Impact of individual and ecological characteristics on small for gestational age births: an observational study in Quebec

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Abstract

Introduction: We evaluated associations between ecological variables and the risk of very small for gestational age (VSGA) birth in Quebec in 2000–2008.

Methods: Ecological variables came from the Canadian Community Health Survey, the Canadian census and Quebec's birth registry; individual variables also came from Quebec's birth registry. Odds ratios (ORs) adjusted for mother's age, academic qualification, parity, marital status and country of birth were estimated using multilevel logistic regression (generalized estimating equations method).

Results: Births in neighbourhoods with a high proportion of people leading a sedentary lifestyle (OR: 1.07, 95% confidence interval [CI]: 1.01–1.11) and those with a high/middle proportion of residents with food insecurity (OR: 1.09, 95% CI: 1.05–1.15; OR: 1.05, 95% CI: 1.01–1.11) had higher odds of VSGA birth. Those with middle proportion of married residents had lower odds of VSGA birth (OR: 0.94, 95% CI: 0.90–0.98).

Keywords: *birth weight, fetal health, reproductive health, social epidemiology, health behaviour, sedentary lifestyle, food insecurity*

Introduction

Individuals with sub-optimal fetal development that results in small for gestational age (SGA) or very small for gestational age (VSGA) birth are at an increased risk of neonatal illness and are more likely to develop type 2 diabetes, hypertension, metabolic syndrome and coronary diseases in adulthood.[1]

Risk factors for sub-optimal fetal development include characteristics of maternal age, race, parity, partnership status, education and smoking.[1-3] Neighbourhood deprivation is also associated with health[4] and with a number of modifiable individual risk factors such as smoking and alcohol consumption during pregnancy.[5]

Unfortunately, past ecological analyses were often mostly based on available data rather than on plausible social pathways.[4,6] In Canada and in the United States, this yielded a set of widely explored neighbourhood census-derived features, including economic deprivation,[7-22] race,[10,11,15,17,19] crime,[15,23] and single-headed households.[19]

A few studies used data from large specific surveys on features of the built and social environment.[8,11,16,24,25] The researchers observed that social support[24] and availability or use of neighbourhood services[11,16] were associated with the risk of adverse birth outcomes, while built environment[16] and availability of restaurants and supermarkets[8] were not. Residents' sedentary lifestyles were previously associated with a higher risk of SGA in a model that was built only from ecological variables for public health purposes.[25] To our knowledge, residents' food consumption was not included in previous ecological analyses of SGA or VSGA.

We had access to information on singleton births through Quebec's birth registration forms. We collected information about Quebec's local community services centres (CLSC) from three sources: Quebec's birth registration forms, a survey on Canadian residents and the Canadian census. While hypothesizing the model shown in Figure 1 to identify program levers for intervention, we evaluated associations between individual variables and the outcome of VSGA. We also evaluated associations between single and aggregated CLSC territory variables and VSGA.

Methods

Study population and setting

The population of this observational study consisted of singleton live births that took place between 2000 and 2008 and their mothers, in Quebec, Canada. Because the survey data from the northern regions of Nord-du-Québec, Terres-Cries-de-la-Baie-James and Nunavik were not methodologically comparable to other provincial regions, we did not include them. Neonates with missing weight or gestational age, those born at less than 22 weeks or more than 43 weeks gestation

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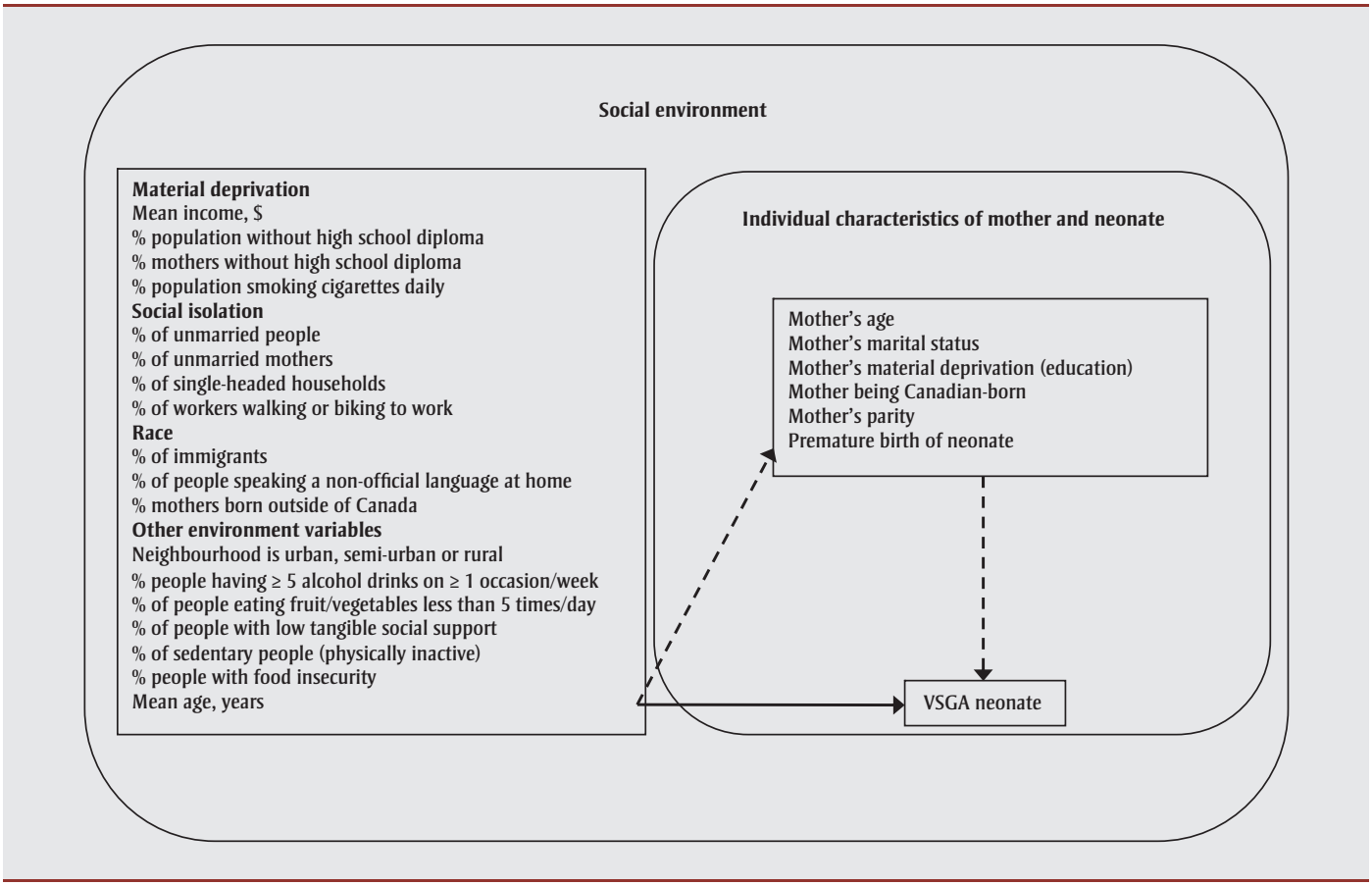
FIGURE 1
Mother and neonate's individual explanatory variables from the birth registry, Quebec, Canada, 2000–2008



Abbreviation: VSGA, very small for gestational age.

Note: Accounting for associations of contextual variables through individual variables (dashed arrows) enabled the study of contextual associations above and beyond association through individual variables (full arrow).

and those with implausible weight for gestational age were also excluded.[26]

Territory definition

Territories were the 143 CLSCs, the first level of organization of the Quebec health care system. CLSCs had an average of 46 727 residents and 4666 singleton live births from 2000 to 2008.

Variables

Outcome

Neonates with a weight for gestational age below the 5th percentile on the Canadian sex-specific standardized scale were identified as VSGA.[27]

Individual variables

We categorized individual characteristics gathered from birth registration forms. These included maternal age at delivery (< 20, 20–24, 25–29, 30–34, ≥ 35 years); marital status (married in a civil or religious ceremony vs. unmarried); highest academic qualification (less than high school, high school diploma, college, university and higher); mother's place of birth (Canada vs. not Canada) and parity (primiparous vs. multiparous).

Aggregated ecological variables

Aggregated ecological variables for births and the whole population of the CLSC (men, other women, youth and the elderly) summarize the average level of a characteristic within the CLSC territory population (Table 1). We calculated birth-oriented variables over CLSC territories by pooling individual data. Population-oriented variables were obtained both by producing proportion-like values from the responses of individuals surveyed in the Canadian Community Health Survey (CCHS)[25,28] and by pooling census profiles of sub-territories. The proportions were coded into first, second and third tertiles (for the lowest, middle and upper-most parts of the distribution). The first tertile was the reference for all variables except for mean income, where the third tertile was the reference.

We imputed missing values using the SAS multiple imputation (MI) procedure, with the MCMC method for categorical individual variables and the EM algorithm with the logit transform for proportions.[29]

Data sources

Birth registration forms from 2000 to 2008 are part of Quebec's registry of demographic events.[30] The forms include information on all live births (weight at birth, maternal age at delivery, marital status,

TABLE 1
Explanatory ecological variables at the local community services centre (CLSC) level, Quebec, Canada, 2000–2008

Target population and data source	Ecological variable
Birth registry information (2000–2008)	
Births	Mothers without high school diploma, %
Births	Mothers born outside of Canada, %
Births	Unmarried mothers, %
Canadian Community Health Survey (2000–2001; 2003; 2005; 2007–2008)	
Population of ≥ 12 years [a]	People smoking cigarettes daily, % [b]
Population of ≥ 12 years [a]	People drinking ≥ five alcohol drinks at each occasion ≥ 1 per week, % [b]
Population of ≥ 12 years [a]	People eating fruit and vegetables < 5 times per day, % [b]
Population of ≥ 12 years [a]	People with low tangible social support, % [b,c]
Population of ≥ 12 years [a]	Sedentary (physically inactive) people in the past 3 months, % [b]
Population of ≥ 12 years [a]	People with food insecurity in the past 12 months, % [b]
Census profiles (2000 and 2006)	
Total population	Urban/rural continuum (local community services centre combines only urban sub-territories, rural and urban sub-territories or only rural sub-territories)
Population 25–64 years (2006) and ≥ 20 years (2001)	People without high school diploma, %
Total population	Mean age, years
Total population	Immigrants, %
Total population	People speaking a non-official language at home, %
Population ≥ 15 years old with income	Mean income, $
Population ≥ 15 years old	Unmarried people, %
Households (private)	Single-headed households, %
Workers ≥ 15 years old	Workers walking or biking to work, %

[a] Includes only individuals living at home.

[b] Proportion-like value that excludes year-cycle and data collection method effects of the survey.

[c] < 15 out of 95 on the Social Support Survey subscale of the Medical Outcome Study.

mother's highest academic qualification, mother's place of birth, parity) and the postal code of the mothers' residence at time of giving birth.

The CCHS is a cross-sectional survey that has, to date, been conducted in four year-long cycles (2000–2001, 2003, 2005 and 2007–2008).[28] To increase statistical power, we pooled the four survey year-cycles.[31]

The 2001 and 2006 census profiles are available at two sub-territory levels: census tracts and census subdivisions.[32] Tracts were used in metropolitan areas and subdivisions elsewhere. Hence, sub-territories had similar population sizes. Sub-territory profiles were aggregated by CLSC regardless of the year of data collection.

Statistical analysis

CLSC values were linked to individual births based on the mothers' postal code of residence. Odds ratios (OR) were used to estimate relative risks.

Regression

We estimated adjusted ORs for individual variables ($OR^{I}_{Adjusted}$) using a multilevel logistic regression fitted through generalized estimating equations (GEE). We chose the mother as the first level and the CLSC as the second.[33] The GEE method provides consistent OR estimates for the population even though the correlation between mothers from the same CLSC is unknown. We assumed this correlation to be small; hence the ''independence working correlation'' structure was provided as a starting point for the computations. We obtained empirical standard error estimates and thus avoided problems with correlation misspecification.[34]

A deviance test determined whether CLSCs explained a significant part of the unexplained variation resulting from the individual model with interaction terms.

We obtained crude ORs (OR^{E}_{Crude}) and ORs adjusted for individual variables and interaction terms ($OR^{E}_{Adjusted\ I}$) using the GEE method for each ecological variable. Interactions between individual variables were selected using the stepwise method with the option ''hierarchy = multiple'' of the logistic procedure (entry/stay p values < .001). A final model was built using variables with significant $OR^{E}_{Adjusted\ I}$ values as candidates in a stepwise method and by forcing inclusion of individual variables as well as interaction terms (entry/stay p values of .25/.05). GEE parameter estimates adjusted for individual variables and for other ecological variables ($OR^{E}_{Adjusted\ IE}$) were produced for every ecological variable.

Ecological results were restricted to showing those variables with differences in

crude ORs. We presented a maximum of one material deprivation, racial and social isolation variable (Figure 1) by dataset (all data available from the authors on request).

The adjusted OR values ($OR^{I}_{Adjusted}$, $OR^{E}_{Adjusted\ I}$ and $OR^{E}_{Adjusted\ IE}$) were validated by two sensitivity analyses, first, with non-imputed data, and second, by incorporating variables at the smallest possible territory level, that is, census and birth data at the sub-territory level (there are 2368 sub-territories) plus CCHS data at the CLSC level.

The Commission d'accès à l'information du Québec and the Ethics Committee of the Université Laval approved this research project. Analysis was carried out using SAS version 9.2 (MI, LOGISTIC and GENMOD procedures).[29] Regression results were considered statistically significant if p values were less than .05.

Results

Descriptive analysis

Of the 676 165 singleton births recorded in all of Quebec's regions between 2000 and 2008, 7379 were to mothers from northern regions, 850 could not be linked to CLSCs, 67 had no SGA status (missing weight or gestational age), 452 had less than 22 weeks or more than 43 weeks gestation and 163 had implausible weights for gestational age. Thus, our population consisted of a total of 667 254 births in 143 CLSCs.

Regression

Every individual variable was significantly associated with VSGA (Table 2). Mothers without and with a high school diploma and with a college diploma were at a higher risk ($OR^{I}_{Adjusted}$ = 2.08, 1.53 and 1.14, respectfully) of VSGA compared with mothers with a university degree; first-time mothers were also at a higher risk ($OR^{I}_{Adjusted}$ = 1.96) than other women, all other individual variables being equal.

CLSCs represented a significant part of the unexplained variation that resulted from the individual model with interactions

TABLE 2
Adjusted odds ratios for VSGA singleton live births according to maternal individual explanatory variables, Quebec, Canada, 2000–2008

Variable	% imputed [a]	N	%	$OR^{I}_{Adjusted}$ [b]	
				Estimate	95% CI [c]
Age, years	0.0		100.0		< .001 [d]
< 20		21 566	3.2	0.90	0.83–0.98
20–24		114 780	17.2	1.00	0.96–1.04
25–29[e]		235 120	35.2	1.00	—
30–34		198 985	29.8	1.08	1.03–1.12
≥ 35		96 803	14.5	1.39	1.31–1.47
Marital status	0.0		100.0		< .001 [d]
Married[e]		268 130	40.2	1.00	—
Unmarried		399 124	59.8	1.18	1.13–1.23
Highest academic qualification	8.7		10.1		< .001 [d]
University degree[e]		229 122	34.3	1.00	—
College degree		173 265	26.0	1.14	1.10–1.19
High school diploma		197 485	29.6	1.53	1.47–1.60
< High school		67 382	10.1	2.08	1.96–2.21
Mother's country of birth	1.2		100.0		< .001 [d]
Canada[e]		540 272	81.0	1.00	—
Other		126 982	19.0	1.28	1.20–1.36
Parity	0.0		47.3		< .001 [d]
Multiparous[d]		351 539	52.7	1.00	—
Primiparous		315 715	47.3	1.96	1.90–2.03

Abbreviations: CI, confidence interval; OR, odds ratio; VSGA, very small for gestational age.

[a] Percentage of births with imputed values.

[b] Odds ratio adjusted for individual variables (mother's age, mother's marital status, mother's academic degree, mother's country of birth and mother's parity).

[c] Confidence intervals built using robust variance estimates resulting from a multilevel model fitted using generalized estimating equations (GEE).

[d] p value of test of global difference.

[e] Reference category.

(chi-square statistic = 497.3 $p < .001$; $df = 142$). For this reason, it was appropriate to include aggregated CLSC variables in the model.

There were significant crude associations between VSGA and every ecological variable presented except for ''people eating fruit and vegetables less than five times a day'' and ''urban/rural continuum'' (Table 3; additional data are available from the authors on request). Adjusted ORs ($OR^{E}_{Adjusted\ I}$) were slightly lower than crude values (OR^{E}_{Crude}), though confidence intervals did not indicate significant differences. When accounting for individual variables, births in CLSCs with lowest mean income ($OR^{E}_{Adjusted\ I} = 1.12$) and variables ranking in the third tertile of the following categories had higher risks of VSGA: mothers without high school diploma ($OR^{E}_{Adjusted\ I} = 1.12$); immigrants ($OR^{E}_{Adjusted\ I} = 1.06$); mothers born outside of Canada ($OR^{E}_{Adjusted\ I} = 1.08$); people speaking a non-official language at home ($OR^{E}_{Adjusted\ I} = 1.08$) and single-headed households ($OR^{E}_{Adjusted\ I} = 1.11$) (Table 3). Births in CLSCs ranking in second or third tertiles of food insecurity ($OR^{E}_{Adjusted\ I} = 1.08; 1.14$) and sedentariness ($OR^{E}_{Adjusted\ I} = 1.06; 1.11$) also had higher risks of VSGA, while those in CLSCs ranking in the second tertile with respect to unmarried residents ($OR^{E}_{Adjusted\ I} = 0.93$) had lower risks.

The final model incorporated ecological variables of food insecurity, sedentariness and partnership status. Births in CLSCs ranking in the second or third tertile of people with food insecurity had higher risks of VSGA ($OR^{E}_{Adjusted\ IE} = 1.05; 1.09$) when adjusted for all individual variables, unmarried residents and sedentariness. Births in CLSCs ranking in the third tertile of sedentariness also had higher risks of VSGA ($OR^{E}_{Adjusted\ IE} = 1.07$) when adjusting for these same variables. In a similar manner, births in CLSCs with middle proportion of unmarried residents had lower risks of VSGA ($OR^{E}_{Adjusted\ IE} = 0.94$) (Table 3).

Adjusted ORs ($OR^{I}_{Adjusted}$, $OR^{E}_{Adjusted\ I}$ and $OR^{E}_{Adjusted\ IE}$) would have been similar had we used non-imputed data. Some $OR^{I}_{Adjusted}$ values (for mothers $\geq$ 35 years, for mothers with high school diploma, for those with less than high school, as well as for primiparous mothers) would have been smaller and $OR^{E}_{Adjusted\ I}$ and $OR^{E}_{Adjusted\ IE}$ would have been similar had we studied 5th to 10th percentile of neonatal weights. Likewise, $OR^{E}_{Adjusted\ I}$ and $OR^{E}_{Adjusted\ IE}$ would have been similar had they been assessed with a logistic model incorporating variables at the smallest possible territory level. Exceptions apply to third tertile mothers without a high school diploma and second tertile single-headed households that had higher $OR^{E}_{Adjusted\ I}$ values in the latter analysis.

Discussion

We adopted a comprehensive approach to understanding the determinants of fetal health in Quebec, Canada, by using ecological information from a separate survey, birth data and the census in a context in which individual data were available. We found associations between VSGA and ecological variables from each source of data independent of individual variables. Neither census data, survey data nor Quebec's birth data contained such a wide spectrum of relevant area variables. The ecological variables of food insecurity and sedentariness were pertinent for inclusion in a model with several ecological variables. Both were significantly associated with VSGA. Those ecological variables are not necessarily proxies for individual food insecurity and sedentariness. For example, in previous analyses an income below the low-income cut-off in the CLSC reflected both social isolation and race, whereas mean income reflected material deprivation.[25]

Some of the ecological variables we investigated in this research have also been examined in Canadian and American studies.[7,9,13,14,19] When individual variables and a few ecological variables were available and accounted for, significant associations were found between SGA and the low-income cut-off both among the births in Quebec from 1991 to 2000[14] and among births in Montréal from 1997 to 2001.[9] There was also a significant association between SGA and material deprivation measured by area income in Ontario from 2004 to 2006.[13]

When individual variables and several ecological variables were accounted for, social isolation and race (measured by single-headed households, low income and ethnicity) were no longer significantly associated with low birth weight among South Carolina births from 2000 to 2003.[19] These variables were not included in our final model with several ecological variables.

Limitations

There are a few limitations worth highlighting. First, we were interested in sub-optimal fetal development as measured by the VSGA indicator. Some constitutionally small births may not have been a result of sub-optimal fetal development but, being classified as VSGA, contributed to a non-differential misclassification bias of the outcome. Such misclassification was minimized using the VSGA instead of the SGA indicator.

CLSC exposure was potentially misclassified. By pooling data, we implicitly postulated that CLSC tertiles remained the same throughout the years. Moreover, information about relocated mothers was unavailable. According to 2006 census data,[35] about 3.5% of women were incorrectly assigned to the CLSC tertile we had attributed to them. These misclassifications contributed to a small bias toward the null value.

Our results might have been subject to confounding of unmeasured individual factors such as maternal characteristics of social isolation, lifestyle (smoking, caffeine, high alcohol consumption, abuse or sedentariness) and health status (daily caloric intake, maternal body mass index [BMI], maternal hypertension or diabetes in pregnancy).

Our pooled data did not allow us to distinguish the effect of ecological exposure during pregnancy from prior exposure and to note whether the association of deprivation with VSGA has changed over time.

Finally, we were limited by the relatively little knowledge available on the spatial scale that is likely to be relevant to this

TABLE 3
Crude and adjusted odds ratios for VSGA singleton live births according to ecological variables, Quebec, Canada, 2000–2008

Variable [a]	Percent imputed [b] %	Population		OR^{E}_{Crude} [c]		$OR^{E}_{AdjustedI}$ [d]		$OR^{E}_{AdjustedIE}$ [e]	
		N	(%)	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Mean income, $	0.0				.001[f]		.012[f]		
Highest tertile (28 798–56 036) (reference)		331 133	(49.6)	1.00	—	1.00	—	—	—
Middle tertile (25 269–28 797)		223 233	(33.5)	1.07	1.00–1.15	1.03	0.98–1.09	—	—
Lowest tertile (16 144–25 268)		112 888	(16.9)	1.22	1.13–1.33	1.12	1.02–1.15	—	—
Mother without high school diploma, %	0.0				< .001[f]		.01[f]		
Lowest tertile (1.9–9.3) (reference)		309 090	(41.3)	1.00	—	1.00	—		
Middle tertile (9.3–13.1)		229 173	(34.3)	1.13	1.06–1.21	1.05	1.00–1.11	—	—
Highest tertile (13.1–41.6)		128 991	(19.3)	1.25	1.15–1.37	1.12	1.04–1.20	—	—
Smoking cigarettes daily, %	1.4				.04[f]		NS[f]		
Lowest tertile (0.5–20.4) (reference)		275 503	(41.3)	1.00	—	1.00	—	—	—
Middle tertile (20.5–25.8)		218 642	(32.8)	1.05	0.97–1.14	1.02	0.97–1.08	—	—
Highest tertile (25.9–47.1)		173 109	(25.9)	1.13	1.03–1.23	1.06	0.99–1.13	—	—
Immigrants, %	0.1				.01[f]		.01[f]		
Lowest tertile (0.2–1.3) (reference)		106 403	(15.9)	1.00	—	1.00	—	—	—
Middle tertile (1.3–4.8)		234 675	(35.2)	0.96	0.89–1.04	0.98	0.92–1.05	—	—
Highest tertile (4.9–61.8)		326 176	(48.9)	1.09	1.01–1.17	1.06	1.00–1.13	—	—
Mother born in another country, %	0.0				.02[f]		.03[f]		
Lowest tertile (0.0–1.9) (reference)		111 383	(16.7)	1.00	—	1.00	—	—	—
Middle tertile (2.0–8.1)		216 916	(32.5)	1.00	0.92–1.09	1.01	0.94–1.09	—	—
Highest tertile (8.2–88.1)		338 955	(50.8)	1.11	1.01–1.21	1.08	1.00–1.16	—	—
Unmarried mothers, %	0.0				.01[f]		NS[f]		
Lowest tertile (14.9–64.9) (reference)		315 619	(47.3)	1.00	—	1.00	—	—	—
Middle tertile (65.0–75.8)		230 812	(34.6)	0.90	0.84–0.97	0.94	0.90–0.99	—	—
Highest tertile (75.8–90.4)		120 823	(18.1)	1.01	0.94–1.09	0.99	0.94–1.05	—	—
Unmarried residents, %	0.0				.005[f]		.03[f]		.04[f]
Lowest tertile (43.9–58.2) (reference)		203 717	(30.5)	1.00	—	1.00	—	1.00	—
Middle tertile (58.3–61.6)		219 668	(32.9)	0.93	0.85–1.02	0.93	0.87–0.99	0.94	0.90–0.98
Highest tertile (61.7–86.0)		243 869	(36.5)	1.05	0.96–1.15	0.98	0.93–1.05	0.95	0.91–1.00[g]
Walking or biking to work, %	0.0				.008[f]		NS[f]		
Lowest tertile (2.4–6.8) (reference)		323 121	(48.4)	1.00	—	1.00	—	—	—
Middle tertile (6.8–10.2)		202 876	(30.4)	1.08	1.01–1.15	1.02	0.97–1.07	—	—
Highest tertile (10.3–64.0)		141 257	(21.2)	1.17	1.07–1.27	1.08	1.01–1.16	—	—
People with food insecurity, %	5.6				< .001[f]		< .001[f]		.001[f]
Lowest tertile (2.5–10.5) (reference)		222 636	(33.4)	1.00	—	1.00	—	1.00	—
Middle tertile (10.6–15.1)		238 685	(35.8)	1.13	1.05–1.22	1.08	1.01–1.15	1.05	1.01–1.11
Highest tertile (15.2–36.4)		205 933	(30.9)	1.25	1.16–1.34	1.14	1.07–1.21	1.09	1.05–1.15
Sedentariness, %	1.4				.001[f]		.005[f]		.05[f]
Lowest tertile (1.7–9.9) (reference)		215 997	(32.4)	1.00	—	1.00	—	1.00	—
Middle tertile (9.9–14.4)		209 287	(31.4)	1.10	1.03–1.18	1.06	1.01–1.12	1.03	0.98–1.07
Highest tertile (14.4–75.3)		241 970	(36.3)	1.20	1.11–1.29	1.11	1.05–1.18	1.07	1.01–1.11
≥ 5 alcohol drinks ≥ once per week, %	2.1				.01[f]		NS[f]		
Lowest tertile (0.0–6.9) (reference)		256 571	(38.5)	1.00	—	1.00	—	—	—
Middle tertile (6.9–9.7)		260 022	(39.0)	0.91	0.85–0.98	0.94	0.90–0.99	—	—
Highest tertile (9.7–20.9)		150 661	(22.6)	1.04	0.95–1.13	1.00	0.94–1.07	—	—

Continued on the following page

TABLE 3 (continued)
Crude and adjusted odds ratios for VSGA singleton live births according to ecological variables, Quebec, Canada, 2000–2008

Variable [a]	Percent imputed [b] %	Population		OR^{E}_{Crude} [c]		$OR^{E}_{AdjustedI}$ [d]		$OR^{E}_{AdjustedIE}$ [e]	
		N	(%)	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Mean age, years	0.0				.003[f]		.04[f]		
Lowest tertile (25.9–38.3) (reference)		264 998	(39.7)	1.00	—	1.00	—	—	—
Middle tertile (38.3–40.5)		246 054	(36.9)	0.99	0.91–1.07	0.98	0.93–1.04	—	—
Highest tertile (40.5–51.8)		156 202	(23.4)	1.10	1.02–1.20	1.05	0.98–1.12	—	—

Abbreviations: CI, confidence interval; NS, non significant; OR, odds ratio; VSGA, very small for gestational age.

Note: Confidence interval built using robust variance estimates resulting from a multilevel model fitted through generalized estimating equations.

[a] The interpretation of an ecological portrait as a proxy of the corresponding individual variable could be inappropriate.

[b] Percentage of local community services centres with imputed value.

[c] Crude odds ratio.

[d] Odds ratio adjusted for individual variables including interaction terms (mother's age, mother's marital status, mother's academic degree, mother's country of birth, mother's parity, academic degree × marital status, country of birth × age, country of birth × marital status, academic degree × country of birth, age × parity and academic degree × parity).

[e] Odds ratio adjusted for contextual variables (people with food insecurity and inactive people) and for individual variables including interaction terms.

[f] *p* value for test for global difference.

[g] Value < 1.0.

specific health outcome.[36] For this reason, sensitivity analyses were done on data pooled by sub-territories.

Mechanisms through which CLSC food insecurity could be associated with lower birth weight for gestational age include interpersonal factors, which have been shown to be consistently related to dietary behaviours in young people.[37] Higher pre-pregnancy weight in mothers, an unmeasured factor, could also lead to gestational diabetes.[38]

Residents from CLSCs with less sedentariness or inactivity are certainly globally healthier and have a lower incidence of chronic diseases and disabilities.[39] Mothers from these CLSCs have a better chance of being physically active themselves. Inactivity of residents might be as a result of the built environment encouraging (or otherwise) activity,[37,39,40] rather than the social environment doing so.[37] In addition, activity also reflects the global understanding of public health messages (people eating well, exercising, not smoking, etc.).[37] Results appear relevant for other countries with similar social welfare systems.

In this effort to enlarge the set of ecological determinants of fetal health, we incorporated data aggregated from a sophisticated Canadian survey with census and birth data to build diversified community-defined portraits. The use of portraits derived from a broad range of variables allowed for the identification of ecological associations between VSGA and marital status, food insecurity and sedentariness of residents. These ecological associations were not identified as ''contextual associations'' as mothers' food insecurity and sedentariness were not adjusted for in the analyses even though many other individual characteristics were.

Results of this study add to the growing body of evidence suggesting that ecological social processes affect fetal health. Future Canadian studies could benefit from the inclusion of information gathered by large surveys such as the CCHS to the narrow set of census data to depict and use details of neighbourhood contexts in a comprehensive approach.

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