We used multivariable linear regression models to examine the strength of the association between IM and maternal, population, community wealth, and social capital characteristics. Community-level IM rates ranged from 2.1 – 25.6 deaths per 1,000 live births in 2000-2002. The final model explained 75% of the variation in IM rates at the community-level (R^2=0.75). The model included a high percentage of low birth weight babies, a decline in mothers who began prenatal care in the second trimester, an increase in the percentage of Hispanics, increased unemployment rates, an increase in the percentage of veterans, an increased rate of foreign-born residents, and smaller average family sizes. Social capital variables, homicide rate and vacant housing, were also significant in the final model. Identifying communities at risk for high IM rates is imperative to improve maternal and child health outcomes because of shortages in public health resources. The development of a parsimonious set of community-level indicators can assist public health practitioners in targeting their resources to prevent infant mortality in high-risk communities.

Keywords: Infant mortality, Community health, Community characteristics

INTRODUCTION

Infant mortality (IM) is a population health indicator and has been gradually decreasing in the United States (United States Department of Health and Human Services, 2014). However, it remains a problem for minority and low-income populations (Bryant, Worjoloh, Caughey, & Washington, 2010; MacDorman & Mathews, 2011). Maternal risk factors explain some of the disparities for these groups; however, community-level risk factors may also be a contributor

(Matteson, Burr, & Marshall, 1998). Targeting interventions for communities at the highest risk is imperative as states renew their efforts for prevention of IM. This study examined predictive characteristics of a large number of aggregate maternal, population, and social measures, and identified a parsimonious set of indicators that may be useful for targeting the communities at the highest risk for programs to prevent IM.

There is ample research investigating maternal risk factors for IM. This includes lack of prenatal care, low educational attainment, and poverty (Coulton, Korbin, Su, & Chow, 1995; MacDorman & Mathews, 2011; Matteson et al., 1998; Sims, Sims, & Bruce, 2007). Low birth weight (LBW) (MacDorman & Mathews, 2011; Wilcox & Skjaerven, 1992), as well as maternal age (Davis, 1988; MacDorman, 2011) and unhealthy behaviors during pregnancy are also IM risk factors (MacDorman & Mathews, 2011; Sims et al., 2007). Racial/ethnic differences do exist in IM, with non-Hispanic black mothers being at the highest risk (Bryant et al., 2010; Hauck, Tanabe, & Moon, 2011; MacDorman, 2011).

To date, few studies have identified community-level risk factors for IM (Bryant et al., 2010; Matteson et al., 1998; Sims et al., 2007). Economic and social capital indicators may be associated with community-level IM rates (Coulton et al., 1995; Matteson et al., 1998; Sims et al., 2007). Community wealth is an economic measure that includes the number of owner-occupied households, home values, and household income (Kaufman, Dole, Savitz, & Herring, 2003). Social capital describes neighborhood cohesion and available resources (financial and non-financial). Social capital measures include crime rate (Hendryx, Ahern, Lovrich, & McCurdy, 2002; K. Lochner, Kawachi, & Kennedy, 1999; K. A. Lochner, Kawachi, Brennan, & Buka, 2003; Sampson, Raudenbush, & Earls, 1997) and the presence of vacant housing (Coulton et al., 1995).

METHODS

Data Source

An analysis of publicly available data for Chicago's 77 community areas was conducted (Chicago Department of Public Health, n.d.). Data was from the City of Chicago's web-based open data portal. The data is collected by the Chicago Department of Public Health's (CDPH) Epidemiology & Public Health Informatics Program. The CDPH collates data at the community level from multiple sources, including death certificates from the Illinois Department of Public Health and the U.S. Census Bureau, using geocoding. Variables in the database provide information on community-level natality, mortality, demographic, economic, and social characteristics.

Variables

Variables were downloaded based on the review of the literature of factors that could potentially influence community-level IM rates. The dependent variable was IM rate, which was operationally defined as the average community-level mortality rate of infants under one year of age per 1,000 live births from 2000-2002. Mortality rates were collected by CDPH from the state department of public health. Independent variables were downloaded for maternal, population, community wealth, and social capital characteristics.

A. Material:

Teen birth rate variable was the average births per 1,000 females aged 15-19 years from 2000-2002. The LBW variable (infants born < 2,500 grams) was the average three-year percentage of LBW babies from 2000-2002. The start of prenatal care during pregnancy (first,

second, and third trimesters) and the receipt of no prenatal care was the three-year percentage from 2000-2002.

B. Population:

Community-level population (sociodemographic) characteristics were based on 2000 census data. Percentages of racial/ethnic groups were downloaded for non-Hispanic Blacks, non-Hispanic Whites, Hispanics, and Asians. Educational attainment variables included the percent of the community with less than a 9th grade education and 9th-12th grade education, as well as the percent of the community who were high school graduates and college graduates. Poverty rates were defined as the percent of the community living below the federal poverty line in 1999; rates were downloaded for families and families with children under 5 years of age. Additional variables based on 2000 census data that were downloaded included: percent unemployed; percent of foreign-born residents; the average family size; and the percent of the community who were veterans of the U.S. armed forces.

C. Community wealth:

Variables that measured community-level wealth were based on 2000 census data. Variables included per capital income (dollars) and median household income (dollars). Variables focused on housing included: the percentage of owner-occupied housing units in the community; the percentage of homes valued less than $50,000; and the median home value (dollars).

D. Social capital:

Community-level social capital variables included the homicide rate per 100,000 persons in 2000 (source: death certificates) and the percent of vacant housing (source: 2000 census).

Data Analysis

Descriptive statistics were computed for dependent and independent variables. Means, standard deviations, and ranges were used to describe characteristics for all 77 communities, i.e., the city of Chicago. Multivariable linear regression was used to examine the strength of the association between community-level IM rates and a priori selected independent variables (e.g., community-level maternal, population, wealth, and social capital characteristics). Models were first computed for each domain independently (material, population, community wealth, and social capital) and reported. The final model was computed using variables from all four domains. Independent variables were entered manually by backward selection to determine the best overall model. Statistical significance was indicated by $p<0.05$. Statistical analyses were performed using SAS version 9.3 (SAS Institute Inc., Care, NC).

This study did not require review from an institutional review board because it was classified as non-human subjects research.

RESULTS

Descriptive statistics are summarized in Table 1. The average IM rate for all communities was 9.4 deaths per 1,000 live births (standard deviation [SD] ±4.8; range: 2.1, 25.6). Among infants born, 10% were of LBW (<2,500 grams) (SD±3.4; range: 5.3, 16.8). More than half of women started prenatal care in the first trimester (76.7%; SD±7.3; range: 59.1, 94.8), compared to 2.2% of women who did not receive any prenatal care (SD±1.7; range: 0.1, 7.7).

Table 1. Descriptive statistics for maternal, population, community wealth and social capital characteristics (N=77)

Characteristic	Mean (SD)	Range
Maternal		
Infant mortality rate[a]	9.4 (4.8)	2.1, 25.6
Teen birth rate[b]	66.0 (33.6)	3.6, 137.2
Low birth weight (< 2,500 grams), %[c]	10.0 (3.4)	5.3, 16.8
Start of prenatal care, %		
First trimester	76.7 (7.3)	59.1, 94.8
Second trimester	15.3 (4.8)	3.8, 23.6
Third trimester	2.7 (1.3)	0.4, 6.7
Received no care	2.2 (1.7)	0.1, 7.7
Population		
Race/ethnicity, %		
Non-Hispanic Black	41.2 (41.2)	0, 98.0
Non-Hispanic White	40.2 (32.1)	0, 96.0
Hispanic	21.8 (25.1)	1.0, 89.0
Asian	4.3 (8.7)	0, 61.0
Educational attainment, %		
Less than 9th grade	12.1 (8.9)	1.5, 39.9
9th-12th grade (No diploma)	17.0 (7.2)	3.2, 31.4
High school graduate	70.9 (13.2)	37.3, 94.6
College education	21.5 (17.5)	2.7, 78.0
Poverty rate for families, %[d]	17.1 (12.4)	1.5, 53.6
Poverty rate for families with children < 5 years, %[e]	25.48 (16.66)	1.33, 68.39
Unemployed, %	11.7 (7.3)	2.8, 33.5
Foreign born, %	19.3 (16.5)	1.0, 52.0
Average family size	3.5 (0.43)	2.3, 4.5
Veteran, %	8.10 (2.74)	3.0, 13.1
Community Wealth		
Per capita income, $	19,376 (10,737)	7,392, 64,309
Median household income, $	38,074 (12,912)	10,739, 68,613
Owner-occupied housing, %	48.2 (22.1)	9.0, 91.0
Homes valued <$50,000, %	5.0 (7.5)	0, 35.0
Median home value, $	158, 415 (97,822)	54,601, 625,692
Social Capital		
Homicide rate[e]	21.7 (21.7)	0, 99.9
Vacant housing units, %	8.2 (5.4)	2.0, 27.4

SD: Standard deviation; [a]Average mortality rate per 1,000 live births, 2000-2002; [b]Average births per 1,000 females aged 15-19 years, 2000-2002; [c]Average 3-year percentage of low birth weight babies, 2000-2002; [d]Poverty rate is the percent below the federal poverty line in 1999; [e]Homicide rate per 100,000 persons, 2000

There was wide variability in community-level population characteristics. Community-level percentages of non-Hispanic Blacks ranged from 0% to 98.0%; 0% to 96.0%. for non-Hispanic Whites; 1.0% to 89.0% for Hispanics; and 0% to 61.0% for Asians. The community average of residents with less than a 9th grade education was 12.1% (SD±8.9; range: 1.5, 39.9). The percentage of families living in poverty with children under the age of five was 25.48% (SD±16.66; range: 1.33, 68.39). Community-level unemployment ranged from 2.8% to 33.5%. There was also variability in the social capital variables. The city-average homicide rate was 21.7 per 100,000 persons (SD±21.7; range: 0, 99.9). Vacant housing ranged from 2.0% to 27.4%.

Table 2 reports the regression models that explained the most variability for IM for each domain (maternal, population, community wealth, and social capital). In the model predicting IM for the maternal characteristics alone, the percentage of LBW babies was the only significant variable ($b=1.11$; $p<0.001$) and explained 62% of the variability in IM rates across the communities ($R^2=0.62$). In the population domain, non-Hispanic Black ($b=0.05$; $p<0.001$), the unemployment rate ($b=-0.10$; $p<0.05$), and the poverty rate for families with children < under 5 years ($b=0.44$; $p<0.001$) were significant predictors and explained 59% of the variability in community-level IM rates ($R^2=0.59$). In the community wealth domain, per capital income ($b=0.0003$; $p<0.01$), median home value ($b=-0.00004$; $p<0.01$), and median household income ($b=-0.0003$; $p<0.001$) were significant predictors and explained 31% of the variability in IM rates ($R^2=0.31$). The homicide rate was the only significant predictor in the social capital domain ($b=0.15$; $p<0.001$) and explained 47% of the variability in IM rates ($R^2=0.47$).

Table 2. Factors associated with community-level infant mortality

Characteristic	b Parameter	SE	R^2
Maternal Domain			**0.62**
Intercept	-1.76	1.05	
Low birth weight babies***	1.11	0.10	
Population Domain			**0.59**
Intercept	4.62	0.69	
Non-Hispanic Black***	0.05	0.01	
Unemployed*	-0.10	0.05	
Poverty rate for families with children < 5 years ***	0.44	0.12	
Community Wealth Domain			**0.31**
Intercept	18.26	1.58	
Per capita income**	0.0003	0.00	
Median home value**	-0.00004	0.00	
Median household income***	-0.0003	0.00	
Social Capital Domain			**0.47**
Intercept	6.05	0.57	
Homicide rate***	0.15	0.02	
Final Model			**0.75**
Intercept	-1.29	4.25	
Low birth weight***	1.28	0.24	
Began prenatal care 2nd trimester*	-0.30	0.12	
Hispanic**	0.08	0.03	
Unemployed***	0.42	0.10	
Veteran***	0.67	0.18	
Foreign-born**	0.12	0.04	
Average family size*	-3.19	1.37	
Homicide rate*	0.06	0.02	
Vacant housing units**	-0.28	0.09	

SE: Standard error; *P<0.05; **P<0.01; ***P<0.001; Adjusted R^2 is reported when more than one variable is included in model

In the final model (R^2=0.75), maternal characteristics that explained IM included a higher percentage of LBW infants (b=1.28; p<0.001) and a decline in mothers who began prenatal care in the second trimester (b=-0.30; p<0.05). Population characteristics included an increase in the percentage of Hispanics (b=0.08; p<0.01), increased unemployment (b=0.42; p<0.001), an increase in the percentage of veterans (b=0.67; p<0.001) and foreign-born residents (b=0.12; p<0.01), and smaller average family sizes (b=-3.19; p<0.05). Among the social capital variables, increased homicide rates were associated with higher IM rates (b=0.06; p<0.05) and a lower percentage of vacant housing was associated with lower IM rates (b=-0.28; p<0.01).

DISCUSSION

This study found that specific maternal, population, community wealth, and social capital characteristics explained much of the variability in IM rates across communities in Chicago. The findings indicate the importance of the early initiation of prenatal care, as well as tailoring resources for "ethnic enclaves" and increasing community-level social capital.

A decline in the percentage of women beginning prenatal care in the second trimester was associated with lower community-level IM rates in the final model. In the univariate regression model, receiving no prenatal care was associated with higher IM rates (not reported; β=1.43; P<0.0001). This supports evidence that lower quantity of prenatal care is associated with worse outcomes and that care should begin in the first trimester (Conway, 2006; McLafferty & Grady, 2004). Community-level interventions can increase early access to prenatal services, and they include increasing the number of primary care providers (Shi et al., 2004) and prenatal clinics (McLafferty & Grady, 2004), as well as using mobile health vans (Edgerley, 2007).

Communities with higher percentages of foreign-born and Hispanic residents, or "ethnic enclaves," were also associated with higher IM rates. This is inconsistent with research examining individual-level IM risk factors, which found lower rates among foreign-born and Hispanic women (excluding Puerto Rican women) (Collins, Soskolne, Rankin, & Bennett, 2013; El-Sayed, Paczkowski, March, & Galea, 2014; Hummer, 2007). Residential segregation may explain the disparity observed in IM rates for "ethnic enclaves" (Anderson, 2014; Britton, 2013; Williams & Collins, 2001), as they may have more barriers accessing prenatal care (White, Haas, & Williams, 2012), as well as limited access to healthy foods, poor housing quality, and toxic physical environments, which could potentially increase IM rates.

The social capital measures of higher homicide rates and vacant housing were associated with higher IM rates. Research indicates communities rich in social capital have lower mortality rates (Kawachi, Kennedy, Lochner, & Prothrow-Stith, 1997; K. Lochner et al., 1999). Strategies to increase community-level social capital involve increasing community assets through the investment in education, community-based organizations and initiatives, and local businesses.

This study had several caveats. It relied on data quality, which may not accurately reflect community-level characteristics. The characteristics included in the analyses were also limited to data availability and were restricted to specific variables that might not have fully explained IM.

CONCLUSION

This study offers some insight into community-level characteristics that are associated with IM. Identifying communities that are at the highest risk for IM is imperative to improving maternal and child health outcomes. This study demonstrates that public health officials and community health workers can use publicly available data to assist with program planning and effective resource allocation. This information can be used to assist agencies in identifying at-risk communities and tailoring community-level interventions. In the case of the communities in this analysis, public health officials and community health workers may want to focus efforts to increase access to prenatal care to areas with high rates of immigrants and ethnic minorities, and limited economic resources (as measured by unemployment rate), and low social capital. Future research should examine the protective properties of social capital in reducing community-level IM rates.

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