Socio-economic inequalities in exposure to industrial air pollution emissions in Quebec public schools

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ABSTRACT

OBJECTIVES: We aimed to assess the relationships between deprivation at Quebec public schools, their proximity to polluting industries, and their exposure to industrial air emission sources including ambient fine particulate matter (PM_{2.5}), sulphur dioxide (SO₂) and nitrogen dioxide (NO₂).

METHODS: We obtained four indicators of school deprivation using data from the 2006 Canadian census called the low-income threshold indicator, the neighbourhood SES indicator, and the social and material deprivation indicators of Pampalon. Using proximity spatial tools, we constructed three buffers of 2.5, 5 and 7.5 km around each school and summed up total emissions of PM_{2.5}, SO₂ and NO₂ for each school. Industrial air emissions were estimated using data from the 2006 Canadian National Pollutant Release Inventory.

The Pearson correlations and LOESS regressions and natural log-transformed industrial air emissions were evaluated for Quebec public schools within the three buffers.

RESULTS: Of the 2189 public schools in Quebec, 608 (27.8%), 1108 (50.6%) and 1384 (63.2%) schools were located near at least one industry emitting one or more pollutants of interest in buffers of 2.5 km, 5 km and 7.5 km of schools respectively. Weak positive Pearson correlations (*r*) were found between log-transformed tons of industrial emissions of PM_{2.5}, SO₂ and NO₂ and both the social deprivation (*r* = {0.23; 0.33}) and low-income threshold (*r* = {0.17; 0.29}) indicators in a buffer of 2.5 km. However, we found negative associations between emissions and the neighbourhood SES (*r* = {0.06; 0.16}) and material deprivation (*r* = {-0.04; 0.08}) indicators.

CONCLUSION: Our study suggests that schools in Quebec with higher rates of socio-economic deprivation among their students may be more likely to be exposed to higher emissions of industrial air pollutants.

KEY WORDS: Air pollution; child; industry; school; social class

La traduction du résumé se trouve à la fin de l'article.

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Primary ambient air pollutants, namely particulate matter (PM_{2.5}), sulphur dioxide (SO₂) and nitrogen dioxide (NO₂), are largely emitted by anthropogenic sources such as vehicular traffic and industry.^{1–3} Exposure to ambient air pollution has been associated with a range of adverse health outcomes in children.^{1–3} Short-term (hours to days) exposure to PM_{2.5}, SO₂ and NO₂ has been associated with the exacerbation of existing respiratory conditions and symptoms (including asthma, pneumonia, bronchiolitis, decreased lung function) and with increases in emergency department visits and hospitalizations for respiratory diseases and symptoms in both healthy and asthmatic children.^{1–4} Longer-term (months to years) exposure to PM_{2.5}, SO₂ and NO₂ has been associated with the development of chronic respiratory diseases or conditions, including asthma and decreased lung function and growth.^{1–4} Recent studies also indicate adverse effects of air pollution on childhood neurodevelopment and cognition.⁵

Children are particularly vulnerable to the exposure to air pollution due to higher respiratory rates, larger lung-to-body size ratios, and more time spent outdoors than adults.⁴ Further, children's organs and immune systems are in a critical period of development and thus the health effects of exposure to air pollution may be stronger.⁴

Studies in Europe and North America found that children of lower socio-economic status (SES) are more likely to live in homes that are closer to vehicle traffic^{6,7} and industrial facilities,^{8,9} and also have higher exposures to ambient PM_{2.5}¹⁰ and NO₂.^{11–13} Children typically have less control over their living conditions, including their home or school location, which can result in involuntary exposure to environmental pollutants. Previous studies of children evaluating the associations between SES and exposure to air pollution have mainly focused on urban or traffic pollution sources near their homes. Quebec children spend at least 1080 hours per year at school and on school playgrounds,¹⁴ and any exposures in these environments may pose a risk to their

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health. Previous studies from Europe and North America indicate that socially deprived children may be more likely to be exposed to air pollution and its resulting health impacts, including acute and chronic respiratory and neurocognitive outcomes.^{5,15} Yet very few studies have evaluated school exposure to industrial-related air pollution⁹ or its association with levels of socio-economic deprivation. Moreover, no studies have evaluated correlations for varying indicators of socio-economic conditions of children.

We aimed to evaluate school exposure to industrial air emissions of PM_{2.5}, SO₂ and NO₂ in Quebec, Canada, and assess whether attending a school with higher deprivation is correlated with greater exposure to these pollutants. We compared our results using four different indicators of socio-economic deprivation. We conducted this study in Quebec because it has several major industrial sectors, including metal smelters, pulp and paper mills, and oil refineries, located in both urban and rural areas.¹⁶

METHODS

We obtained four indicators of socio-economic deprivation using data from the 2006 Canadian census. Using proximity spatial tools, we constructed three buffers, of 2.5 km, 5 km and 7.5 km respectively, around each Quebec public school and summed all reported industrial emissions of PM_{2.5}, SO₂ and NO₂ for each school and within each buffer. Industrial air emissions were estimated using data from the 2006 Canadian National Pollutant Release Inventory. We then evaluated the associations between industrial air emissions using the three buffers around the schools and the four deprivation indicators, using Pearson correlations and LOESS regressions. Finally, we conducted complementary analyses separating urban and rural schools and using deprivation indicators with categorical values.

School data and selection

We identified and geo-located 2385 public elementary and high schools in Quebec using the 2013 school database provided by the Ministry of Education. The database is published yearly and includes the six-digit postal codes of all public elementary and secondary schools in Quebec as well as their yearly enrolment. We excluded private schools, public schools with <30 students, and schools from school boards with a special status (Crie, Kativik and Littoral) because information for them with regard to low-income threshold and neighbourhood SES indicators was not available.¹⁷ We also excluded public schools in dissemination areas (DA) for which Pampalon indicators were not calculated for the respective DA due to small population size or collective households.¹⁸

Socio-economic deprivation of schools

Low-income Threshold Indicator

A yearly income-based indicator called the low-income threshold indicator ("*Seuil de Faible Revenu*", SFR)¹⁹ is obtained from the Ministry of Education for each Quebec public school. Calculation of the indicator is based on the percentage of families of each population unit living below or close to the low income cut-off (LICO). The LICO varies depending on the level of urbanicity (i.e., if the residential area is rural, urban with <30 000 inhabitants, or >500 000 inhabitants),²⁰ thus the indicator is useful by region and particularly for urban settings like Montreal where the LICOs do not vary. However, because of the regional variation of

low-income thresholds, it should be used carefully when pooling together all Quebec regions.²⁰

This metric was computed at the population unit level based on the income of the individuals living in that unit as reported in the 2006 Canadian Census. Population units are areas delimited by school boards of Quebec. They include at least 200 school children in 100 homes that have at least one school-aged child. They are based on a continuous territory in order to reflect the natural delimitation of household SES characteristics. SES at the population unit is intended to be representative of the family SES status for the largest number of children in each school.²¹ Each child is assigned the score of his or her population unit of residence and the scores of all children attending a school are averaged.²¹

Neighbourhood SES Indicator

The neighbourhood SES indicator is a combined employment and education-based measure ("*Indice de Milieu Socio-Économique*", IMSE)¹⁹ produced yearly by the Ministry of Education for each Quebec public school. Its calculation integrates the percentage of under-schooled mothers and the percentage of parents who are inactive on the employment market within each population unit.²⁰ The neighbourhood SES indicator allows for comparison of SES deprivation of schools between Quebec regions.²⁰

The continuous values of the low-income threshold and the neighbourhood SES indicators for each school are divided in deciles, and the Ministry of Education of Quebec classifies schools that fall into the 8th to 10th decile as deprived.²⁰ The calculation of these indicators relies on variables retrieved at the population unit scale. We retrieved indicators from the 2013–2014 academic year (based on 2006 Census data) for this study.

Material Deprivation of the Pampalon Indicator

Using Principal Component Analyses, three socio-economic variables are combined into the material indicator of Pampalon for each Census DA: 1) the proportion of people without a high school diploma, 2) the population/employment ratio, and 3) the average income.¹⁸ DAs are small geographic units comprised of one or more dissemination blocks with 400–700 persons on average.²² The Pampalon indicator at the Quebec province scale was used and its data were based on the 2006 Census data, which included all individuals >15 years of age.¹⁸

Social Deprivation of the Pampalon Indicator

This metric is an indicator based on three socio-economic variables for each DA: 1) the proportion of people living alone, 2) the proportion of individuals whose marital status is separated, divorced or widowed, and 3) the proportion of single-parent families.¹⁸ These variables are combined using Principal Component Analyses. Similar to the material deprivation indicator, the social deprivation at the Quebec province scale is used and its data is based on the 2006 Census data, which included all individuals >15 years of age.¹⁸

The continuous values of material and social deprivation are also categorized in quintiles, where the first quintile represents the least deprived population and the fifth quintile the most deprived. The categorization allows public health agencies and other organizations to more readily use and interpret the indicator.¹⁸ The material and social deprivation indicators rely on variables

calculated for Census DAs; each school was attributed the value of the indicators from the DA where they were located.

Industries and their emissions

We identified all industries in Quebec and neighbouring provinces (New Brunswick, Newfoundland and Labrador, and Ontario) that reported emissions of PM_{2.5}, SO₂ and NO₂ in the 2006 National Pollution Release Inventory (NPRI).²³ Industries were geo-located using their latitude and longitude coordinates in the North American Datum of 1983 (NAD1983). We did not restrict industries by pollution emissions or by the type of industrial activity.

Using the proximity spatial tools in ArcGIS, we formed three concentric buffers (2.5 km, 5 km and 7.5 km respectively) around the location of each public school and summed the yearly tons of PM_{2.5}, SO₂ and NO₂ emitted by all industries that were located within each of the three buffer areas. The chosen buffers were used in previous studies^{16,24} and are based on distances at which air monitoring stations have shown that ambient air pollution is influenced by local industrial emissions.²⁵

Statistical analysis

We conducted our analyses using a complete database of 2189 schools; 196 schools were excluded due to missing deprivation indicators. Summary statistics including the geometric mean, median, arithmetic mean, standard deviation (SD), first and third percentiles of PM_{2.5}, SO₂ and NO₂ emissions were generated for each school.

We evaluated the Pearson correlations between the four deprivation indicators using their continuous values. The relationships between continuous values of the four deprivation indicators and industrial air emissions of PM_{2.5}, SO₂ and NO₂ for the three buffer areas around each school were evaluated with Pearson and Spearman correlation analyses. For this analysis, tons of emissions were log (base 10)-transformed. Emissions equal to 0 were replaced by 10⁻⁵ and then log-transformed.

As sensitivity analyses, emissions equal to 0 were replaced by values smaller and greater than 10⁻⁵. In addition, the associations between SES deprivation and industrial air pollutant emissions were separately evaluated for urban and rural areas. Rural areas were defined based on the 2006 census and used in the development of the Pampalon indicators, whereas urban areas included large census metropolitan areas, other census metropolitan areas, and census agglomeration.

In addition, since the low-income threshold and the neighbourhood SES indicators are computed based on children enrolled at school for the year 2013–2014, we conducted sensitivity analyses where the relationships were also analyzed with emissions of PM_{2.5}, SO₂ and NO₂ from 2013.

Finally, Welch Two Sample *t*-tests were used to compare emission exposure in the three buffers of low and high SES deprived schools, based on the low-income threshold and the neighbourhood SES indicators. As the Pampalon indicators are divided in quintiles, ANOVA with Tukey's multiple range tests were run to compare the exposure to industrial air emissions in the three buffers, of the five levels of deprivation. All analyses were conducted in R (version 3.10; R Studio R Core Team 2014).

RESULTS

Using the low-income threshold and neighbourhood SES indicators, 620 (28.3%) and 827 (37.8%) Quebec public schools were considered "deprived" respectively. Using the material and social deprivation of Pampalon, 528 (24.1%) and 417 (19.0%) schools were considered highly deprived (i.e., in the highest quintile) respectively (Table 1), whereas an additional 517 (23.6%) and 457 (20.9%) schools, respectively, were considered moderately deprived (4th quintile).

Among the 2189 Quebec public schools included in our analyses, 1500 (68.5%) were located in urban areas (Table 1). In buffers of 2.5 km, 5 km and 7.5 km, 608 (27.8%), 1108 (50.6%) and 1384 (63.2%) schools respectively were located near at least one air pollution-emitting industry. Within a radius of 7.5 km, 57.1%, 52.6% and 41.3% of schools were exposed to PM_{2.5}, SO₂ and NO₂ respectively. Seventy-five percent of industries located within this 7.5 km radius emitted <50.38, 374.28 and 558.38 tons of PM_{2.5}, SO₂ and NO₂ respectively (Table 2).

Correlations between deprivation indicators

Measures from the low-income threshold indicator were weakly correlated with the neighbourhood SES (Pearson *r* = 0.48) and the social deprivation of Pampalon (*r* = 0.32) indicators (Table 3). The neighbourhood SES indicator measures were positively correlated with both Pampalon indicators, with a stronger relationship with material deprivation (*r* = 0.58) than with social deprivation (*r* = 0.12). We did not find a relationship between the low-income threshold and the material Pampalon indicator (*r* = 0.06), or between the material and social Pampalon indicators (*r* = -0.04).

Table 1. Characteristics of schools and their levels of deprivation according to four deprivation indicators (*n* = 2189)

Characteristics of schools	<i>n</i> (%)
Urban	1500 (68.5%)
Rural	689 (31.5%)
Elementary	1737 (79.4%)
High school	452 (20.6%)
Low-income threshold indicator*†	
Not deprived	1569 (71.7%)
Deprived	620 (28.3%)
Neighbourhood SES indicator*†	
Not deprived	1362 (62.2%)
Deprived	827 (37.8%)
Material deprivation indicator (Pampalon)*	
1‡	357 (16.3%)
2	383 (17.5%)
3	404 (18.5%)
4	517 (23.6%)
5§	528 (24.1%)
Social deprivation indicator (Pampalon)*	
1‡	378 (17.3%)
2	454 (20.7%)
3	483 (22.1%)
4	457 (20.9%)
5§	417 (19.0%)

* Data obtained from the 2006 Canadian census.

† Indicators attributed to schools by the Ministry of Education in 2013.

‡ Lower deprivation level (1st quintile).

§ Higher deprivation level (5th quintile).

Table 2. Industrial air emissions in buffers around schools

Estimated emissions (tons)*	Median	25 th –75 th percentiles	Geometric mean	Arithmetic mean (SD)	Schools exposed (n) (%)
Fine particles (PM _{2.5})					
2.5 km	0	0–0	3.17×10^{-4}	17.03 (105.00)	533 (24.3%)
5.0 km	0	0–15.81	7.62×10^{-3}	36.21 (131.45)	1003 (45.8%)
7.5 km	3.24	0–50.38	5.37×10^{-2}	73.67 (198.51)	1249 (57.1%)
Nitrogen dioxide (NO ₂)					
2.5 km	0	0–0	2.79×10^{-4}	65.19 (265.70)	449 (20.5%)
5.0 km	0	0–103.30	5.36×10^{-3}	188.30 (540.86)	830 (37.9%)
7.5 km	4.86	0–374.28	7.08×10^{-2}	376.32 (825.34)	1152 (52.6%)
Sulphur dioxide (SO ₂)					
2.5 km	0	0–0	1.63×10^{-4}	236.34 (1772.14)	357 (16.3%)
5.0 km	0	0–130.73	2.30×10^{-3}	582.19 (2410.79)	674 (30.8%)
7.5 km	0	0–558.38	1.84×10^{-2}	1113.53 (3067.29)	905 (41.3%)

* Data obtained from the 2006 National Pollutant Release Inventory.

Table 3. Pearson correlations (*r*) and 95% confidence intervals between measures from different deprivation indicators

	Neighbourhood SES indicator*†	Material deprivation indicator (Pampalon)*	Social deprivation indicator (Pampalon)*
Low-income threshold indicator*†	0.48 (0.45, 0.51)	0.06 (0.02, 0.11)	0.32 (0.28, 0.35)
Neighbourhood SES indicator*†	–	0.58 (0.56, 0.61)	0.12 (0.08, 0.16)
Material deprivation indicator (Pampalon)*	–	–	–0.04 (–0.08, 0.01)

* Data obtained from the 2006 Canadian census.

† Indicators attributed to schools by the Ministry of Education in 2013.

Correlations between industrial emissions and school deprivation indicators

We found positive correlations between industrial air emissions of PM_{2.5}, SO₂ and NO₂ using buffers of 2.5 km and the low-income threshold indicator ($r = 0.25$, 95% CI: 0.21, 0.29; $r = 0.24$, 95% CI: 0.20, 0.28; and $r = 0.21$, 95% CI: 0.17, 0.25 respectively) as well as the Pampalon social indicator ($r = 0.27$, 95% CI: 0.23, 0.31; $r = 0.28$, 95% CI: 0.24, 0.31; and $r = 0.29$, 95% CI: 0.25, 0.33 respectively) (Figure 1). Similar correlations were found using buffers of 5 and 7.5 km (See Supplementary Figures S1–S3 in ARTICLE TOOLS section on journal site). However, associations were not consistent for all three buffers between neighbourhood SES or Pampalon material indicators and emissions of PM_{2.5}, SO₂ and NO₂, with positive associations in a buffer of 2.5 km and negative associations in a buffer of 7.5 km around schools. We found similar relationships between deprivation indicators and 2013 emissions of PM_{2.5}, SO₂ and NO₂ in all three buffers (results not shown).

Complementary results from the Welch Two Sample *t*-tests supported differences in exposure to industrial emissions between deprived and not deprived schools (See Supplemental Material, Tables S3–S4) using the low-income threshold and neighbourhood SES indicators. ANOVA and Tuckey's tests also supported differences in exposure to industrial emissions between schools using the quintiles of the social and material indicators of Pampalon (See Supplemental Material, Tables S5–S6).

In urban areas, we found positive associations between low-income threshold, Pampalon (social) and neighbourhood SES indicators and industrial air emissions of PM_{2.5}, NO₂ and SO₂ in all three buffers (See Supplemental Material, Table S1). No association

was found with the material deprivation of the Pampalon indicator in urban areas. In rural areas, no associations were found between air pollution and the low-income threshold, neighbourhood SES, or the Pampalon material indicators in any of the buffers (See Supplemental Material, Table S2). However, we found a positive trend between the social deprivation of the Pampalon indicator and emissions of PM_{2.5}, NO₂ and SO₂ in all three buffers in rural areas.

DISCUSSION

In previous studies of social-environmental inequities, individual deprivation was assessed with various indicators, including poverty status, ethnicity,^{8,11,13,26} employment, education,^{6,27} or enrolment in reduced-fee meal plan programs.^{7,28} We found a weak or no correlation among the composite deprivation indicators used in this study, implying that deprivation metrics rely considerably on the information and variables chosen to build the indicators, and that it may be important to evaluate numerous indicators of social deprivation. Our indicators included variables related to either social or economic disadvantages. Chan et al. (2015) developed a new indicator for Canada that includes variables related to social advantages, cultural identity, material ownership and economic status. This indicator may better capture the prevalence of health outcomes related to deprivation and the authors suggested it could be used in future research involving exposure to air pollution.²⁹

We found weak but positive associations between multiple metrics of school deprivation and school exposure to industrial emissions of PM_{2.5}, SO₂ and NO₂. Our results are consistent with previous studies conducted in Europe and North America showing socio-economic inequities in the proximity of homes to industry.^{8,9}

Figure 1. Relations between log₁₀-industrial air pollutant emissions of PM_{2.5}, NO₂ and SO₂ within buffers of 2.5 km around schools and deprivation indicators. Pearson's correlation coefficients and their 95% confidence intervals are presented on the upper-left of the graphs. The figure also presents locally weighted scatterplot smoothings (LOESS) (span = 1.0)

and roadway traffic.^{6,7,9,26,28} They are also consistent with studies conducted in Europe, the United States and Canada that observed socio-economic inequities in both measured³⁰ and modeled^{13,15,27,31} exposure to air pollutants (NO₂, PM₁₀, PM_{2.5} and SO₂) at children's homes^{11,13,15,27,30,31} and schools.^{12,28}

We found inconsistent associations between deprivation and exposure to industrial air emissions using the neighbourhood SES and Pampalon (material) indicators among the three buffers. This may be due to the variables used to construct the indicators; these two indicators use the education level and may capture social dimensions excluded by the other indicators.

We found associations between industrial emissions and deprivation in urban but not in rural areas. This may be related to the characteristics of populations of rural population units, which may be more heterogeneous than those of urban areas. Rural populations may choose their home locations based on factors other than its proximity to different emissions sources. Further, there are more housing options and choices in urban areas such that people can more easily select into neighbourhoods that are farther from industry.

Limitations of the study

Our study is subject to a number of limitations to be considered in future studies on this topic. First, the NPRI database collects and tracks yearly emissions of 300 substances or groups of substances released in one or more of the air, water and land substrates³² from facilities exceeding the 20 000 hours employee threshold and facilities with a special status that are obliged to report their emissions. Other facilities are only encouraged to report their emissions voluntarily. Therefore there is a lack of information on "small" facilities and on daily emissions. Annual emissions that would be based on daily estimates would be more accurate. Moreover, self-reported emissions are not measured but rather estimated using mathematical algorithms resulting in multiple biases. Indeed, Brand et al. (2016) reported poor correlations between reported emissions and measurements of pollutants in Quebec.¹⁶

In addition, we did not consider emissions from other sources such as wood stove burning, traffic, or natural sources like dust. We instead limited the scope to industrial emissions for which we had publicly available information that could be geo-located with

school location. Important limitations also relate to the proxy measure of exposure used in this study. Industrial emissions are only rough proxy measures of students' exposure while at school. Emissions are influenced by environmental factors, including meteorological conditions, topology, and height of the chimney stack, and thus are imperfect surrogates for outdoor ambient pollution concentrations. Further, outdoor concentrations are themselves only surrogates for indoor school exposure. Children are exposed to both outdoor and indoor air pollution concentrations while at school. Further, environmental factors that may vary across Quebec and also influence industry-related air pollution concentrations and resulting exposures include topography, wind speed, wind direction and temperature; we did not account for these in this study.³³ Though 91.8% of Quebec schools were included in our analysis, our exclusion of public schools, smaller schools and schools from boards with special status may limit the generalizability of the results. Finally, our analysis relies on ecologic information; we did not use individual deprivation and exposure data, which could result in biased associations. For example: 1) populations of the DAs may not adequately represent the socio-economic status of children attending schools, and 2) schools' coverage areas may vary depending on their size and geographical localization (especially between rural and dense metropolitan areas).

CONCLUSION

To our knowledge, this is the first study to evaluate the associations between school exposure to industrial emissions of PM_{2.5}, SO₂ and NO₂, and whether these associations varied by level of SES deprivation. We found weak but positive correlations when using deprivation indicators calculated based on the geographical location of schools or the neighbourhood of residence of children attending the schools. Our study provides information on possible industrial exposure at school, which has been little studied. Given that children are a particularly vulnerable subgroup with regards to the health impacts of environmental exposures, including industry-related emissions, this study is of interest to researchers and policy-makers in both the environmental health and environmental justice communities. Future assessments could benefit from more detailed and recent measures of exposure to industrial air pollutant emissions and meticulous choice of deprivation variables and indicators.

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RÉSUMÉ

OBJECTIFS : L'objectif de cette étude était d'explorer la relation entre le niveau de défavorisation des écoles publiques québécoises, leur proximité aux sources industrielles et leur exposition aux émissions industrielles de particules fines (PM_{2,5}), de dioxyde de soufre (SO₂) et d'oxydes d'azote (NO_x).

MÉTHODES : L'indice de faible revenu (SFR), l'indice de milieu socio-économique (IMSE) et les indices de défavorisation sociale et matérielle de Pampalon, basés sur le recensement de 2006, ont été utilisés. Des cercles de rayons de 2,5 km, 5 km et 7,5 km ont été construits autour des écoles. En utilisant l'Inventaire national de rejets de polluants, les émissions industrielles de PM_{2,5}, SO₂ et NO₂ de l'année 2006 ont été sommées dans chaque rayon.

Les relations entre les émissions industrielles log-transformées et la défavorisation ont été évaluées pour les écoles en utilisant des corrélations de Pearson et des régressions LOESS.

RÉSULTATS : Des 2189 écoles incluses dans cette étude, 608 (27,8 %), 1108 (50,6 %) et 1384 (63,2 %) étaient localisées à proximité d'au moins une industrie émettrice d'un ou plusieurs polluants d'intérêt dans un rayon de 2,5 km, 5 km et 7,5 km autour des écoles, respectivement. Des corrélations de Pearson (*r*) positives ont été notées entre les tonnes d'émissions industrielles log-transformées de PM_{2,5}, SO₂ et NO₂ et l'indice de défavorisation sociale de Pampalon (*r* = {0,23; 0,33}) et le SFR (*r* = {0,17; 0,29}) dans un rayon de 2,5 km. Cependant des corrélations contre-intuitives ont été observées avec l'IMSE (*r* = {0,06; 0,16}) et l'indice de défavorisation matérielle de Pampalon (*r* = {-0,04; 0,08}).

CONCLUSION : Cette étude suggère que les écoles québécoises plus défavorisées pourraient être davantage exposées aux émissions industrielles de polluants de l'air que les autres.

MOTS-CLÉS : école; enfant; industrie; statut socio-économique; pollution de l'air