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RESEARCH PAPER

Racial/ethnic minority segregation and low birth weight: a comparative study of Chicago and Toronto community-level indicators

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ABSTRACT

We examined the association between racial/ethnic minority segregation and low birth weight (LBW) in Chicago and Toronto communities. While previous work has documented the importance of contextual effects on LBW, these studies have usually been conducted within a single city. We used Pearson correlation coefficients and OLS regression models to examine potential variability in the association between racial/ethnic minority segregation and LBW in Chicago ($N = 77$ communities) and Toronto ($N = 140$ communities). Results indicate that racial/ethnic minority segregation, unemployment, and low educational attainment are not associated with LBW in Toronto, while these indicators have strong and significant associations with LBW in Chicago. In a combined model with data from both cities, a 10% increase in minority composition is associated with a 0.5% increase in LBW, controlling for the effects of unemployment and low educational attainment. Stratified models show that this effect is only significant in Chicago, and subsequent models revealed opposite effects for percentage non-Hispanic Black and percentage Hispanic. Future research should consider additional cities for comparative analysis. Such work could test the notion that Chicago and Toronto represent opposite sides of a spectrum, reflecting variability in how social determinants map on to public health outcomes. Future research should also examine the significant heterogeneity observed in highly segregated communities, particularly in Chicago.

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Racial segregation; low birth weight; urban areas; regression; health equity

Introduction

The influence of community characteristics on low birth weight (LBW) has received considerable attention in the past 20 years, with studies highlighting the influence of community-level economic disadvantage and racial/ethnic segregation (Masi, Hawkley, Piotrowski, & Pickett, 2007; Pickett, Collins, Masi, & Wilkinson, 2005). Studies from Chicago point specifically to community marginalization, urban violence, and racism as risk factors for LBW delivery among Black mothers (Collins & David, 1997; Collins & Hawkes, 1997; David & Collins, 1997). More and more studies in this field also recognize that racial/ethnic segregation is associated with entrenched poverty, poor educational opportunities, and high rates of economic hardship, contributing to the development of a critical framework for understanding health inequities in urban settings.

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Yet there is also a tendency in the literature to conceptualize race, rather than racism, as the essential risk factor for LBW delivery. From this perspective, 'black race' becomes a risk factor alongside cigarette smoking and drug abuse. Referencing the work of Slattery and Morrison (2002), Masi et al. observe that

> research has established that risk factors for preterm delivery are similar to those for LBW. These include lower socioeconomic status (whether defined by occupation, income, or educational attainment), *Black race*, multiple pregnancy, extremes of age or parity, *cocaine use*, cigarette smoking, and bacterial vaginosis. (Masi et al., 2007; emphasis added)

Defining 'black race' as a risk factor for LBW delivery ignores the social context which gives race meaning; it ignores the process of racism and racialization (Fullilove, 1998; Mullings & Schulz, 2006; Paradies, 2006; Veenstra, 2009). This reifies socially constructed racial categories and leads to the neglect of the historical processes that have marginalized communities with large concentrations of minority residents (Lee, Mountain, & Koenig, 2001).

Masi et al. (2007) went on to document the importance of neighborhood economic disadvantage, violent crime, and racial/ethnic segregation over individual behaviors, thus contributing to a reconceptualization of the determinants of LBW delivery. Their work, along with the work of Pickett et al. (2005), O'Campo, Xue, Wang, and Caughy (1997) and LaVeist (1989), has done a great deal to focus new research on community-level characteristics and not just individual-level predictors. Much of this literature has focused on racial/ethnic segregation, 'group density' (the degree to which an individual is a majority in his or her community), but also socioeconomic conditions and other community-level characteristics. This helps us to move away from biological or genetic explanations and the tendency to victim-blame, and toward a more holistic and structural understanding of health equity. This is in line with a call issued by Roberts 20 years ago:

> Maternal health inequalities should be explored in the context of historical segregation, social stratification, the dynamics of social support, and resource sharing among communities. Several community characteristics associated with poverty are negatively associated with low birth weight. The traditional focus on individual risk factors for low birth weight limits our understanding. (Roberts, 1997)

There is a broad consensus on the need to expand the explanatory model beyond individual characteristics, and while more research is needed to disentangle associations and identify connecting mechanisms, there is movement in this area of work that points toward what are now called the structural determinants of health.

The shift in focus from individual-level predictors to community-level predictors of LBW also builds directly from the findings of David and Collins (1997), who in a now-classic study observed that African-born immigrant women have, on average, birth outcomes that are comparable to US-born White women, whereas US-born Black mothers experienced a higher risk of LBW delivery. In a similar vein, Black women living in areas with a higher racial concentration (excluding extreme segregation) have better birth outcomes than Black women living as a minority population in their community, regardless of socioeconomic status (Masi et al., 2007). From these studies, we can infer that it is not in race/ethnicity that determines birth outcomes, but rather the lived experience of minority status in a discriminatory society (Collins, David, Simon, & Prachand, 2007; Geronimus, 2013; Warren-Findlow, 2006).

The traditional focus on individual-level risk factors is a limit on our understanding of inequities in LBW deliveries. A second important limitation of this area of research is the lack of comparative studies comparing community-level factors across cities. By exploring the differences in LBW outcomes in different cities and even across countries, we can continue to contest genetic explanations and look deeper into the root causes of health inequities. Yet comparative research has not been standard in health equity work in Chicago, where most of the work has either been at the level of the city or exploring differences between communities within the city (Shah, Whitman, & Silva, 2006). Relatively few studies have compared community-level data from different cities, though some work has compared aggregate indicators across a large number of US cities (Hunt & Balachandran, 2015; Hunt, Whitman, & Hurlbert, 2014). However, comparing aggregate (city level) indicators misses the inequities that exist *within* cities.

We hypothesize that comparing Chicago – one of the most segregated cities in the United States – with Toronto, a multicultural city of comparable population size yet without the same legacy of

concentrated disadvantage (Raphael, 2011), will be useful in showing how the relationships between social determinants of health and LBW can vary from place to place. This follows the 'most different' research design used in some comparative studies (Przeworski & Teume, 1970; Sampson, 2012), where the objective is to understand whether relationships transcend place boundaries. This comparison of seemingly disparate cities is designed to explore the universality of the association between racial/ethnic segregation and LBW.

Methods

Our study compares publicly available community health data from Chicago and Toronto. All data for Chicago were obtained from the City of Chicago's Open Data Portal. Toronto data were obtained from the Toronto Community Health Profiles Partnership. In both cities, the focal relationship pertains to the correlation between racial/ethnic minority segregation and LBW deliveries in that community. We examine an interaction effect between racial/ethnic minority segregation and city. We test the robustness of that association through the addition of community socioeconomic status to the regression model. Moreover, given the known differences in health outcomes for Black and Latino communities in Chicago (Cervantes, Keith, & Wyshak, 1999), we further explored the data by racial/ethnic subgroups.

In both cities, we used locally meaningful definitions of 'community'. In Chicago, community boundaries were established by the Social Science Research Committee of the University of Chicago in the late 1920s and have been used since that time in public policy and public health. In Toronto, community boundaries are also well-established by the City of Toronto government and have likewise remained static for decades, allowing for longitudinal studies of changes over time in each community.

LBW was defined as a birth weight of less than 2500 grams; we examined the percentage of total live births in a community that were recorded as LBW. Chicago data are from 2009 and were obtained from the Chicago Department of Public Health (CDPH), who calculated the percent of total births by community area using geocoded annual birth certificate datasets supplied by the Illinois Department of Public Health. Toronto LBW data are from 2011 and were obtained from the Toronto Community Health Profiles Partnership, who compiled data from the Ontario Ministry of Health and Long-Term Care. In both cities, we used the most up-to-date data available.

In Toronto, racial/ethnic minority segregation was first defined as the percentage of community residents who are a 'visible minority'. The Canadian government defines visible minorities as

> persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour … the visible minority population includes the following groups: Chinese, South Asian, Black, Filipino, Latin American, Southeast Asian, Arab, West Asian, Japanese, Korean and Pacific Islander. (Statistics Canada, 2004)

The definition of 'visible minority' status in Canada is controversial (De Maio, 2012; De Maio & Kemp, 2010); indeed, the operationalization of this complex and debated concept is fraught with methodological pitfalls (Mentzer, 2002). The designation includes a wide range of heterogeneous groups; it aggregates groups whose experiences in Canada have historically differed and who currently hold different positions in the economic system, as gauged by average incomes (Mentzer, 2002). The designation also confounds race, ethnicity, and nationality. Yet the term is widely used in Canadian health equity research and remains an important feature of Statistics Canada data sources. Subsequent models disaggregated visible minority into percentage non-Hispanic Black and percentage Hispanic, corresponding to the standard US racial/ethnic classifications, which we emphasize are social constructs and not biological categories (Barr, 2014; Muntaner, Nieto, & O'Campo, 1996). In Chicago, racial/ethnic minority segregation was first defined as the percentage of community residents who are not non-Hispanic White. Subsequent models disaggregated percentage minority into percentage non-Hispanic Black and percentage Hispanic.

Data analysis

Our analytic strategy involved first examining descriptive statistics, followed by correlations (Pearson coefficients). Our final step involved the development of OLS regression models (Aneshensel, 2013; Tarling, 2009). We first examined both cities together, using an interaction effect between percentage minority and city. Subsequent models stratified the data by city, creating separate models for Chicago and Toronto. The stratified model enabled an exploration of the differential effects of racial/ethnic minority segregation within each city. To test the robustness of the relationship between racial/ethnic segregation and LBW deliveries, we included two measures of community-level socioeconomic status to our models: percentage unemployed and percentage with less than a high school diploma, with all continuous variables scaled to reflect a 10% increase. All analyses were conducted using Stata.

Results

Birth outcomes are worse in Chicago than in Toronto, with a higher overall prevalence of LBW deliveries. The mean community proportion of LBW deliveries in Chicago is 10.1, while in Toronto, it is 7.3 (see Table 1). There is greater dispersion in the Chicago data, with a larger standard deviation and a higher maximum value – with one community having a LBW prevalence of almost 20% (see Figures 1 and 2).

Racial/ethnic segregation is more present in Chicago than in Toronto (see Table 1). A greater proportion of Chicago communities cluster above the 90% minority level, reflecting Chicago's pronounced pattern of segregation. On average, communities in Toronto include 42.2% minority respondents, while in Chicago, this figure is 70.3% (see Table 1). Reflecting Chicago's heightened pattern of racial/ethnic segregation, there are communities with 0% non-Hispanic Black and Hispanic residents and also some communities that comprise almost entirely of non-Hispanic Black (98.5%) and Hispanic (85.7%) residents. Toronto communities, in contrast, never reach the same level of segregation by subgroup. Socioeconomic conditions are also worse, on average, in Chicago communities – with higher community-level rates of unemployment (15.4 vs.7.5%) and residents with less than a high school education (20.3 vs. 12.5%; see Table 1).

Correlations between LBW and all independent variables are presented in Table 2.

In Toronto, the correlation between percentage minority and LBW is small and not significant ($r = .15$, $p = .07$), while in Chicago, it is large and significant ($r = .65$, $p < .001$); see Figure 3.

Disaggregating percentage minority into its two main components, percentage non-Hispanic Black and percentage Hispanic, reveals important differences. These community-level characteristics have opposite correlations with LBW in Chicago but not Toronto. In Chicago, percentage non-Hispanic Black is strongly positively correlated with LBW ($r = 0.83$, $p < 0.001$), while percentage Hispanic is negatively correlated with LBW ($r = -0.50$, $p < 0.001$). In Toronto, this is a weak correlation between percentage non-Hispanic Black and LWB ($r = 0.28$, $p < 0.01$) and no correlation between percentage Hispanic and LBW (see Table 2 and Figures 4–5).

These community-level characteristics also have divergent correlations with socioeconomic indicators: percentage non-Hispanic Black is positively correlated with percentage unemployed in both Chicago ($r = 0.81$, $p < 0.001$) and Toronto ($r = 0.57$, $p < 0.001$), while percentage Hispanic is negatively correlated with percentage unemployed only in Chicago ($r = -0.25$ $p < 0.001$). In contrast, percentage non-Hispanic Black is positively correlated with percentage without a high school diploma in Toronto but not Chicago. In both cities, percentage Hispanic is associated with percentage without a high school diploma.

Our regression results are presented in Table 3. First, we estimated combined models, pooling data from Chicago and Toronto. Model 1 examines the effect of a 10% increase in minority overall. Model 2 incorporates a dummy variable for Toronto, and model 3 examines the interaction between a 10% increase in minority and the Toronto dummy variable. Lastly, model 4 adds community-level socioeconomic indicators as potential confounders.

Table 1. Description of community-level indicators.

	Low Birth Weight		% Minority		% Non-Hispanic Black		% Hispanic		% Unemployed		% With less than high school diploma	
	Chicago	Toronto	Chicago	Toronto	Chicago	Toronto	Chicago	Toronto	Chicago	Toronto	Chicago	Toronto
Mean	10.1	7.3	70.3	42.2	39.7	8.0	24.3	2.7	15.4	7.5	20.3	12.5
Standard deviation	3.9	1.4	28.4	22.1	40.5	6.9	27.1	2.8	7.5	2.0	11.8	8.0
Minimum	3.5	3.4	6.4	8.5	0	0	0	0	4.7	4.0	2.5	1.5
Maximum	19.7	11.0	99.8	94.0	98.5	30.7	85.7	16.2	35.9	15.5	54.8	36.6

Notes: There are 77 community areas in Chicago, with an average population size of 35,008. Toronto has 140 neighborhoods, with an average population of 18,679.

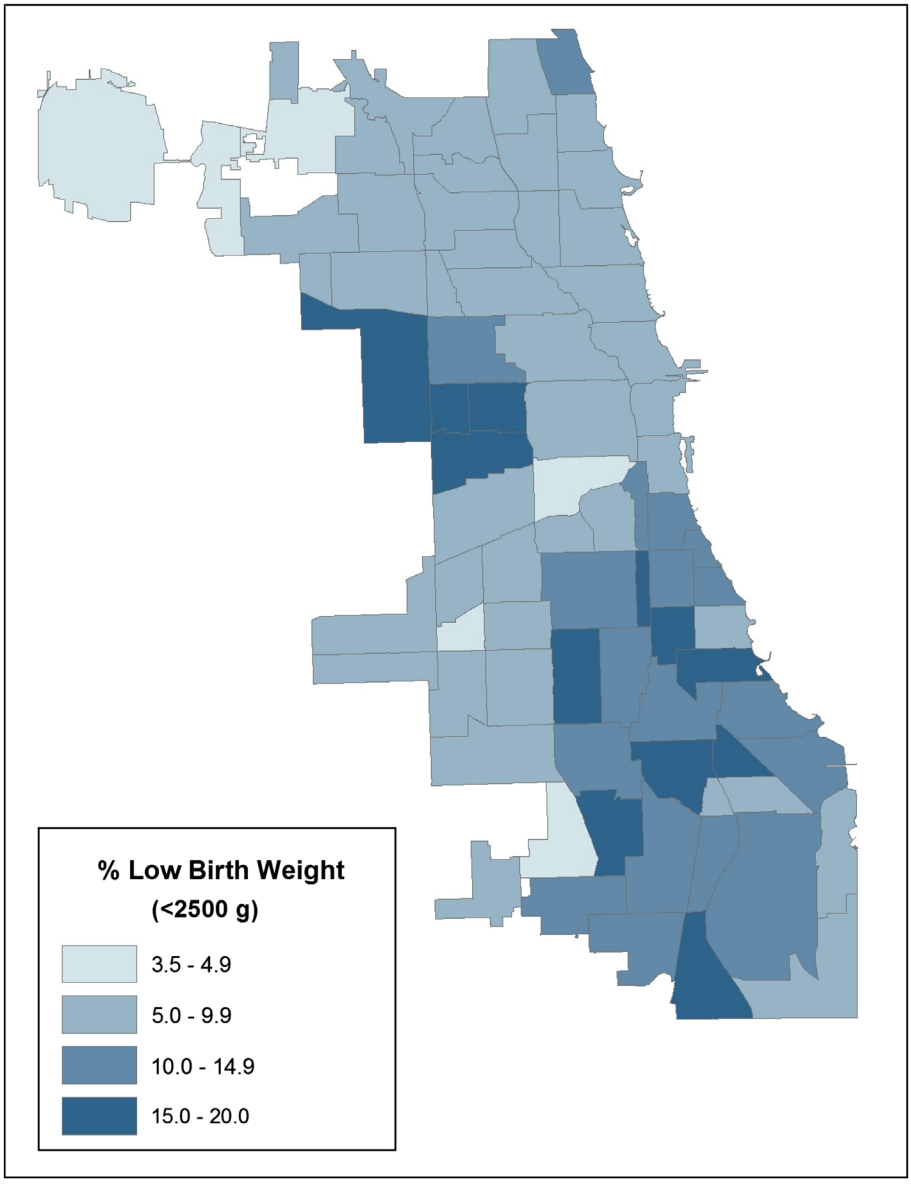

Figure 1. Percent low birth weight by Chicago community.

Table 2. Associations between community-level LBW, racial/ethnic concentration, and socioeconomic indicators (*r* values).

	LBW	% minority	% non-Hispanic Black	% Hispanic	% unemployed	% without a high school diploma
LBW	1.00	.15	.28 **	.06	.11	.14
% minority	.65 ***	1.00	.56 ***	.13	.73 ***	.39 ***
% non-Hispanic Black	.83 ***	.73 ***	1.00	.57 ***	.56 ***	.58 ***
% Hispanic	−.50 ***	.06	−.60 ***	1.00	.12	.64 ***
% unemployed	.75 ***	.81 ***	.81 ***	−.25 *	1.00	.39 *
% without a high school diploma	.03	.56 ***	−.08	.73 ***	.36 **	1.00

Notes: Chicago correlations are shaded, below the diagonal. Toronto correlations are unshaded, above the diagonal.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

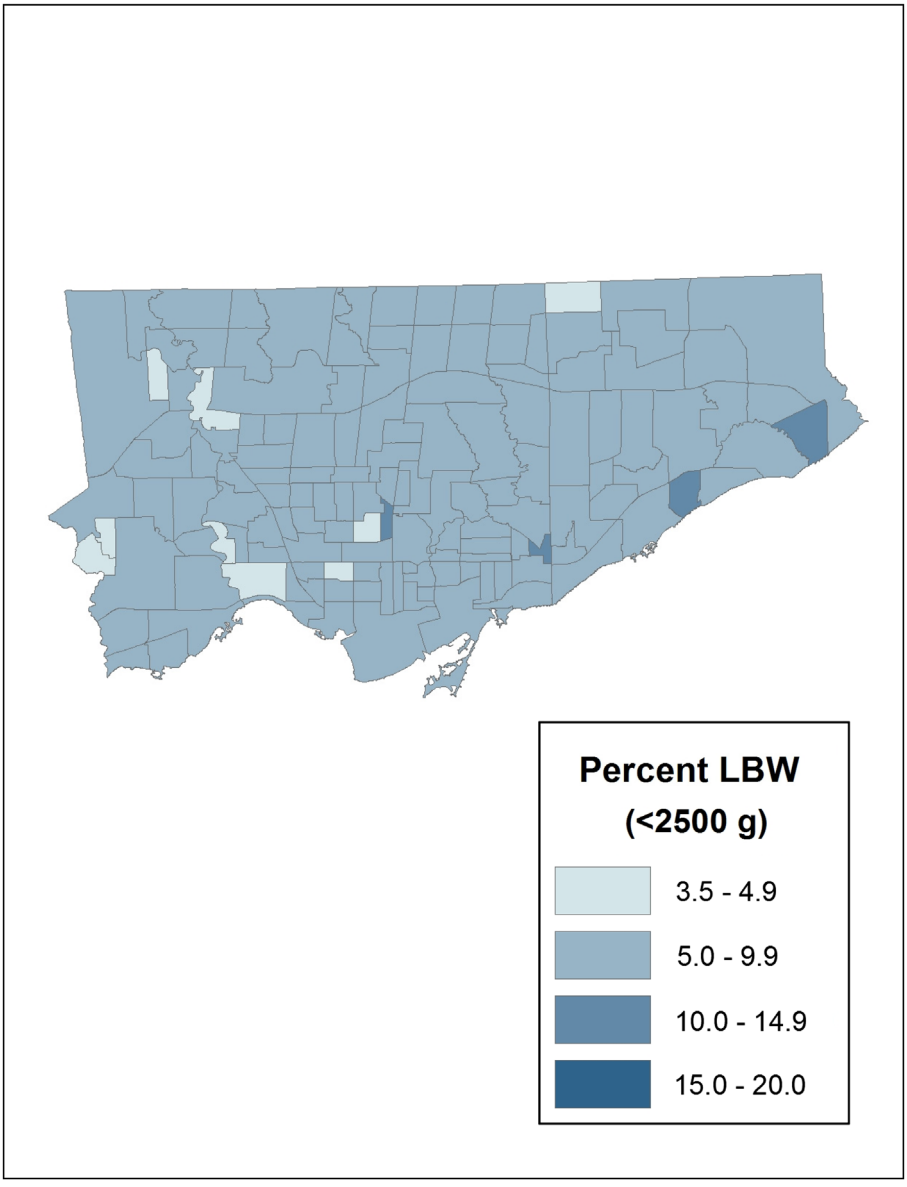

Figure 2. Percent low birth weight by Toronto community.

The combined model 1 obtained an r-squared value of 0.33 and suggests that a 10% increase in minority concentration may be associated with a 0.6% increase in LBW. This coefficient was stable throughout combined models 1–4. The interaction effect between minority concentration and city indicates that the effect of minority concentration in Toronto is close to 0, with a main effect of 0.9 (SE = 0.09) and an interaction effect of −0.8 (SE = 0.12). The effect of minority concentration was robust to the inclusion of the possible socioeconomic confounders. The combined model 4 obtained an r-squared of 0.59 (see Table 3).

Stratifying by city reveals important differences between Chicago and Toronto. The Chicago models generated high r-squared values, while the Toronto models yielded very low values, always less than r-squared of 0.1. Confirming the bivariate results, the inclusion of the possible socioeconomic

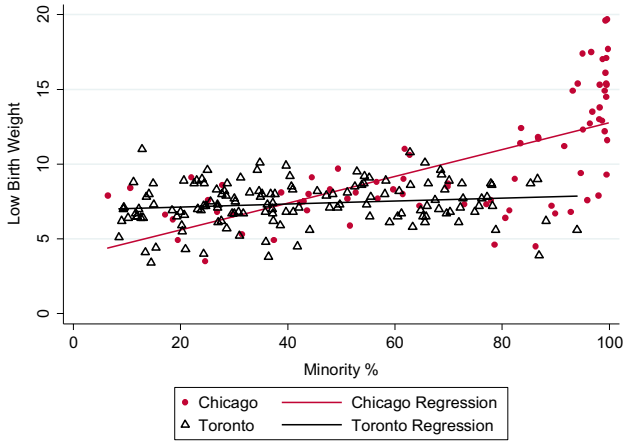

Figure 3. Association between community level % minority and LBW delivery (% live births), Chicago and Toronto.

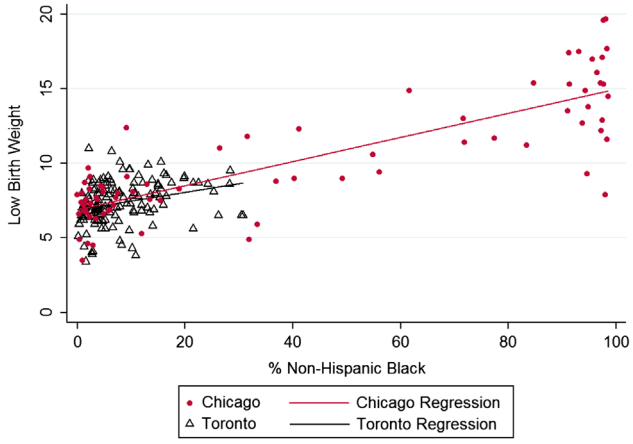

Figure 4. Association between community level % Black and LBW delivery (% live births), Chicago and Toronto.

confounders did not alter the positive association between percentage minority as well as percentage non-Hispanic Black and LBW in Chicago. The negative association between percentage Hispanic and LBW was also robust for Chicago.

Discussion

Following the 'most different' research design for comparative studies (Przeworski & Teume, 1970; Sampson, 2012), we examined two cities with very different histories and politics, and very different health care systems. We detected variability in the association between racial/ethnic segregation and LBW. In particular, our study found that racial/ethnic minority segregation, unemployment, and low educational attainment were not associated with LBW in Toronto, while these indicators had strong and significant associations with LBW in Chicago. In a combined model with data from both cities, a 10% increase in minority composition is associated with a 0.5% increase in LBW, controlling for the effects of unemployment and low educational attainment. Stratified models show that this effect is only significant in Chicago, and subsequent models revealed opposite effects for percentage non-Hispanic Black and percentage Hispanic. In Chicago, racial/ethnic minority segregation, unemployment, and low

Table 3. Predictors of community-level LBW (OLS regression), combined and stratified by city.

	Intercept	% Minority	City dummy (Toronto = 1, Chicago = 0)	Interaction between city (Toronto = 1) and % minority	% Unemployed	% w/out HS diploma	% non-Hispanic Black	% Hispanic	R-squared
Combined models									
1	5.2**	.6**							.33
2	6.7**	.5**	−1.4**						.37
3	3.8**	.9**	3.1**	−.8**					.48
4	4.0**	.5**	2.1*	−.4**	2.7**	−.6**			.59
Stratified by city									
Toronto									
1	6.9**	.1							.02
2	6.9**	.1			0				.02
3	6.9**	.1			−.2	.2	–	–	.03
4	7.2**	–			−.5	0	.7*	–	.08
5	6.8**	–			.4	.3	–	−.2	.02
Chicago									
1	3.8 **	.9**							.42
2	3.7 **	.2			3.4**				.57
3	4.3 **	.6**			2.8**	−1.4**			.68
4	5.8**	–			1.2	0	.6 **	–	.71
5	6.1 **	–			2.9 **	.7	–	−.7 *	.68

Note: All continuous variables scaled to reflect a 10% increase.
*$p < 0.05$; **$p < 0.001$.

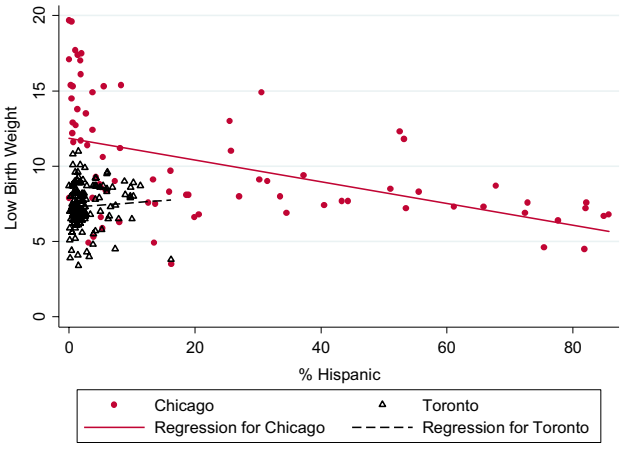

Figure 5. Association between community level % Hispanic and LBW delivery (% live births), Chicago and Toronto.

educational attainment explain approximately 70% of the variance in LBW across communities, while these indicators are not significant predictors of LBW in Toronto.

It is well documented that Chicago suffers from health inequities in LBW outcomes for non-Hispanic blacks (Collins et al., 2007; Collins & Hawkes, 1997; David & Collins, 1997). However, little research has been done comparing this phenomenon within and between other cities. By analyzing LBW inequities by racial/ethnic segregation and comparing those outcomes across cities, we can begin to uncover the reasons behind these health outcomes. This type of work highlights the difference between race and racism, shifting public health attention from race as a characteristic of individuals (a 'risk factor') towards racism as a social process that damages the health of populations across generations (De Maio, Mazzeo, & Ritchie, 2013; Krieger, Chen, Coull, Waterman, & Beckfield, 2013; Krieger et al., 2014). Future research may explore if Chicago and Toronto constitute a high and low end of a spectrum, with the strong association between percentage non-Hispanic Black and LBW in Chicago reflecting the health effects of a highly segregated city in a country without universal health care and a stigmatized welfare system, and the lack of association between percentage minority and low birth in Toronto reflecting a diverse and multicultural city in a country with a strong safety net. At the moment, these are hypotheses that need that to be tested. Such work would open up interdisciplinary research on community development, the historical effects of segregation, and public health outcomes.

Future work should also examine the significant heterogeneity observed in highly segregated communities, particularly in the Chicago data. Some communities in Chicago have very high proportions of non-Hispanic Black residents and their LBW values range from very low (on par with the city average) to very high (three times as high as the city average). Qualitative research may be particularly useful for documenting the history of these communities and thus help to identify their differences which manifest in different LBW patterns today.

There are several limitations to this study. First and foremost are the limitations of an ecological analysis, and the susceptibility to ecological fallacy (Diez-Roux, 2002; Robinson, 1950). More research, particularly work involving multilevel analysis (Tarling, 2009), is needed. Such work could not only disentangle compositional and contextual effects, but could also explore the clustering of minority communities in a city. Second, we know from previous work that nativity, not just race/ethnicity, matters as a predictor of LBW. In Canada, previous research has examined the 'healthy immigrant' effect in relation to birth outcomes. Ray et al. (2007), for example, found that the longer an immigrant woman had resided in Ontario, the greater her risk of placental dysfunction (after controlling for maternal age, income status, pre-existing hypertension and other related factors). Their study was followed by other Canadian investigations of immigrant status and preterm birth, small-for-gestational age birth, and LBW that revealed underlying paradoxical effects of socioeconomic status (Auger, Luo, Platt, & Daniel, 2008; Moore, Daniel, & Auger, 2009) and emphasized the importance of taking into account the length of

time an immigrant has been in the country (De Maio, 2012; Urquia, Frank, Moineddin, & Glazier, 2010). In Chicago, the work of David and Collins (1997) has documented varying health outcomes between US-born Whites, US-born Blacks, and foreign-born Blacks, highlighting the importance of nativity and length of time in the United States as a predictor of LBW. Third, while there are advantages of using locally meaningful community boundaries, a weakness of our design is that we had differences in neighborhood size between our two cities – with Chicago communities being roughly twice as large as Toronto communities (see Table 1). But given the large number of communities within each city, we do not think this biases our results. Indeed, given that Toronto has more community units than Chicago, it might be expected that our r-squared values would be lower for Toronto than Chicago, when in fact we found the opposite. Fourth, our analysis is based on racial/ethnic segregation as a marker of discrimination. Yet this measure may not reflect the lived experience of minority status in a discriminatory society; for example, a person's experiences in a predominantly minority community may be very different depending on other factors, including isolation, marginalization, stigma, and the overall quality of social relations between minority and majority groups. Future work should incorporate more nuanced measures of segregation (De Maio, Sosina, Williams, Shah, & Ansell, 2016; Massey & Denton, 1989).

Considerable debate also exists over the value of LBW as a public health measure (David, 2001; Wilcox, 2001a). Wilcox, in particular, has questioned the link between LBW and infant mortality, while not discounting the idea that LBW may be an effective way of testing 'the tangible effects of racism on physical processes' (2001b: 1245). Along these lines, David (2001) acknowledges that the 2500 gram cutoff for LBW is crude, yet argues that the variable may nevertheless be a good measure through which to examine health inequities. In the past 20 years, LBW has been used widely in Chicago-based health equity research (Collins & David, 1997; Collins & Hawkes, 1997; David & Collins, 1997).

Future work in this area should also include a more nuanced conceptualization of community conditions. In this exploratory study, we used two commonly used measures of community socioeconomic status: percentage unemployed and percentage without a high school diploma. The advantage of these measures is that they are roughly comparable across our cities. Yet more nuanced measures of community privilege and deprivation exist, including the index of concentration at the extremes, which has shown significant promise as a metric for the monitoring of inequities based on socioeconomic and racial/ethnic segregation (Krieger et al., 2016). Future work in this area should also test the relationships between community-level characteristics and health outcomes across a larger sample of cities. Such work would lead to a better understanding of the dynamics of health inequities, reinforcing the idea that the link between social determinants of health and particular health outcomes are amendable to change.

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